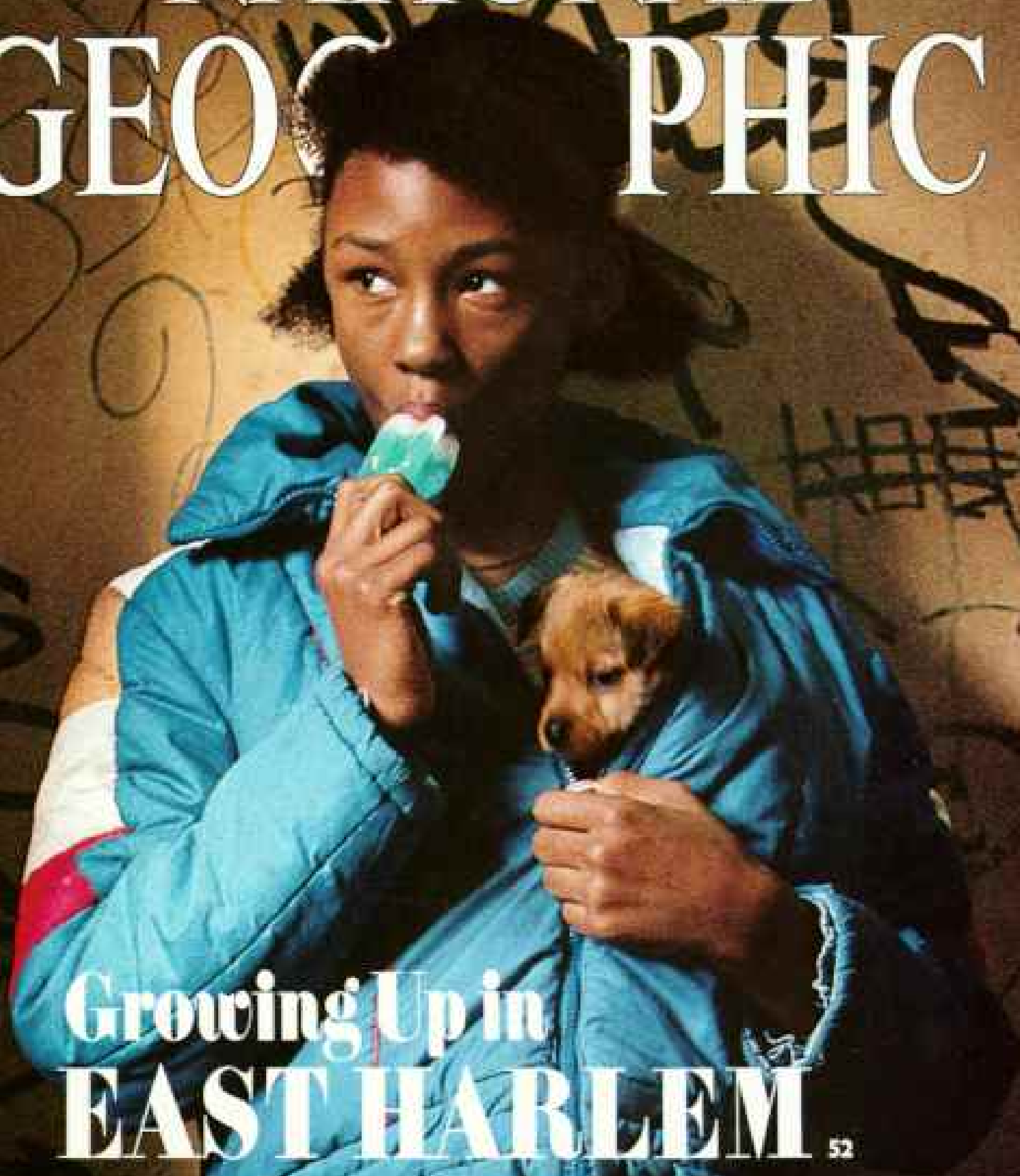


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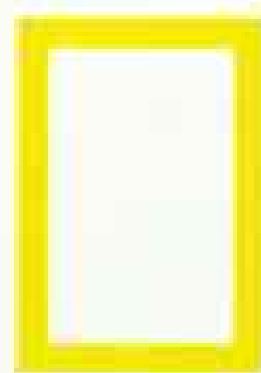
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BREAKFAST IN NGORONGORO CRATER

## Africa's Great Rift 2

*Slashing from the Red Sea to Mozambique, an immense system of faults cuts deep across the face of East Africa, creating a landscape of extremes. Limnologist Curt Stager reports on varied environments in this geologically active area. Photographs by Chris Johns.*



LAKE MALAWI FISH COLLECTOR

## The Living Jewels of Lake Malawi 42

*Southernmost of the great lakes of Africa's rift system, Malawi boasts more fish species than any other lake in the world. Ichthyologist Peter Reinthal and photographer Bill Curtsinger document the bizarre life-styles of unique and colorful species.*

## Growing Up in East Harlem 52

*Amid the poverty and epidemic drug use of New York City's el barrio—Spanish Harlem—Jere Van Dyk discovers a stubborn streak of optimism. Photographs by Joseph Rodriguez.*



AT HOME IN EAST HARLEM

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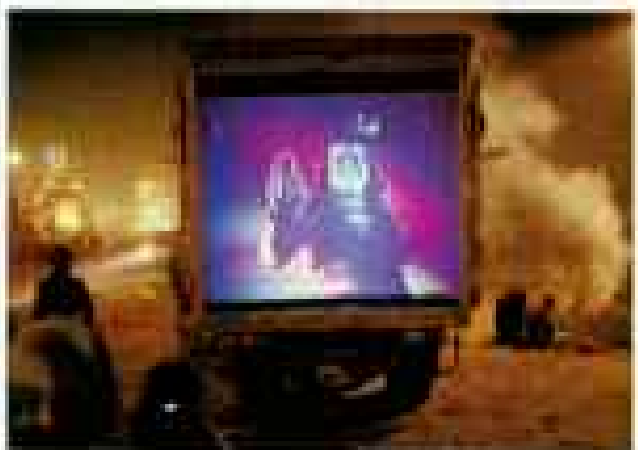
*Sixty-three people died in last October's catastrophe, and more than 28,000 buildings were damaged or destroyed. But the quake released only a sixtieth the energy of that in 1906, and Californians ponder what may lie ahead. Thomas Y. Canby examines the lessons offered, including prediction and the building of safer structures.*



SAFETY CRUIZ AFTER THE QUAKE

## Sacred Space, Sacred Time: India's Maha Kumbh Mela 106

*At a time determined by astrologers, about once every 12 years, millions of Hindus throng to the confluence of the Ganges and the Yamuna Rivers for India's largest religious festival. Writer-photographer Tony Heiderer witnesses this ritual of purification, the largest periodic gathering of people on our planet.*



VIDEO VAN IN INDIA

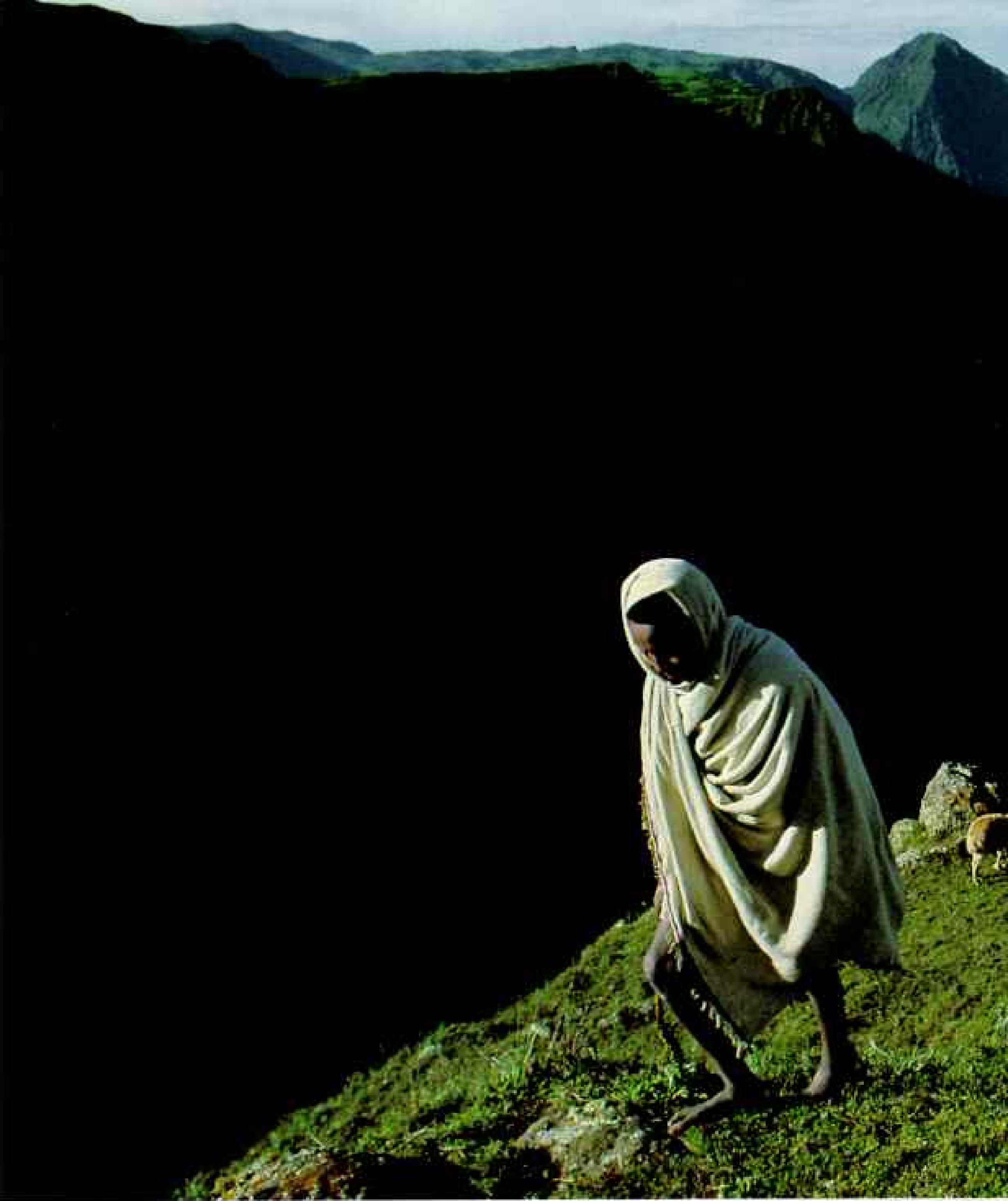
## Searching for India: Along the Grand Trunk Road 118

*The highway built by the British in the mid-1800s from Calcutta to Peshawar follows a route laid down over the centuries. Like Rudyard Kipling, who earlier traveled this way, Harvey Arden encounters "all castes and kinds of men." Photographs by Raghbir Singh.*



HINDU FESTIVAL SHOPPING EXCURSION

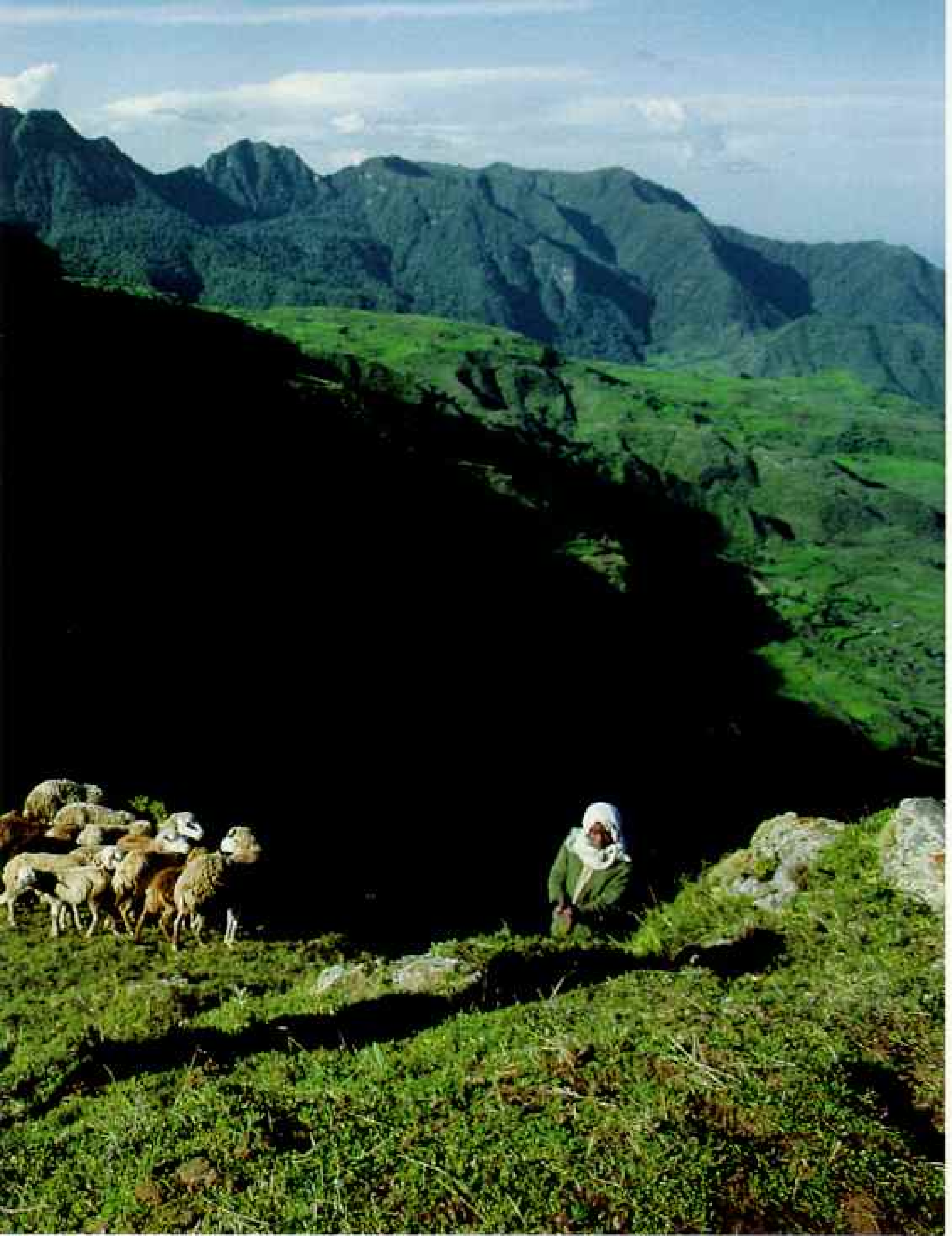
*COVER: Savoring a frozen treat, a young girl pauses in a hallway in New York City's East Harlem, where childhood passes quickly amid shadows of poverty and drugs. Photograph by Joseph Rodriguez.*



*With a precarious toehold on survival, Ethiopian shepherds near Ankober*

# AFRICA'S

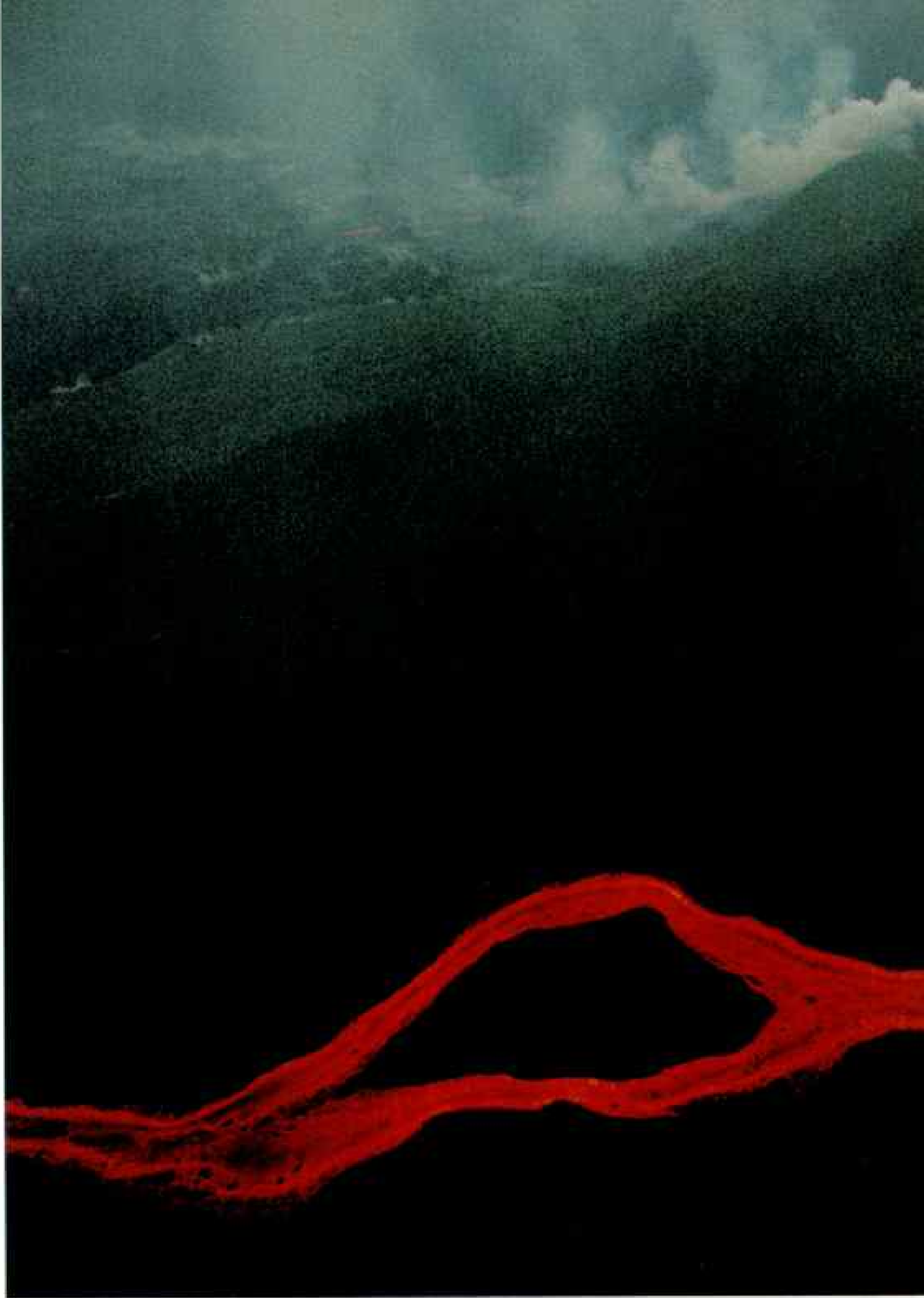
By CURT STAGER    Photographs by CHRIS JOHNS



*move flocks across highlands shaped by earth's elemental forces of uplift, volcanism, and faulting.*

# GREAT RIFT





*"IT SOUNDED like a freight train rumbling through a thunderstorm," recalls photographer Chris Johns, who witnessed this active fissure spewing fountains of lava and molten rivers 30 meters across in the Virunga Mountains of Zaire in May 1989. Such violent eruptions are a by-product*



*of the rifting that has been ripping eastern Africa apart for millions of years. Today the East African Rift System is one of the planet's most complex, conspicuous features—and one with a surprisingly long and complex human history.*

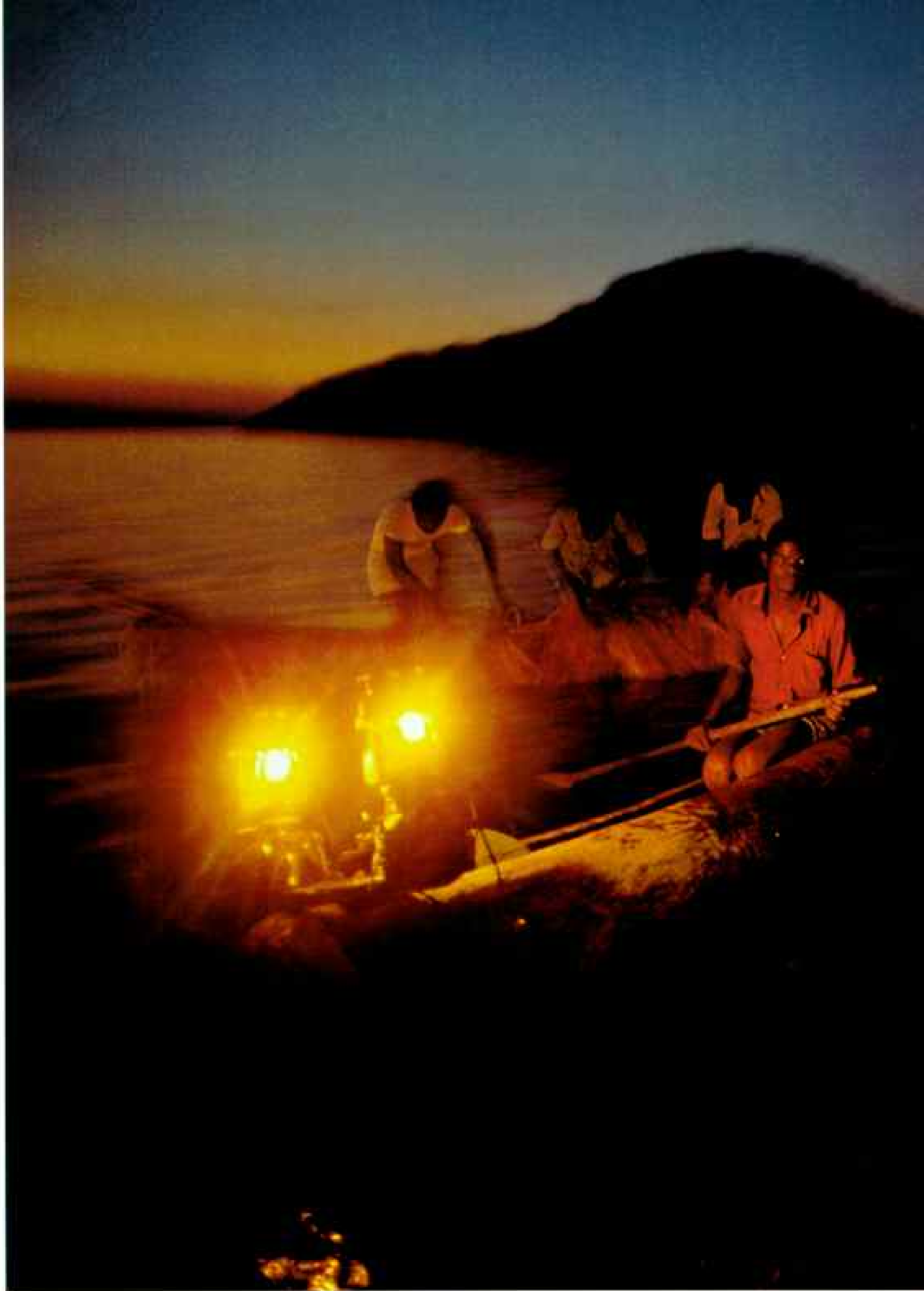


*SCORCHING SUN* casts long shadows as camels cross the salt flats of Lake Assal, Djibouti, one of the lowest places on earth at 156 meters (512 feet) below sea level. It is also one of the hottest—summer temperatures reach 57°C (135°F). Coastal ridges keep the sea from

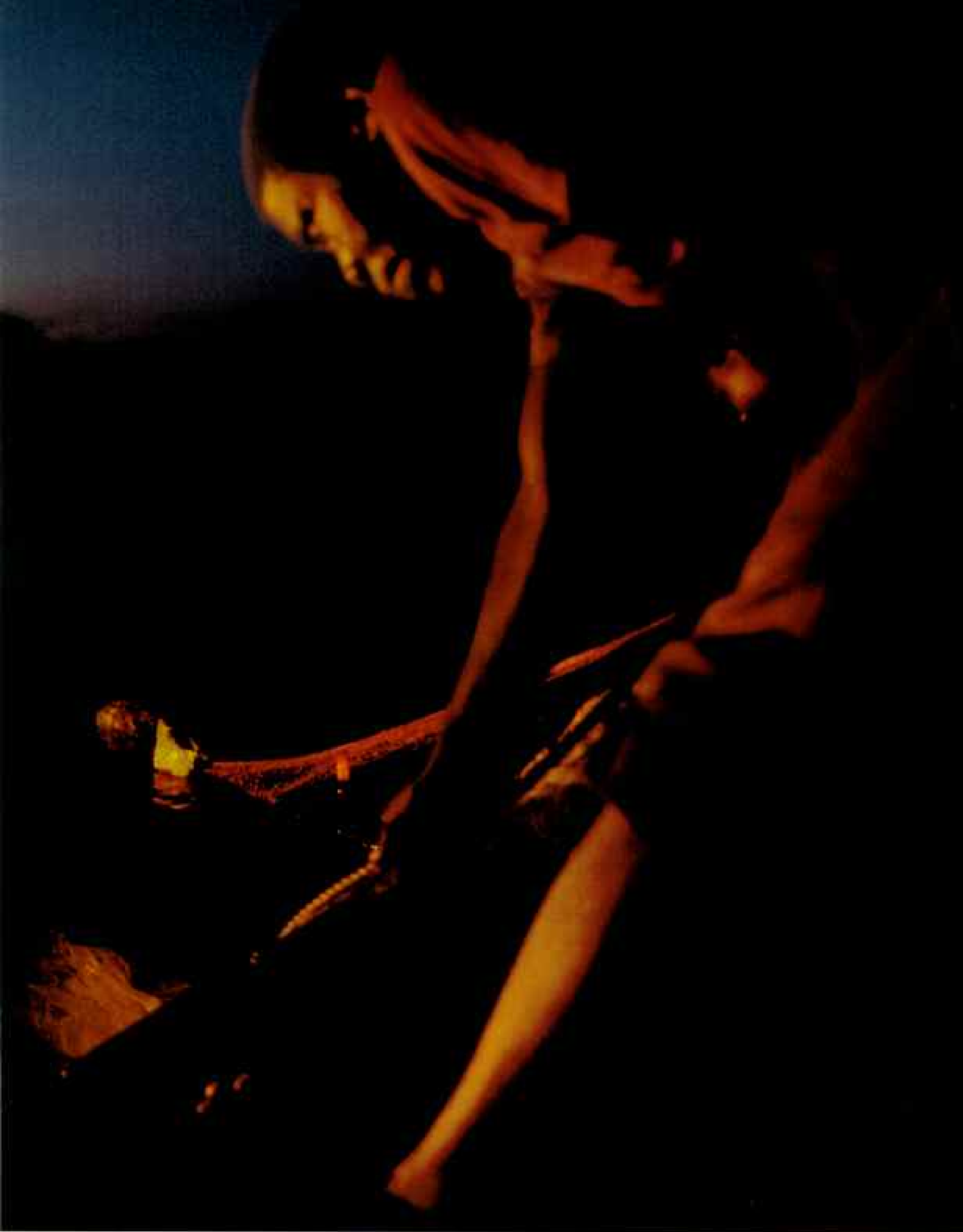


*flooding depressions in the Afar Triangle. Here the north end of the rift system joins related rift zones under the Red Sea and the Gulf of Aden. Even in the torrid basin, nomads find water and eke out a living, raising goats, sheep, and camels.*





*USING LIGHT AS A LURE, fishermen off Cape Maclear at the southern end of Lake Malawi attract sardine-like usipa to their nets. Sun-dried on the shore, the fish are sold throughout Malawi, providing the main protein for a nation of nearly nine million. Typical of the*



*lakes in the western branch of the rift, Lake Malawi formed in a trough opened by faulting. The depth of sediments in the lake's northern end suggests a life span of nearly 20 million years. The steep shore and the distant island are both granite formed before rifting began.*

**T**HE ROAD HAS RISEN swiftly as we leave Nakuru, a town that sits just south of the Equator in Kenya. Now, as we drive beneath cool gray rain clouds, we pass the lush tea plantations of Kenya's colonial past. Abruptly the clouds break, and before our windshield the red earth drops away. A gash 700 meters (2,300 feet) deep and 16 kilometers (ten miles) across—an offshoot of Africa's Great Rift—lies before us. Far to the left, stretching beyond the horizon, I see a glimmering expanse of water—Lake Victoria.

In earlier days, at my laboratory at Duke University, this lake had conjured up visions. Of Ptolemy and his Mountains of the Moon. Of Burton and Speke and their quest for the source of the Nile. Even of Bogart and Hepburn and their odyssey with the *African Queen*. But first and foremost Lake Victoria had evoked mud.

This is because I too am an explorer—of time and of change. I specialize in reading the history written in lake sediments. For eight years I have studied the great lakes in East Africa: Tanganyika, Turkana, Malawi. Until now all I have seen of Victoria is the samples of her muddy floor that were collected by my thesis adviser, Daniel A. Livingstone.

Those samples yielded a surprise. The fossil algae and snails in the mud suggested to me that 13,500 years ago this, the third largest lake in the world, had dried out. In fact, there have been several Lake Victorias. They come and go with changing climates and with the violent earth movements that shape this part of Africa.

Now I have been sent to Africa to explore not just this lake but the entire rift system around it.

I reach the edge of the lake at Kisumu and am tempted to wade in. But I stop short. There, clinging to the water weeds, are snails much like those whose fossils told me the lake had shriveled up. Today descendants of those mollusks carry worms that cause schistosomiasis, or bilharzia, a widespread and debilitating disease.

So much for the fantasy of immersing

---

CURT STAGER, a biology professor at Paul Smith's College in New York State, wrote "Silent Death from Cameroon's Killer Lake," in the September 1987 issue.

myself in the lake once sought as the source of the Nile. The Great Rift has been rigorous enough to travel. And I am only midway through my journey.

Visitors to Kenya know the rift as the breathtaking escarpments they pass on safari. Few realize it is actually an immense series of cracks in the face of the continent that runs 5,600 kilometers, from the Red Sea south to Mozambique. Enormous troughs—in places 90 kilometers across and nearly two kilometers deep—have formed along those cracks.

Here in central Africa the rift has two branches. The eastern bisects Kenya and skirts both Kilimanjaro and the Serengeti Plain in Tanzania. The western rift cleaves the heart of Africa, cupping a great chain of lakes. The rifting earth lifts the Ruwenzori Massif and stokes the volcanic fires of the Virunga Mountains, home to the endangered mountain gorilla. Lake Victoria sits atop a plateau between the two branches.

Rifting also generated the highlands of Ethiopia and the Afar desert. It was there I began my journey.

**H**OW DIFFERENT the shriveling lake known as Assal is from Victoria. As different as the cool Kenya Highlands are from the hellish, brooding landscape we are traversing here in Djibouti, a tiny but strategic country in the Horn of Africa. Djibouti guards the channel between the Red Sea and the Gulf of Aden.

Photographer Chris Johns and I head for Lake Assal. We leave the capital, Djibouti, at dawn. The humid air is already 37°C (100°F). Few visitors venture far from the white-washed minarets and colonial storefronts of the port. The land is harsh beyond belief. Even withered thornbushes struggle to survive on black lava ridges.

Why am I here, I wonder, as the heat sears my nostrils. Because, I tell myself, this is where the East African Rift System begins.

Scientists trace the system much farther north—a related fissure runs up through the Red Sea to connect with a major fault running through the Dead Sea all the way to Turkey. A third fissure, underlying the Gulf of Aden, branches away from the rift here in the Horn of Africa. This junction of the three systems is named the Afar Triangle, after the Afar nomads who live here.



# The East African Rift System

Slashing the eastern side of Africa for 5,600 kilometers (3,500 miles), the Great Rift furrows north from Mozambique, affecting the lands and lives of a dozen nations. Here the stretching earth has created such spectacular features as the Ethiopian Highlands, bold escarpments, and dramatic valleys.

For reasons unclear, the system divides into two branches. Deep lakes trace the curving course of the western branch. When rifting opened the basin that is Lake Tanganyika, it changed the course of ancient rivers and created an abyss that filled with water to a depth second only to Siberia's Lake Baikal. The route of the eastern branch, including the Gregory Rift—named for 19th-century Scottish explorer John W. Gregory—is traced by shallow alkaline lakes, and volcanoes such as Kilimanjaro, Africa's highest peak. In the north, the rift strikes through Ethiopia into the Afar Triangle. Both branches suffer frequent earthquakes.

In some rift valleys, layers of sediments and protective volcanic ash have helped preserve hominid fossils going back perhaps four million years. Key records of human ancestry have been found along the Awash and Omo Rivers of Ethiopia, at Lake Turkana in Kenya, and Olduvai Gorge and Laetoli in Tanzania.

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# Is Africa breaking apart?

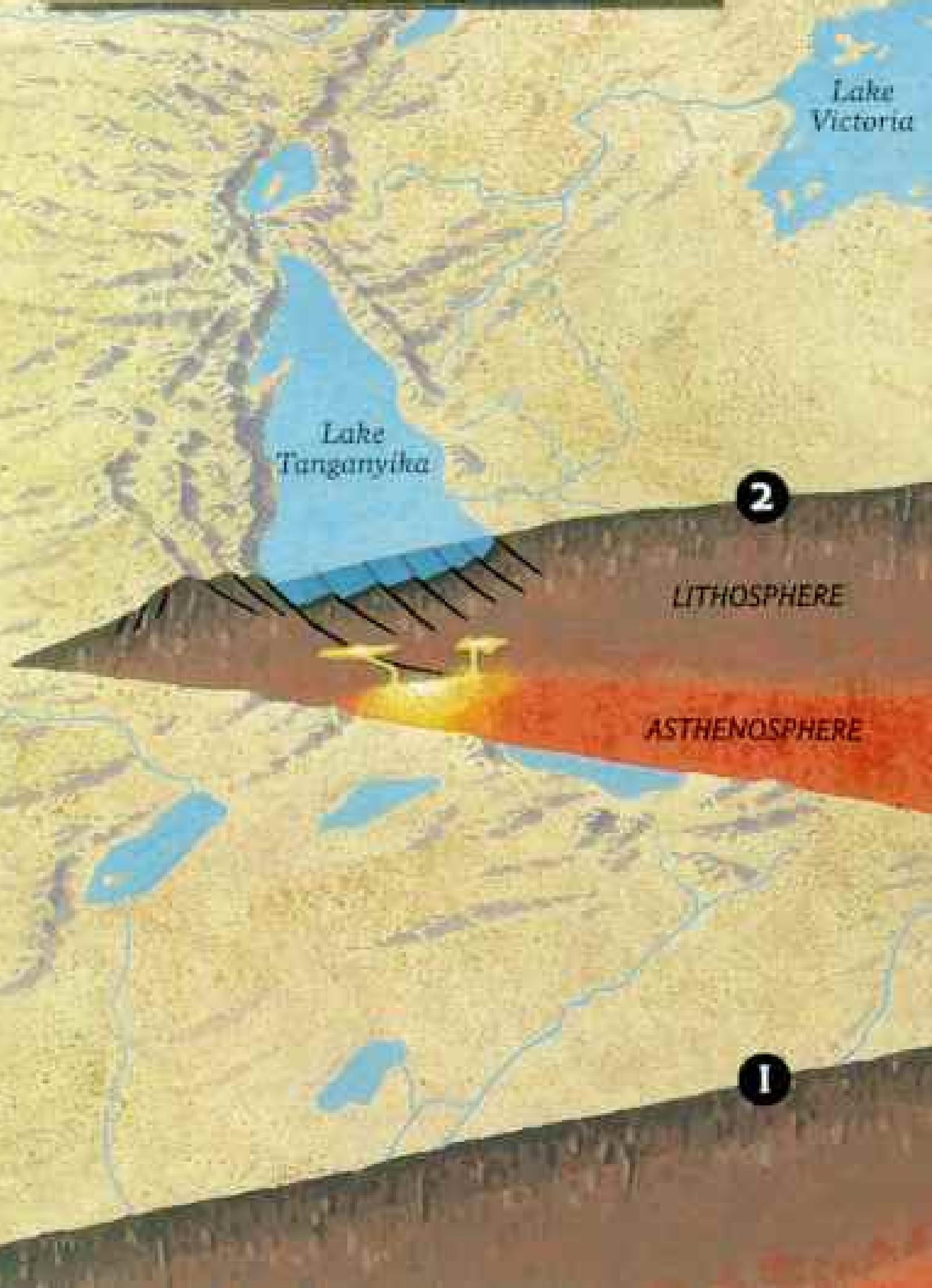
The East African Rift System affirms the theory of plate tectonics, which describes earth's crust as broken into great mobile rafts of lithosphere. On these plates the granitic continents ride, surrounded by basaltic ocean floor.

In some areas of the globe one plate plunges beneath another in a process called subduction. Where plates are moving apart, as under the Red Sea and the Gulf of Aden, hot magma from the asthenosphere rises, attaching itself to the departing edges.

Fueled by ultrahot upwelling from the asthenosphere, the continent thins and stretches and domes arise, creating the high elevations of Kenya and Ethiopia. Vast outpourings of lava coat the land. Eventually, faults fracture the crust, and segments of the rift tilt in opposing directions, as seen in the painted cross sections at right.

The Afar Triangle serves as a key to the future. If it continues to crack open during future millennia, the nascent Somali plate will break away. If, on the other hand, crustal thinning and stretching ceases here, plate separation will stop and the plates will move in other directions.

PAINTING BY PIERRE MATHI;  
NETWORK BASED ON DATA FROM BRUCE B. ROSENBERG,  
ROSENSTIEL SCHOOL OF MARINE AND ATMOSPHERIC  
SCIENCE, UNIVERSITY OF MIAMI; VOLCANIC DATA FROM  
SMITHSONIAN INSTITUTION



# RED SEA

5

5 Active seafloor spreading occurs under the Red Sea as upwelling magma from the asthenosphere fills the void left by separating plates. In the adjacent Afar Triangle similar spreading is visible on dry land.

4

4 Magma plumes penetrate through the lithosphere and reach the surface as volcanoes or lava flows — rifting is very active here. Huge flows have been so common in the Ethiopian Highlands over the millennia that they conceal the floor of the rift, burying clues to earlier activity.

3

3 Magma chambers reaching into the crust have fed several volcanic centers at Lake Turkana. This cross section shows that the crust is thinning and rifting is more active.

2 Lake Tanganyika is a deeper trough than Lake Malawi. Either rifting has been occurring here longer or faster or both. Sediments extend 5,000 meters deep.

1 Lake Malawi evidences only slight stretching and is thus probably the youngest part of the rift. The lithosphere—the crust and top of the upper mantle—has thinned but is still at least 100 kilometers thick.

Will a new ocean slice its way through the northeast shoulder of Africa? Many scientists say yes. Alfred Wegener, early proponent of continental drift, noted how the Afar Triangle spoiled the symmetry of the Red Sea's parallel

coasts: "If one cuts this triangle out, the opposite corner of Arabia fits perfectly into the gap." In the 1960s scientists recognized the Afar as an extension of the Red Sea spreading center. Some 30 million years ago Africa and the

Arabian Peninsula were part of the same plate (below, far left). If rifting splits the Afar Triangle, the crust may open farther south millions of years from now. The Somali plate will drift away, as Madagascar did 165 million years ago.

30 million years before present

7 million years before present

30 million years in the future

Present-day shoreline shown above left.

Lake Malawi



For some 25 to 30 million years the Afar Triangle has seethed with volcanism. Scientists know that two of the rifts that converge here—those creating the Red Sea and the Gulf of Aden—are active spreading centers. They are like the Mid-Atlantic Ridge, where oozing magma creates new seafloor as the Eurasian, African, and American plates move apart. The spreading centers that lie off the Horn of Africa, however, extrude their new crust as the Arabian plate moves away from Africa and collides into Eurasia (painting, previous pages).

Usually these processes occur under the ocean. And indeed part of the Afar is below sea level. However, coastal mountains, the Danakil Alps, seal off this part of the Afar from the waters of the Red Sea. Thus Djibouti offers the unusual phenomenon of oceanic crust being extruded as dry land. "As such Djibouti is Africa's fastest growing nation," observes local geologist Anis Abdallah. "We are expanding several centimeters a decade."

Our trip to Lake Assal offers a rare glimpse of earth's crust being formed.

We meet Bruce Kinser, a thick-bodied oil driller from east Texas, at a government geothermal project outside Djibouti. Steam roars deafeningly through a well that may one day provide electric power for the country.

"The earth steams here because magma is so close to the surface," he says. "Seawater from the Gulf of Aden leaks down, then boils up through vents." The earth's crust here is thin—perhaps only 25 kilometers thick.

In Kinser's truck we bounce down a valley strewn with boulders toward Lake Assal, 156 meters below sea level. As we drive along the tortured black cliffs, Kinser says, pointing to a congealed flow of lava, "This land's only ten years old." The day now seems hot enough to remelt it.

We pause by a long black fissure. A decade ago 800 earthquakes shook this area. Then several square miles of lava oozed forth. Volcanologists rushed here to witness the rare event. Iceland is the only other site where scientists can observe seafloor spreading on dry land as two plates move apart.

Far below us, nearly smothered in desert haze, lies Lake Assal. At my feet I notice white flecks among the rocks. They are snail shells. Freshwater snails, miles from the nearest fresh water. This must have been the shoreline of Lake Assal 5,000 to 10,000 years ago, when a wetter climate swelled tropical lakes. Perhaps there were even lush forests in this most desolate spot.

We reach the water's edge, and the depression has become a furnace. My thermometer, good for 50°C, has gone off its scale. The heat bakes us on all sides, so evenly that I cannot tell where the sun is without looking.

**L**AKE ASSAL can exist in such fierce heat only because seawater constantly percolates into the depression. Evaporating rapidly, it leaves salt everywhere. In the clear shallows it drifts like fine snow. Salt cauliflowers knobble the shoreline.

For centuries these deposits have drawn the Afar nomads. They pile their camels high with salt, which they then sell to the tribes of the Ethiopian Highlands to the south.

"How do the nomads do it?" wonders Chris. "The average human couldn't survive here, let alone work."

The Afar are a tough, resourceful, and fiercely independent people who nurture their reputation for collecting human testicles as trophies. Freely wandering across the Ethiopian border, they share Djibouti's back country with another nomadic group, the Issas of neighboring Somalia. Despite the geologic violence, Djibouti is a pocket of calm between the wars and famines of its neighbors. In fact most of the inhabitants of the capital's shantytown are refugees from these continuing crises.

Heading back to town, we stop to watch the sun set through the yellow haze. An old man in a ragged tunic appears across the road. He stares. I think he is an Afar, because his gray beard lacks the orange stain more popular among the Issas. His double-edged dagger is also Afar. We face each other wordlessly. A young foreigner (Continued on page 20)

*EARTH GAPPED OPEN in 1978 beside these volcanic cones along the inlet called Ghoubet Kharab—"the devil's throat"—in Djibouti. The fracture continues to widen today and draws geologists to one of the few sites on land where they can see a new ocean in the making. If rifting continues, the region may eventually become submerged.*









*LIKE A RIDGETOP CITADEL, a mosque dominates Adi Cateh, a farm village in Ethiopia's northernmost province of Eritrea, where a rebel movement seeks independence. Villagers, both Muslims and Christians, till nearby fields of wheat, lentils, linseed, peas, and beans.*

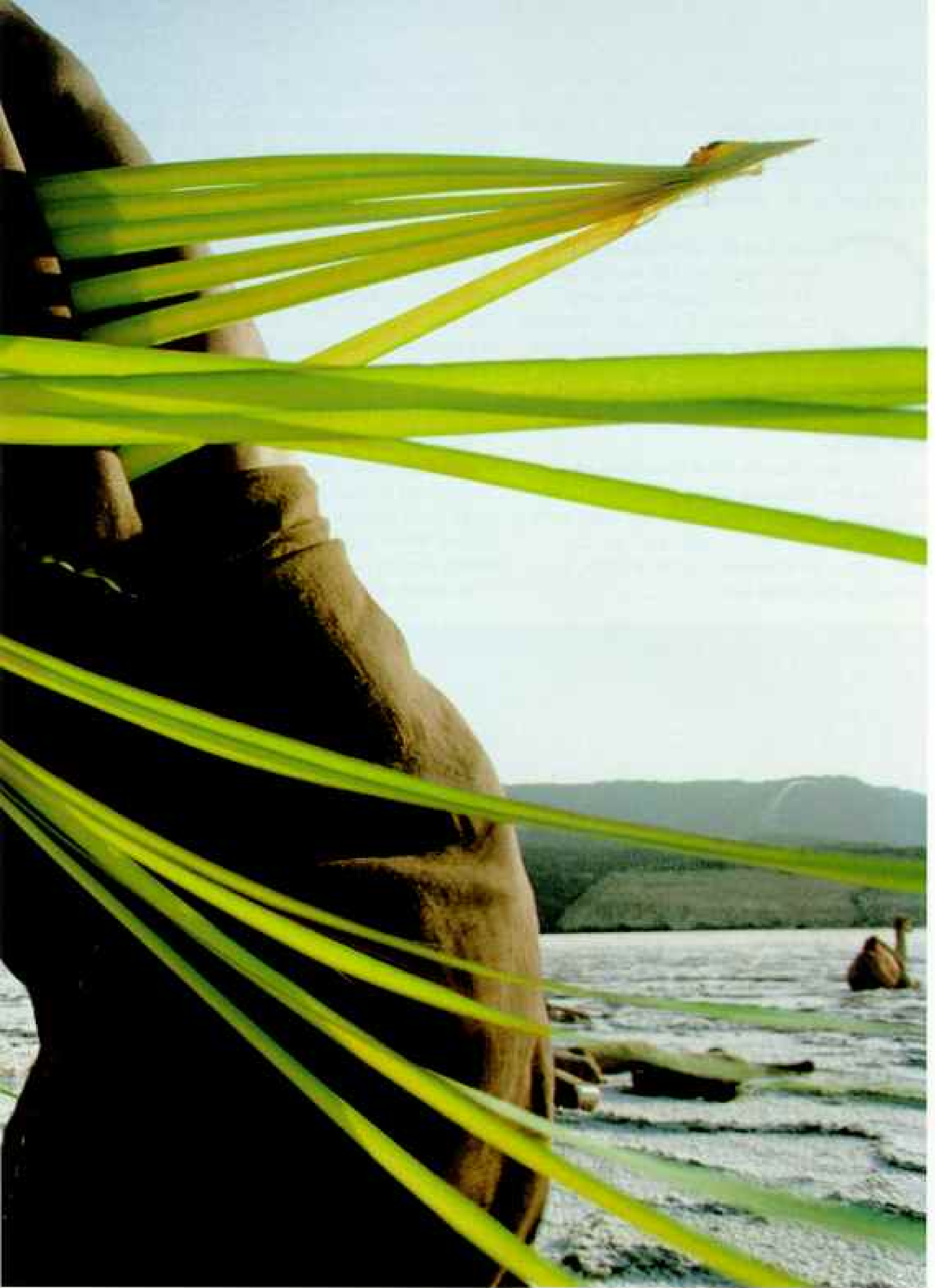


*Rift escarpments in the distance, now heavily eroded, once adjoined the Arabian Peninsula before the Red Sea opened. The escarpments shifted when the continental crust moved west, as the Red Sea formed in stop-start action during a 30-million-year period.*



*FINDING A LIVELIHOOD IN DESOLATION, an Afar nomad mines salt from Lake Assal in the relative cool of March when temperatures reach only 50°C (122°F). He and his companions fill sacks, sewing them closed with palm fronds. Taken by camel to Ethiopia, salt is sold*





*to buy coffee, sugar, and other staples. Not until 1928 did the first Europeans cross the Afar Triangle. One of them, L. M. Nesbitt, wrote about tribes fighting over the vast salt pans. Peering into crevices, he described salt compacted like marble for 60 meters down.*



(Continued from page 14) and an old African untouched by the modern world. Then I notice his dagger hangs from a strip of yellow plastic, probably from the loading docks of Djibouti. The illusion evaporates; we are part of the same present after all.

**C**HANGE IS the very fabric of this land—geologically and socially. The Afar Triangle was once underwater. Alternately wet and dry, its cycles may have shaped our earliest forebears. Now there are so many of us that we are changing the old order. We are beginning to shape the very land that mothered us.

This is abundantly clear at saline Lake Abbe on the Djibouti-Ethiopian border. We have driven all morning. Now the road ends at water's edge, but we still can't see the lake. Abbe, 16 kilometers at its widest, is hidden by waves of heat.

Cream-colored pinnacles as high as 30 meters surround us. Hot springs have built these conical deposits over the ages. Meanwhile, climate change has forced the lake's retreat from the springs. Today Abbe faces total desiccation.

Abbe is fed by the Awash River, which flows north from the Ethiopian Highlands. For millennia the lake was replenished, despite an evaporation rate that reaches 3.6 meters a year. Now Ethiopian farmers are diverting the Awash for irrigation, and the lake loses more water than it gains. The Afar nomads are losing the largest water hole in the desert.

We wander through the forest of pinnacles, and I realize that the Afar are losing more than water to change. A tiny girl in a red robe steps from behind a spire, hugging a toy camel. More giggling children emerge. The oldest thrusts out his hand, palm up.

In much of Africa, children have learned



*SPIRES ON THE SHORES of Lake Abbe are formed above faults by evaporation of mineral-laden water. Moisture from the vents also nourishes wiry grass, fodder for Afar camels and goats. Djibouti has been working on a project to harness its geothermal energy for electricity and fresh water and is seeking a commercial developer for its vast salt supplies.*

that tourist pockets are deep and leaky. Such seemingly harmless begging from tourists angers many Africans. They fear it destabilizes families. A begging child might bring home in one day what a parent makes in a month. Incentive to work fades. And so does parental authority.

Some 250 kilometers up the Awash, at a place in Ethiopia called Hadar, river erosion has exposed the site where one of the earliest known hominids walked between three and four million years ago when the climate was more hospitable. Here Donald Johanson found the famous fossil Lucy.

Great Rift geology in the Afar is ideal for creating fossils. "It's a low area that collects sediments necessary to bury and preserve bones," explains Bob Walter of the Institute of Human Origins in Berkeley, California. "There's also volcanic ash, which lets us date the sediments. Faulting along the rift helps by bringing old bones back to the surface where we can find them."

Long before Lucy, heat from earth's mantle bowed the crust like a great dome, lifting today's Ethiopian Highlands. The dome eventually cracked, which formed the 480-kilometer-long trough of the rift zone in Ethiopia. Magma later rose up in a series of volcanoes from the Afar Triangle south to Tanzania.

The Ethiopian Highlands are far cooler and moister than the surrounding lowlands. Although plagued in recent years by drought, this area is, in normal times, an agricultural island in a desert sea.

The highlands feed great rivers with their rains. The Awash drains the northern flanks. Lake Tana in the west drains into the Blue Nile, which races down toward its junction with the White Nile at Khartoum in Sudan. To the south flows the great dark Omo, famous for its enormous crocodiles.

The Omo feeds a lake far larger than Abbe or Assal. Once called Black Lake, then Lake Rudolf, this isolated sea in remote northern Kenya today bears the name of the nomadic people along its shore—Lake Turkana.

"Lake of suffering" these waters might be called. A century ago Hungarian Count Samuel Teleki and Austrian Lt. Ludwig von Höhnel became the first European explorers to reach the 250-kilometer-long lake. They arrived on foot, nearly dead from hunger and thirst; several Africans in their party died.

I had been to Turkana before—in the summer of 1981—to study the details of climate changes hidden in the lake's sediments. This time I was intrigued by what the lake tells about human change.

I have landed at a camp where anthropologist Richard Leakey and his associates are excavating fossils of *Homo erectus*, a predecessor of *Homo sapiens*. Directly across the lake from us lie the rich fossil deposits of Koobi Fora. Turkana, like the Afar Triangle to the north and Olduvai Gorge to the south, holds a rich lode of information about the early stages of human evolution.

National Museums of Kenya paleontologist Izhiah Odhiambo Nengo leads me across a rolling gravel plain that slopes gently up from the shore. Tear-shaped hand axes litter the ground. I pick one up, feeling that I am the first hominid to hold it since *Homo erectus*.

Nengo meets my gaze and holds it: "As a Kenyan, I can trace my ancestry back two million years."

I notice two heaps of brown bones at his feet. "Human," he says. "Probably fishermen from 10,000 years ago. We found bone harpoons with them."

**F**ISHERMEN still inhabit these shores. The original Turkana had been pastoralists—nomads who invaded from the northwest centuries ago and lived on the blood and milk of their cattle and goats. Then European farmers claimed the lush highlands, where the Turkana pastured their herds during dry seasons.

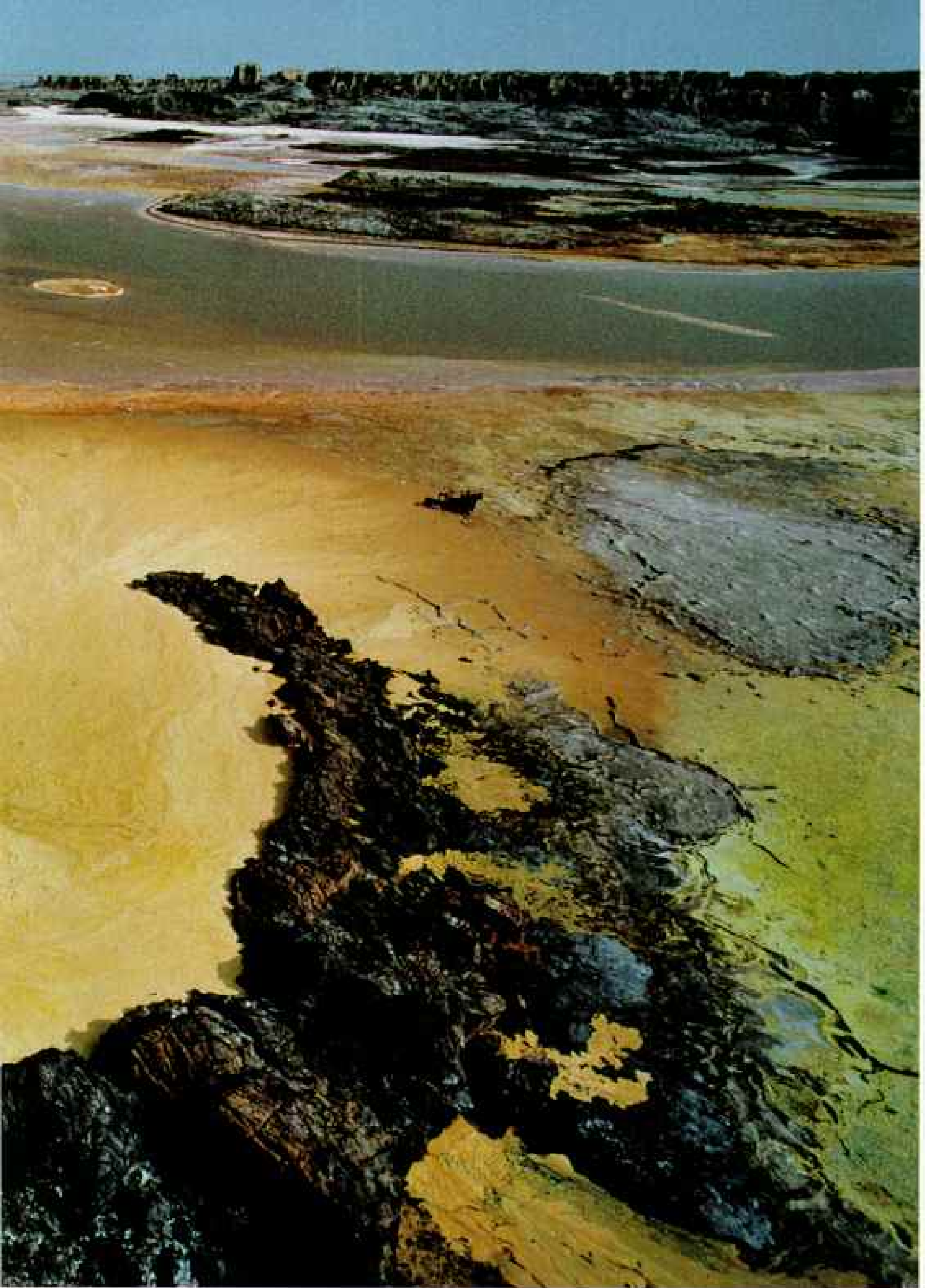
Consequently, Turkana livestock began to overgraze the valley. In the 1960s drought brought devastating famine. The Turkana had to turn to fishing for a livelihood—a difficult transition for a people whose social status was determined by the size of their herds.

Straddling palm logs or wading chest deep in the crocodile-infested shallows, Turkana men netted small fish called tilapia and hooked the monstrous Nile perch. They set up a cooperative storage facility in the coastal village of Kalokol and trucked their catch to highland towns like Kitale or to Nairobi. Children went to school, learned English, and took to wearing Western dress. The Turkana were entering the 20th century. Then the door slammed shut. The lake was shrinking. (Continued on page 26)



*"HELL-HOLE OF CREATION," explorer Nesbitt called Ethiopia's Danakil Depression, which he investigated on foot. When photographer Johns arrived by helicopter, torrential rains had filled the shallow basin of Lake Karum. Iron-laced brines rising from fissures produce*





*the rust-colored hues. Local tribes in the 1920s mined potash at Dalol and shipped it by rail to Mersa Fatma on the Red Sea. The wrecked truck, right, dates from the 1960s, when an American company prospected here for potash.*





*ON THE FRONTIER OF NOWHERE* an Afar chieftain in a new branch-roofed home near As Ela, Djibouti, keeps an eye on the trickle of French tourists bent on viewing Lake Abbe, on the Ethiopians and Somali crossing the border to flee famine and civil war, and on any possible



*smugglers. In the tradition of warrior ancestors sometimes called the Danakil, he wears a broad dagger, supplemented by a modern rifle. France ruled Djibouti until independence in 1977 and maintains a military presence of 4,000 men there.*

I had taken a boat across Ferguson's Gulf, a favorite fishing area, as a graduate student in 1981. Today Chris and I are driving across it, trailing dust. Joseph, a young Turkana, stares out the car window. "Many people have gone back into the bush to tend their goats," he tells us. "They were glad to give up fishing. But some of us are staying."

Joseph blames the lake's shrinkage on Ethiopian irrigation schemes that divert Omo River water. Others blame the climate. In fact, shelly beach deposits far inland suggest that Turkana, like the other rift lakes, rises and falls with climatic cycles. Some believe the recent overgrazing of the Turkana basin has changed evaporation patterns, helping the climate deteriorate locally. No one knows how long the trend will continue or if it will turn Turkana into another Abbe.

It is evening. We take Joseph to his home on a sandy spit that once separated the gulf from the main lake. He beckons us into the two-meter dome of bent poles and thatch. A kerosene lamp glows beside a tape deck atop a wooden crate. Outside, villagers clap and chant under brilliant stars. Joseph switches on the tape deck and begins to dance.

"Where would you like to be now," Chris asks him, "if you could be anywhere in the world?"

"In Kitale," he replies. "Maybe Nairobi."

**C**OSMOPOLITAN NAIROBI, sprawling beyond the rift's eastern shoulder, illustrates the evolution of modern Africa. Born as a railroad camp at the turn of the century, it has become a thriving city of high-rise steel and glass and the hub of tourism in East Africa. Nairobi is also a magnet for young rural Africans who would traditionally have inherited land or livestock. Unfortunately jobs are scarce, even for the best educated, and many newcomers who find work send much of their pay home. Others get money any way they can.

Inevitably some turn to crime. Armed gangs of thieves make it dangerous to walk the streets at night. So Chris and I explore the nightlife by car. Buffalo Bill's Bar catches our attention. It is a place where old and new worlds meet. African and European patrons crowd the American-style bar. It is crowded with beautiful women: exotic Masai, dark Kikuyu, and lighter skinned Ethiopians. All

the beauty of Africa. All in slinky Western dress. They beckon us from saddle-shaped barstools, inviting us to dance.

Even this, the oldest profession, is adapting to change. A recent survey has found the majority of Nairobi's prostitutes to be infected with the virus causing AIDS. The devastating impact of AIDS on African society is said to have led many prostitutes to carry condoms as a matter of survival.

Nairobi epitomizes the social rifting that accompanies unequal rates of change among ethnic groups. The westernized Kikuyu, who dominate the city politically, have entered the 20th century. Others, like the Masai who now flock to town from the overpopulated countryside, encounter obstacles.

At a crowded pizza restaurant, the waiters bustle in smart uniforms. Our server, however, looks confused. I notice he has bare feet. His earlobes, stretched from wearing heavy ornaments, tell me he is Masai.

To many Westerners the Masai represents the noble savage wandering with his cattle and spearing lions. Until colonial times fierce Masai warriors repelled all invaders. But Masai populations have tripled in the past 30 years as their lands have shrunk under the pressure of agriculture. This Masai, his pasturelands probably overgrazed, is struggling to adjust to a new reality. He has given up his spear. His earlobes are as bare as his feet. And he has one of the best jobs a former herdsman can expect in Nairobi.

We head for traditional Masai country. The road from Nairobi takes us over the Ngong Hills and down into the rift. Schoolchildren in red-and-white uniforms crowd the road, heading home. A young girl, maybe 12 years old, waves us down for a ride. The aroma of livestock follows her into the backseat. No words pass between us until, miles farther, she points and cries, "This!"

She hops out, smiles thanks, and runs into the dusty landscape of thorn trees toward a low hedge. In reality, it is a corral; within are cattle and the dung-plastered domes of traditional Masai houses. What will life be like for this girl ten years from now?

We turn south along the floor of the Gregory Rift, a portion of the eastern branch named for the Scottish geologist John W. Gregory, who mapped it in 1893. This stretch is what most people have in mind when they think of the Great Rift Valley.

Many lakes dot the valley: Baringo, Bogoria, Nakuru, Elmenteita. So do volcanoes. Largest is Menengai, which means "corpse" in Masai. A volcanic bowl known as a caldera, Menengai is all that remains of a volcano that underwent one of the most violent types of eruptions known. Caldera eruptions destroy the cones of the mountains that give them birth, leaving only huge craters behind.

**V**OLCANISM has given the shoulders of the rift their fertility. Several times during the past three million to five million years fissures on the valley floor have filled the rift to the brim with fiery lava, which occasionally overflowed onto the surrounding plateaus. The rains of the highlands have weathered this black rock into rich red soil.

The valley floor, loaded with the lava and ash and sediments eroded off the scarps, has progressively sagged. The original bottom of the rift now lies a kilometer below sea level and several kilometers below the current valley floor. Seismic profiles tell us that the bottom of the rift is a jagged montage of blocks that shift independently during the earthquakes that accompany rifting.

Pushing southward, I reach Lake Magadi. On its shore a large factory spews out eruptions of fine white dust.

Magadi holds an alkaline mineral, called trona, leached from the ash of rift volcanoes. Trona is refined to make glass and detergents. It is Kenya's largest mineral export.

Even though the plant sits in the heart of Masailand, it employs few Masai. A language and education barrier, says manager Joseph Boit, restricts Masai job opportunities.

"Years ago," says Boit, "Masai chaps weren't so keen on working here. Now a lot have changed their minds, and we are making efforts to recruit employees locally rather than from other parts of the country." But on days off the Masai still put on traditional clothes and walk away into the bush.

In a remote corner of Lake Magadi hot springs bubble darkly along the barren shore. I peer into a spring, shoes sinking deep into foul-smelling trona muck. I touch the water. It would be too hot to bathe in. But my touch disturbs a group of tiny fish. I am startled that something survives in this hot pool, which is brinier than the sea.

These fish live only in the soda lakes of the Gregory Rift. Other fascinating biota live in neighboring soda lakes: Elmenteita and Nakuru to the north, and across the Tanzanian border, Lakes Manyara and Natron.

Increased aridity over the past few thousand years has shrunk the soda lakes, concentrating their minerals into a corrosive alkaline brine inhospitable to most aquatic life. Free from competition, bacteria and algae thrive. They in turn support millions of pink flamingos whose sieve-like bills strain the water for food. More than half the world's flamingos live in the Gregory Rift, and the tourists who throng to see them are vital to the economies of Kenya and Tanzania.



*SWATHED AGAINST THE SUN, an 11-year-old Afar girl named Hassna Afkada tends her family's goats near Lake Abbe. The Djibouti government encourages the Afar and other nomadic peoples to send children to town boarding schools.*



These ecosystems are dependent on a particular type of volcanism active only here in the Gregory Rift.

A gray cone looms through the haze along the Tanzanian border. Ol Doinyo Lengai—the sacred “mountain of god.” The Masai still bring offerings to its foot and sometimes hear god thundering on its summit.

**T**O A GEOLOGIST Lengai is also sacred as the world’s only active carbonatite volcano. Carbonatite, which becomes washing soda on contact with water, is used as a cleansing and bleaching agent. Volcanologists are intrigued by this magma because they do not agree how deep in the earth it forms. It also comes out only half as hot as most magma—barely hot enough to glow. It is this ash that makes the soda lakes to the north alkaline.

I am determined to climb Lengai, if only

because I have never been to the top of an active volcano.

Lengai has competition close by; many breathtaking volcanoes have arisen in the past three million years. Mount Kenya, for example, once pierced the clouds at more than 6,000 meters. Although it has eroded about 900 meters, this equatorial peak remains high enough to be mantled in snow. Unfortunately for my purposes, it is extinct.

Kilimanjaro, 5,895 meters, still retains three steaming craters on its icy summit. But geologists consider it dormant. Besides, it seems that now everyone climbs Kilimanjaro.

So it will be Lengai, which erupted violently in 1966 and is still grumbling.

With a group of volcanologists I make the steep six-hour ascent. Then we descend into Lengai’s 300-meter-diameter crater. At the bottom a nine-meter-wide vent hisses and spews out a river of lava like boiling tar.

Every few seconds the ground rocks; a



*A BLACK SMEAR OF LAVA erupts gradually on a moonlit morning, darkening the crater of Ol Doinyo Lengai—“mountain of god” to local Masai—in Tanzania. Composed of carbonatite, the flow turns the color of dirty snow within 24 hours. Such eruptions slowly well up in the crater on this peak, the only active carbonatite volcano known.*

fountain of lava bursts through the vent and crashes against its walls. As I approach, I realize that this tar pit is actually a hole in a congealed crust. Beneath my feet seethes a lava lake.

"Don't worry," says French volcanologist Maurice Krafft as he strides on. "Remember, this lava is cooler than most. If you punch through, you'll have time to scream before you die."

Reluctantly I follow him onto the thin crust that covers a new lava flow. Sensing my fear, he continues to tease me. "The whole thing could collapse at any time . . . then there could be an enormous eruption."

As he speaks, his left leg vanishes through the crust. Amid a puff of smoke he yanks it free, cursing in French. His shoelaces are gone. His pantleg is charred. I smile to myself as we retreat; the "mountain of god" is a dispenser of justice.

Off Lengai's western flanks in Tanzania lies the Serengeti, the endless plain. The plain itself is largely a product of this carbonatite volcanism. Its layers of carbonatite ash perhaps exploded from now dormant Kerimassi. Rains turn this unusual ash into a hardpan impenetrable to tree roots, leaving the plains to shallow-rooted grasses. The grasses nurture more than a million wildebeests and 200,000 zebras. They in turn feed a healthy population of lions, estimated at 3,000.

Just southeast of these grasslands, where the rift meets the plain, are two celebrated geologic features. Olduvai Gorge is where Louis and Mary Leakey discovered so many important hominid fossils. The Olduvai specimens owe their spectacular preservation to the cement-like quality of the carbonatite ash.

**S**OUTHEAST of Olduvai lies East Africa's largest caldera, Ngorongoro. Born about three million years ago in a titanic explosion and subsequent crater collapse, Ngorongoro today contains one of the planet's greatest game preserves.

Many of East Africa's game preserves are either in or along the rift, on land too dry or rugged for agriculture. Ngorongoro is special. Its steep crater walls make a natural border, separating game inside its rim from the encroaching farms and ranches of the new Africa. It cannot keep out the influence of civilization, however. In recent years that

influence has forced new inhabitants into the sheltering crater.

Safari guide Jill Strand weaves a rattling Land-Rover toward a grove of thorn trees. In the grove I can see a group of these invaders—a dozen elephants.

"They are all males here in the crater," Strand says. "Females refuse to bring their calves in over the steep rim."

A young bull strips a branch from a tree, oblivious to its thorns. "They'll eventually destroy that grove."

When they do, one of the few patches of woodland in Ngorongoro will be gone.

"Then there will be no other place for them to go," Strand says.

In earlier times the elephants could have moved on to other groves or even other countries. But today humans need ever more land for cultivation. Little habitat remains outside preserves. Farmers are hostile to elephants that damage their crops.

Meanwhile, poachers armed with automatic weapons wantonly disregard park boundaries in their quest for ivory. All along the rift the elephant is rapidly disappearing.

Today wildlife draws tourists—and hence badly needed foreign currencies. So Africa must decide quickly how, and indeed whether, to preserve its remaining wildlife.

The Gregory Rift disappears south of the Serengeti, and I head toward the western rift. Just as the Gregory is a land of fire, the western is a land of water, where I feel most at home. Some of the world's deepest lakes fill its troughs.

These waters, like the land itself, see accelerating change.

I see it at Lake Victoria, where I stop en route to the western rift. Fishermen here are abandoning the natural-fiber line they once used for their nets. Instead they buy the stronger synthetics. They need the strength to catch big Nile perch, which were introduced in the early 1960s. The voracious perch, which can weigh 180 kilograms (397 pounds), are a major cause of the near extermination of many species of Lake Victoria's cichlids. Several hundred unique species have evolved in the lake; they are found nowhere else.

The shift to perch fishing causes little concern, despite the fact that the fishermen must buy expensive new nets and go farther offshore to catch the perch. Some of their customers prefer

*(Continued on page 36)*



*SWIRLS OF PINK on Lake Natron, Tanzania, are lesser flamingos nesting by the thousands on exposed mud flats. The water birds dribble mud to build raised conical nests that will keep their eggs and chicks dry should the shallow water rise. The water, heavy with*



*soda from hot springs bubbling through volcanic rock, supports tons of algae, the birds' main food. Thousands of flamingo feet churn up the dense algal mass, exposing lower layers to life-giving sunlight. Sticky mud discourages the approach of predators.*





*FINDING SANCTUARY* in an extinct volcano, a bull elephant makes a meal of a yellow-barked acacia in Tanzania's Ngorongoro Crater. The great basin, 20 kilometers across, formed when a volcano blew its top, perhaps three million years ago, leaving an immense caldera.



*Hundreds of grasses, shrubs, and trees took hold, drawing animals and eventually Datoga and Masai cattle herders as well as German ranchers. Hunting was banned in 1928, a conservation area declared in 1959, and cattle restricted in 1974.*





*IN AN AGE-OLD CYCLE of the hunter and the hunted, young lions cripple a Cape buffalo in Ngorongoro Crater. Twenty-four hours later hyenas were chewing the bones. The big cats themselves once fell prey to tribal warriors, who won great honor—and the favor of young*



*girls—by spearing them. Now Africa's highest concentration of lions lives in the crater, part of the Ngorongoro Conservation Area that protects both animals and indigenous peoples. The preserve offers a window on wildlife amid spectacular rift valley landscapes.*



(Continued from page 29) the perch to the bony cichlids. Victoria even exports perch filets as far as Europe.

But biologists around the world have decried this aquatic invasion. Fisheries authorities are concerned about a potential side effect of the loss of diversity.

"There's a lot more algae in the lake," observes James Ogari of the Kenya Marine and Fisheries Research Institute. "We suspect this is partly due to loss of herbivorous cichlids. Dead algae accumulate on the bottom and use up oxygen as they decay. There is a high risk of fish kills when strong winds churn up the anoxic bottom water."

But there is a bright side. The perch are themselves being overfished. "The cichlids may make a comeback," says Ogari. If so, they should continue their peculiarly rapid rate of evolution: The cichlids in these lakes are known for explosive speciation. Many of the endemic species in Victoria apparently evolved in the 13,500 years since the lake nearly dried out. It was a surprise to many biologists that speciation could occur so quickly.

**E** VOLUTIONARY THEORIES of another sort are being challenged along the shores of Lake Edward in Zaire, the first of the great western rift lakes I visit.

A bush plane takes me to Lake Edward's north shore and the banks of the Semliki River. Forty years ago archaeologist Jean de Heinzelin discovered Paleolithic bone harpoons in a nearby bluff. Other sites contained much older stone tools, along with animal remains. Violence following Zaire's independence drove out de Heinzelin and other Belgians in 1960. Now an international team of scientists has returned. They suspect that this western rift site may be important to the earliest stages of human evolution. But the rift itself thwarts efforts to prove their controversial new theory. Here it does not have the layers of volcanic ash that give researchers on the savanna such accurate dating.

"We have many artifacts resembling the two-million-year-old tools from Olduvai," says Rutgers University archaeologist Jack Harris as we sip tea under a tent at Senga Five, where the oldest stone artifacts were found. "But we have no hominid bones yet. We have to estimate the ages of our strata by comparing fossil pig teeth found here with

others from Kenya dated by the ash. Our pig teeth date from 2.3 million years ago."

If that date is correct, the Semliki hominid artifacts would be among the oldest found.

"The western rift has been practically ignored," says Harris. "Partly because we found no ash layers and partly because lakes cover most of the fossil beds. Our finds at Senga Five, however, suggest that woodlands here were as important to hominid evolution as the savannas in the eastern rift."

Between Lakes Edward and Kivu rise the eight beclouded volcanoes of the Virunga range. Two are still active. Nyamulagira has erupted sporadically since the first European saw it in 1894. In 1977 its neighbor, Nyiragongo, blew. Its 460-meter-deep lava lake drained out of its base in less than an hour. Moving 60 kilometers an hour, blazing lava raced through forests, roads, and farms, killing about 50 people.

Volcanologist Maurice Krafft witnessed the aftermath. "After the lava cooled, we found big bubbles in the flows," he recalls. "Each contained the perfect mold of an elephant, right down to the skin texture. Other bubbles had molds of people in them."

The Virungas dramatically shape the rift landscape, damming rivers that once fed Lake Edward and the Nile. One result may have been Kivu, among Africa's loveliest lakes, which today spills southward into Lake Tanganyika.

Nearly 80 kilometers wide, placid Lake Kivu fills the rift between Zaire and Rwanda. Its steep, plunging walls remind me of fjords I've seen in Scandinavia. But it also reminds me of another African lake I studied—Nyos in Cameroon. In 1986 Lake Nyos threw a toxic cloud of carbon dioxide into a densely populated valley. Seventeen hundred people suffocated.

Lake Kivu could be a bigger time bomb. A larger store of carbon dioxide lies beneath Kivu's beauty. Seeping through fissures in the lake floor, CO<sub>2</sub> accumulates under pressure in the deep waters. Unlike Lake Nyos, in Kivu bacterial action has converted much of the CO<sub>2</sub> to methane, which can be burned as fuel. Already a Rwandan brewery fuels its boilers on lake methane. But experts who recall 1986 at Lake Nyos urge caution in exploiting Kivu's methane reservoir.

German physicist Klaus Tietze warns that careless pumping or a natural event could

trigger a runaway release of the flammable gas that could ignite as soon as it reached a cooking fire. The resulting fireball would devastate the densely populated lake basin. Tietze advocates a controlled degassing.

**W**HEN Burton and Speke explored Lake Tanganyika in 1858, they were not the first non-Africans to do so. Arab traders had developed thriving ivory and slave trades there 50 years earlier; indeed Arab outposts provided the British explorers with vital supplies and guidance.

The explorers had hoped to prove that Tanganyika was the source of the Nile. They were wrong. The 650-kilometer-long lake drains westward into the Atlantic. It feeds one of the many tributaries of the great Zaire River, formerly known as the Congo.

The most important outcome of their visit,

in my eyes, proved to be Speke's collection of snail shells from several beaches. The unusual ridged and spiny shapes of these shells surprised European zoologists: They resembled marine forms. Many 19th-century biologists believed therefore that Tanganyika was once an arm of the Atlantic.

Geologic studies showed no evidence of such a connection, and similar organisms were found in other African lakes. The snail shells are probably adaptations to local habitats, developed over millions of years of isolation. The snails living in Tanganyika's crashing surf tend to have heavy shells, while others have long, delicate spines that may help prevent sinking into soft mud.

Tanganyika, perhaps the oldest of the rift lakes, outstrips all others for sheer biological diversity. Even so, its riches are underexplored. There may be good reason.

"Wading in the waters off Bujumbura, it's not automatic that you'll be attacked by a



*FERTILE VOLCANIC SOIL enables women of eastern Zaire to raise three crops of peas a year—rainfall permitting—on slopes cleared of forests. Their farms overlook Lake Kivu, which may have been formed when volcanoes of the Virunga chain threw up a dam of lava and ash across the western rift, blocking the northward flow of several rivers.*



*PEOPLE MOVER* for centuries, Lake Tanganyika provides a ferry route for passengers and produce on a 60-hour voyage from Mpulungu, Zambia, to Bujumbura, Burundi. During the 19th century, European colonial powers turned rift valley waterways into territorial



*borders. Lake Tanganyika remains a border for four independent nations. Covering an area larger than Belgium, the lake is subject to frequent severe storms. It is also Africa's deepest lake, a transportation route, and a source of fish for millions.*





*A SPIRIT OF MISCHIEF moves a Malawi dancer, whose mask mimics a white man. For centuries clans in Malawi impersonated animals and ancestral spirits in a ceremony called Gule Wamkulu. The dance survived attempts by missionaries and others to suppress it, but traditional society, like the land itself, undergoes constant alteration along Africa's Great Rift.*

crocodile," says Pierre Brichard, a veteran fish collector in the region. "There's only one every thousand meters or so. But you never know where they are."

The lake's unique aquatic cobras and parasite-laden snails further discourage casual diving. So do the hippos that frolic offshore. These not-so-harmless creatures often graze the lawns of Bujumbura, capital of Burundi. When I worked there in 1981, a gardener tried to shoo one away. His arm was torn off.

Tanganyika's less intimidating endemic biota includes freshwater crabs and more than 200 species of cichlids. Only Siberia's Lake Baykal is deeper and as rich in endemic life. But unlike Baykal, Tanganyika crowds its biological wealth into its upper layers. Below 200 meters, the 1,500-meter-deep lake is devoid of oxygen.

Today it is the cichlids for which Tanganyika is best noted. Like Lake Malawi to the south, it supplies the attractive little fish to collectors around the world, who pay hundreds of dollars for some species.

Pierre Brichard, who has been attacked by a large crocodile and bitten by an aquatic cobra, pioneered Tanganyika's cichlid trade in 1971.

"It's lucrative but not easy," he says. "We lost money for ten years until we solved our problems. You have to know each fish and its needs. Some have to be decompressed when you bring them up. Others need to be treated for parasites. Each has its special diet. That's why they are so expensive."

Brichard is careful not to overharvest Tanganyika's cichlid bounty. "We know we must leave enough to repopulate," he says. "I've invested too much in this business to do otherwise."

Sediments 5,000 meters thick suggest that Lake Tanganyika is as much as 20 million years old. Its great age helped its inhabitants evolve so distinctively and bears on a debate over whether the rift is actively spreading.

"The rift may eventually become a new ocean," claims geologist Anis Abdallah. "That's what happened when Madagascar

broke away from East Africa long ago."

Israeli geologist Zvi Ben-Avraham takes exception.

"Rifting is not the same as spreading," he says. "The Atlantic Ocean probably began spreading after five million years of rifting. East Africa has been rifting already for about 20 million years. Perhaps the oceanic ridge systems on both sides of Africa prevent it from splitting apart."

In 1981 I helped make echo soundings that revealed thick sediment stacked under the lake floor. The ecologist in me thrilled to think of using that mud to reconstruct the environments of our ancestors. My geologist colleagues were more excited by the pockets of natural gas that peppered the organic mud. Seeps of oil form natural slicks in places. The four nations bordering the lake hope one day to tap these fossil fuels.

But oil exploration on Tanganyika worries many who fear its impact on aquatic life. Other potential stresses include localized urban pollution and traces of agricultural pesticides. Such are the dilemmas of our overpopulated century.

**I**T HAS BEEN seven years since my first visit to Tanganyika. I return to a sandy beach I knew well near the bustling docks of Bujumbura. Steep escarpments line the distant shores to my left and right. Gray waves roll in from the horizon. A warm breeze fans my face; I almost expect to taste salt on it.

A freighter lumbers out of port, heading south for Zambia; I imagine it to be an Arab dhow, laden with exotic goods. I imagine that the naked men bathing in the muddy shallows before me are ivory hunters, though elephants are now long gone from here. But the open sewer pipe at my feet does not fit my reverie. Nor do the plastic bags and bottles that litter the beach among the snail shells.

My imagination leaps from the past to the future. What may some later explorer of time read in the rift's sediments? Will it be a layer of snails, followed by a layer of trash? With all my heart, I hope not. □



# The Living Jewels of Lake Malawi

By PETER REINTHAL    Photographs by BILL CURTSINGER



*A brilliant aquatic menagerie called cichlids populates Lake Malawi, where divers harvest the fish for the aquarium market. Southernmost of the major Great Rift lakes, Malawi may hold some 500 to 1,000 cichlid species, such as *Pseudotropheus heteropictus* (left), and has more fish species than any other lake in the world. Fascinating behavior and hardiness make cichlids popular worldwide.*





**S**WARMS of rock-dwelling cichlids, known by the local name *mbuna*, pluck plankton from the water above a rocky outcropping. Most *mbuna* usually stay close to algae-covered rocks for feeding and protection but will opportunistically feed on clouds of plankton that chance by.

While members of the intriguing Cichlidae family can also be found elsewhere in Africa as well as on other continents, distinctive assortments of species exist in most of the lakes along

the Great Rift. Almost all of Lake Malawi's species are endemic—they are found here and nowhere else.

Lakes Tanganyika and Victoria rank close behind Malawi in number of species, and cichlids thoroughly dominate the fish fauna in all three lakes. The cichlids in one lake often exhibit traits similar to those in another, despite their isolated locations. One of the evolutionary wonders of the world, these lake cichlids have developed many extraordinary biological

features, characterized by complex feeding and breeding habits and a remarkable array of physiological adaptations.

Lake Malawi's cichlid population utilizes almost every type of edible material available, and most species have their own specialized diets. Food sources include snails and other invertebrates, fish larvae, zooplankton, phytoplankton, algae, aquatic plants, and fish. Some species feed almost exclusively on the fins, parasites, or even the eggs and embryos of other fish. One



species feigns death and resembles pale and rotting fish to lure juveniles close enough to prey upon them. At least two other cichlid species mimic their prey in order to get close enough to scrape the scales from their flanks. Little that can be eaten is left unexploited.

Each cichlid species has two sets of jaws that are tailor-made for its particular feeding habits. One set is in the mouth, and the other, the pharyngeal bones, is located in the back of the throat. Teeth on the oral jaws specialize

in prey capture and getting food into the mouth, and the pharyngeal teeth are used for chewing. The food that a species eats can be determined by studying the shape of its teeth. The oral teeth of most predators are pointed. Some algae-feeders have brush-like teeth for scraping plant life off rocks. Snail-feeders have strong pharyngeal jaws and teeth for crushing shells.

PETER REINTHAL, a research fellow at New York City's American Museum of Natural History, studies fish ecology and classification.





**B**EARING the burdens of motherhood, a female *Tyrannochromis macrostoma* (above) guards her brood as they search for food. Juveniles are constantly threatened by predatory cichlids. At the first sign of danger she chases away an intruder (below). She then signals her young to reenter her mouth (left), where they are out of harm's way.

All Lake Malawi cichlids but one are mouthbrooders. Their dramatic reproductive cycle starts when the male claims rocky territory or builds a nest in sand and begins an elaborate courtship to attract a female.

Releasing her eggs one at a time, the female takes the egg

into her mouth, then nuzzles the male's genital region, causing him to release sperm into the water, which the female inhales, thereby fertilizing the egg. This sequence is probably abetted by the coloration of the anal fin, which often has spots that the female attempts to mouth, apparently mistaking them for eggs. The female carries the eggs in her mouth until they develop into juveniles, protecting them until they are ready to survive alone.

Some cichlids feed on eggs and juveniles of others. Some species with protruding lower jaws crash into the heads of females carrying young. This forces the mothers to disgorge the broods.







**M**ALAWI recognizes the biological significance of the lake. In 1980 the nation established the world's first freshwater, primarily underwater national park, in the lake's southern region specifically to protect the cichlids.

Outside park boundaries a diver captures cichlids (above), taking care to avoid damaging the fish. While rare cichlid species caught in the wild bring

hundreds of dollars a pair, many others are more modestly priced. Most cichlids sold on the American market are raised in U. S. fish farms. Wild fish are more popular in Europe, where many buyers want assurance of the genetic purity of the species they purchase.

Among popular varieties is the tangerine colored *Labeotropheus trewavasae* (A), which intrigues scientists by its

apparent ability to change its sex. The blue and yellow *Pseudotropheus aurorea* (B) is an inveterate homebody that will return to its territory even after being released as far as two kilometers (more than a mile) away.

A male of the genus *Copadichromis* (species as yet undescribed) (C), sometimes called the sulfur blaze, develops its colorful patch during breeding season. Other species include a



D



A



C



B

member of the diverse *Pseudotropheus tropheops* group (D) and the ubiquitous *Melanochromis auratus* (E), known for its sex-specific coloration. The male is black with yellow stripes; the female is yellow with black stripes.

Most islands and rocky outcrops have distinctive mbuna. Crucial to courtship, color is often the only way to distinguish between related species.

Diving sometimes reveals new species. Photographer Bill Curt-singer, our Malawi assistant diver James Whitiman, and I dived among spectacular underwater mountains never before explored. Swimming at deep levels, we discovered a number of new species and made observations of others in their natural environment.



E



**M**ONUMENT to the power of the reproductive drive, a large sand nest is patrolled by its builder, a male *Copadichromis eucinostomus*. During the breeding season the male of most sand-dwelling species builds and

aggressively defends such a nest against rivals. In building his nest, a male meticulously moves sand one mouthful at a time. He creates a nest with a shape characteristic of his species.

Since most Lake Malawi cichlids are mouthbrooders, nests

are used only for courtship and mating. Many rock dwellers defend patches of rock and will even guard algae gardens that are attractive to females.

Competition for mates and nest sites is keen. After a male establishes his nest or territory,





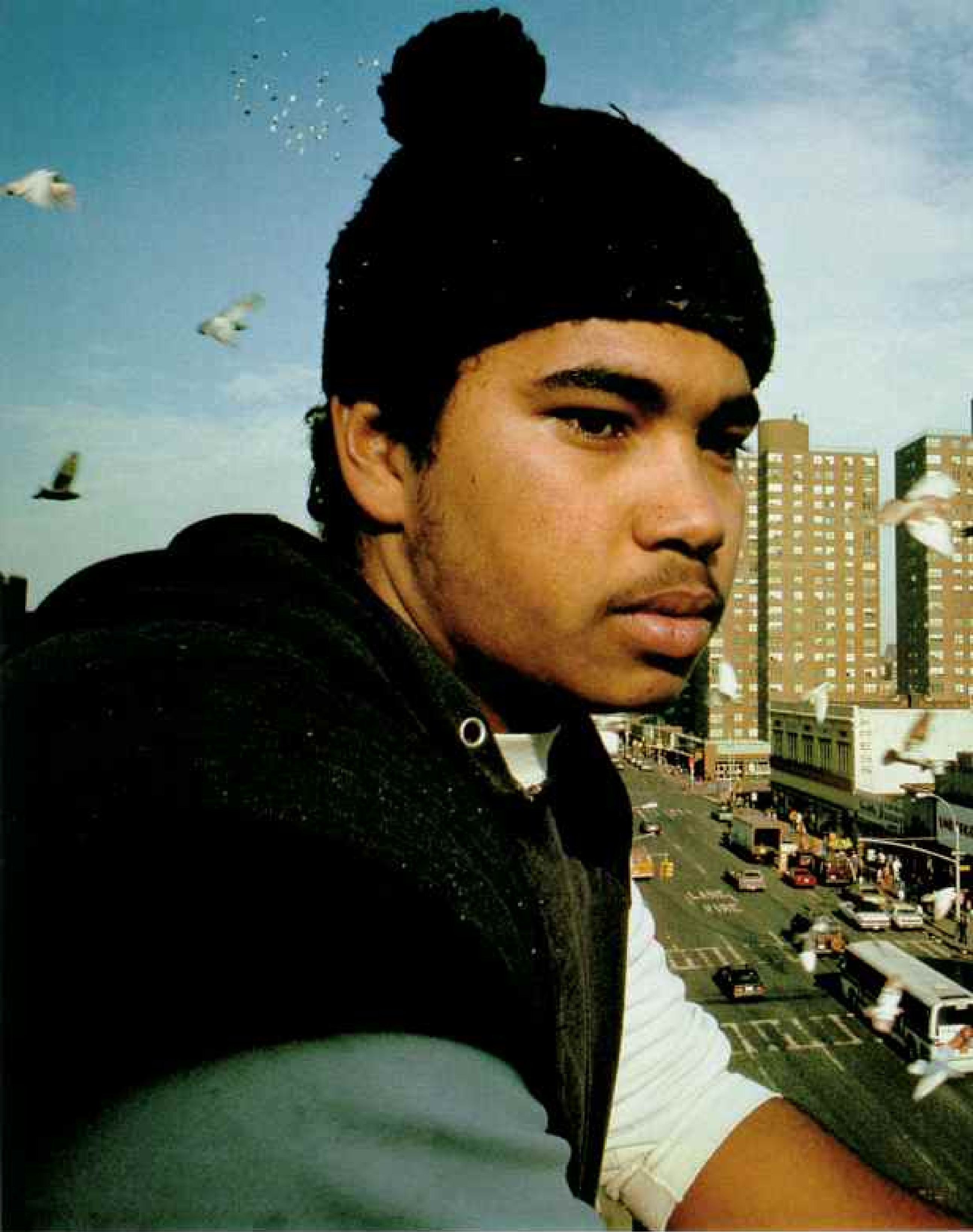
he must constantly be on guard against male intruders, sometimes locking mouths with and vigorously shaking a rival. All the while he works to entice females to enter his domain. He will often mate with several females during a season. Once

he has mated, the male has no role in the care of his offspring.

The people of Malawi get well over half their animal protein from fish, and Lake Malawi supports an important commercial fishery. Cichlids range from several grams to more than two

kilograms (4.4 pounds) but are dwarfed by 30-kilogram catfish. Dugout canoes trailing longlines for large fish and boats working in tandem to pull nets are a common sight as traditional fishermen pursue the lake's abundant living treasures. □





Growing Up in **EAST**



By JERE VAN DYK

Photographs by  
JOSEPH RODRIGUEZ

BLACK STAR

**T**he mainland's oldest and most vibrant Puerto Rican community, standing just north of New York City's wealthy Upper East Side with its shoulder to Black Harlem, struggles to overcome a legacy of neglect and a recent invasion of crack cocaine. For Tany Davila, dreams take wing from a rooftop above Third Avenue, where he flies some of his 175 hand-groomed pigeons.

# HARLEM

**I**T WAS CALM AND HOT as I watched the barrio waking up for another Saturday. A man worked under a car, the wash flapped on a rooftop line, Latin music throbbed up from the street. Someone made strong coffee and new bread.

From the roof of a high rise that was littered with crack cocaine vials and broken bottles, I could see the green fields of Central Park, a sailboat tacking on the East River, the glittering skyscrapers of midtown Manhattan, a world away.

In the middle was East Harlem itself: brownstone tenements, housing projects, vacant lots, burned-out buildings, shattered windows—200 square blocks where 120,000 people live beset by drugs, crime, and despair but also in a cousinship of hope, love, and optimism that stirs the outsider.

Fifty percent of the people are of Hispanic origin, 49 percent black, a few others of Italian or Asian ancestry. Per capita income hovers around \$4,000. One in seven East Harlem adults is out of work. More than one in three gets some form of public assistance, among the highest welfare rates in the nation. The area has some of the city's worst crime and one of the nation's highest school-dropout rates. Drugs and AIDS haunt every man, woman, and child who lives here.

To live in Spanish Harlem—the neighborhood, *el barrio*—you must watch yourself and everyone else, because you are in another world; you are, as my friend Joe Rodriguez told me on my first day, “across the line.”

“Don't stare. Be cool,” Joe said. He had been here, he spoke the language. “It's all body language,” Joe said, showing me how. “Look up and ahead, never down. Do a bee-line. Keep your hands out of your pockets.”

Walking along Third Avenue, we passed a stand selling yucca, yams, *batata*, *plátanos*, mangoes. Then we came to a bad corner, Lexington and 110th Street, filled with people with quick eyes and dark clothes.

“Three star, three star,” a man shouted, hawking cocaine. “Methadone 60, 80,” said another, advertising synthetic heroin. A man with his hair in dreadlocks silently held out two hypodermic needles in a wrapper.

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JERE VAN DYK, a writer living in New York City, covered the Brahmaputra River for the November 1988 GEOGRAPHIC. JOSEPH RODRIGUEZ grew up in Brooklyn, New York. This is his first assignment for the magazine.



*Born addicted to cocaine but now fully withdrawn, a four-year-old screams, perhaps for attention, while his uncle sells heroin over the*



phone. Since the boy's parents both deal and use drugs, he and a sister are being raised by their maternal grandmother. Two other siblings, including a girl born with only one hand—possibly due to her mother's crack habit—live with another grandmother.







A dented blue police car pulled up, and two young officers, bareheaded, with their hair combed back, stared coldly at the corner. Business slowed, the dealers' voices dropping as one of the cops spoke into a walkie-talkie, then drove away. I went down another street and found an undercover officer frisking two young men against a brick wall. These suspects looked about 14.

"Kids support their parents by selling drugs now," explained a uniformed cop who had come with others to assist the undercover officer. You can buy crack, heroin, angel dust, and other illegal drugs in a hundred places in East Harlem. When the city police department's tactical narcotics teams swept dealers out of the Lower East Side, West Harlem, Queens, and Washington Heights, the pushers moved to the barrio, renting apartments, working out of grocery stores, moving on.

"We need a warrant to go in," the cop said. "By then it's too late. Our hands are tied." A woman dispatcher's voice crackled on his radio, calling out another address. The day would be long.

"Drugs have become a major part of the economy," said the young officer, whose white bulletproof vest showed under his shirt.

Neither the New York City Police Department nor the federal Drug Enforcement Agency knows how much drug money changes hands in the barrio each day. But Capt. Joseph Lisi of the police department's narcotics division was willing to guess: "It's millions of dollars a year," an amount that would easily cover the rent on the Empire State Building.

Not so long ago, it was different. "This was a nice community," recalls Pete



*Before innocent eyes, drugs and thousands of dollars change hands each day in el barrio—East, or Spanish, Harlem. A line forms at night outside a school on 117th Street; look-outs whistle and shout code words to screen passersby (far left). A recent 90-day police operation saw the arrest of 2,000 for sale or possession—many from outside the city—and the seizure of more than a hundred firearms. "I'm afraid of crack fiends," one dealer admitted. "They're savages."*

*Avoiding crack's intense but brief high and its subsequent jitters, some addicts prefer shooting speedball, cocaine and heroin, a practice that like all frequent needle use collapses veins and causes swelling.*



Long the refuge of poor immigrants, the tenements of Spanish Harlem march south like barracks toward the skyscrapers of midtown. Many Harlem buildings have been abandoned by landlords as unprofitable, and some have been torched, leaving streets pocked with vacant lots. Towering projects, erected by the city after the 1940s, break the low skyline on both sides of busy Third Avenue. These superblocks provide needed housing for some of the area's 120,000 residents.

Saddled with ownership of more than 60 percent of the vacant land and buildings, the city provides grants to groups



willing to renovate and buy. It is not enough, according to homesteaders like Estela Vázquez and her husband, Key Martin (right), who have spent five years of evenings and weekends submitting forms, framing windows, and guarding against vandals.

"It feels sometimes like we're building the Pyramids," says Estela. Her group, one of only three active in el barrio, sees the character of the neighborhood itself at stake. With speculators buying up buildings and one-bedroom condominiums selling for \$130,000, real estate values are bound to rise, forcing long-time residents from their homes.









Pascale, 75, remembering the simple East Harlem of his youth. The neighborhood was known then as Little Italy, a place of two-cent ice creams, ten-cent movies, unlocked doors, kerosene lamps, and a policeman on the corner who knew your name and your reputation.

"People worked hard," Pascale says, his face reflecting the pleasant memory. "There was respect for the family."

Even today you catch glimpses of what it must have been like—in community vegetable gardens that thrive in vacant lots, in a school

classroom where kids talk about the future, in the hospital where a doctor hugs two children she has known since they were born, in a church parade on a summer night.

I watched the 105th annual procession of Our Lady of Mount Carmel coming up 116th Street. The faithful—Hispanics, blacks, and whites—walked together at a solemn pace, candles flickering in the dark, following a plaster Madonna on a float, led by a brass band whose members wore black pants and red berets. These were proud people any American



"I can relax here," says Margaret McQuillar (below, at right) of the garden she and Elizabeth Smoaks help tend on Pleasant Avenue. Children and civic pride blossom amid the okra and apple trees. At a 110th Street old-timers club, men unwind with dominoes after work. Talk includes politics, sports, and plans for the block party.



would recognize, people who cared about their neighborhood. Seeing them made me realize that there are pockets of calm just beneath the barrio's turbulent surface.

**L**UGO'S BARBERSHOP on Lexington Avenue is a warm place where neighbors can talk, surrounded by color maps of San Juan and Puerto Rico. Relaxed families smile from snapshots on display. Inspirational, handwritten mottoes are posted on the walls: "Never become a victim of fear

or envy; that will keep you from doing good." "He who has obstacles and overcomes them is the winner."

The man behind the mottoes, Alejandro Lugo (pages 66-7), ran a comb through his customer's hair. "You find good and bad all over the world," he said. "I always wanted to come to this country. I saw the big buildings in a dream when I was a boy living in Mayagüez." Since 1952 Alejandro has lived in the barrio, and he intends to stay.

Alejandro is a Puerto Rican, belonging to



the next-to-last wave of immigrants in the barrio. The first Europeans to arrive were the Dutch, who came in the mid-1600s. They imported African slaves. Two Dutch brothers, Hendrick and Isaac DeForest, were among the earliest settlers, breaking land for a small farm by the river. A village called New Haarlem, named for the city in Holland,

flourished there. The English came next, then the Germans, Irish, and Swiss. Each group prospered in turn and was joined by the next wave of immigrants speaking a new language but looking for the old opportunities, working for low wages in sweatshops.

Jews and Italians came in the 1890s, fleeing Manhattan's overcrowded Lower East Side.





The new immigrants worked in the needle trade, sewing garments. When those workers moved on, the garment industry recruited new ones from Puerto Rico. By 1930 some 45,000 Puerto Ricans lived in East Harlem. They still predominate there, though newcomers arrive steadily from poor Caribbean countries and from war-ravaged Central America.

*A parents' protest, stuffed animals occupy an abandoned building on 118th Street where crack dealers once gathered. Created by Juan Antonio "Tito" Rolon, who lives across the street with his wife and two sons, the artwork attracted attention and helped persuade dealers to move on. The building is now being renovated for homeless people.*





"I was an orphan," said Alejandro. He put his scissors down. "A nun took me in and sent me to Catholic school. Now I try to give back. I am a deacon of the street." On Sundays Alejandro closes his shop and changes into a long robe for services at St. Cecilia's, the cathedral of the barrio, as it is called. During the week he visits the sick, teaches the Bible to children, and lends an ear to neighbors in trouble.

I watched him speak to the congregation at St. Cecilia's. "We see miracles every day," he said fervently. "Herod wanted to kill the children, and no one helped prevent it. Today we can care for our children."

You want to believe his words when you look around the church. There were altar boys with jeans and running shoes showing beneath

their robes, altar girls in dark dresses, and uncertain new immigrants with their hair wetted down. The building was packed, and the worshipers clapped as they sang. Father Norman Simmons delivered the homily in Spanish, and when the Mass was finished, children ran up and down the aisles.

Outside St. Cecilia's, after the service, the sun was bright and the air smelled fresh after a hard rain, and on the church corner two disposable hypodermic needles glistened in a puddle.

Who sold the drugs? I was about to find out. In the dark hallway of a boarded-up house, I waited to meet a crack dealer who had agreed to talk. I heard the lock slide inside the door and he let me in.



The dealer took a swig of Olde English beer. I'll call him José. A Bible, covered with dust, lay on a dresser.

"No names," José said, establishing the ground rules. "Just titles. The boss puts up the money. The carrier makes the buy. The runner brings the stuff into the spot, a house or an apartment in the neighborhood. The bookie keeps track of the money. *That man is never alone.*" José grinned, putting the bottle to his lips again. "Another runner brings it to the pitcher, who sells it on the street."

Dealers keep regular hours. If a worker fails to show up on time, the boss comes to find out why. And there is turf, jealously guarded. "One guy owns a block. He leases the corners," José said. "You need money to get

*A woman's work is never done in el barrio, where nearly half of all households are headed by females, one of the highest ratios in the U. S. For mothers on 111th Street (above left), sharing the gossip and salsa that float on city breezes helps ease the burden of large families and insufficient day care. Relatives and neighbors offer support, as do the area's many active churches.*

*While retail and service jobs exist locally, unemployment runs high. Much of the garment industry (above) has moved overseas or across the East River, as immigrants from war-torn Central America crowd into other boroughs.*

started and to hire workers. And you've got to pay protection money. A middle-class day is \$50,000."

José took another drink, letting the profit figure sink in.

"Right now," he said, "there are 20 brands of crack on the street." Entrepreneurs sometimes try to break into business by underselling the competition—a dangerous practice, according to José: "On Wall Street you hire a lawyer. Here you kill."

We heard what sounded like gunfire coming from outside. José's wife, Therese, turned up the television. "The walls have ears," she said, as she lit up a joint. Acrid marijuana smoke filled the room. José got up, picked up a vial, walked into the back room. He talked as he went away, then was quiet for a few seconds. When he came back, his eyes were glassy, his movements quicker. I was

uneasy. Crack sends you up, makes you fearless, unpredictable.

Outside in the air again, I walked down the middle of the street, my head reeling. Under streetlights, people stood around, leaned on double-parked cars, sat on stoops. Three motorcycles shot by, screaming in the night.

**E**VERY MORNING for weeks I went into the barrio, and every evening I walked slowly out again, past where it abruptly ends at 96th Street. Walking down Park Avenue, I felt the eyes of uniformed doormen of elegant granite buildings examining my unshaven face, my old jeans and running shoes. It didn't matter if they thought I was from the barrio; I knew I was only a visitor there. You had to be born in the barrio to understand it, to know what really made it tick. Fear, crime, violence,





drugs—that was the frightening exterior you read about and saw.

It was the humanity that drew you in: The ice-cream man with the drooping mustache tending his wooden cart, Mexican-American boys selling flowers on the corner, weekend baseball on a neat diamond near the river, a happy man crossing the street to shake a friend's hand, kids practicing rap music on the corner, dressy little girls playing hopscotch in the park.

There were people like Dr. Nabil Saad and Raymond Cornbill, who help run North General Hospital, a small 200-bed facility on 124th Street.

"We take everyone who walks in the door," said Nabil Saad, Egyptian-born president of the medical staff and chief of pediatrics. "We accept the poorest of the poor."

"Even if they can't pay," said Raymond

Cornbill, chief operating officer, "we have a moral obligation."

It's clear that things here are tough. Life is on the edge—big families, small incomes. The hospital's staff does indeed see some of the most desperate cases in the barrio—the homeless people with venereal disease, the tuberculosis patients, the AIDS victims. But East Harlem isn't all drugs and crime.

I came to know many of those residents—people who work, send their kids to school, shop in the little stores that open for business every day. Self-reliance, usefulness, responsibility—that is their code.

"I've worked for everything I've got," said Maria Penton, showing me her airy loft on 107th Street. Around us were rows of sewing machines, ironing boards, a time clock, dresses on metal racks—the tools of her successful dressmaking business.



*A healing presence, Alejandro Lugo (left), a deacon at St. Cecilia Church, often closes his barbershop to minister to shut-ins. Paid "grandmothers" play with toddlers (above) so mothers can attend classes at a center run by the Little Sisters of the Assumption. "Poverty is the enemy," says co-director Judy Garson. "Drugs are the cheapest way to feel good." One rising cost: babies born with AIDS, their mothers infected by needles. Dr. Richard Stone, Metropolitan's chief of pediatrics, cradles Angela, who died at 18 months.*







"Too many people lost their self-esteem when they came from Puerto Rico," she said. "The government gave them apartments, clothing, furniture; it made the people shrivel up and die." Maria has lived in the barrio since 1948. She has witnessed gang wars, crack fights, decay.

She pointed a finger at me. "They created a monster! All those generations of welfare!

There is no respect any more because people haven't worked."

But she is proud of her accomplishments. She showed me some black cotton dresses with puffed sleeves. "I can give you this dress in ten days. Hong Kong takes longer. That's how I can make it."

She starts her workers at minimum wage and gives them four raises a year. She



pointed to a man lugging dresses around—her husband.

"I offered him what he was making at his other job," she said. "He accepted." She lit another cigarette. "I'm the boss here. He's the boss at home."

Third Avenue, like 116th Street, is a business district, where sidewalks are filled with racks of shirts and dresses. Store owners are

*Valued only as a shortcut, a vacant lot collects debris. Around the corner, stores line Third Avenue as it saunters north toward el barrio's commercial heart at 116th Street. Such lots are disappearing as new offices and stores open in the area, matching a slow but steady spread of public-housing units and renovated condos. Citing the area's quick access to other boroughs and financial incentives as a state economic-development zone, business leaders talk confidently of the future.*

often Asian. Corner groceries are run by families from the Dominican Republic. Yemenite Arabs operate the candy stores, bought from Jews. Koreans run vegetable stands and fish stores. Chinese are buying whole buildings.

Near 118th Street, I saw a sign in a window full of televisions, lamps, furniture: "Muebleria Kosches, Est. 1888." Inside, Robert Kosches finished talking in Spanish to a young couple and walked me to the back of his store.

Robert had grown up in the neighborhood but now commuted from New Jersey. "My grandfather, who came from Austria, started this business," he said, switching to English.

He is hopeful. "There is a tremendous market up here. I get calls from real estate agents every day," he said, pointing across the street to Inner City Sports, Casa Elegante, McDonald's, all newcomers. Several streets away a mosque for New York's thriving Islamic community is rising.

**S**INCE 1988, when East Harlem was designated as a state economic-development zone, land appraisals have climbed. Businesses can qualify for utility subsidies, generous construction loans, and tax breaks, based on the size of their investment and the number of local people they employ. Urban homesteaders, who renovate old tenements and buy them from the city at bargain rates, are beginning to change the face of the neighborhood as well.

Walking up Second Avenue, I came across a young man with a carpenter's tool belt slung over his shoulder. His boss, David Calvert, of Youth Action Homes, explained what the carpenter was doing.

"We take old buildings that have been foreclosed by the city and rehabilitate them for homeless people," David said. Kids from East Harlem, where the program originated more than a decade ago, do the work.

Ramon Nuñez, the carpenter I had seen in the street, put down his tools and looked me in the eye. "I feel more responsible now. I'd rather work, take my time, do it right."

Ramon, one of 36 youths under David Calvert's instruction, works a week, goes to school a week. If Ramon stays off drugs and sticks with it for a year, he will receive a high school diploma, a driver's license, and a permanent job. Most trainees make good, with 40 of 60 youths advancing to full-time jobs each year—at 20 percent over the minimum wage.

Their work was good. In the newly renovated apartment the molding hugged the corners, the bathroom door hung straight, the closet doors shut tightly.

What about life on the streets?

A tall, thin boy spoke up. "I envy the drug dealers sometimes, but it's not worth it," he said, referring to the gold chains and the \$80 running shoes that pitchers and runners and carriers can buy with the profits of their trade. His jeans and work boots were covered with dust from work. He was an appealing young man, 17 years old, polite, soft-spoken. He had a nice smile. I'll call him Roberto.

What about the future?

"This is New York City," said Roberto. "You never know what might happen."

A few weeks later I heard that Roberto had been shot in a street dispute over drugs. He would survive, but life would be different now that he was out of David Calvert's program.

**P**EOPLE ARE STRUGGLING against great odds," said Sister Judy Garson, leading me into a brownstone town house with bars on the windows and a steel gate on the door. The Little Sisters of the Assumption and other volunteers work out of this house, helping barrio families with food, nursing care, child care, advice. The Little Sisters have been here for 30 years.

"Believing in yourself is so important," said Sister Judy, as another nun put aside groceries for a young mother. "Often the only time a woman is praised is when she produces a beautiful baby. It's two steps forward, one back. But people are making it."

Luz Maldonado, 32, is one of them. "My husband left me, but I've got my feet on the ground," said Luz, a gregarious woman who drops by the Little Sisters' house regularly. She sat with her baby, Marisa, who seemed healthy and well cared for.

"Coming here, being with the Little Sisters, I know I'm not alone," Luz said, upbeat, smiling again. "I'm going to college at night." She took off her coat, put it aside, and looked lovingly at her daughter. "I'm going to make it," she said.

Women like Luz keep the barrio glued together. The percentage of households in East Harlem headed by women—48 percent—is among the highest in the U. S. While men play dominoes in the shade or drink from brown paper bags on the corner, women take care of the family. I saw them day after day, walking the kids to school in clean clothes they can be proud of, waiting for them in the afternoons, making sure they got past the dealers. Women often make the difference between a child who survives and one who dies early.

I met youths who study hard and look to the future at the Manhattan Center for Science and Mathematics, a consolidated grade school, junior high, and high school on 116th Street. Once known as the Drug Store, for the illicit business openly conducted there, the school now attracts national attention for academic excellence. The student body is 98 percent black and Hispanic. The school's dropout rate is less than 2 percent, well below the city average of 40 percent. Some 90 percent of its students rank at or above their grade levels in reading tests, and nearly 100 percent of its graduates go on to college.

"When I came here four years ago, there was no running water in the bathrooms," says Patricia Cook, the high school principal. She explained how investments by companies such as IBM and General Electric have helped turn the school around. The corporations provide much needed equipment, and their employees tutor students, serve as role models, and give advice.

Ms. Cook leans over the table. "When you see how these kids have been wronged in life. . . ." Her voice drops off. "I want to give them the best education possible. We require four years of math and science. Next year we start Japanese." Her eyes fairly burn, this young blond educator, born in the Bronx and educated at Vassar. When the bells ring here, students hurry to class. "I want this to be one of the best prep schools in the world," she says.

Throughout Community School District No. 4, which lies entirely within the barrio, things are looking up. In 1974 the district ranked last in (Continued on page 74)



## Pedro: on the path to manhood



Approaching a cave in Schoharie County, New York, 200 miles north of el barrio, 15-year-old Pedro Tirado matches strides with unofficial big brother Barry Greene. "There's no cave he can't handle," says Barry, a Bronx real estate investor who befriended Pedro eight years ago. For Pedro, who's been in perhaps a hundred caves, "seeing fossils and animals is the best part." Curiosity served Pedro well in elementary school, from which he graduated in above-ground attire (above), and led to his meeting Barry, then an instructor at a local pool. "He pestered me to show him my flippers and mask," says Barry. "He had this spark you don't see very often."









“**G**uys who used to be my friends got me to skip school,” says Pedro, at home with his mother, Anna (left). “But I don’t do that no more.” Now in eighth grade, Pedro attends Harbor School for the Performing Arts, one of East Harlem’s 20 schools of choice. Observers credit this idea with having helped the district raise reading scores from lowest in the city in 1974 to just above average. Pedro pursues gymnastics and circus arts as well as subjects like mathematics. “I love probabilities,” he says.

With six people living in a two-bedroom flat, Pedro studies where he can, usually the living room (lower

left). His bedroom is a place to play with visiting cousins, even as his 26-year-old brother, Flaco, naps. Flaco was later shot to death over an alleged theft of stereo speakers.

“I will definitely get a high school diploma, and maybe college,” says Pedro, who has been offered help by Barry Greene. Either achievement would put him in the minority in East Harlem, which suffers one of the nation’s highest dropout rates. Only one-third of the residents have finished high school.

“Someone once told me there is a third category of people in addition to wolves and sheep,” says Barry. “There are the eagles. Pedro’s an eagle.”





citywide reading scores. By 1988 East Harlem students had climbed to 17th place, just above the average. The private investments help, but the district has also pioneered in schools of choice, under which East Harlem junior high youths can enroll in any of 20 "theme schools" in the district. These schools specialize in one area of study: music, computers, science, and so on.

At Public School 83 proud students stood in front of their exhibits on tooth decay, snails, electricity, water pollution, frogs.

Migdalia Maldonado-Torres, the school administrator, turned to Armandi Muniz, 11,

and asked a question: "What do you want to be when you grow up?"

"A scientist," he said, eyes bright.

Lizette Santiago was next: "A veterinarian and an actress," she answered, poised and serious in her white blouse and blue skirt.

"I grew up in East Harlem," said Mrs. Maldonado-Torres. "I live in Westchester County now, but I feel a commitment here." She paused. "It's not for the paycheck."

Though they know the odds, people still choose to live in the barrio. Raphael Flores is in that category.

When I first saw Raphael, he was on the



phone at Hot Line Cares, the neighborhood's only 24-hour crisis counseling center. He is its director and founder.

He gently chided a caller: "We don't have time to dance! You have to clean your insides of the hurt, your anger, and the habit."

The doorbell rang, and a waif-like young woman walked in, trying to smile. Warren, a former street kid who works as a volunteer, filled out a form for her.

"I don't know where I live," she said tentatively. "I . . . I would like to seek some help. I don't have nobody to talk to."

"What about drugs?" Warren asked.

*Warming up for a winter parade, Orlando Oquendo prepares to march on Three Kings Day. The celebration of the Feast of the Epiphany cheers residents with camel-riding kings, folk music, and hundreds of costumed children. Renewed in spirit, a small town in a big city, el barrio carries its burdens with an irrepressible Latin beat.*

"I've been off crack for a week," she said.

Warren made some calls. The rehabilitation centers were full, but she could sleep here until they found a place. She smiled.

When Raphael had a moment, the two of us stepped outside. "There are so many young people like that," he said. "I talk to them about God, tell them they can't do it by themselves. I read them the Bible. It's the only answer I know."

**I** THOUGHT about the people I had met: Roberto, shot; Therese, now in prison for selling heroin; José, negotiating the treacherous currents of the crack trade. But there was also the tenacious Maria, still making dresses and money at her shop; Sister Judy, walking up another flight of stairs to visit another young mother; Alejandro, philosophizing as he clipped another customer's hair; Raphael, trying to save the lost kids; Luz, watching over her daughter. And there was Steven Sloan.

"Come on," Sloan said, "don't drag now." I looked up and saw him, a black man striding ahead of a dozen youngsters. Sloan tapped the ground with a long white cane, feeling his way. When the blind man stopped in the park, the children stopped with him.

"Stretch easy now," Sloan said. "Make sure your legs are straight." He touched their backs and legs with his hand.

"OK, everybody run a lap," said Sloan, a physical education teacher who works with learning disabled youths at Public School 102.

One by one the students straggled back after running their laps on the concrete oval in Jefferson Park.

"I try to teach the kids that life is hard, life is tough, nothing comes easy," Sloan told me. "I try to teach them character, to be proud of what they are."

He made them do sprints again and again. I found myself watching a slender boy, about 14, running ahead of the others. He had a nice easy stride; he could be good. □



# EARTH

## Prelude to The Big One?

By THOMAS Y. CANBY SENIOR ASSISTANT EDITOR

**L**IKE THOUSANDS of other good Californians, Lee and Terry Peterson had gone to the third game of the World Series that evening, to see the Giants try to bounce back against Oakland at Candlestick Park. Far south of the park the Petersons' new frame home, their pride and joy, clung to a shoulder of the Santa Cruz Mountains, near a dark peak named Loma Prieta.

Eighteen kilometers beneath that home and peak another contest was playing, in an arena known as the San Andreas Fault. Here two enormous plates of earth's crust had been locked in a planetary pushing match since the great San Francisco earthquake of 1906. These players were tiring, reaching the breaking point. Their game was in the last inning.

The Petersons found their seats at Candlestick Park. Expectantly they watched the teams warm up. The clock hands reached 5:04. *(Continued on page 84)*

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*After riding out the collapse of her four-story apartment building in San Francisco's Marina district, Helene Warwick, right, embraces her sister, Nancy Peterson. The major quake last October 17 terrified bay area residents. Is worse to come?*



# QUAKE



# With a roar, hillsides collapsed





*"My watch read 5:04"—right on time, according to the recorded moment of the earth's upheaval. Landscaper David Gasser had pulled his pickup off Route 1 about 70 kilometers south of San Francisco when "the cliffs began exploding" across the road. The amateur photographer, 30 kilometers from the quake's epicenter, captured the center and flanks of the resulting landslide.*

*(left, top to bottom). Minutes later it still seethed (below), as did a distant slide, at lower right. As the dust settled from San Francisco south to Santa Cruz and beyond, a wide-angle picture of destruction emerged: 63 people dead, nearly 3,800 injured, more than 28,000 homes and businesses damaged, and losses totaling some six billion dollars.*





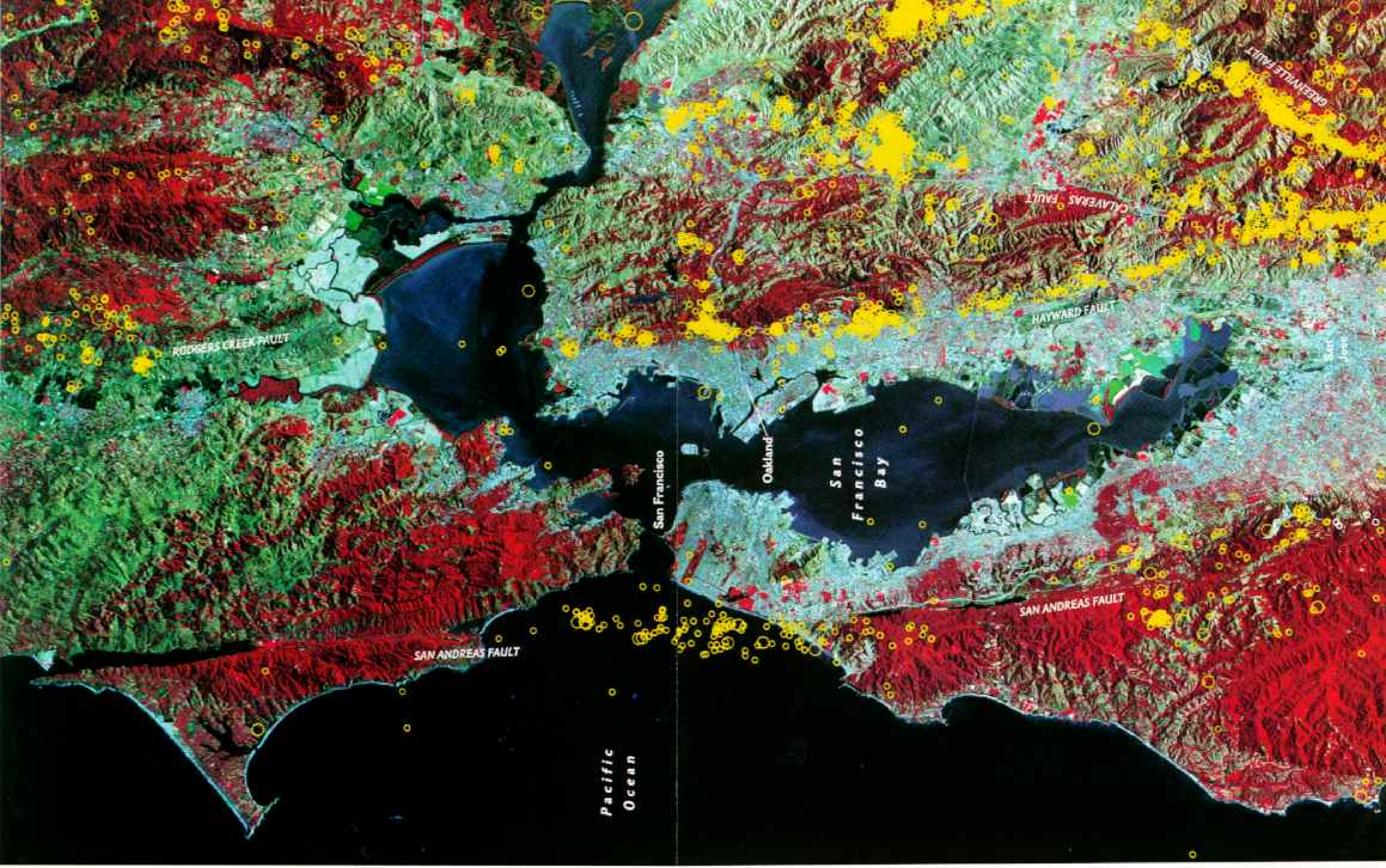
# Loma Prieta: Not The Big One



Despite the violence of last year's northern California earthquake that registered a sharp 7.1 on the Richter scale, scientists warn that it was merely a dress rehearsal. They see a much more catastrophic event as inevitable in a land locked in the high-pressure grip of the San Andreas Fault and its associated fractures.

People felt the October 17 quake across a million square kilometers, from Los Angeles to southern Oregon and western Nevada. Its most acute effects fell within this satellite view, ranging from the Marin Peninsula in the north, upper left, clearly cleaved by the San Andreas, through San Francisco Bay at center to Monterey Bay at lower left. Northeast of Monterey, in the Santa Cruz Mountains, near a peak called Loma Prieta that christened the event, a segment of the San Andreas Fault broke, triggering the quake. Its main shock is shown by the largest white symbol; others indicate some of the 6,000 aftershocks. Yellow symbols trace tremors of magnitude 2 or greater throughout the region over the past 20 years.

Some destructive seismic waves raced southward, ripping apart downtown Santa Cruz, then continuing on to batter other nearby communities, especially Watsonville, a center for vegetable processing. The waves rumbled north to cripple Los Gatos and rattle San Jose, where most structures survived. The seismic juggernaut announced itself to



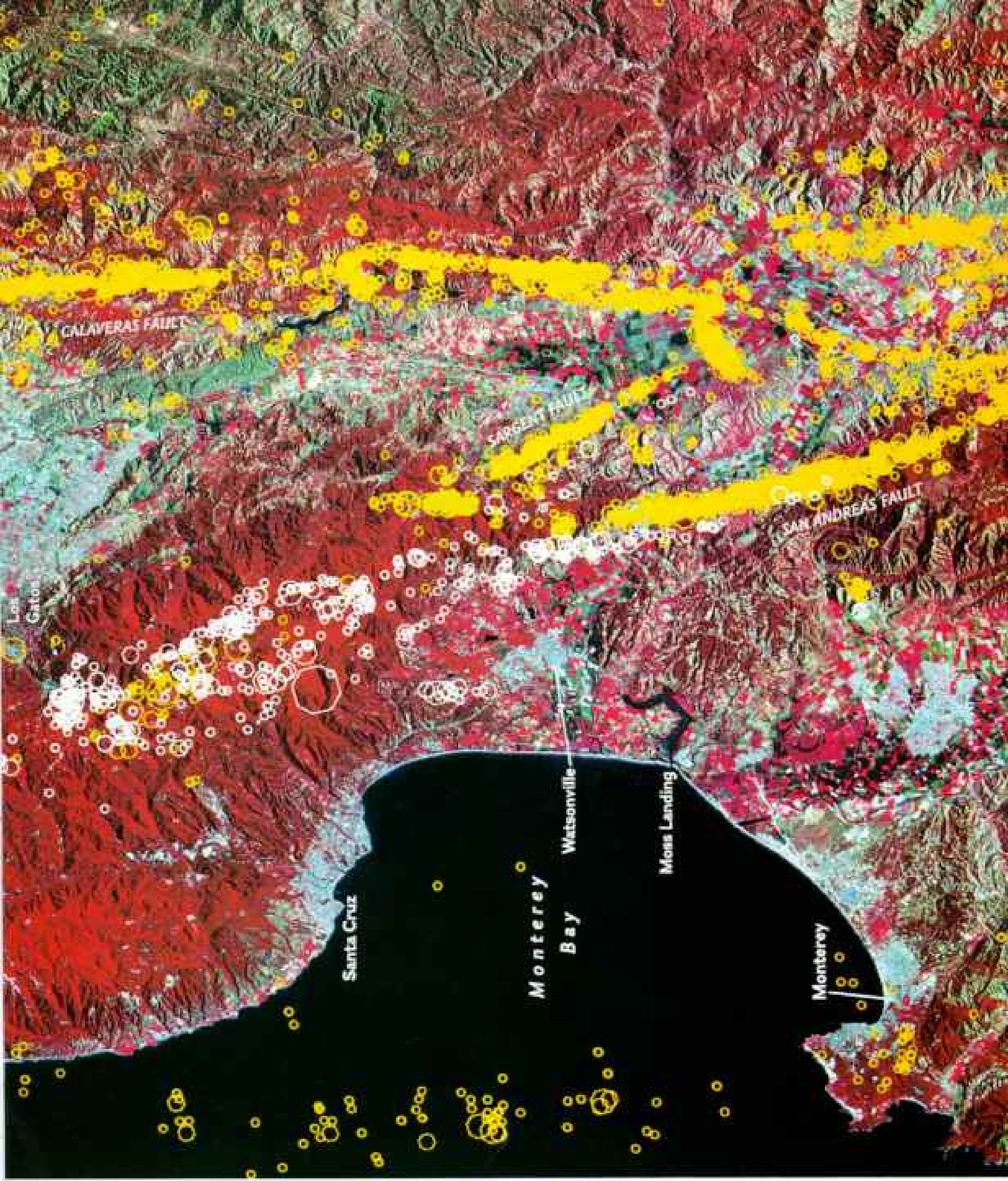


some 62,000 fans at Candlestick Park and 50 million nationwide viewers by emphatically preempting the World Series.

Yet even as the waves weakened, now 95 kilometers from their origin, they were amplified by soft fill material where San Francisco and Oakland had grown into the bay. In a final crescendo, they sacked the Marina district, yanked open a section of the Bay Bridge, and caused the ghastly collapse of Interstate 880 in Oakland.

But planners fear far worse effects from an earthquake originating closer to densely populated areas. While the Loma Prieta event relieved stress on one San Andreas segment, tension continues to build on others, as well as along the Hayward Fault, outlined by yellow symbols just east of Oakland and running south through its teeming suburbs. Seismologists predict a 50 percent chance of a magnitude 7 quake occurring in the region within 30 years.

THE MONTECAL, EARTHQUAKE HISTORY BY MICHAEL SAWYER, EARTHQUAKE DATA COMPILED BY JOHN SLATE, U.S.G.S., MENLO PARK, CALIFORNIA



*(Continued from page 76)*

Deep beneath the Petersons' mountain home a section of weak rock snapped. The two sides of the San Andreas shot past each other. Simultaneously the west side of the fault rose, lifting the mountains themselves.

The ripping was unstoppable. For about eight seconds earth's crust unzipped at more than two kilometers a second, 20 kilometers to the north and south. The bucking Santa Cruz Mountains flicked the Peterson house off its foundation, cracking it like an eggshell.

The faulting released a frenzy of seismic waves. They set seismometer needles scribbling around the world and carried a lethal message to Californians.

Waves rolling to the south bludgeoned the city of Santa Cruz, only 16 kilometers from the epicenter. They took out its commercial heart and snuffed four lives.

The waves smashed into Watsonville, damaging or destroying most homes and turning Main Street into a ghost town. They mutilated Hollister and churned the rich sediments of the Salinas Valley.

Waves rolling north roiled the ground beneath picturesque Los Gatos, shattering Victorian houses and half the business district. They shook San Jose, but most buildings held.

The waves swept up the peninsula, rattling securely planted cities such as Palo Alto and Menlo Park. At Stanford University they found old, brittle structures and twisted and cracked them.

Ahead lay Candlestick Park, packed with 62,000 fans and ripe for disaster. The waves shook the Petersons and other bewildered spectators. But Candlestick sits on bedrock, and it defeated the waves.

Now the waves were weakening. With little effect they jiggled southern San Francisco and towns across the bay.

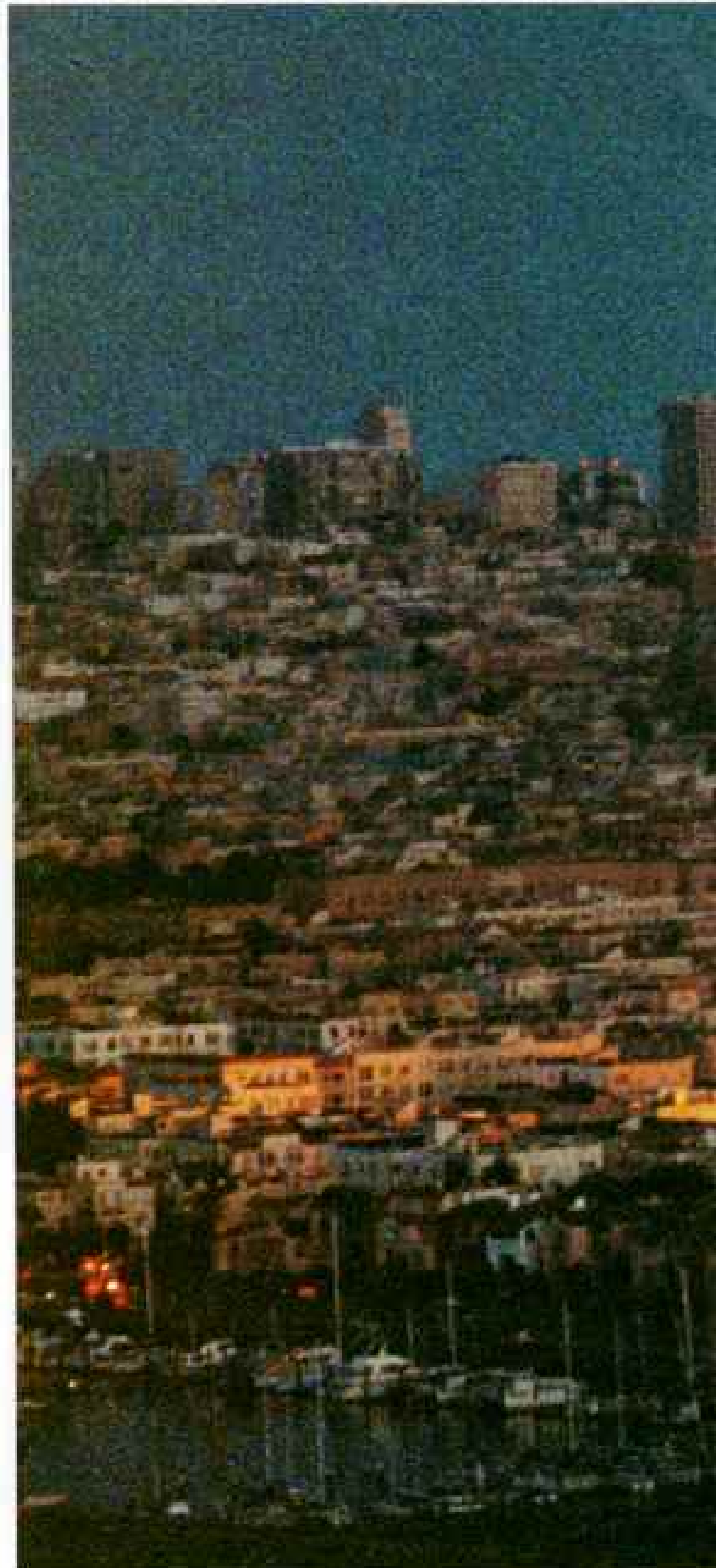
A tiring vanguard of waves reached San

Francisco's old Market Street area and Marina district and Oakland's busy waterfront. These areas sit on man-made fill. Here the waves found soil in tune with their own vibrations and strummed it like a guitar string.

More waves arrived and pumped in more energy. The earth grew alive and danced.

The vibrations flowed upward into buildings and highway structures. Picking up the rhythm, soil and structures swayed to the strengthening beat like partners in a dance.

Marina buildings buckled; many fell. Column joints supporting Oakland's Interstate



*Blacked out by the upheaval, stunned San Francisco is lit only by an inferno fed by broken gas lines in the Marina district. Other fires erupted, but lack of wind kept them from spreading, the bane of the 1906 quake. Residents helped fire companies wield hoses, embodying a volunteer spirit that staffed shelters in the bay area and hard-hit communities to the south soon after the earth ceased to tremble.*



880 failed, and 44 slabs of concrete deck, each weighing 600 tons, collapsed on cars below. The waves pushed the Oakland end of the Bay Bridge 18 centimeters to the east, and a 15-meter section crashed onto the level beneath.

**W**ITHIN 15 SECONDS the vibrations faded. But 63 persons lay dead or dying. Some 3,800 others suffered injuries requiring medical attention. The waves damaged more than 24,000 houses and apartment buildings as well as nearly 4,000 businesses. At

least a thousand structures faced demolition.

Measured in adjusted dollars, property damage approached that of the dreadful tremor of 1906, which unleashed 60 times as much energy. The Loma Prieta damage exceeded that inflicted by Hurricane Hugo during the hours it lashed the Southeast.

Still, California had been lucky. A few more seconds of shaking could have severed a crucial joint of San Francisco's battered Embarcadero Freeway, bringing it crashing down like I-880, and thousands more homes would have been damaged or destroyed. If bolts had



not failed on the Bay Bridge, swaying trusses could have pulled down more of the vital span. If the World Series had not riveted Californians in their safe homes to watch TV or clustered them in the protective nest of Candlestick Park, who knows the tally of highway victims?

With the many wounds, moreover, came a new sense of confidence among Californians, a belief that they are doing many things right about quakes. A few of the pluses:

□ The relatively low level of damage. "Keep in mind that the vast majority of bay area buildings suffered *no* damage," emphasized John Osteraas of Failure Analysis Associates, Inc., a Menlo Park engineering firm.

□ The value of preparedness. Within hours of the earthquake, shelters opened from the Marina district to Hollister. Though staffed partly by legions of spontaneous volunteers, these nerve centers had been carefully planned. Throughout the year the Red Cross, the state Office of Emergency Services, and other agencies conduct rehearsals that bore fruit in the October 17 response.

□ The growing reliability of quake forecasts. A 1988 assessment of earthquake probabilities along the San Andreas Fault, published by the U.S. Geological Survey, had assigned the southern Santa Cruz segment the highest likelihood of slipping for northern California.

"Loma Prieta strengthens our confidence that our simple models are accurate enough to be useful," said the Survey's Allan Lindh, a leading force in earthquake prediction.

□ The human response. Like an opened spigot, the quake released an untapped flood of caring and kindness. Volunteers materialized as if from the shaking earth, directing traffic on darkened streets, comforting the terrified with a word and a hug, extricating the injured and the dead.



ONE SAW IT EVERYWHERE, from the war zone of the wealthy Marina district to the shambles of blue-collar Watsonville.

"Nearly 400 of us are helping here," said Lynne Newhouse, a Red Cross volunteer at the Marina Middle School. The concrete structure swarmed with homeless and helpers.

Lynne lives in Pacific Heights, on the precipitous hills above the Marina. Surely those precariously perched houses had slid in the shaking. But no; the good rock of the hills had resisted the waves, and she had escaped with only a brief loss of electric power.

In the school gymnasium cots covered a wooden floor marked out with two basketball courts. Homeless victims sat on their cots or in chairs ringing the courts.

One chair held Alice Legare, a slim retiree of



*Eerie signatures: A pier of the San Francisco-Oakland Bay Bridge creates circular ripples after being vibrated by seismic waves and the collapse of an upper section of the double-deck span. One driver died. If the section had not snapped, more of the bridge might have whipped down, killing many others. Service was restored a month later.*

*At his home outside Napa photographer Peter Menzel first watched his parked car do a seismic dance, then discovered a dramatic wave pattern created by the earthquake in his pool, inspected by puzzled sons Jack, at left, and Evan.*

Sylvie Mallette, Alfa Press (left)

79 whose three-story Marina apartment building had rocked mightily that evening.

"Usually, when a quake hits, I get up from the sofa and run to my hallway, a safe spot," she said. "This time I couldn't; every time I rose from the couch, the shaking pulled me down again. The building leaped, and everything in my room came crashing down. I held my ears and began yelling, 'Oh no! Oh no!' I was sure the building would collapse."

With the electricity off, Miss Legare turned on her battery radio, and it told her about the Middle School shelter. "Some of the yuppie tenants piled in their cars and went to motels in Marin County," she related.

A youthful volunteer approached, passing out coffee and soft drinks. Miss Legare declined appreciatively. "This experience shows you what a good element this city has."

Miss Legare herself would suffer seismic shocks this day. In the morning she feared her building would be red-tagged—the dreaded notice of unsafe. "I guessed I would return to my family in New England. But I love this city, its climate." She received a green tag and exultantly returned. But there had been a mistake: Soon a red tag branded the building, and she had 15 minutes to abandon her home of 40 years. A latent heart condition flared, and the Red Cross cared for her until her family could escort her to Massachusetts.

**P**ROWLED the Marina, past water crews restoring the area's 66 broken mains, past streams of evacuees towing wheeled suitcases full of clothes. I saw houses that were intact but had partially sunk into the soil. Beside them I found small volcano-shaped piles of sand, signs that the shaking had liquefied the soil, allowing the building to settle.

With Lawrence L. Litchfield, superintendent of the city's hard-pressed building inspectors, I checked out a red-tagged house on North Point Street in the Marina. Its first-floor garage level had cracked, and it leaned gently against a similar row house.

The agonized owner, 61-year-old Gloria Cary, awaited the outcome from the sidewalk. Until October 17 she had lived on the floor above the street-level garage. Her daughter and three children occupied the top level. Since the quake she had taken up chain smoking and was calming herself with Valium.

Mrs. Cary's former husband, Bill, stood beside her, an arm around her shoulders. Since the quake the three generations of women had slept at Bill's nearby apartment. "A family pulls together at a time like this," he said.

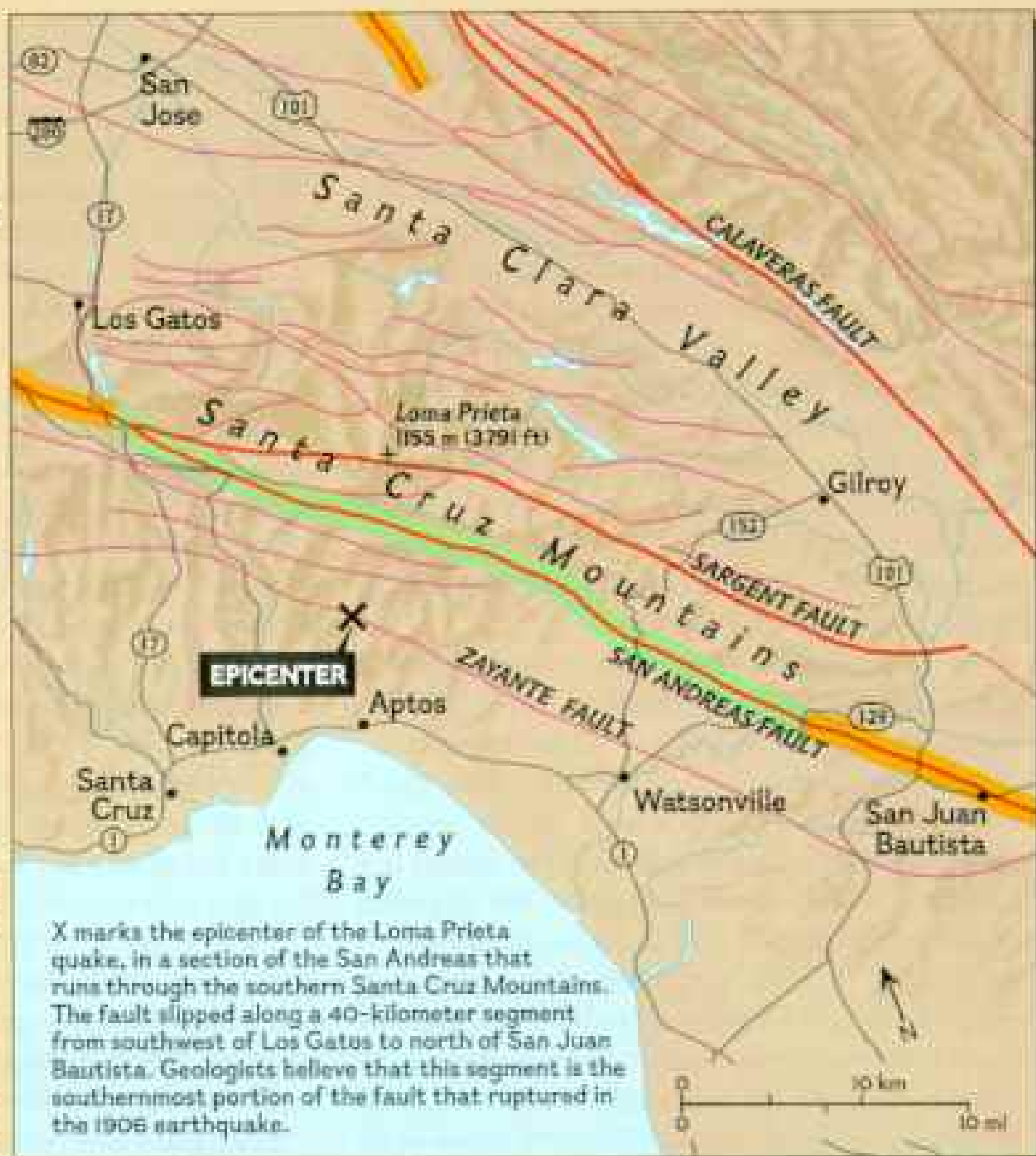
Now their fate rested in the hands of the city inspectors, represented by Larry Litchfield.

He examined the garage level. Several of its spindly wooden supports had shattered. Most

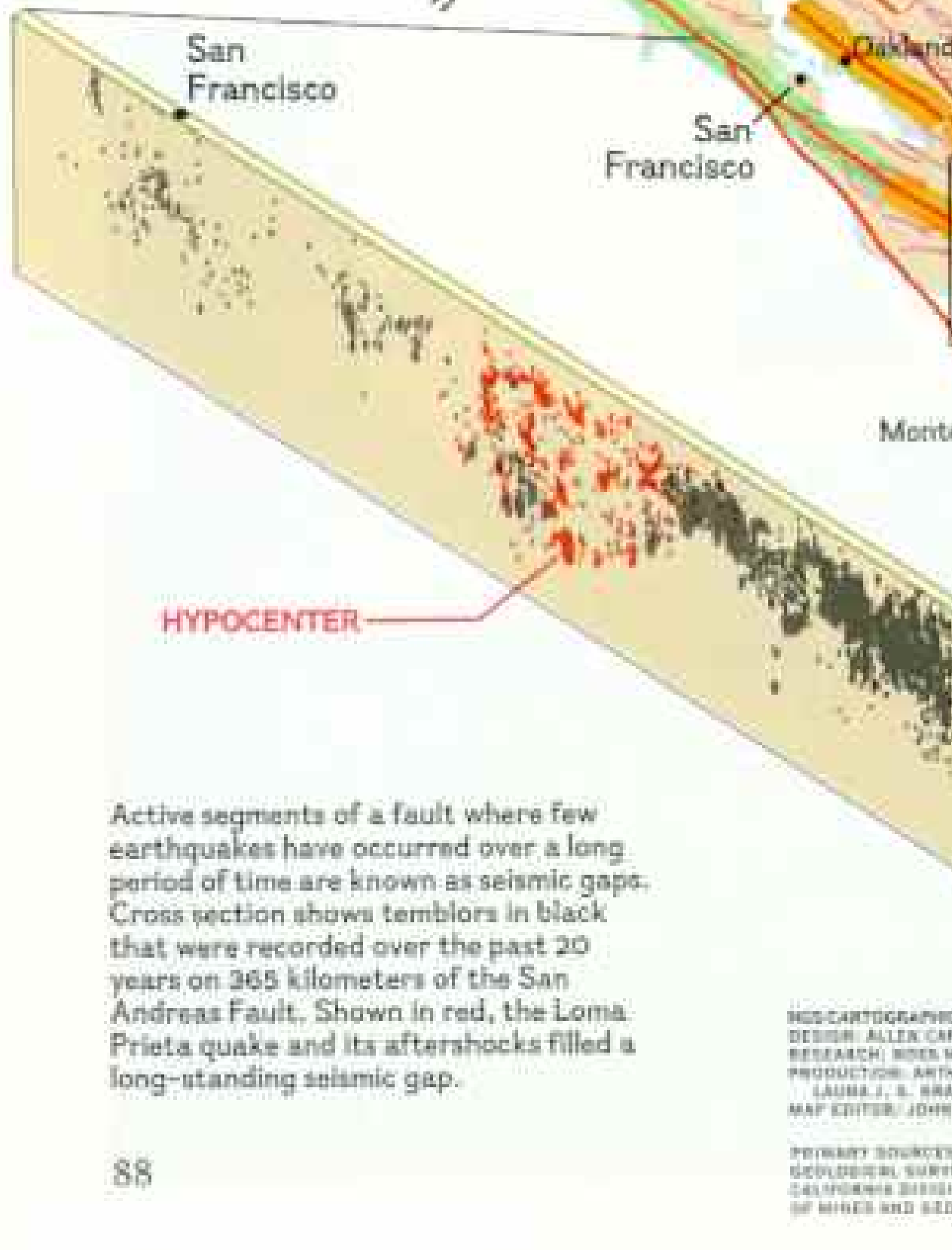
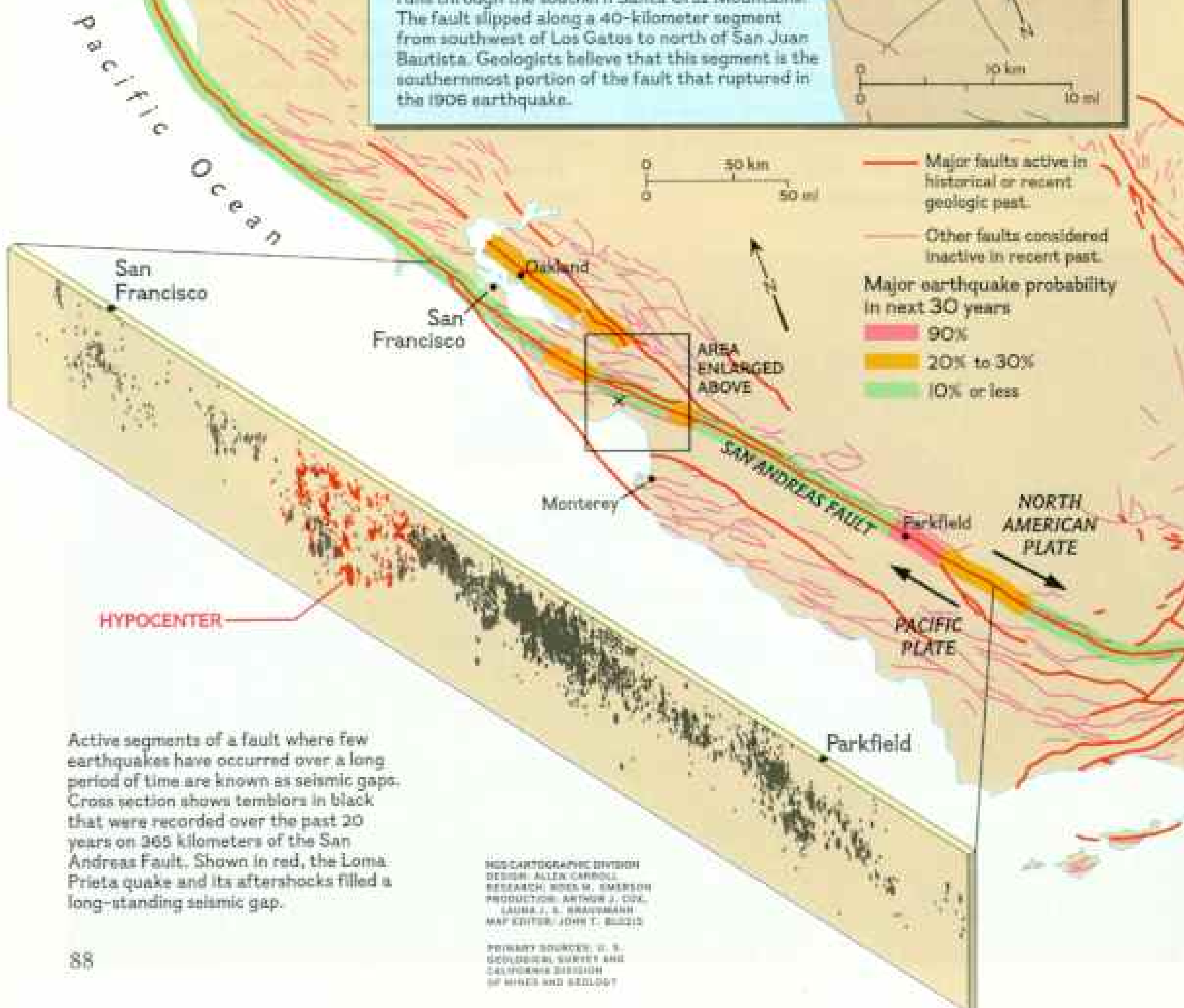




Fundamental fact of life for millions of Californians, the San Andreas Fault forms a 1,200-kilometer-long boundary between two enormous tectonic plates, the Pacific and the North American. For some 30 million years the Pacific plate has been grinding northwestward past the North American plate at an average rate of six centimeters a year. But most movement along the fault occurs in sudden jumps. When the plates become locked, strain builds up until a sudden release produces an earthquake. Loma Prieta was the fifth quake of magnitude 5.3 or greater to hit the San Francisco Bay area since 1865.



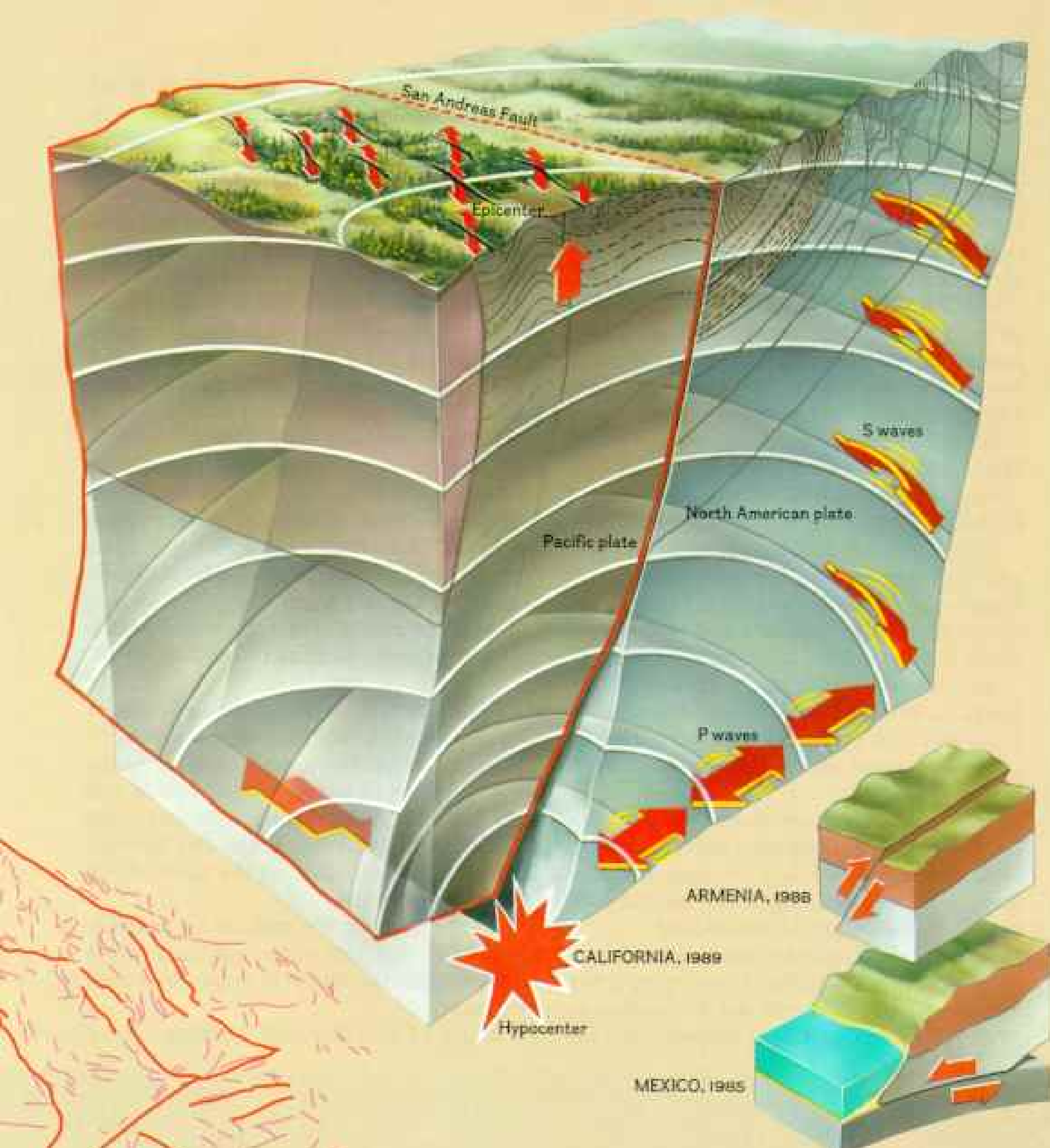
X marks the epicenter of the Loma Prieta quake, in a section of the San Andreas that runs through the southern Santa Cruz Mountains. The fault slipped along a 40-kilometer segment from southwest of Los Gatos to north of San Juan Bautista. Geologists believe that this segment is the southernmost portion of the fault that ruptured in the 1906 earthquake.



Active segments of a fault where few earthquakes have occurred over a long period of time are known as seismic gaps. Cross section shows temblors in black that were recorded over the past 20 years on 365 kilometers of the San Andreas Fault. Shown in red, the Loma Prieta quake and its aftershocks filled a long-standing seismic gap.

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PRIMARY SOURCES: U. S. GEOLOGICAL SURVEY AND CALIFORNIA DIVISION OF MINES AND GEOLOGY



## Birth of an earthquake

Some 18 kilometers beneath the surface, the San Andreas Fault suddenly ruptured—the earthquake's hypocenter. White curves show energy radiating in all directions: P (primary) waves caused by compression of the rock and slower S (secondary) waves that result from shearing along the fault. When the fault broke, the Pacific plate slipped two meters northwest past the North American plate and also rode upward about one meter. This motion was mostly absorbed well below ground, causing relatively

small cracks and only moderate uplift on the surface.

The quake occurred on a strike-slip fault, where two plates slip laterally past one another. The 1988 temblor that killed tens of thousands in Armenia took place on a thrust fault. And a 1985 quake on a subduction-zone thrust fault killed 10,000 people in Mexico City. Though geologic mechanisms differed, all three caused the worst damage in structures on soft soils—man-made fill or ancient lake and riverine sediments.

PRINTING BY RICHARD LESCH. PRINCIPAL CONSULTANTS: JOHN B. FULSON, USGS, RESTON, VIRGINIA; MALCOLM M. CLARK, DANIEL L. PORTI, RAY E. WELLS, USGS, MENLO PARK. DESIGN BY MARY R. HOLMES. RESEARCH BY WENDY CORTES.





against each other and were of different heights," said Helmut Krawinkler of Stanford University. "This gave them different periods of vibration and caused them to butt against one another. Some pounded each other to ruins. Sometimes the shorter building, with the quicker movement, dislodged the taller building's side wall, and it fell on the short structure. Unreinforced masonry buildings are death traps and should be reinforced whenever possible."

With Santa Cruz residents Bob and Jean Holston I drove up into the mountains, toward the dark peak named Loma Prieta. On a mountain shoulder, Lee and Terry Peterson's house still stood, but its spine was broken.

I walked around a small moving van and stuck my head inside the house.

Immediately I felt disoriented. The floors sloped off, each room at a different angle. Walls tilted. Only a chandelier, hanging like a plumb bob, indicated a true direction.

Walking unsteadily to the kitchen, I found Mrs. Peterson sorting things to be saved, things to be cast out. Mr. Peterson and their friend John Everett were eyeing a huge refrigerator, one of the last items yet to be removed.

I uttered my sympathies.

"It's just a house," said Mrs. Peterson cheerily. "We still have our lives, our pictures—I still have my wedding dress." She paused. "This place is still settling. If you hear a creaking, go for a door."

I helped tilt the refrigerator onto a dolly. From kitchen to door, the floor slanted uphill. We put our

*(Continued on page 96)*



CHARLES O'BRIEN, WEST LIGHT



On shaky ground, Robert Brown of the U. S. Geological Survey photographs a sand boil that burst up through a mud flat south of San Francisco. The phenomenon results from a process called liquefaction, treacherous to buildings. In an earthquake, loose and saturated sandy layers become like quicksand, with virtually no strength to support structures as the ground heaves. Through weak spots in the soil, sand boils erupted into basements, yards, and streets atop man-made fill where San Francisco and Oakland grew both before and after the 1906 earthquake (left). Built on fill, the Marina district was heavily damaged. There, some sand boils acted as time capsules, ironically spewing fragments of buried redwood and other debris from the 1906 quake used as fill.



# The Quake of 1906

**Dramatic images of an  
unforgettable event**





**L**ike the cold marble statuary gracing the funeral pyre of a city in flames, the horses lay in the wholesale district, killed by falling bricks. This was the seizure against which all San Francisco calamities would be measured, the triptych of earth, wind, and fire that began on April 18, 1906. Visiting from the Stockton area, a 22-

year-old photographer named Edith Irvine (left) captured 60 powerful images on glass plates, preserved in the Brigham Young University Library.

At the time, she may well have hidden her plates from authorities bent on minimizing adverse publicity—some photographers' work was confiscated. But in a sense, the terrible flames she recorded

also consumed her career. Records involving her father's ownership of several major mines were destroyed when fire ravaged City Hall. With the family fortune in legal limbo, the young photographer apparently could no longer afford to make pictures. So Edith Irvine went home to Mokelumne Hill and eventually became a schoolteacher.







*On May 1, 1906, another young woman who survived the earthquake, Exa Atkins Campbell, poured out her impressions to her parents in Pleasant Hill, Louisiana. Her hitherto unpublished letter is here transcribed in part:*

*Excuse errors, etc. as my nerves are still on edge  
& I have earthquakes every little while.*

Dear Folks at Home:

I have been waiting [until] I felt equal to telling you something of the terrible disaster which has just befallen dear old "Frisco."

The moment I felt the house tremble . . . I leaped out of bed and rushed out to the front door . . . I was sure the house would fall before I got out. It rocked, like a ship on "rough sea."

Streams of people . . . poured into the streets . . . a mourning, groaning, sobbing, wailing, weeping, and praying crowd.

The deathly-still air [was] very oppressive. . . . quiver after quiver followed . . . until it seemed as if the very heart of this old earth was broken and was throbbing and dying away slowly and gently.

People were beginning to get out from town and . . . circulate all kinds of frightening reports about the loss of life, that San Francisco was sinking, that the water was two blocks up Market St. . . . and dozens of other fibs, so people were almost crazy with fear.

Then the awful fires broke out . . . & no water to speak of. . . . We heard that . . . the big fire in the mission was caused by a man and woman who, after being made to put out the first fire they made, built another as soon as the policeman left. He came back . . . called them out and shot them dead.

The car tracks were torn up and the iron rails even broken. . . . there was no way to fight the fire except to dynamite the buildings. . . . mansions of the millionaires were blown to atoms.

Night came on, but there was no night for us. The reflection of the fire extended over the city changing night into day.

The city was patrolled to prevent thefts and keep people from using lights in the houses, as some were crazy enough to do it on the sly. One woman was shot after being twice ordered to put out a light and a man was hung & a sign placed on his body, saying "This man was hung for stealing."

That second day will never be forgotten. We heard that all the western coast was visited by a worse quake than Frisco. Then we heard there was a Globe Earthquake, that Chicago was under twenty feet of water, also that New York had sunk, that Seattle was burning and Los Angeles was wiped out.

The entire day people were moving out our way. . . . Some were dragging trunks . . . some used baby buggies, chairs with rollers, little play wagons . . . tables with runners put on. . . .

All night the fire raged and all night the earth shook from the great explosions of dynamite, block after block went down.

It is horrible.

It will be a long time before Frisco will be her old self if ever.

It is a remarkably queer fact, daily discussed, that no government buildings here were totally destroyed or seriously injured by the fire.

It is a sad sight to see the dear old City Hall, which required seven years' building, a total wreck.

I forgot to say that sixteen little babies were born in the Park the day after the quake, and one woman had triplets.

This calamity has brought every body to a level—we are all equal sufferers and sharers of trouble—there is no distinction.

LETTER COURTESY MR. AND MRS. JAMES ATYNS TAYLOR

**R**efugees came from all classes, like these women with their belongings in trunks watching as a blaze devours Russian Hill (left). Fires raged for three days after the 1906 quake, estimated at magnitude 8.3—60 times the energy of last year's jolt. From Nob Hill, Edith's lens looked southwest into utter devastation (above). Out of a population of 400,000, only 498 died, or so said the Army. After 25 years of research, San Francisco archivist Gladys Hansen now estimates fatalities at more than 3,000.

*Exa*

shoulders to the dolly. P-u-s-h! It rode over a post that had thrust up through the flooring. We stopped for breath with the refrigerator blocking the doorway, the only usable exit. Don't collapse now, house. . . .

Another caller: Mark Sawyer, the insurance adjuster. A quick glance around, and he started writing a check. "This will give them a sense of assurance." He looked around to see that the Petersons were out of earshot: "This house is the worst I've seen, by far."

Outside, Mr. Peterson gestured. "Up there on the ridge—that's where I'm thinking of rebuilding. We had a geologist out, and he found good rock. This time we'll bolt down."

Insurance . . . good rock . . . bolting down the house: These are buzzwords in post-quake California.

**ONCE NOTORIOUSLY UNINTERESTED** in earthquake insurance, Californians have changed their ways. "Policy purchases have skyrocketed in the past 15 years," said Risa Palm of the University of Colorado in Boulder. In a study of four California counties completed a year ago, she found that about 30 percent of homeowners were insured.

Since 1985, state law has required insurance companies to offer quake coverage with homeowner policies—by certified mail to assure receipt. Dr. Palm credits this with part of the increased sales.

Who buys quake insurance? Not necessarily those who live near known faults or on unsafe soils. "The buyers," said Dr. Palm, "are those with the greatest earthquake awareness—people who *perceive* the risk."

Californians in increasing numbers are investing in another form of house insurance: simple structural reinforcement. "A homeowner can bolt the home to its foundations and strengthen the crawl space with plywood for about \$500," said Peter Yanev of EQE, Inc., the nation's largest earthquake engineering firm. "A contractor will do it for \$2,500."

Like insurance and reinforcement, the value of living on bedrock came home on October 17. "The safest place you can be," remarked Robert Brown of the USGS, "is on level ground that is bedrock. Unfortunately, California doesn't have enough of either."

Can Californians learn what lies beneath their dwellings?

"The word has been out for a long time," said the Survey's Roger Borchardt. In 1975

*Touring in a limousine, a Japanese TV crew films a geologist studying a crack near the epicenter in the Santa Cruz Mountains. Landslides closed nearby Route 17 for weeks. Although fissures abounded, none represented actual surface faulting, the usual signature of so large an earthquake.*







BOOTH BY JIM RICHARDSON, WEST LIGHT

*Falling debris engulfed a car as the quake shattered more than a third of the Pacific Garden Mall in the heart of Santa Cruz. Across the county five people died, 671 were injured, 6,377 fled their homes, 744 houses were destroyed and 13,329 more suffered serious damage. The toll was placed at half a billion dollars.*

he, Kenneth Lajoie, and James Gibbs published a seismic-intensity map for the bay area, based partly on Dr. Borchardt's analysis of soil reactions to seismic waves from underground nuclear tests in Nevada.

Their map has had impact. Local jurisdictions have incorporated versions into land-use plans. Los Angeles and other areas have followed suit. But development pressures continue. Dr. Borchardt worries about high rises invading Redwood Shores, a community built on compacted fill south of San Francisco. "The fill has a natural seismic period of about one second—the same as a ten-story building. These could shake violently in a large quake."

**T**HE SOIL LESSONS of Loma Prieta echo the quake experiences of Armenia in 1988, Mexico City in 1985. More than 25,000 died in Armenia; unofficial estimates double that figure. Mexico City's temblor claimed 10,000 victims. In both locales the devastated buildings sat atop deep lake and riverine sediment that amplified the waves as much as ten times.

I descended the mountains on Highway 17. Enormous slides, triggered by the quake,

closed the road to general traffic. Road crews would toil a month to clear 435,000 tons of rock, soil, and trees and open the vital link between Santa Cruz and San Jose.

Low on a plain in the Pajaro Valley lay Watsonville, a frozen-vegetable processing center. Here damage rivaled the Marina's, but the misery was incalculable. Many of Watsonville's distressed were poor: Hispanic migrant workers and laborers in the food plants.

I stopped at a shelter. "A lot of our people live in ramshackle houses, garages, and shoddy low-income housing," said Carlotta Woolcock, a manager of a farm workers association. "They suffered worst."

Ms. Woolcock presided calmly over a scene reminiscent of D day. A succession of trucks unloaded food, clothing, and bedding donated from around the state and nation. Human chains passed the goods to impromptu depots. Lines of victims picked up the goods. Across the road, National Guard helicopters ferried in more supplies.

Behind the shelter, a tent village held families whose houses were no longer habitable or who avoided a roof overhead for fear of aftershocks. Some had acquired this fear four years



## No exit: terror on the freeway

Flattened to its axles, what once was an automobile lies entombed under the Nimitz Freeway, a 2.7-kilometer segment of I-880 that collapsed in Oakland. Apparently the columns that supported the

double-decked structure's upper level were not connected firmly enough to those of the lower roadway, and 26,000 tons of the upper deck pancaked straight down (right), killing 42 people.

Amid the disaster, a twist of

fate united three fire fighters. One who survived the ordeal, Treasure Island fireman Tim Petersen (left, at center) revisits the scene with two Oakland firemen—his father, David, at left, and rescuer Andy Papp. Tim lay pinned in his crumpled pickup for more than five hours with six broken bones and a collapsed lung while Andy and a colleague worked to free him. "The steering wheel was jammed into my crotch," Tim recalls. "It was like someone had kicked me there and left their foot in." Finally, using special tools, the rescuers extricated Tim. Andy had previously worked with Tim's father, a fact Andy learned as he struggled to save his friend's son. "I look at things differently now," says Tim. "It can all end so fast."



MONTY W. FARMER (TOP); JAMES A. SUGAR (BOTTOM); MARTIN E. KLUMER



earlier in Mexico City, where a powerful aftershock demoralized stricken inhabitants.

Main Street, Watsonville's commercial core, was eerily deserted. Stores showed cracked facades, fallen gables, smashed showcase windows. At the north end St. Patrick's Church stood wounded, hemmed with fallen brick. "That's bad for this community, so strongly Catholic," said Yolanda Ortega, whose bungalow had buckled but stood.

**DROVE** up the east side of the bay to Oakland. The gray hulk of collapsed I-880 slumped in its rubble, a somber headstone for a part of civilization that failed.

That concrete pancake had trapped 58 vehicles, some flattened to less than a foot high. The grisly task of extricating the dead fell to Navy nurse Alison Mueller, director of emergency training at Oakland Naval Hospital.

"I wanted to reach them quickly, so we could notify relatives," recalled Commander Mueller. Working five days with little rest, she would learn much about how the trapped motorists had died.

"I positioned myself on top, with the Caltrans digging equipment," she recalled. "Below in the pancake, men crawled in on their stomachs and gave the exact locations of cars.

"The excavators dug down to a car roof, and firemen peeled it back. I extricated the victims and their personal possessions. Some bodies were so crushed I had to dismember them. I tried to do it with dignity, for the sake of their loved ones—I guess that's the nurse in me. We worked the length of the collapse and pulled out 35 bodies.

"By the end I saw a pattern in the motorists' behavior. Some swerved over to the support columns, believing these would save them. Some speeded up, hoping to outdistance disaster. Some left their cars and tried to escape on foot. All died quickly."

Built to the earthquake-engineering criteria of the 1950s, later strengthened in part but never completely, I-880 today stirs a tempest of faultfinding and priority-sorting. There is little dispute, however, about the treachery of the soil it stood on.

The intensity map prepared by Borchardt, Lajoie, and Gibbs identifies the ground as fill over bay mud and predicts "violent" shaking. A field test conducted by seismologists at Columbia University's Lamont-Doherty



# Structural staying power

**H**omes and businesses built on filled land in the San Francisco area can be made more resistant to earthquakes by using proven engineering techniques — some required by building codes. The major objective: to prevent building collapse and loss of life. Walls, floors, roof, and foundation should tie together to create a structure that can withstand horizontal and vertical forces resulting from violent ground shaking and liquefaction-caused settling.

This composite building, a multifamily dwelling of wood frame construction faced with brick and stucco, illustrates some of these techniques. A new steel-reinforced concrete slab (A) under the entire building would provide an ideal foundation for liquefaction-prone locations. In a less expensive retrofit for an undamaged building, a new foundation might be poured only under the front wall (B), in which four garage door openings create a gaping lack of support. Seen in the cutaway section, a steel frame (C) has been added to one garage. Anchor bolts secure it to the new foundation (D). The garage ceiling is reinforced with plywood (E) protected by wall-board to guard against fire. Near the original foundation (F) a semiflexible natural gas line (G) can give during a quake without breaking. Metal straps hold another part of the gas line to a ceiling beam (H). Full plywood sheets reinforce old walls (I), and heavy furniture like bookcases are bolted to other walls (J). Water-heater vent for gas fumes is secured to side (K). Insets detail other important retrofitting techniques.

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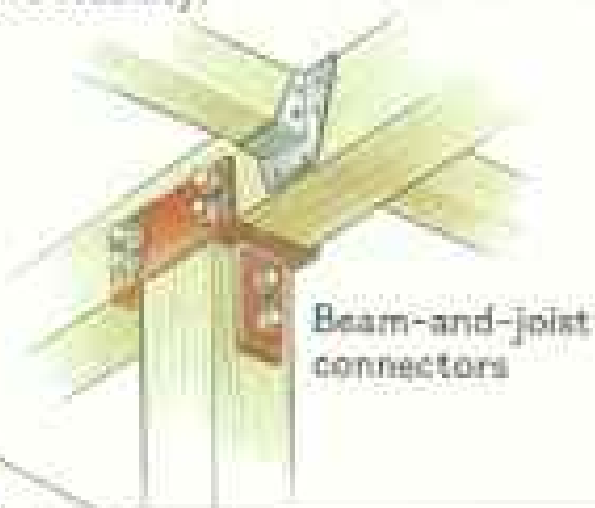
## Liquefaction

A building constructed on loose, saturated sand courts disaster in a quake. Ground shaking causes the sand to separate, producing a slurry incapable of supporting foundations. Uneven settling can lead to building collapse (right).

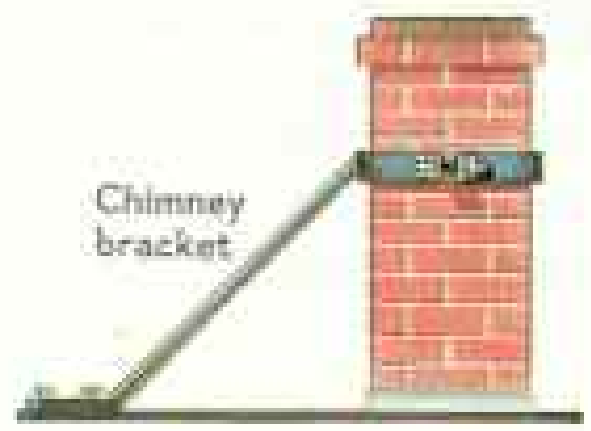




**1** Steel connectors bolt beams and joists, joining horizontal and vertical elements in order to assure stability.



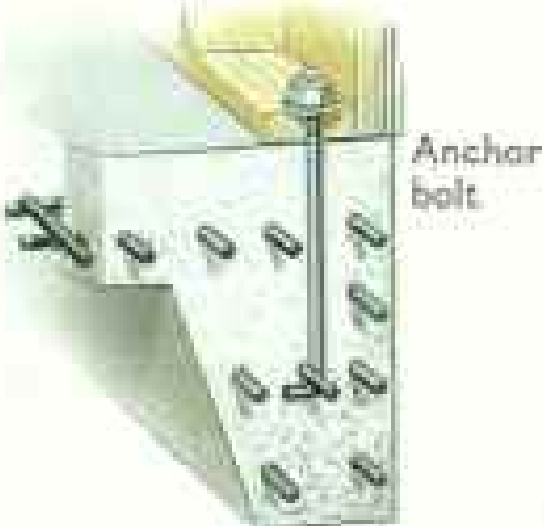
**2** Steel brackets anchor brick chimney to roof. Many buildings now have lighter, safer metal chimneys.



**4**

**2**

**3**



**3** Around the perimeter, anchor bolts fasten walls to a new foundation, providing structural continuity.



**4** Straps bolted to wall studs hold a water heater in place during a quake, preventing gas-line rupture and fire.

Geological Observatory showed that the freeway structure vibrated at the same frequency as the underlying mud, which amplified the wave motion as much as eight times.

What kind of quake would deliver such a strong punch 95 kilometers from its source? By most geologic measures Loma Prieta had been a strange beast. A few of its peculiarities:

□ Depth of rupture. The hypocenter, or point of first slip, was 18 kilometers down, instead of the usual 10 or 12 on the San Andreas. "The mountain may sit atop a downward bulge of the crust," said the Survey's Robert Burford.

□ Lack of surface rupture. Quakes of this size usually gash the surface in their path. Loma Prieta scarified the mountains with cracks, but no surface cleft marked the rupture, although it extended underground for 40 kilometers. "Perhaps the surface was inelastic, like sand, and did not respond to the motion beneath," theorized Will Prescott of the USGS.

□ Quick release of energy. The rupturing lasted only about eight seconds, brief for so large a temblor. "This is because it spread bilaterally, from the center outward to both sides," said Bruce Bolt of Berkeley. The 1906 quake,

which began near the Golden Gate Bridge, ripped the peninsula for a full minute.

□ Unusual thrust. Along the San Andreas, geologists expect the two sides of the fault to slip past each other horizontally, the west side moving to the northwest. This movement totaled about two meters. But the west side also moved vertically, riding up on the east side between one and two meters. "It caused the Santa Cruz Mountains to grow at about ten times the rate we normally associate with mountain building," said Dr. Prescott.

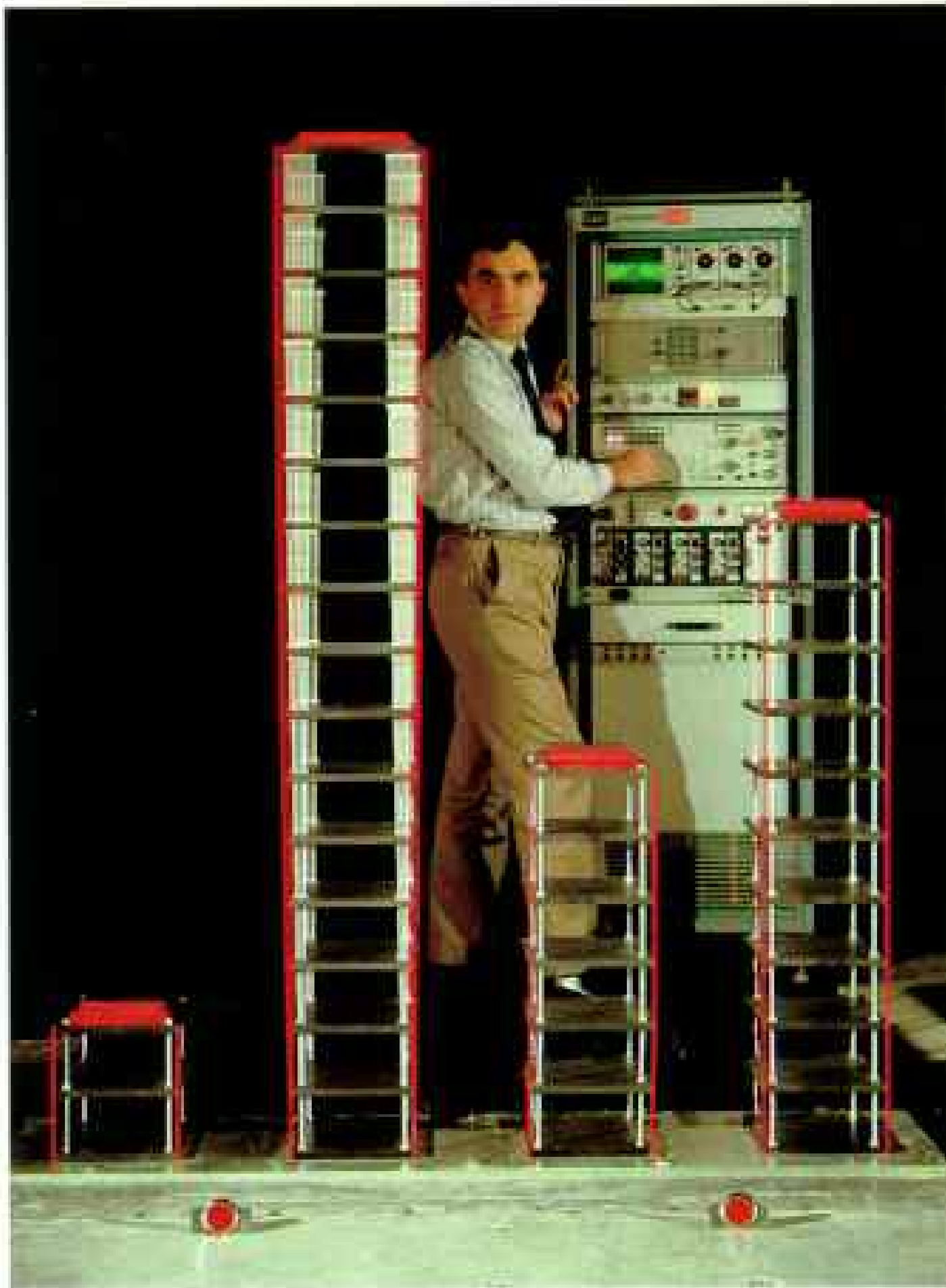
Lack of surface rupture disturbs geologists. "In the past we identified quake activity by surface faulting," said Kenneth Lajoie. "If a large quake can leave no geologic record, we could be living on top of hazards we don't know of."

**L**IKE THE TAIL of a comet, thousands of aftershocks followed Loma Prieta. The most severe—a magnitude 5.2—terrified residents only 37 minutes after the main shock. As this article went to

press, 24 had registered magnitude 4 or stronger. (On February 28 an unrelated quake measuring 5.5 rattled southern California.)

Aftershocks and foreshocks intrigue scientists. So do microquakes, the faint seismic chatter that emanates from many faults. "These pulses illuminate the tectonics below," said William Ellsworth of the USGS—"if you're there to see them."

To "see" them, seismologists set out arrays



JAMES A. SIGAN

*Buildings vibrate at different frequencies, simulated with a computer-controlled shake table and steel models by Dr. Piotr Moncarz of Failure Analysis Associates. If the frequency of the ground motion during a quake is close to the building's natural frequency, resonance occurs and ground motion will be greatly amplified in the building motion. Here the frequency matches that of the tallest model.*



of seismometers. Some 700 eavesdrop on California's web of faults, checked by the Survey, University of California, Caltech, and others.

The seismic signals may be telling geologists exactly where major quakes will occur. Hear David Oppenheimer of the Survey:

"Microquakes occur along a fault as a result of stress buildup. Over time we see that their activity leaves one area quiet. Foreshocks behave the same way—their hypocenters appear anywhere but in that quiet area. That quiet area is where the sides are locked; that is where the earthquake will occur."

He sees this pattern emerging on the Rodgers Creek Fault, a little-known but potentially dangerous extension of the Hayward Fault north of Oakland. The likely magnitude is 7.

When?

"The time aspect is the wild card," said Mr. Oppenheimer. "We're working now on a carbon-14 date for the last quake on Rodgers Creek. That could give a rough idea."

The timing of quakes is indeed the big unknown. Nevertheless, scientists have calculated earthquake probabilities for the various segments of the San Andreas.

Each fault segment has its own quake chronology. This includes the size of the last quake and when it occurred—information often revealed by fault-line excavations pioneered by Kerry Sieh of Caltech. These geologic histories, melded with instrument data, enabled scientists to calculate the probabilities.

The time brackets for these forecasts are wide. For the section ruptured by the Loma Prieta earthquake, the probability was 30 percent in the next 30 years.

Imprecise, certainly. But even such gross forecasts can be helpful to long-term planners such as earthquake engineers.

Are precise predictions on the way?

Fifteen years ago many earth scientists thought so. But the quarry has proved elusive.

A major obstacle is to discover where a quake might occur, so instruments can be set out to record the quake's precursors.

The discovery of a dependable quake fell to the Survey's Allan Lindh and William Bakun, and Thomas McEvilly of U. C. Berkeley. Its lair is Parkfield, a ranching community on the San Andreas midway between San Francisco and Los Angeles. Every 22 years or so the people of Parkfield are hammered by a quake of magnitude 6. And another is due any moment.

With Thomas Burdette of the Survey, I took

a look at the world's most densely instrumented quake trap. "Whatever has been reported as a possible precursor to a quake, we have an instrument set to record it here," he said.

We passed by seismometers, accelerometers, and creepmeters; strainmeters, tiltmeters, and magnetometers; leveling lines and geochemical sensors.

We drove up Carr Hill, toward the laser shed. On the right the San Andreas carved a narrow trough; I leaped across it, from the Pacific plate to the North American.

At the top the laser can train on other hills bounding the 600-square-kilometer experiment. Three times a week Duane Hamann, the teacher at Parkfield's one-room school, ascends to measure surface movements less than half the thickness of a dime.

We drove past Middle Mountain, epicentral area of the Parkfield quakes. The earth beneath us trembled—the quake! But it was only the shaker truck, a U. C. Berkeley machine that pounds the earth so scientists can look for changes in wave travel time—possible precursor of a quake.

A University of Alaska experiment monitors the level of "white noise," earth's normal background electromagnetic activity. Japanese and Soviet scientists have reported strong fluctuations preceding quakes. Such changes could be related to reports of unusual animal behavior—a phenomenon that has often been reported but not scientifically verified.

**D**ID LOMA PRIETA give precursors? There are several candidates, with varying credentials.

Eleven days before the quake, a radio receiver in the Santa Cruz Mountains detected the onset of low-frequency signals about 30 times stronger than normal. Three hours before the quake the signals shot off the instrument's scale.

"They certainly seem associated with the quake," said investigator Antony Fraser-Smith of Stanford. "The cause could relate to currents generated as a result of stress in the rock. The USGS has persuaded me to set up a similar test in Parkfield."

Interest also focuses on two magnitude 5 quakes that occurred near the northern end of the Loma Prieta rupture in August 1989 and June 1988. Both episodes triggered advisories warning of increased hazard of earthquakes. The understanding of those foreshocks could



*His dream house near Capitola a shambles, Roger Hanson is left with memories and pictures documenting his \$300,000 home as it took shape in 1977 (top and middle). Photograph of the house (above), which hung on a wall, was torn during the quake. A real estate appraiser, Roger plans to rebuild if a \$100,000 loan from the Small Business Administration comes through. Did he have earthquake insurance? "No." Will he have it for the new house? "Yes."*

JIM RICHARDSON (RIGHT); ROGER HANSON



lead the way to more accurate predictions.

Enthusiasm is growing for a type of earthquake warning espoused by Thomas Heaton of the U. S. Geological Survey in Pasadena. It is based on the fact that radio waves travel much faster than earthquake waves.

In this real-time process a major earthquake activates a seismometer. Instantly a warning signal flashes by satellite to distant receivers, giving notice tens of seconds before the destructive waves arrive. Time for students to duck under desks, computers to be turned off, nuclear power plants to respond.

Today prediction plays little role in plans for



coping with quakes. Instead, emphasis is on preparedness. Observers generally agree that emergency-service organizations responded well to Loma Prieta.

Unquestionably, preparedness training in California has accelerated in recent years. Each April the state observes the anniversary of the 1906 disaster with Earthquake Preparedness Month. Schools are required by law to conduct rehearsals twice a year. Utilities and other businesses have intensified emergency responses and the bracing of buildings. Many show increasing concern for the earthquake safety of employees' families.

Will the area rebound? Surely so, if it sustains the spirit of the merchants and townsfolk of Santa Cruz. With their mall destroyed, storeowners erected tents behind shattered buildings and stocked them for Christmas shoppers.

Slow recovery is seen for hard-hit areas such as Watsonville, where the prolonged need for emergency services strains facilities already stressed to their limits.

Has the bay area seen the Big One? Geologists are virtually unanimous that it has not. Observed William Ellsworth: "Loma Prieta was merely a shot across our bow." □



# India's Maha Kumbh Mela Draws Millions

# SACRED SPACE,

Text and  
photographs by  
TONY HEIDERER

*In an act of devotion a Hindu sadhu, or holy man, impales a lime on the end of a spear at India's largest religious festival, the Maha Kumbh Mela. The spear will then be ceremonially dipped in the holy river, the Ganga (Ganges).*

*In his left hand the sadhu bears the silver, many-faced image of his sect's particular deity. Hinduism does not demand adherence to one set of dogmas, nor does it prescribe the form of devotion to its myriad gods.*

*Common to all Hindus is reverence for the Ganga, especially near Allahabad, in north-central India, and especially during the Maha Kumbh Mela. Then millions gather for ritual bathing in what may be the largest periodic assemblage of human beings on the planet.*



# SACRED TIME

Hindu gods and demons vied for the pot, or *kumbha*, that held *amrit*, the nectar of immortality.



A DISPLAY AT THE FESTIVAL (TOP) DEPICTS THE GREAT RIVERS OF INDIA LOOKED FROM THE HAIR OF THE GOD SIVA (ABOVE).

ABOUT EVERY 12 YEARS—the most propitious time is calculated by astrologers—millions of Hindus of all castes, classes, doctrines, and sects come together near the city of Allahabad for the greatest of India's mass immersion rituals, the Maha Kumbh Mela. Gathering at the confluence of the Ganga (Ganges) and the Yamuna Rivers—where also flows the mythical river of enlightenment called Saraswati—worshippers wash away their sins and pray to escape the cycle of endless reincarnation.

Before the masses arrived for the 1989 festival, much of the riverbed, uncovered in winter, lay damp and shifting under clouds of blowing sand. By early January the exposed land was beginning to fill with encampments. Soon, caravans borne by elephants, horses, and camels moved in procession toward the rivers. Ahead of them rushed a man covered with ash. He was a sadhu, or holy man, and he waved a sword at the crowd to open a path for a hundred sadhus, who marched bearing tridents, symbol of the god Siva.

In the next days, temporary roads and power and water lines went in. Newly pitched pilgrims' tents, surrounded by bamboo fences strung with pulsating lights that illuminated portraits of major Hindu deities, began to spread across 3,600 acres. Overnight, tea stalls hatched into stores and markets.

Merchants laid out plastic jugs, blankets, medicinal cures, metal

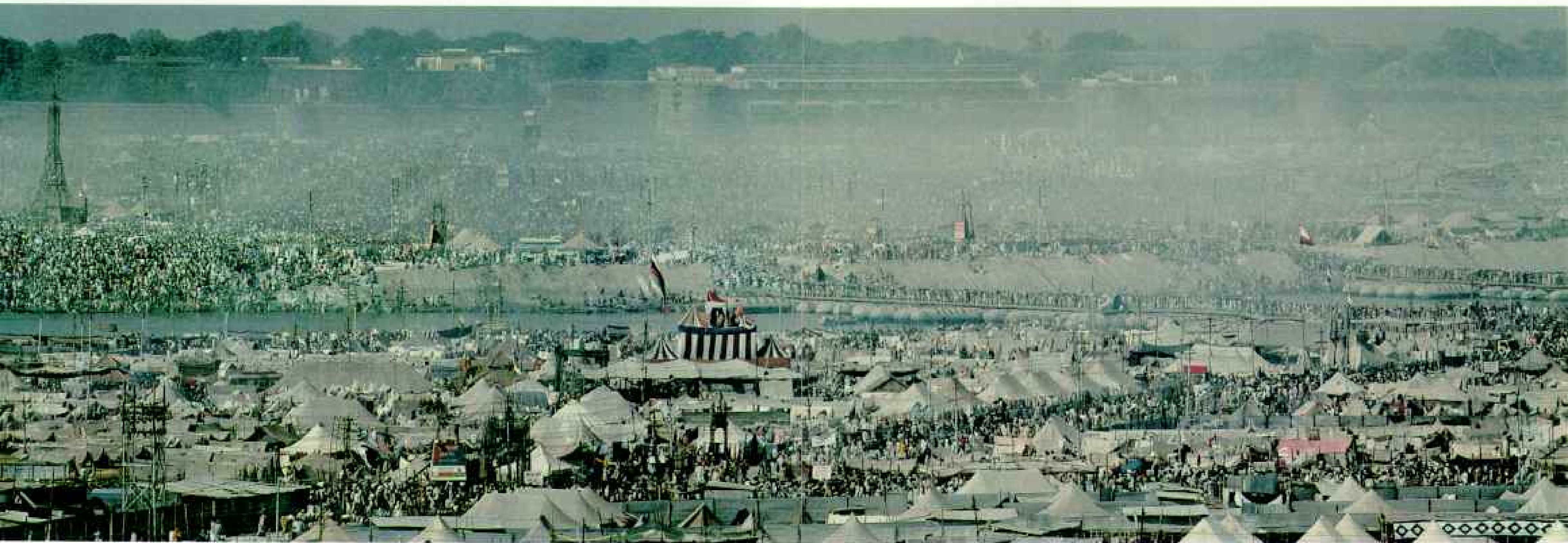




KASHUBIR SINGH (BELOW)







*As the immense crowds begin to gather, ten pontoon bridges (left) are set in place across the Ganga so that pilgrims may cross to the encampments on both banks.*

*Tent cities, provided by the government, stretch to the horizon (far left) along a main thoroughfare paved with metal plates. Plays that recount incidents in Hindu mythology are given in large, lighted tents with children as the actors.*

*India's giant film industry produces a huge supply of films about Hindu heroes and gods, and pilgrims find a walk-in movie shown on a truck-mounted screen.*

*All such entertainment is secondary to ritual bathing on the most favored day at the most sacred location. That place, the Sangam, lies just beyond a long spit of land (above, at far left), where the Ganga and Yamuna Rivers meet.*





Four drops of amrit fell to earth, making four sacred places. Holiest is the site of the Maha Kumbh Mela.



NATIONAL REMOTE SENSING AGENCY, GOVERNMENT OF INDIA

pots, religious pamphlets; and gourds and stacked great bundles of glittering bangles.

The sadhus' ascetic traditions go back more than 2,000 years. Like Christian monks they take vows of poverty and chastity, but they typically live as solitary itinerants relying on daily charity. With the armor of nakedness, *nagas* are the most militant of the sadhus—and in times past defended Hinduism against the fervor of a younger religion, Islam.

By February 4 every road had vanished under an unbroken stream of people bearing food and bedding. By evening, riverbanks were blanketed with pilgrims huddled around charcoal or dung fires whose smoke did not rise but thickened around them.

Before dawn on February 6, that year's Kumbhayog, or most auspicious time for bathing, *nagas* rose and dressed themselves in ash. People began moving through a thick fog toward the rivers. The *nagas* soon left their compound to lead the way for other sadhus, and a great rush of holy men, horses, camels, and endless pilgrims made for the Sangam, the sacred confluence. From every bank and sandbar, on foot or from boats, millions entered the waters to dissolve the sins of all their past lives. Then (almost as quickly, it seemed) the human stream reversed and began to pour outward into all India.



IMAGE FROM INDIA'S REMOTE-SENSING SATELLITE OF THE CONFLUENCE OF THE GANGA AND YAMUNA RIVERS DURING THE 1990 MAHA KUMBH MELA.



Brandishing staffs and clad in ashes from dung fires, rope-haired *nagas* escort a sacred image borne on a palanquin in procession to the Ganga. During Kumbhayog,



DIETER LÜDWIN, SIPA

*the most favorable time for ritual bathing as divined by astrologers, images as well as pilgrims are purified in the waters of the Sangam, or holy confluence.*





RASHODIA SINGH (ABOVE AND RIGHT)

*Symbolically cleansed by flames from clay oil lamps, young sadhus prepare for initiation to a higher level within their order (right).*

*Carried along in a gilded litter by his disciples, a mahant, or guru of high rank, is returned from the river (above).*

*Facing east at dawn, even an ordinary pilgrim seems transformed by immersion, his eyes looking beyond the substance of the world and the weight of his mortality.* □





# SEARCHING Along the

By HARVEY ARDEN  
NATIONAL GEOGRAPHIC SENIOR WRITER  
Photographs by  
RAGHUBIR SINGH

118

*Bus passengers seek to touch a sacred elephant on India*





FOR INDIA

# Grand Trunk Road

*renowned highway. Here travelers find a nation as diverse in earthly condition as in spiritual belief.*



**Y**OU DON'T TAKE the Grand Trunk Road. The Grand Trunk Road takes you. "Such a river of life as nowhere else exists in the world," wrote Rudyard Kipling nearly a century ago of this north India highway—"the backbone of all Hind"—on which he saw "all castes and kinds of men . . . all the world going and coming."

Modernized by the British in the mid-1800s to link their domain from Calcutta to Peshawar (map, pages 122-3), the Grand Trunk Road follows a historic route marched by conquerors from the ancient Aryans to the Moguls and trod by sages of five faiths—Hinduism, Buddhism, Jainism, Islam, and Sikhism.

Envisioning it as the symbolic route of the Wheel of Life, Kipling made it a locus of his classic novel *Kim*, along which the mercurial ragamuffin Kimball O'Hara and his dotting Tibetan lama search for their destinies, Russian spies, and life's higher meanings.

But the bard of British imperialism would hardly recognize his beloved road, for in his day "only country-carts and such like" used it, "bearing without crowding India's traffic for fifteen hundred miles. . . ." Today it bears some of the nastiest vehicular traffic on the planet.

Any U. S. interstate can handle more vehicles at higher speeds. But set those trucks, cars, and buses down on a tarred strip maybe 16 feet wide, with dirt ruts on either side . . . hurl them at one another at 45 to 70 miles an hour in an eternal life-and-death game of chicken . . . put between them bullock carts, bicycles, rickshas, jitterbugging motorbikes, and sluggish black minibuses called Tempos that resemble elongated versions of Darth Vader's helmet on three wheels . . . toss in ruminating cows, pariah dogs, surly camels, an elephant or peacock . . . add desperate-eyed pedestrians suicidally crossing between onrushing drivers who would never dream of stopping . . . then color the whole with blue-black smoke from snorting exhaust pipes trailing a shroud of fumes that burns the eyes, sears the lungs, and seems to drain the life-giving oxygen out of the air. . . . Such are the joys

of travel on today's Grand Trunk Road.

Plunging into that maelstrom recently, I was swept from the urban apocalypse of Calcutta, through the heart of the Gangetic Plain—home to more than 200 million people—to the sacred battlefield of Kurukshetra, where the divine charioteer Lord Krishna bestowed on the warrior Arjuna the glorious spiritual instructions known as the *Bhagavad Gita*, or "Song of the Blessed One," crown jewel of Hindu scriptures.

**I**BEGAN, appropriately, in the snares of illusion—standing before the labyrinthine Great Banyan Tree in the Botanical Gardens outside Calcutta. It rises 90 feet, spreads more than a thousand feet around, boasts 1,825 aerial roots. The *Bhagavad Gita* compares a similar tree, "with its roots above and branches below," to the mesmerizing entanglements of this world. Only by felling it with "the strong ax of detachment," Krishna counsels Arjuna, can one be freed from illusion and the cycle of birth, death, and rebirth.

And yet it seemed a pleasant enough illusion this balmy December afternoon, midway between the monsoon rains and hot weather, as a breeze set the leaves to clattering and stirred the bright pink lotus blossoms in a nearby pond. A girl in white poised like an inverted bird on a tree stump. "That's the plow posture," said my companion Chandrapal Kaman, who practices yoga himself. "Good for spine and intestines."

Now a muezzin's soul-stirring tenor called the faithful to prayer at a mosque on the grounds, where I watched Muslim women reading the Koran before votive candles outside a latticed screen. Within, men on their knees faced Mecca and prayed to Allah, the One God.

In a tiny Hindu temple just behind the mosque, an image of the monkey god Hanuman glowed bright orange. An attendant took a dab of pigment from the image and put a tilak—or "third eye"—between my brows.

On our way back a Muslim girl shouted at us. I turned to Chandrapal. He shrugged: "She says you will go to hell because you

passed the mosque without praying and then worshiped the Hindu monkey god!"

Shamed, I rubbed off my third eye, my sense of oneness with all things shaken. Suddenly I was in a lousy mood—the perfect frame of mind for a trip up the Grand Trunk Road.

The taxi driver, who appropriately dangled from his mirror a portrait of Kali, goddess of destruction, erupted into traffic—knowing that, in the divine scheme, automobiles yield only to trucks, buses, and sacred cows.

Shops selling everything from bicycles to live chickens to “astrological gems” walled this early stretch of the road in teeming Howrah, just across the Hooghly River from Calcutta. White-helmeted traffic policemen waved their arms without effect. A crowd milled before a movie house showing *Big Zapper* (with a lurid poster of a nubile woman with a machine gun between her legs). The bumper sticker on a cycle ricksha proclaimed: “Be happy! Sing Hare Krishna!” Men carrying mirrors and stools hawked their services: For a rupee (about six cents) they’ll swab out your ears and snip the hairs from your nostrils.

Lights came on in shops, interiors aglow like Rembrandt paintings. It was late afternoon, when cooking fires—many fueled by cow dung—are lit all over India. Polluted air thickened with the acrid smoke and aroma of the sacred cow’s contribution to India’s energy needs. A bluish pall turned the setting sun into a bloodshot eye.

We halted behind a hay cart stopped by two cows ambling across the road. To hit one is bad business; those who do usually abscond before the mob forms.

I opened my backseat window, letting in not only fumes and stench and clamor but also an all but fleshless brown arm little thicker than a

celery stalk. Now a young girl’s face confronted me: a contorted, wild-eyed visage almost too grotesque to behold, a squawk stuck in her throat. Lifted by a boy, who thrust her deformed body right into the car, she clutched at me with her claw of a hand. I dug in my pocket for a coin, but just then our taxi lurched ahead and she was wrenched away. I threw the coin, but another urchin grabbed it instantly.

“You shouldn’t,” chided Chandrapal. “She doesn’t get the money. It goes to the man who runs the begging ring. He just uses it to buy more children to cripple, knowing that people like you will pay more!”

That night I looked from my window in our Calcutta hotel to the near-empty street where rickshas awaited fares. These weren’t auto or cycle rickshas, (Continued on page 126)



*YIELDING THE RIGHT-OF-WAY to faster vehicles, a cycle-ricksha driver takes a family shopping in Howrah during the Hindu Durga Puja festival. Three of India's religions—Buddhism, Jainism, and Sikhism—were founded in the region traversed by the highway, where 40 percent of the nation's 835 million people live.*



# AFGHANISTAN

Kabul

Jalalabad

KHYBER PASS

Peshawar

TAKILA (Ruins)

Islamabad

Rawalpindi

Skirting the Himalaya to the north and the Great Indian Desert to the south, invading Aryans around 1500 B.C. followed the natural route that was to become the Grand Trunk Road.

India claims Kashmir but administers only the area south of the line of control. China governs the Aksai Chin region.

AKSAI CHIN

Boundary claimed by India

LINE OF CONTROL

Jhelum

Chenab

Srinagar

Jammu

India

Golden Temple

Amritsar

Jullundur

Lahore

Ludhiana

Chandigarh

Ambala

KURUKSHETRA

PANIPAT (Battle site)

Delhi

New Delhi

Aligarh

Vrindavan

Mathura

Agra

TAJ MAHAL

Gwalior

Jaipur

Chambal

Yamuna

Uttar Pradesh

MADHYA PRADESH

RAJASTHAN

PUNJAB

HIMACHAL PRADESH

JAMMU AND KASHMIR

AFGHANISTAN

PAKISTAN

INDIA

CHINA

NEPAL

BHUTAN

SIKKIM

ARUNACHAL PRADESH

ASSAM

WEST BENGAL

ODISHA

MIZORAM

TRIPURA

WEST BENGAL

ANDHRA PRADESH

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# GRAND TRUNK

## Road of conquest and culture



Stretching from Calcutta to Peshawar, the Grand Trunk Road also spans the centuries. Emperor Candragupta Maurya, who ruled from 321 to 297 B.C., built a road from Pataliputra, his capital, toward the northwest. A forerunner of today's highway, the royal road had rest houses, was sloped for drainage, and had officers assigned to maintain it.

During the 16th century Emperor Sher Shah built a tree-lined military road from Sonargaon through Delhi to the Indus River. This highway, which came to be known as the Grand Trunk Road, was improved and rerouted through Aligarh by the British in the mid-1800s. Today, as part of the national highway system, it remains a strategic artery.



*Rich in natural resources, India has only recently begun to meet its economic objectives. Industry burgeons along the road in West Bengal and Bihar, where coal is mined. Refineries in Haryana and Uttar Pradesh process sugarcane. Punjab, India's major wheat producer, owes much of its agricultural wealth to chemical fertilizers and high-yield seeds introduced by the green revolution of the 1960s.*



*WAIST-DEEP IN BLACK DUNES, laborers load coke at the steel mill on the Grand Trunk Road in Durgapur. Too fine to use in the steel-smelting process, the coke is sold for heating and cooking on small stoves. Built by the British in the late*





*1950s, the mill is one of three in the area—the northern edge of the nation's coal belt. The slow move toward automation in the industry will eventually threaten the employment of these laborers.*

but man-pulled—elsewhere condemned as inhumane. Calcutta has some 80,000, and visitors wrestle with the dilemma of using them since many pullers, afflicted with tuberculosis and malnutrition, survive only a few years. Use them, and you're a moral slob. Don't, and you deprive 80,000 families of a livelihood.

Locals have no such compunctions. You see paunchy businessmen, elegant ladies, even schoolchildren being blithely pulled along by these gaunt men with the hacking coughs.

One of them signaled for me to come down. Why not? I'd already been accused that day of offending God and causing the crippling of beggar children. What harm in a touch more guilt? So for half an hour I was pulled through Calcutta's streets, peopled by derelict families huddling around tiny fires under rag rooftops propped on sticks over a gutter.

For decades Calcutta has been a paradigm of unspeakable poverty, ruled for 13 years by a communist government no more able than its predecessors to halt the seemingly inevitable urban collapse. And yet, pugnaciously, as if to

confound its doomsayers, Calcutta survives as an economic hub and vital center of Bengali culture. Here, during the agony of partition of the Indian subcontinent into India and Pakistan in 1947, Mahatma Gandhi worked the "Calcutta Miracle"—giving readings from the *Bhagavad Gita*, staging a fast that kept local Hindus and Muslims from massacring each other.

And Calcutta remains a city of miracles.

"**T**HIRST, I QUENCH," read the inscription on a representation of Jesus in the mother house of the Missionaries of Charity at 54A Lower Circular Road. My hopes of meeting Mother Teresa were dashed: She had just left for the U.S.S.R. to solace victims of the Armenian earthquake. But her transfiguring presence remained.

I watched the sisters in their blue-trimmed white saris minister to starving orphans, the dying, the crippled, the abandoned. Their white vans of mercy patrol the Grand Trunk Road and other Calcutta streets to rescue those no one else will take.

At a hospice called Prem Dan, or "gift of love," two sisters changed the bedclothes of a man whose swollen face was only a mouth in a tortured mass of flesh. They stroked him, whispering fondly as mothers to their children.

And the mouth smiled!

On the walls you see hand-lettered signs such as "Let Every Action of Mine Be Something Beautiful to God." A volunteer from England, Renee Mallardo, commented: "At first I could barely cope with the suffering, the body fluids, the excrement. Then one

day I looked up at a sign: 'This Is the Body of Christ.' Suddenly I understood. Not only had God given me strength to do it, but he had filled me with love instead of revulsion."

The word God springs easily to the lips here, as though it were not a noun but a verb driving each sentence, each thought.

"God bless you," came a croaking voice at the leprosy center at Titagarh, where an old woman on a low cot grabbed my ankle as I



TAKING A BREAK from hours on the road, truck drivers stop at a dhaba north of Dhanbad. Evolved from ancient times when there were rest houses along the road, these truck stops today offer meals, charpoy on which to sleep, minor repairs, and a place to wash up. Trucks carry commodities such as coal, wheat, and rice.

walked by. "God bless you," I replied, and leaned down to kiss her forehead.

"It's addictive, this work for God!" said Sister Chantal, my guide through Mother Teresa's extraordinary world. Though I'd missed Mother herself, she called from Moscow and told a sister coming after her to bring boots and warm clothes.

Ever mindful of her vow of poverty, she flies coach class. Returning from the United States, where she'd been given a large crucifix for an altar, she was offered an empty first-class seat. She refused for herself but had the flight attendant put the crucifix in it. "Our Lord should always go first class!"

"**B**UT, SIR," scowled my driver Mustaq, as we inched through industrial towns across the river from Calcutta. "If I take the bypass, we can be out of here in no time. This is the world's worst road!"

"But it's the road I want to see!" I insisted. Preferring the near-gridlocked two lanes of the Grand Trunk to a four-lane bypass! Mustaq fumed at such stupidity.

My companion Chandrapal now looked like a blue-faced grasshopper, having put on a blue surgical mask because of the pollution. "Would you like one?" he asked. Throat burning, I declined. I wanted to experience the Grand Trunk Road in all its impurity.

Our car was that ungainly stalwart of the Indian road, the Calcutta-built Hindustan Ambassador—modeled after an early 1950s British Morris Oxford. Recently, the Indian-Japanese Maruti has challenged it. But the heavier Ambassador so routinely squashes these snooty waterbugs that it still dominates.

The Ambassador's parts are also standard everywhere, along with experts who will gravely shake their heads, then emerge triumphantly from a shed with precisely the part you need—300 rupees, please.

Drive-it-yourself rentals being unavailable, hired Ambassadors became my long-distance transport, their drivers good-natured, eager to share whatever wisdom or misinformation they had on hand. But not Mustaq.

A few miles out of Calcutta he grazed a peanut vendor's stand with a fender. Peanuts flew everywhere. Normally he would have kept going, but a group of men blocked us. I offered the vendor a ten-rupee note; he took it with a snort. They wanted Mustaq. After a tug-of-war at his door, Mustaq, closing his eyes as if in

prayer, got out into the crowd. With great dignity he picked up every one of the peanuts and set them back on the tray.

"Men are killed for less every day," said Chandrapal as we drove off.

Mustaq glared at me in the mirror. "We should have taken the bypass," he muttered. I couldn't argue.

**N**EXT DAY, with another driver, we continued up the Grand Trunk. Some 30 miles north of Calcutta it merges with the bypass we'd avoided, becoming India's National Highway 2. Even so, the two lanes widen to four only around major cities—and often not then.

Out here local traffic subsides and trucks dominate, belching noisome exhaust into the lovely green rice country of West Bengal. Here the Grand Trunk resembles the road Kipling knew, running arrow straight, flanked by sturdy neem trees the British planted to shade travelers. Tall, thin eucalyptus trees bracket dirt lanes on either side that once bore slower vehicles but today carry mainly foot traffic.

We passed ornate brick *kos* markers (a *kos* is about two and a half miles), along with wells and ruined serais, or hostels, that date back to Mogul times. When the Afghan warrior Sher Shah briefly usurped rule from the Moguls in the mid-1500s, he built roads over which the British superimposed much of the Grand Trunk. One can imagine British troops of the 1880s slogging along, as in Kipling's "Route-Marchin'":

*We're marchin' on relief  
over Injia's sunny plains,  
A little front o' Christmas time  
an' just be'ind the Rains,  
Ho! get away, you bullock-man,  
you've 'eard the bugle blowed,  
There's a regiment a-comin'  
down the Grand Trunk Road. . . .*

Hammers and sickles painted on walls remind one that West Bengal is communist. Industrial Durgapur stopped us 20 minutes for a demonstration of workers on bicycles, red flags fluttering. They were protesting modernization of India's steel industry—which would vastly increase efficiency but cost thousands of jobs. Near the Bihar border we passed through coal towns tarred by the same cosmic black brush—built on slag heaps with begrimed inhabitants.





*A PASSING HERD of camels adds to the wear and tear on the heavily traveled Grand Trunk Road. Shortly after the annual monsoon rains subside, repairs along the road begin. Side by side, men and women sort and crush rock to spread on the road's surface (right). A layer of tar is poured manually over the gravel and rolled. Although road building and maintenance are still largely done by hand, India is slowly beginning to use modern machinery.*





The countryside greened again, and we entered the holy land where, 2,500 years ago, walked two strangely similar prophets—Buddha and Mahavira, Great Hero of the Jains. Both princes renounced earthly wealth and power for the spiritual life. Both rejected the caste system and sacrificial rites of the priestly Brahmans. Both favored meditation and believed in the sanctity of life. Both founded contemplative orders that would evolve into religions.

Jainism—with its emphasis on *ahimsa*, or nonviolence (which powerfully influenced Gandhi and, through him, Martin Luther King, Jr.)—remains the faith of nearly four million people in India today. Buddhism, on the upswing in its homeland, claims some five million adherents in India and more than half a billion followers worldwide.

Both are rooted here in Bihar. The state is also noted for bandits, called *dacoits*—of whom, I'm happy to report, I saw nary a one, despite vivid news accounts of their kidnappings, murders, and bold daylight robberies of trains and buses. Still, nothing today compares to the thuggee sect, whose “thugs” ritually murdered thousands of travelers in the early 1800s. The thugs were finally crushed by the British, whose agent, Capt. William Sleeman, penetrated their bizarre secret rituals in disguise to learn their identities.

**A**T BODH GAYA, where Buddha attained enlightenment, the Mahabodhi Temple was closed for the day as police rehearsed security for a visit of India's president to dedicate a new Tibetan monastery. The Jerusalem of the Buddhist



*RESTRAINED BY ROPE, stake, and master, a buffalo endures the process of getting a new set of shoes. Farm laborers carrying baskets and tools take a respite from their journey to watch Mohammed Liyas, who often leaves his shop to make*





*"house calls" up and down the road shoeing horses and bullocks. His business near Aligarh is one of many such enterprises along the Grand Trunk Road, where travelers can purchase almost any conceivable service.*

world, Bodh Gaya attracts streams of tourists, pilgrims, and scholars to its ever expanding complex of temples. Some are newly built; some date back centuries.

Through a fence I glimpsed orange-robed monks praying before candles at the base of the soaring temple. Here Siddhartha Gautama sat in meditation beneath the Bodhi Tree while the demon Mara assailed him with temptations and terrors reminiscent of Christ's on the Mount of Temptation. Resisting all blandishments, the prince at last arose as the Buddha—the Enlightened One.

Disappointed at not getting into the temple, I checked into a nearby hotel filled with Japanese tourists. By the time I'd showered off the road's soot and eaten at a restaurant prowled by foot-long rats, it was night. Wandering the bazaar outside the temple, I saw a gatekeeper let a group of East Asian women into the grounds. I followed, a shadow in their wake.

Entering the marble enclosure around the Bodhi Tree (said to descend from the original), each took from her plastic shopping bag squat red candles, a black gown, and a white mat. Donning the nunlike gowns, they lighted and set the candles before gilded images of the Buddha that magnified their light manyfold.

Kneeling on the mats and bowing to the images, they prayed in unison, led by two monks with shaven heads. They chanted an exquisite phrase over and over as they circled the Bodhi Tree, bathed in the quicksilver light of a full moon. One woman burst into ecstatic sobs.

"They sing 'Greetings to Sakyamuni our Teacher,' " a man whispered to me. He was the guide for these Taiwanese women on a pilgrimage to Buddhist holy places.

From Bodh Gaya, the newly enlightened Buddha walked 130 miles to Sarnath, where he gave his first sermon. Following on the Grand Trunk Road, I wandered the ruins of the Buddhist stupa and monasteries amid the immaculate grounds outside Varanasi, or Banaras. Chandrapal had disappeared, and I found him in a seated yoga position, eyes closed, behind a crumbling wall. The very feel of the place beckons meditation.

A white-bearded man seated on a blanket, writing in a notebook, looked up and smiled as I walked past. Was he a Buddhist? I asked. He shook his head. A Hindu, a Muslim? Again he shook his head. "Does it matter? I'm a man."

I asked what he was writing.

"The truth," he said. "Only the truth!"

There must have been lots of it in that thick notebook, to which he now returned.

**B**EWARE OF CHEATS!" warned our driver as Chandrapal and I headed down the claustrophobic maze of lanes to the famous bathing ghats of Banaras.

A human tide swept us along between timeworn walls plastered with "STUDY COMPUTER!" posters. Shops sold containers of holy Ganges water, along with sweets and flowers for *puja*, or worship, in one of the thousands of temples that honeycomb this sacred city of Hinduism.

As we passed their ornate doorways (half expecting Indiana Jones to stumble out of the shadows at any moment, some unholy terror at his heels), a guide materialized. In India even guides have guides, and you find yourself with two or three in tow, each with his expertise.

Chandrapal bought candies and marigolds as an offering for our safety on the Grand Trunk Road. While a Brahman assisted him at a beflowered Siva altar, I stood under a tree filled with evil-tempered monkeys that snarled and hissed and snatched at me. A man introducing himself as a priest offered to "do puja" for me and my family 101 times each day for three days. I paid his fee, wondering if I was being blessed or cheated.

We entered a building with a balconied room. Several mummy-like forms lay on the concrete floor. "This is for poor women who need a place to die," said a guide. "See that one: She'll be dead by morning. There's no greater blessing than to die in Banaras!"

We came to a ghat—wide steps leading down to the Ganges—and rowed out as darkness fell. I'll not forget watching bodies being burned at night on Manikarnika Ghat: the swirl of sparks as torches ignited the pyres, smoke rising against the stars, the odd crackling sound like a bat hitting a hardball. . . .

"That's the skull being broken so the soul can come out," said the boatman. He told us cremations took place here around the clock.

"It takes three hours for a body to burn, then the bones and ashes are thrown into Mother Ganga. Young children, holy men, and people with smallpox aren't cremated. A stone is tied to their bodies, and they're put in the river."

He scoffed at an electric crematorium the

government was building. "People still want the old way." The modern method, though, would leave fewer semiburied corpses for the dogs that prowl the water's edge.

I touched a few drops of the Ganges' holy water to my lips. They say the water, though badly polluted, causes no harm to those who bathe in and drink it. I wasn't so sure.

**J**UST OUTSIDE BANARAS our car broke down, and, instead of rushing along, I simply let the Grand Trunk Road pass me by. While the driver, Kumar, searched for a "power coil," I crossed to a stand and enjoyed *chai*—tea—served hot, sweet, and milky in a clay cup. The cup, I learned, you toss away when you finish—not only for hygiene but also because you wouldn't want to drink out of the same cup as someone of another caste, would you?

Down the road came a bearded young man in a white *dhoti*, or loincloth. He was walking from Allahabad to avoid the millions of pilgrims converging there for the following month's Kumbh Mela (page 106). He carried his possessions: a cloth bag slung around his neck, a wooden staff, and an aluminum begging pot.

"Might I take a picture?" I asked. He nodded.

When I proffered coins, he waved a leprous hand in protest. "I never touch money. It buys only trouble. I would have to fight off thieves. Please, all I want is world peace!"

I rummaged in my camera bag for a small flashlight. Surely he could use that on the road. I dropped it in his bag.

Perplexed, he walked off. About a hundred yards down the road he took something out of his bag and gave it a fling. My flashlight!

At Allahabad we crossed the long bridge spanning the Ganges near its confluence with the Yamuna River and that night reached industrial Kanpur.

Next morning I asked Kumar to take us to the memorial to British victims of the 1857 Sepoy Mutiny, or, as Indians think of it, the

first war of independence. The sepoys—Indian soldiers in British employ—mutinied over a rumor that animal fat was being used in cartridges they had to bite in order to load their rifles. (Hindus had heard it was beef fat, Muslims that it was pig fat, violating taboos of both). British troops, racing up and down the new Grand Trunk Road, barely put down the insurrection. The British garrison at Kanpur, with its women and children, was slaughtered, and the word "Cawnpore"—as it was then spelled—became a rallying cry for British vengeance. The rebellion precipitated the end of the East India Company's rule and led to the British raj—direct rule by the crown.

After independence the memorial was moved from a public park to a churchyard. Not a soul could tell us where it was. Four policemen gesticulated ten minutes, each pointing in a different direction. After two hours of searching, I lost patience. "Let's get out of here!" I barked to Kumar.

But where, now, was the Grand Trunk Road? At last an elderly man said, "Oh, you



*FOUR TO A SCOOTER*, New Delhi families enjoy an afternoon in a park. Two hundred million strong, India's middle class has become a large consumer society. Riders without helmets and the overloading of single-passenger vehicles add to the high number of traffic-related deaths on India's roads.





*CAUGHT IN RISING WATERS*, a young girl (left) nearly drowned when she attempted to cross a flooded village in Punjab to reach the road. Carried to a private car, she was taken to a nearby hospital, where she recovered.

Monsoon waters released from the Bhakra and Nangal Dams washed away part of the road in Punjab state in September 1988 (above). Damage extended to large areas of Punjab, Haryana, and Pakistan, resulting in hundreds of deaths and great loss of property. Believing that the flooding was deliberate, Punjabi terrorists shot and killed the head of the dam project.

*National Geographic, May 1990*



*Along the Grand Trunk Road*



*AT A CHECKPOINT in Punjab, officers of the Central Reserve Police Force (above) search bus passengers for weapons. Thousands of Punjabis have been killed in the on-going conflict between the Indian government and the Sikhs, who want an independent state. Violence has become a growing threat since the Indian Army's 1984 attack on the Sikh Golden Temple in Amritsar.*

*In the shadow of a Sikh gurdwara, or temple (right), a mélange of vehicles travels the Grand Trunk Road, lifeline of a nation finding its way into the 21st century.*







mean the G. T.!" and maddeningly he told us we had a choice. Between Kanpur and Delhi the Grand Trunk has two branches. I opted for the route via Agra, so I could treat myself to a lifetime of daydreams—the translucent beauty of the Taj Mahal, Mogul emperor Shah Jahan's memorial to his wife Mumtaz Mahal.

**W**ELCOME to Krishna's Birthplace" said a sign as we turned off the road beyond Agra and left the material world altogether. According to Hindu lore, this area of Mathura and Vrindavan is the transcendental abode where Lord Krishna was born and grew up millennia ago. In the forest near here—as depicted in Hindu art—he consorted with impassioned *gopis*, or milkmaids. Those who see earthly eroticism in this are chastised by devotees: Krishna's "pastimes" represent the love of the individual soul for God and have nothing to do with lust. To them he is not simply another god or an incarnation of Lord Vishnu, preserver of the universe. Rather, Krishna *is* God.

Every Hindu child knows the tales of Krishna's childhood. Sunday morning crowds gather at shop windows to watch the latest dramatization of his life on display television sets. It's easy to mistake Krishna for just a folk hero as he plays childhood pranks like stealing butter from a churn or eating clay. But when his chiding foster mother looks into his mouth, she sees the entire universe, with its suns and stars and whirling planets.

At Vrindavan I visited a temple complex of the International Society for Krishna Consciousness—better known as the Hare Krishnas. Hansa Rupa Das, a devotee from New York City, oversees construction of a mausoleum for ISKCON's founder, A. C. Bhaktivedanta Swami Prabhupada.

"It has some of the most intricate carving this side of the Taj," he told me. "It's all marble, all done by hand with hammer and chisel. We're in our fourth year with two more to go. But if NATIONAL GEOGRAPHIC comes through again in a thousand years, it'll still be here!"

I'd arrived on the "disappearance day" of Bhaktisiddhanta Sarasvati Thakura, guru of Swami Prabhupada. "By 'disappearance day' we mean that he didn't actually die but returned to Krishna's spiritual abode," said saffron-robed, shaven-headed Dhanurdhara Swami (who hails from New York) as we sat

down to a vegetarian feast on the marble floor of a temple. On a platform sat a lifelike resin image of the founder, who departed this world in 1977.

Recalled devotee Acyuta Dasa: "Swami Prabhupada was told by his spiritual master to spread the message of love for Krishna to the West. So he sailed to the States in 1965 with just 40 rupees and some crates of his writings. In a park on New York's Lower East Side he began chanting our *mahamantra*:

*Hare Krishna, Hare Krishna  
Krishna Krishna, Hare Hare  
Hare Rama, Hare Rama  
Rama Rama, Hare Hare.*

"These are all names of God. We believe that by merely hearing his name listeners will turn to Krishna. Soon devotees came to Swami Prabhupada, and he established ISKCON. People who think we're just freaks don't realize we're part of an ancient tradition of *bhakti*, or devotion to God."

At Keshava Ji Gaudiya Math, a monastic community in Mathura, guru Narayan Maharaja explained those roots.

"Brahma, creator of the universe, began the line of teachers. He taught everything to the great sage Narada Muni, who taught it to Vyasadeva, compiler of the *Bhagavad Gita*. And the line of teachers has continued without interruption. Our spiritual masters gave the teaching to Swami Prabhupada and me, and we have given it to our disciples: The love of Lord Krishna never ends. . . .

"This world isn't our real home," he concluded. "We proclaim the message that everyone needs to go back home, back to God."

**E**VEN AS I ARRIVED in New Delhi, a "black warrant," or execution order, had been issued against two Sikhs convicted of conspiring to assassinate Prime Minister Indira Gandhi in 1984. The city was on edge—rioting after the assassination had killed thousands of Sikhs, and many feared that Sikh separatists waging a terrorist war in Punjab state for an independent Khalistan would seek vengeance for the execution of their compatriots. Since Punjab state was off-limits to foreign travelers, I had to defer taking the Grand Trunk Road to Amritsar, site of the Golden Temple—which Indian Army troops had stormed to dislodge Sikh rebels, an act that led to the assassination of

Mrs. Gandhi five months later by her own trusted Sikh bodyguards.

I visited Mrs. Gandhi's home at Number One Safdarjang Road—now a museum and shrine visited by thousands daily. The spot in her garden where she was gunned down is bracketed by two soldiers (definitely not Sikhs); her bloodstained, bullet-riddled sari is on display inside. Crowds gather before these, many weeping. Memorials to the grand line of India's "modern gods"—Mahatma Gandhi, Jawaharlal Nehru, and now Indira Gandhi—are as much the objects of pilgrimages as any temple.

Continuing a hundred miles north, I made my own pilgrimage to Kurukshetra, site of the ancient battle between two of India's ruling dynasties, the five pious Pandava brothers and their malevolent cousins, the hundred sons of King Dhritarashtra—the "good guys" and "bad guys" of the *Bhagavad Gita*.

Blessedly a few miles off the cataclysmic Grand Trunk Road, the place made as idyllic an ending to my journey in search of India as the Botanical Gardens outside Calcutta had made a beginning.

A great pool reflects banyan trees and myriad temples, many painted Pepto-Bismol pink and filled with white-marble sculptures of mythic heroes. There's the mighty Pandava archer Arjuna with his magical bow Gandiva, capable of shooting 30,000 arrows at once; he rides a horse-drawn war chariot driven by the divine charioteer Krishna.

Here, as told in the 11th chapter of the *Bhagavad Gita*, Lord Krishna temporarily bestowed on Arjuna a "divine eye" and showed him his "universal form":

*. . . all-wonderful, resplendent,  
boundless. . . . If the radiance of a thousand  
suns were to burst forth at once in  
the sky, that would be like the splendor  
of the Mighty One.*

I was reminded of Exodus 33 in the Bible, where God reveals his glory to Moses, who takes shelter from the overpowering sight in a cleft of Mount Sinai. Once, on a journey to Sinai, I'd crawled into such a cleft. Now I was at the site of another theophany. Always looking, it seems, never quite seeing. I could almost hear Krishna laughing at me from behind that banyan tree, the other side of illusion.

Breathing deep, I returned to the Grand Trunk Road and a world of imperfection. □

◆

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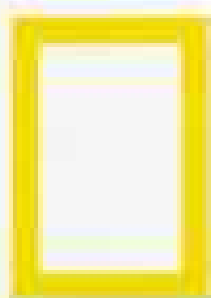
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FROM THE PRESIDENT

# Heroes of the Earth

## THE NATIONAL GEOGRAPHIC SOCIETY

**A**LL ACROSS EAST AFRICA he is known as the "Rhino Man." He earned this title in 1982 when he walked across Kenya to draw attention to the black rhinoceros. Relentlessly hunted for their horns, these animals have declined by 95 percent in the past 30 years and now teeter on the brink of extinction. "If there is no hope for an animal so huge, strong, and recognizable," he asked, "what hope is there for lesser animals—the reptiles, the monkeys?"

His real name is Michael Werikhe, and for his efforts on behalf of African wildlife he has been selected one of the first winners of the Goldman Environmental Prize, the largest international award ever created for grass-roots environmentalists. Werikhe and five others named in April will each receive \$60,000 for helping to protect the earth.

Lois Marie Gibbs of Arlington, Virginia, was also selected. As a housewife in 1978 she discovered that 22,000 tons of toxic waste were buried in Love Canal beneath her neighborhood in Niagara, New York. With no prior experience as an activist, she organized a campaign that led to the evacuation of nearly 900 families. Today she is director of the Citizen's Clearinghouse for Hazardous Wastes.

Harrison Ngau lives half a world away in Malaysia, where he has led indigenous peoples in their struggle to save the rain forests of Sarawak. For his part in blockading logging roads in northern Borneo, Ngau was jailed for 60 days in 1987 and kept under house arrest until last June. In recognition of his efforts to combat the loss of such forests—as well as to preserve the cultures of the people who live in them—Ngau was also named a Goldman Prize winner.

Pressures from authorities in Budapest did not deter Hungarian biologist János Vargha from protesting the damming of the Danube River by Hungary, Czechoslovakia, and Austria. Convinced that the Gabčíkovo/Nagymaros River Barrage System would cause irreversible environmental damage, he founded the group Danube Circle in 1984, despite a ban on such activities. The environment, he said, was "a matter for all Hungarians, not just the government." Following a petition campaign in 1988, the Hungarian Parliament voted last October to cancel their section of the project.

For Janet Gibson of Belize City, the challenge was to save a small, fragile part of the great reef that runs along the coast of the Yucatán Peninsula. Working as a volunteer with the Belize Audubon Society, she traveled throughout her country, lobbying for the creation of the Hol Chan Marine Sanctuary in 1987, one of the first of its kind in Central America. When fishermen saw that the reserve could help repopulate the areas they fish, she said, "we gained their full support."

The sixth Goldman Prize winner, Bob Brown of Hobart, Tasmania, helped found the Tasmanian Wilderness Society in 1976 to prevent the damming of the state's last major wild river. The Australian government was planning to build a reservoir on the Franklin River, despite the fact that UNESCO had named it a World Heritage site. Arrested for blockading the dam site, Brown was elected to the Tasmanian Parliament days after his release from jail. The project was halted in 1983 and the case hailed as a turning point for conservation in Australia.

We at the National Geographic Society are pleased to be one of 15 nominating institutions for the new prize, which was established by philanthropists Richard and Rhoda Goldman of San Francisco. By drawing the world's attention to front-line heroes of the environment, it may well inspire others—people like you and me—to achieve extraordinary deeds on behalf of planet earth.



*On the road with a baby rhino to raise public awareness of African wildlife, Michael Werikhe of Mombasa, Kenya, shows the kind of dedication that earned him the "Nobel Prize" of environmental awards. Viewers of National Geographic EXPLORER met Michael in 1988 in the award-winning film "The Rhino War."*

DUNCAN WILLETTS, CAMERAMAN

*Silvert A. Browner*

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We're lending a hand to the National Commission Against Drunk Driving. And, with government agencies and various sports organizations, we've helped form TEAM (Techniques for Effective Alcohol Management)—asking people to think responsibly when drinking at sporting events. If you'd like to find out how you can get involved as well, just write to: Allstate Consumer Information Center, Public Issue Department 200, P.O. Box 7660, Mount Prospect, IL 60056-9961.

Choosing not to drink and drive is how you personally can do something to help fight the rise in insurance costs. But that alone won't solve the problem. The car insurance system is due for a change. We're working to see it become a reality.

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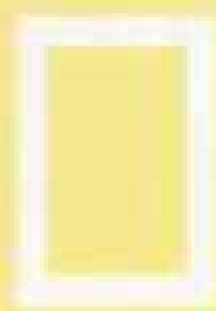


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JAY BEOWNE, SOUTH CAROLINA FORESTRY COMMISSION

## Hurricane Devastates a State's Forests

**W**hen Hurricane Hugo slammed into South Carolina last September, it caused major problems for residents. But the storm also inflicted enormous damage on the forests, increased the danger of major fires, and threatened the habitat of a species of woodpecker that was already endangered.

State Forestry Commission studies show that Hugo caused 1.04 billion dollars in damage to South Carolina timber. Trees containing 6.7 billion board feet of sawtimber and 20 million cords of pulpwood were damaged. Scott Wallinger, a paper-company executive who heads a council directing salvage efforts, says the storm wiped out twice as much timber as the 1980 eruption of Mount St. Helens (*NATIONAL GEOGRAPHIC*, January 1981). Only 25 percent of the downed timber can be salvaged, Wallinger says.

Hard hit was the 250,000-acre Francis Marion National Forest. Donald W. Eng, a U. S. Forest Service supervisor, says the storm damaged or destroyed

70 percent of the trees with a diameter of more than 10 inches—some one billion board feet. Trees on the ground are potential fuel for fires, and fire fighters would have a hard time reaching a blaze.

The Francis Marion forest was home to 470 colonies of red-cockaded woodpeckers, birds perilously near extinction that live in the cavities of mature pine trees. Only 5 percent of the trees they lived in were undamaged. Crews have made cavities in some of those trees to give the birds a home; about half of them are in use, Eng says.

## Start Early, Keep at It, to Learn Map Reading

**O**nce we learn the conventions of map reading, they seem so simple: Up is north, blue is water, a star denotes a capital. But when and how do we learn to read a map?

Research shows that even three-year-olds can master, at least in a basic way, the key map-reading concept: A map is a two-dimensional symbol for three-dimensional space. Linda Acredolo of the University of California,

Davis, showed a child a map of a room, pointed out on it where a toy was hidden, and asked the child to find that toy. Depending on the map's orientation, about half the three-year-olds and almost all the five-year-olds could successfully do so.

Three years may be the age at which the idea sinks in. Judy DeLoache of the University of Illinois let children watch her hide a small toy in a scale model of a room and asked them to find a larger version in a real room. "A three-year-old can do it, but a 2½-year-old has no idea that the model has to do with anything larger," she says.

But even if the basic notion is there early, Lynn Liben and Roger Downs of Pennsylvania State University found that children still have a lot to learn. Second graders assume that north is always at the top of a map because of the hanging maps they have seen. "If you ask them to close their eyes and point in the direction of north, often they'll point straight up," says Liben. She says children acquire map-reading skills gradually, and teachers must begin by using maps of familiar areas: their own classrooms, homes, and neighborhoods.



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## An Explosive Finding About Early Ceramics

Since the 1920s, when the earliest known examples of fired ceramics began to turn up in the Pavlov Hills of Moravia in Czechoslovakia, scientists have been frustrated by the fact that so few ceramic figurines were intact. Now a research team, supported in part by the National Geographic Society, has an explanation: The figurines were *intended* to explode as they were being fired in kilns or hearths for some reason important to their creators. The research team examined some of the thousands of figurine fragments, including the 25,000-year-old Dolni Vestonice Venus (GEOGRAPHIC, October 1988), as well as fired ceramic pellets found at the site. They established that the ceramics were made of local soil, determined its chemical makeup, then made their own samples. The pellets survived the firing process intact, even at high temperatures. But the figurines, which contained water, exploded with a pop when heated—"a new form of pop art," says Olga Soffer, a team member.

The explosions didn't just happen, the team concluded; they were the result of intentional effort and practice.

## A New Director for Karisoke Centre

Diane Doran, a former Peace Corps volunteer who has studied chimpanzees in Zaire and Côte d'Ivoire (formerly called the Ivory Coast), has become director of the Karisoke Research Centre in Rwanda. The center was founded and headed by

Dian Fossey until her murder in December 1985.

Doran, who recently received her doctorate from the State University of New York at Stony Brook, is extending her earlier study of chimpanzee posture and locomotion to include the other great apes while administering the Karisoke center.

"I look forward to continuing the work here," she says, "but I wouldn't describe myself as Dian Fossey's successor. After all, Dian dedicated 20 years of her life to understanding mountain gorilla behavior and to insuring that the population would continue to flourish. Through her efforts, Karisoke became a research center, and I can begin my work with her knowledge and experience before me."

The appointment was made by the Digit Fund, a Colorado-based conservation group named for one of Miss Fossey's favorite mountain gorillas, who was killed by poachers in Rwanda's Parc des Volcans (GEOGRAPHIC, April 1981).

## For Matthew Henson, a Home-State Honor

A new state park in Maryland has been named for Matthew A. Henson (above right), a Maryland native who accompanied Robert E. Peary on his Arctic expeditions (GEOGRAPHIC, September 1988). Residents of the area near the park suggested the name because a nearby Montgomery County high school was named for Peary.

The park is located along Turkey Branch, a feeder stream for Rock Creek, which courses through Washington, D. C. The wooded site, much of it floodplain, was purchased by the state between 1959 and 1969 as part of the right-of-way for a highway that was never built. Over the years, as housing developments grew up nearby, it became a favorite haunt of its new



ROBERT E. PEARY COLLECTION

neighbors, who helped clean it up and fought road-building plans. Last year the community persuaded the Maryland legislature to create a park on the site and to keep the 105 acres in its natural state. "The land was saved," Elliot Chabot, a community leader who fought for the park, says proudly. "No trees were cut, the creek was never piped, no asphalt was laid."

## Ancient Animal Fossils at the Side of the Road

It was just exposed rock at the side of a road 15 miles southwest of Richmond, Virginia, in an area that was to become an office park. But when Hans-Dieter Sues (below, foreground) and Paul Olsen began exploring it as part of their study of a geologic formation called the Newark supergroup, they found a gold mine. Or rather a fossil mine—225 million years old.

The discoveries by Sues, of the Smithsonian's National Museum of Natural History, and Olsen, of Columbia University's Lamont-Doherty Geological Observatory, include well-preserved remains of more than 20 kinds of creatures. Most common are jaws, teeth, skulls, and skeletons of tiny mammal-like reptiles, close relatives of the ancestors of the earliest mammals. The work was funded by the National Geographic Society.

"This is the only place in North America where mammal-like reptiles of this age are abundant," says Olsen. Sues says that the collection resembles fossil assemblages from South America and Africa. When the fossils were laid down, the earth had only one supercontinent. Scientists wondered if the death of mammal-like reptiles in North America was caused by its separation from other parts of the world or if they simply hadn't found rocks of the right age. "Now we know," says Olsen, "it was the latter."



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FABRICE ROBERT, STEPH

## Côte d'Ivoire Church: World's Largest?

For centuries, St. Peter's Basilica in Rome (*Geographic*, December 1971), consecrated in 1626, has ranked as the largest Christian church in the world.

Now it has a rival for that distinction: the new basilica of Notre Dame de la Paix—Our Lady of Peace—in the city of Yamoussoukro in the West African nation of Côte d'Ivoire. It rises 525 feet to the tip of the cross atop its dome, higher than the 452-foot dome of St. Peter's. Built in only three years, it has what may be the largest stained-glass window ensemble in the world and can seat 7,000 worshippers, with room for another 11,000 standees inside. St. Peter's, on the other hand, can accommodate 50,000 people.

Yamoussoukro is a city with about 100,000 residents that has been Côte d'Ivoire's designated capital since the early 1980s. Not coincidentally, it is the birthplace of the country's president, Félix Houphouët-Boigny, who has led the nation since it achieved independence from France in 1960. Like some 12 percent of Côte d'Ivoire residents, the president, who ordered the basilica built and personally paid for its construction, is a Roman Catholic. More than half of the population practices animism (*Geographic*, July 1982).

## Finding Another Victim on the Little Bighorn

He was about five feet eight and between 30 and 40 years old when he was killed on the Little Bighorn River in June 1876. He had been struck in the face, perhaps by a lance or a gun barrel, probably while trying to retreat with Maj. Marcus Reno after a failed attack on an Indian village. A few miles away a larger

group of Seventh U. S. Cavalry troops under Lt. Col. George Armstrong Custer was about to be wiped out by a large Sioux-Cheyenne force (*Geographic*, December 1986).

But who was he?

The soldier's remains were found just outside Custer Battlefield National Monument in Montana last summer by volunteers on a day off from their main task: excavating what was thought to be a major equipment dump from the Battle of the Little Bighorn, one of the most famous battles ever fought on American soil. The dump site yielded little of consequence, but the remains of the trooper produced yet another mystery.

Douglas C. McChristian, the monument historian, says that, after a search of military records, the newly found soldier could be one of two members of Major Reno's battalion: Pvt. William Moodie or Sgt. Edward Botzer. But there are no known photographs of either man to compare with the recon-



JOE RICHARDSON, WEST LIGHT

struction of the soldier's face to help identify him. "There's always a chance we can find a photograph in a dusty attic somewhere," McChristian says. "You never know."

## A Chinese Locomotive Steams into Iowa

Leaders of a tourist railroad in Boone, Iowa, were eager to find a steam locomotive to carry passengers on an 11-mile excursion through the Des Moines River Valley. Then the March 1988 *Geographic* arrived at the home of Aaron Keller, one of the railroad's founders. In it he saw Bruce Dale's photographs and read Paul Theroux's description of a Chinese factory, the Datong Locomotive Works.

Keller called a Chinese trade official



DAVID C. PETERSON

and told him the Boone & Scenic Valley Railroad wanted to buy a locomotive. And so, last December, a group of Chinese engineers arrived in Boone to fire up a JF-model Chinese-built steam locomotive for the first time and show Iowans how to operate it. The locomotive's cost? Says Keller: "\$355,000, delivered."

The railroad raised funds by selling unlimited travel on the line to major donors and first-day rides to other contributors. It also obtained a grant, funded by the state lottery, designed to support local economic development.

Chinese officials said this was the last steam locomotive to be made at the Datong works. They're switching over to diesel locomotives, leaving only one firm regularly making steam locomotives in China and, as Theroux wrote, the Chinese "are definitely the last people on earth still making steam locomotives."



**THE DRAGONETTE SOCIETY**  
for the Preservation of Endangered Animals, Inc.

**Orphaned Elephant**

The Dragonette Society for the Preservation  
of Endangered Animals, Inc.  
P.O. Box 666706, Marietta, Georgia 30066  
Contributions are tax-deductible.

## The Orphans

This orphaned elephant is very lucky, she's happy and well taken care of here in the United States. Not all orphaned African elephants survive without the protection of the mother, if they survive at all.

Poachers show no mercy, they kill entire families. Without the guidance of mothers, aunts, and grandmothers, these little ones have great difficulty trying to survive on their own.

Because of poaching for their ivory tusks, an estimated 250 elephants will die today. Even elephants as young as this one (6 years) whose tusks are only 3 to 4 inches long.

The Dragonette Society is a non-profit organization dedicated to preserving the life of endangered animals. Our immediate project is to raise funds for desperately needed equipment for aircraft to ground communication. And for vehicles that rangers, who daily put their lives in jeopardy, will use to track the poachers *before* they begin their insane slaughter.

Unless we all help today, the remaining African elephants will become the poachers' ivory crop tomorrow. Please don't buy ivory, it could have belonged to this young orphaned elephant's mother.

If you would like to help by sending greatly need contributions or if you'd like information on this Orphaned Elephant poster, please write to the Dragonette Society.

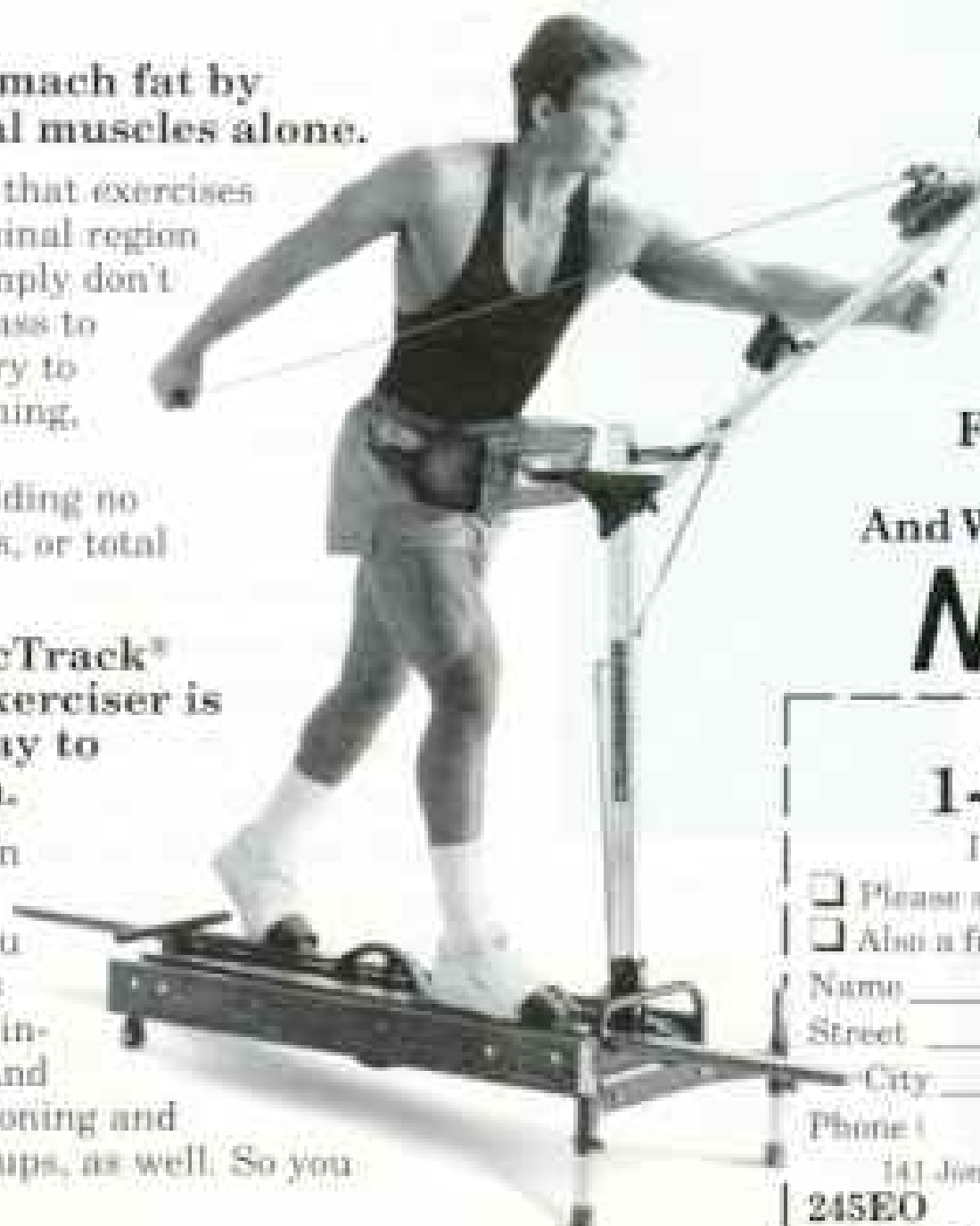
# Why it takes legwork to flatten your stomach

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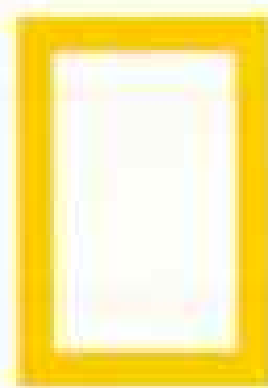
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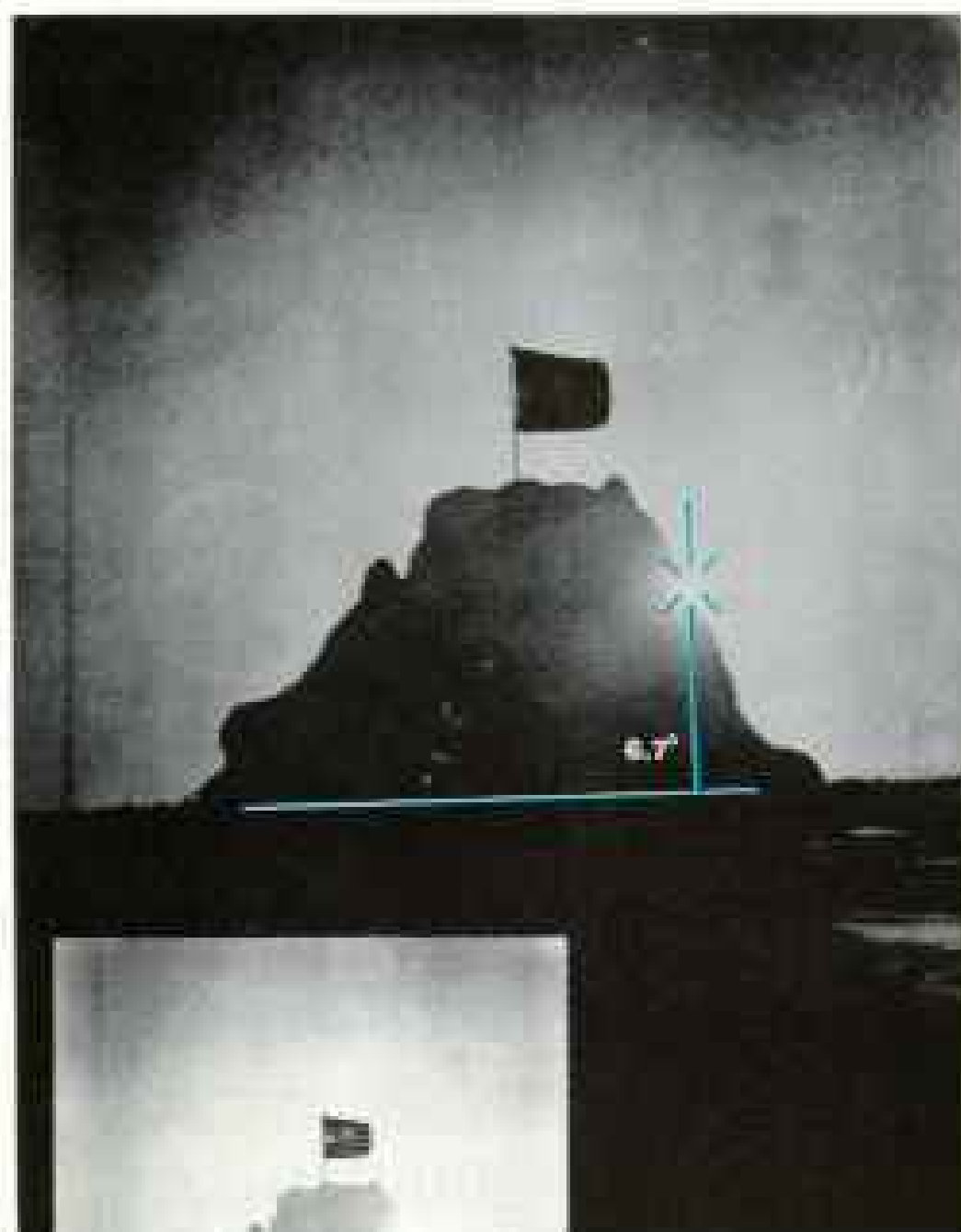
# Members Forum

## Peary Report

Not a single expedition that has attempted to reach the North Pole in the past 80 years has risked success by relying on latitude shots to give them a very rough heading. In my September 1988 *GEOGRAPHIC* article, and more fully in my biography of Robert E. Peary (*The Noose of Laurels*, Atheneum, 1989), I had hoped to introduce into the polar controversy a more practical and sympathetic understanding of this great explorer. Now, in place of the practical issues and the complex character of Peary himself, we are asked to accept as proof the evidence of shadows: No amount of armchair theory will ever convince those of us who have been there that Peary reached the Pole.

WALLY HERBERT  
*Stoke Gabriel, Devon*

*In the Peary collection Rear Adm. Thomas Davies recently found this April 6, 1909, view of*



*Measuring from the sun's center to the horizon gives an elevation within one-tenth of a degree of that obtained using shadows.*

*the ice pinnacle also seen on page 52 of the January issue. Because the sun's location is clear, especially in the darker print, a direct calculation of its elevation can be made. This elevation is so close to that obtained by analyzing shadows that it confirms the photogrammetric method.*

Rear Admiral Davies has this reader's compliments for his convincing analysis. My respect for the findings is enhanced by the presence on the Navigation Foundation's board of John M. Luykx. He served as navigator of a naval vessel that I had the privilege to command. In the art of navigation John may have some peers but certainly no superiors.

EDWARD E. CONRAD, USN (Ret.)  
*Castine, Maine*

Peary could never have known how important his photographs and ocean depth findings would become to supporting his claim. He may finally receive his just recognition from all quarters for being the first man to lead a party to the North Pole. His five traveling companions and support party deserve a lot of accolades too.

ROBERT F. SOMMERVILLE  
*Wilmington, Delaware*

The article is an excellent example of how such a critique should be done—an examination of the facts and scientific data. From my own study of the Pole problem since the 1988 article, I realize an interesting phenomenon. Starting from any unknown location on the earth, one may proceed to the near vicinity (20 to 30 miles) of either Pole without the aid of scientific instruments, using only unaided observations of the rising and setting positions of the sun (or its highest and lowest point at latitudes where it does not set). These observations provide a self-correcting and convergent indication of true north as one approaches either Pole, which should allow an approach to within 1/4 to 1/2 degree of the Pole.

MARSHALL McDONALD  
*Houston, Texas*

## Oil Spill

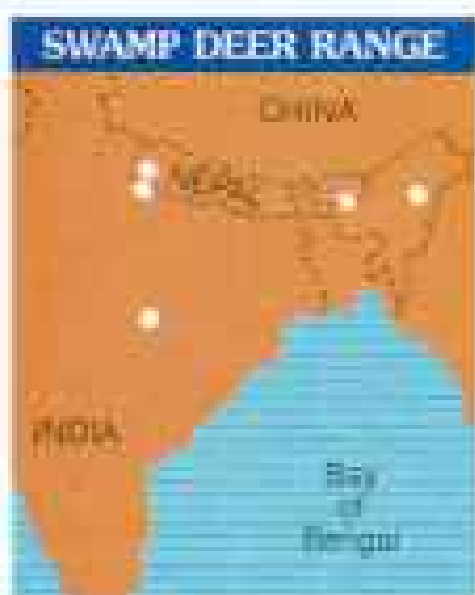
Bryan Hodgson's article "Alaska's Big Spill" (January 1990) is well researched. At the time of Exxon's mid-September pullout, the state of Alaska estimated that of the 257,000 barrels of crude that gushed from the tanker, 30 percent had evaporated, only 13 percent had been recovered, and 57 percent remained unrecovered. As for the bacteria-inducing fertilizer Inipol, the state is hopeful that a rigorous analysis of the past season's results will demonstrate that the material is as effective as it has been made out to be. It is still too soon to tell.

DON W. COLLINSWORTH  
*Commissioner, Fish and Game  
Juneau, Alaska*





# WILDLIFE AS CANON SEES IT



## Swamp Deer

Genus: *Cervus*

Species: *dunaei*

Adult size: Shoulder height, 119-124cm

Adult weight: 172-182kg

Habitat: Grasslands in India and Nepal

Surviving number: Approximately 4,000

Photographed by Belinda Wright

Alert to their surroundings, a female swamp deer and her young graze in the grasslands of Kanha National Park in central India. Swamp deer roamed the lush bottomlands of India's large rivers until habitat destruction and poaching severely reduced their numbers to a few scattered populations that today exist only in the safety of parks and reserves. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems. Color images, with their unique ability to reach people, can help promote a greater awareness and understanding of the swamp deer and our entire wildlife heritage.



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Canon

I was amazed to read the remarks of NOAA's David Kennedy concerning Alaska's zero-tolerance policy regarding the closure of commercial fishing areas in the presence of oil. His statement that there is always a certain amount of spilled oil in any fishing endeavor is ludicrous. The Alaska commercial salmon fleet for the most part utilizes state-of-the-art technology. I would venture to say that the diesel, bilge, hydraulic, and other oils Kennedy encountered came not from the fishing fleet but from the Exxon cleanup effort. Last July I witnessed a ship involved in the cleanup operations inadvertently discharge diesel fuel into Herring Bay not once but twice. There was no containment boom on the vessel,

and a slick several miles long drifted out to sea. It is the final irony for the fishermen of Alaska to be blamed for the destruction of their own fisheries.

JOHN VELSKO  
*Homer, Alaska*

Where's the blame on Exxon? Yes, the captain and crew were responsible for the initial "accident," but let's put the blame where it belongs, on the multibillion-dollar corporation. Your attitude that "the damage is already done, don't worry about it" is appalling.

MARY JANE ZARRELLA  
*Monroeville, Pennsylvania*

# If you can't pack it



Nature has been healing itself from the effects of earthquakes, volcanoes, forest fires, and hurricanes for far longer than mankind's existence. It should come as no surprise that the disastrous *Amoco Cadiz* spill off France in 1978, which discharged six times more oil than the *Exxon Valdez*, has produced little or no long-term environmental damage. Certainly Exxon cannot be forgiven for its reckless behavior or for the terrible damage. Nevertheless, we should recognize and take consolation in the knowledge that given a little time, to nature no damage is irreparable.

PETER S. MAHER  
*St. Louis, Missouri*

Alaska's big spill . . . almost as spectacular and breathtaking as the wilderness itself. How could one of North America's biggest and worst environmental disasters be so fascinating and appalling at the same time? I found the article to be most positive, concentrating on the important issues.

JOHN FREEMAN  
*Surrey, British Columbia*

### Electronic Bee

Mark Moffett did a good job of popularizing the robot bee experiment of Michelsen and associates in terms of the dance-language hypothesis of honeybee forager recruitment. However, he doesn't mention the controversy that currently

# or pull it with this, forget it.

Ah, the family trip. What a moving experience. Things can get emotional just packing up. Before you know it, you're sobbing uncontrollably into that sleeping bag that won't fit.

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horizons.

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## **A Nation of Libraries.**

American Library Association

surrounds the hypothesis. To me their results strongly support an alternative interpretation: The recruited bees appear to have been seeking odor sources rather than using "language."

PATRICK H. WELLS  
*Biology Department  
Occidental College  
Los Angeles, California*

*Since the robot never leaves the hive, it carries no odor from the outside. Thus its dance provides the only guidance, or communication, the bees can use to reach the target bait. However, under natural conditions both dance language and odor do play a role in locating food sources.*

Another fine article by Mark Moffett. My father used to say that if there was nothing else to do, one could sit out in the backyard and watch the grass grow. Had I known what amazing things were going on between the blades of grass, I might have taken his advice. Mr. Moffett, according to his On Assignment profile, has turned an idle pastime into a fascinating career.

WILLIAM V. REID  
*Sutton West, Ontario*

### **Kremlin**

The life-and-death difference that exists between the Soviet Union and the United States is bluntly illustrated by the fact that a professional athlete has to ask his government's permission to play outside his country. If *glasnost* meant anything substantial, Gorbachev's answer would have been, "You don't need our permission." In the U. S., rights are individual and inalienable. In the U.S.S.R. there are still no rights of the individual—only privileges or freedoms that can be revoked any time.

MARK J. ZUG  
*Lancaster, Pennsylvania*

Jon Thompson has done a dazzling factual and sensitive job in letting Americans know about the dark, mysterious, and fantastic world within a world. Even better is today's U. S. press *glasnost* that enables you to publish these articles. I remember returning from my first trip to the Soviet Union in 1961 with material for six articles and being told by a magazine editor that no one would run an article that showed the Russians as human beings.

M. D. MORRIS  
*Ithaca, New York*

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

*National Geographic, May 1990*



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If you're looking for lean, <sup>© Luck</sup> you're in Luck.



I'd like to tell you a juicy story. A story everyone in Luck, Wisconsin knows. It's about herb marinated beef steak. It's about braised






steak provençal and broiled steaks with company potatoes. But most of all, it's about good fortune. Because many cuts of beef  are surprisingly low in calories. Lower than

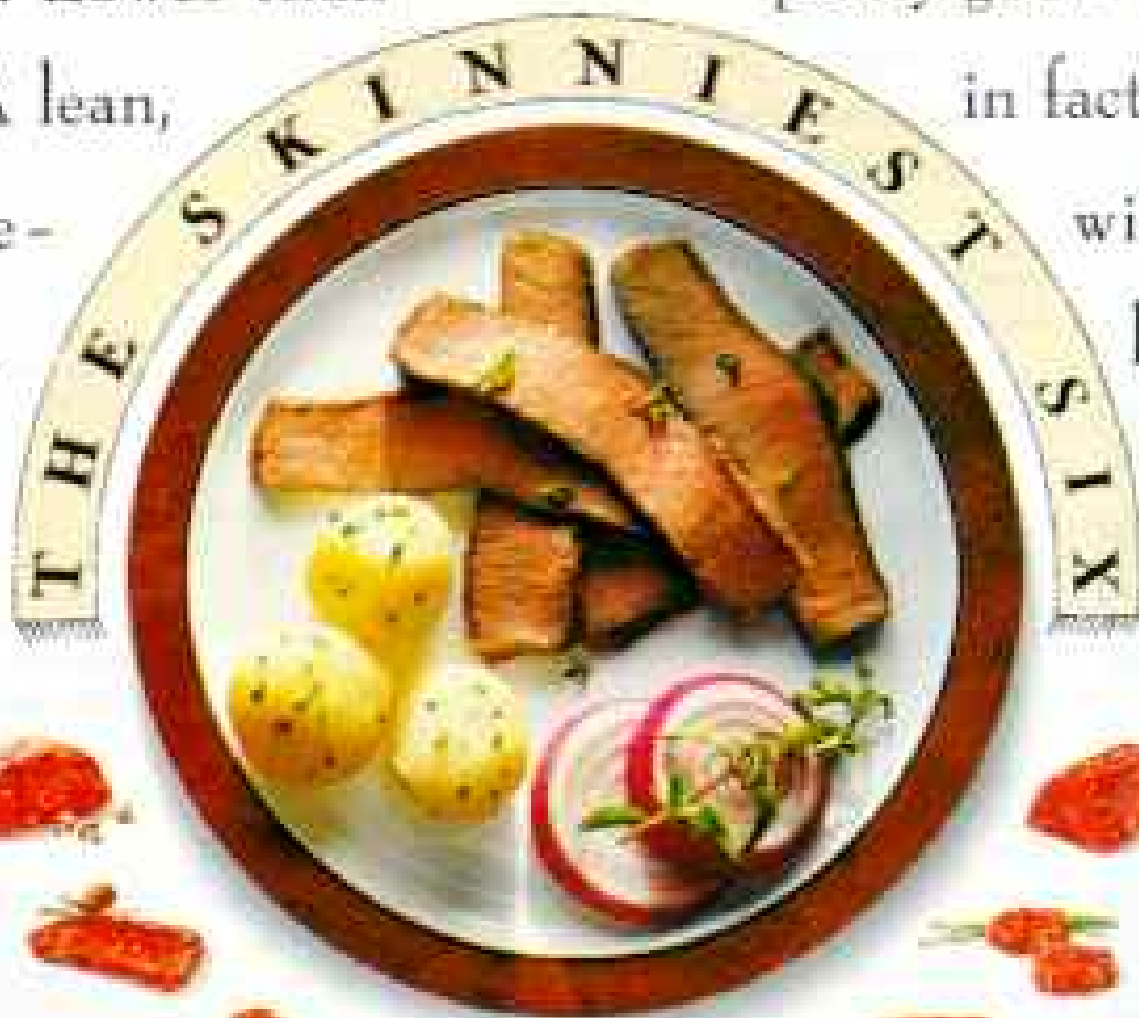
most people think. A lean, trimmed  three-ounce serving averages less than 200

calories. Round tip, for example, hardly tops 149 calories. That's an inspiration to anyone holding a menu. Or following a diet.

You know,  according to legend, the town of Luck was

named  by Dan Smith, an early logger. Having faced much adversity in life, he solved the problem by always being "in Luck." Today, our luck is still pretty good —delicious,

in fact. Where would we be without beef? Out of luck, I'd say. See you in the next town. 



**ROUND TIP** 149 calories  
5.0 gms total fat\* (1.8 gms sat. fat)

**EYE OF ROUND** 141 calories  
4.0 gms total fat\* (1.5 gms sat. fat)

**TOP ROUND** 169 calories  
4.3 gms total fat\* (1.5 gms sat. fat)

**TENDERLOIN** 175 calories  
3.1 gms total fat\* (2.0 gms sat. fat)

**TOP LOIN** 168 calories  
2.1 gms total fat\* (2.7 gms sat. fat)

**TOP SIRLOIN** 162 calories  
5.8 gms total fat\* (2.3 gms sat. fat)

**Beef.**  
Real food for real people.

\*Source: USDA Handbook #42-1000. Fat figures are for a 2 oz. cooked serving. Beef trimmed before cooking. 4 oz. uncooked yield 3 oz. cooked. For a beef recipe booklet, write the B.F.C., Dept. C, 444 N. Michigan Ave., Chicago, IL 60611. Please enclose 50¢. ©1993 Beef Industry Council and Beef Board.



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**A** FRIEND in Belize, businessman Barry Bowen, has become frustrated. After three years of trying to sell a piece of rain forest below market value to a group of cash-poor conservationists for parkland, he reports they still haven't come up with the money.

"I've got a new name for you people," he says: "Conversationists. All I get is a lot of talk."

He's not all wrong. Conservationists do a lot of talking. It is said that talk is cheap, but certainly land isn't, nor are the solutions to any of our major environmental problems.

On April 22 conservation talk will reach a crescendo when tens of thousands of people meet in Washington, D. C., for events tied to Earth Day 1990. The cost in energy and dollars to get these people to Washington and clean up after them would buy several rain forests.

Is there anything to show for all the talk since the first Earth Day 20 years ago? A lot. True, the earth is in even worse shape now, but people outside the environmental movement are listening. No longer are environmentalists viewed as just tree-hugging revolutionaries out to destroy capitalism. The public is concerned—even frightened. No politician can risk ignoring environmentalists. President Bush proudly calls himself an environmentalist.

Nor can corporations seem unconcerned. Exxon recently added noted oceanographer John H. Steele to its board of directors. Weyerhaeuser advertises itself as the "tree-growing company." Du Pont is phasing out its 750-million-dollar chlorofluorocarbon business—though it may take ten years to do so. Wal-Mart stores has asked its 7,000 suppliers to provide more recycled and recyclable products.

Corporations now give money and jobs to conservationists. The Business Council, an organization of only corporate chief executive officers, is devoting its annual meeting this May to listening to environmentalists. The program was conceived and organized by John Smale of Procter & Gamble, a company that has been a sometime target of environmentalists in years past.

No matter that talk is not always cheap. If it can reverse the insensitive rush to explore, develop, and consume the earth as fast and profitably as possible, it will be a bargain whatever the cost. Sadly, there is still more lip service than action, but as we see talk slowly producing results, perhaps more conversationists will become effective conservationists. Then we might even get enough money together to buy Barry's rain forest and save it from the chain saw.

*Wilbur E. Garrett*

EDITOR

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# On Assignment

**T**HE MAN HAS A PENCHANT for living on the edge," a life-long friend says of photographer CHRIS JOHNS. He has climbed frozen waterfalls in British Columbia, been buried by an Alaska avalanche, and been narrowly missed by an Oklahoma tornado. He witnessed the eruption at El Chichón and the aftermath of Mount St. Helens. "I've had hot rocks bouncing off my head before, but nothing like this," says Chris of the pyrotechnics in Zaire during his East African Rift coverage. "I could stand here only five minutes before the stench and heat got me."

Chris had planned to become a veterinarian or teacher until a friend interested him in journalism. After graduate work at the University of Minnesota, Chris free-lanced and is now on contract with the Society. For him Africa's Great Rift was the assignment of a lifetime; it also introduced him to Elizabeth Matthews, then a U. S. Foreign Service officer in Addis Ababa, whom he married.

For photographer BILL CURTSINGER the warmth of tropical Africa—and the friendliness of Malawians—proved a welcome change. He is more accustomed to cold-water climes than to the tepid



waters of Lake Malawi. He began his career with a Navy diving photographic unit, often going on secret missions in the 1960s. After six months in Antarctica, he proposed the article that appeared in the November 1971 issue. He returned to report on the rich sea

life under the ice of McMurdo Sound for April 1986. Bill is one of the few photographers to have also worked beneath Arctic ice.

Twenty years in the business have not been without perils. Bill was scarred by a shark attack in the western Pacific, has swum with whales in three oceans, and came face to face with dangerous leopard seals under the ice in Antarctica. In Lake Malawi he had only to keep an eye out for hippos and crocodiles.

On dry land "he's incredibly easygoing and friendly," says author Peter Reinthal, who was on his ninth diving expedition to Lake Malawi. "The local people really liked him. Once he dove down to 110 feet to untangle a fisherman's net; another time he transported a stranded man to join his crew on a sailing dhow. And for our going-away feast Bill purchased the goat that the Malawians butchered and roasted."

PHOTO: J. KURDSTEIN, BOB STAFF (ARROW), PETER REINTHAL



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