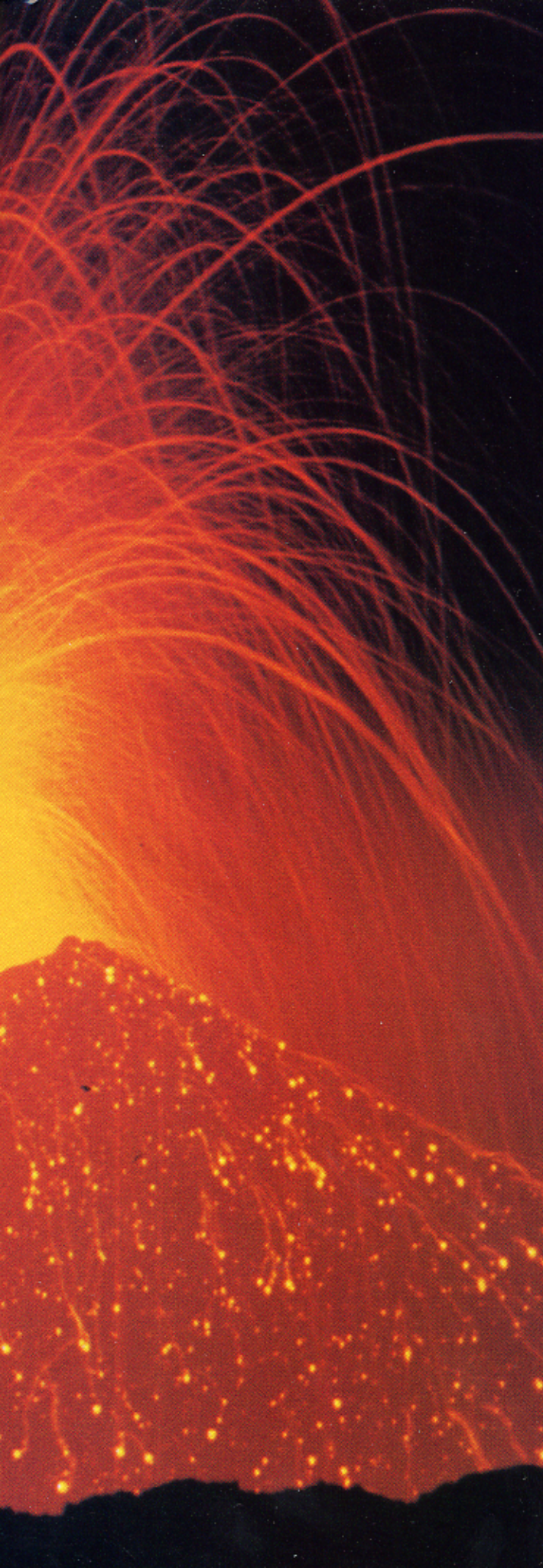


A dramatic photograph of a volcanic eruption. A massive, billowing plume of ash and fire rises from a dark, jagged volcanic rim at the bottom. The plume is composed of numerous bright, glowing streaks of lava and ash, creating a dense, textured wall of fire. The colors transition from deep red and orange at the base to bright yellow and white at the top, where the most intense heat is visible. The overall scene is one of raw, powerful natural energy.

Nature's Red-Hot Caldrons



Volcanic activity is intense in Central America. The region usually reports at least one eruption every year and one major blast during a normal human lifetime

By Jaime Incer

THE WRATHFUL GODS roared through the gaping crater at the top of the mountain in a thunderous explosion. The eruption of incandescent rock, and the shower of burning ash that immediately followed, spread as far as Acahualinca on the southern edge of Lake Managua. The terrified hunters hastily abandoned their chase of deer and bison on the nearby meadows and fled to the lake for relief, leaving the imprints of their bare feet in the mud on the shore.

Ashes covered the footprints, which in time petrified and were preserved intact until their discovery 8,000 years later. They were found accidentally by quarry workers in Managua in 1878, some 13 feet below the present ground level. They had lain buried under several volcanic strata deposited one on top of the other by ashfalls and alluvial sediment brought down to the lake by streams in rainy seasons.

These traces of the remote past merely hint at the intense telluric activity of the Central American region. Recent studies have reconstructed the geological history of the plain where the city of Managua stands today, surrounded by craters that have become lakes, mute witnesses to explosions and collapses of primeval volcanoes. The footprints at Acahualinca are also among the oldest traces of the presence of *Homo sapiens* in the Central American region, and the first evidence of flight by human beings from a prehistoric eruption in the most active volcanic and seismic region of the Hemisphere.

"Nicaragua is considered to be the most [geologically] explosive region in the world," states Alfred Rittmann in his classic study of volcanology in comparing the data recorded by German geologist Karl

JACANA/Alain Creveset-Eon

The Pacaya volcano in Guatemala is one of the region's most active. Incandescent magma spews forth in fiery eruptions, then congeals to sheath the cone in flows of black lava



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Sapper, who made the first geochemical study of the Central American volcanoes at the end of the last century. To illustrate this assertion, we need only cite the prodigious eruption of the Cosigüina volcano on the Gulf of Fonseca in 1835. Half its cone was pulverized, and the ash cloud was so dense that for 90 hours it darkened the sky over surrounding towns in Nicaragua, Honduras and El Salvador. The echo of the explosions bounced off the high atmosphere to be heard as far away as Veracruz, Bogotá and Caracas, the latter a city over a thousand miles away. Howell Williams, a volcanologist at the University of California, reconstructed this violent eruption when he visited the area in 1949 to make an "autopsy" of the volcano by collecting samples from the surrounding area and studying the accounts left by witnesses to the event. Williams concluded that the explosion was the result of a sudden swelling and puffing of the magma entrapped under the cone, and he estimated that in the three days of the eruption, the volcano hurled out some two and one-third cubic miles of material. By way of comparison, Mount St. Helens threw less than two-thirds of a cubic mile of material into the atmosphere when it erupted in 1980. Sapper wrote that "Cosigüina's eruption alone brought forth more juvenile material

from inside the earth than all the other Central American eruptions of historical times combined." Williams describes the event as "the most violent eruption ever to take place in the Americas in historical times."

Mighty as this famous eruption was, Central America has other great volcanic caldrons, such as those of Atitlán in Guatemala, Ilopango in El Salvador, and Apoyo in Nicaragua, which were formed earlier by more formidable explosions that produced craters of diameters far greater than the crown of Cosigüina's truncated summit.

An inventory of the volcanic formations that have emerged in Nicaragua in the last million years includes 28 structures, not counting crater lakes and similar depressions. They are all situated along a 180-mile-long fracture between volcanoes that are active or dormant today. A similar alignment can be seen along the volcanic axis of the isthmus, which runs parallel to the Pacific littoral and has cones and craters strung out side by side from Mexico to Panama. Working together in random combinations, water and fire have created the most admired landscapes in Central America.

Rare is the year in which no volcano erupts somewhere on the isthmus. The most active volcanoes are

The great clouds of ash discharged by volcanoes such as Nicaragua's Telica, right, another of Central America's most active cones, are a nuisance when they settle on residential areas. But these violent explosions create the beautiful landscapes for which the region is famous. The view at left is south of the city of Granada in Nicaragua



Alain Crevsol-Eon

Pacaya, Santiaguito and Fuego in Guatemala; Izalco and San Miguel in El Salvador; Telica, Masaya and Concepción in Nicaragua; and Poás and Irazú in Costa Rica. In the last four centuries activity has been recorded for at least 25 Central American volcanoes. This activity has included the birth of new volcanoes such as Izalco and Cerro Negro, which emerged unexpectedly in 1770 and 1850 in El Salvador and Nicaragua, respectively. In addition, eruptions of surprising magnitude have burst out of cones that were thought to be extinct, such as Cosigüina in 1835, Santa María in Guatemala in 1902, and Arenal in Costa Rica in 1968—three violent eruptions in less than 150 years.

The history of volcanism in the region points to the probability of at least one major eruption somewhere in the isthmus within a normal human lifetime. This eventuality deserves to be taken seriously in view of the fact that 60 percent of the Central American population lives within reach—a radius of 25 miles—of some volcano. The inhabitants of San José, Costa Rica, still remember the months of suffering in 1963 when Irazú poured ash over the city. And in León, Nicaragua, the townspeople incessantly swept off the roofs of their colonial buildings to keep them from collapsing under the weight of the cinder spewed out by Cerro Negro in 1968 and 1971.

In addition to ejecting pulverized material, volcanoes also discharge incandescent lava, which flows down slopes incinerating everything in its path. In 1772 the Masaya volcano released a great stream of lava that ran for some 10 miles like a river of fire, spreading panic in settlements nearby. One area of the lava stream branched off into a nearby lake, where it was extinguished in a great cloud of vapor-

izing water. Other volcanoes, such as Pacaya, Fuego, San Miguel and Momotombo, have slopes sheathed in congealed black lava flows laid down by past eruptions.

One of the most fearsome of volcanic outbursts is the *nuée ardente*, a suffocating mixture of dense gases and semifluid particles that rushes down a slope sweeping all before it. It was a *nuée ardente* that burst out of Mt. Pelée in 1902, destroying the capital of the island of Martinique and instantly suffocating its 30,000 inhabitants. The eruption of Arenal in Costa Rica in 1968, which devastated two villages in its vicinity, was of the same kind.

The summits of the Central American volcanoes have no snow. (On those that do elsewhere, the snow melts when the intense heat of the volcano is rekindled, as was recently the case of the Nevado del Ruiz in Colombia.) In the rainy season, however, or in the wake of an earthquake, avalanches of rock and mud can occur, with great potential for destruction in either situation. One of the most dramatic events occurred in 1541, when rains caused the collapse of the slope of the Mt. Agua volcano, destroying the first Guatemala City, which had been founded by conquistador Pedro de Alvarado. Something of the same sort happened in Nicaragua in 1570, when an earthquake brought down the walls of the old crater of the Mombacho volcano, which contained a deep lake. The loosed waters swept stones and clay down the slope in a monstrous avalanche that flattened forests and cacao plantations and ended by entombing a village of 500 Indians. Archaeologist Payton Sheets of the University of Colorado has discovered in El Salvador and Costa Rica pre-Columbian monuments that were buried in events of this kind, and are thus preserved as the

sole remains of cultures that once flourished trustingly at the feet of the volcanoes.

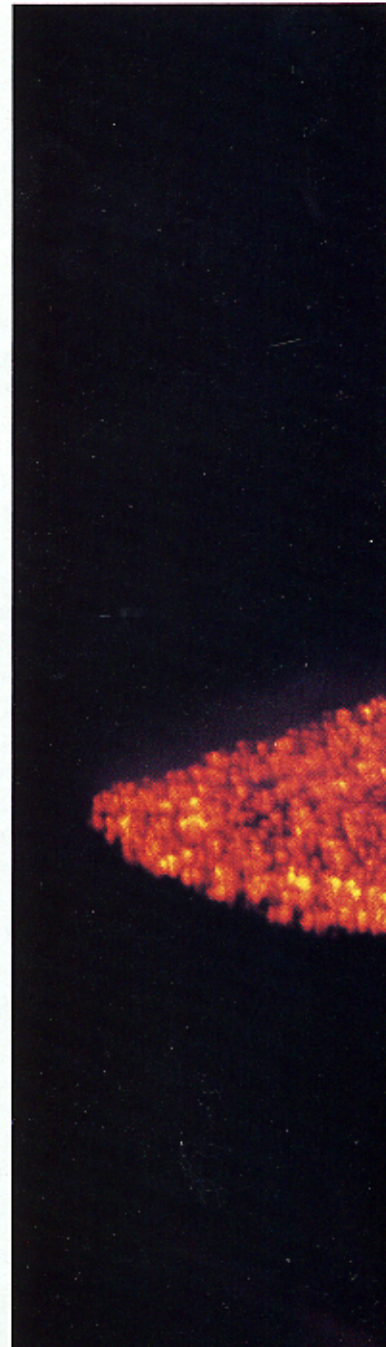
The continuousness of volcanism in Central America is explained by the theory of plate tectonics. The crust of the planet is broken up into plates that move and rub against each other, carrying continents and seas on their backs. The Cocos plate, a piece of the Pacific Ocean floor west of Central America, is slipping beneath the more stable Caribbean plate, on whose western edge the isthmus reposes. Every year some 3.5 inches of ocean floor disappear beneath the continent along a 1,200-mile undersea furrow best known as the Middle-American trench. As material of the Cocos plate is forced under its neighbor, the Caribbean plate, the friction at the subterranean interface between the two plates causes that material to melt into large

Lake Coatepeque fills an old volcanic crater now lushly overgrown in El Salvador, *bottom*, while the crater of still-active Poás in Costa Rica looks more like a barren moonscape, *below*. During an eruption, lava snakes down the slopes of Pacaya in Guatemala, incinerating everything in its path, *bottom right*

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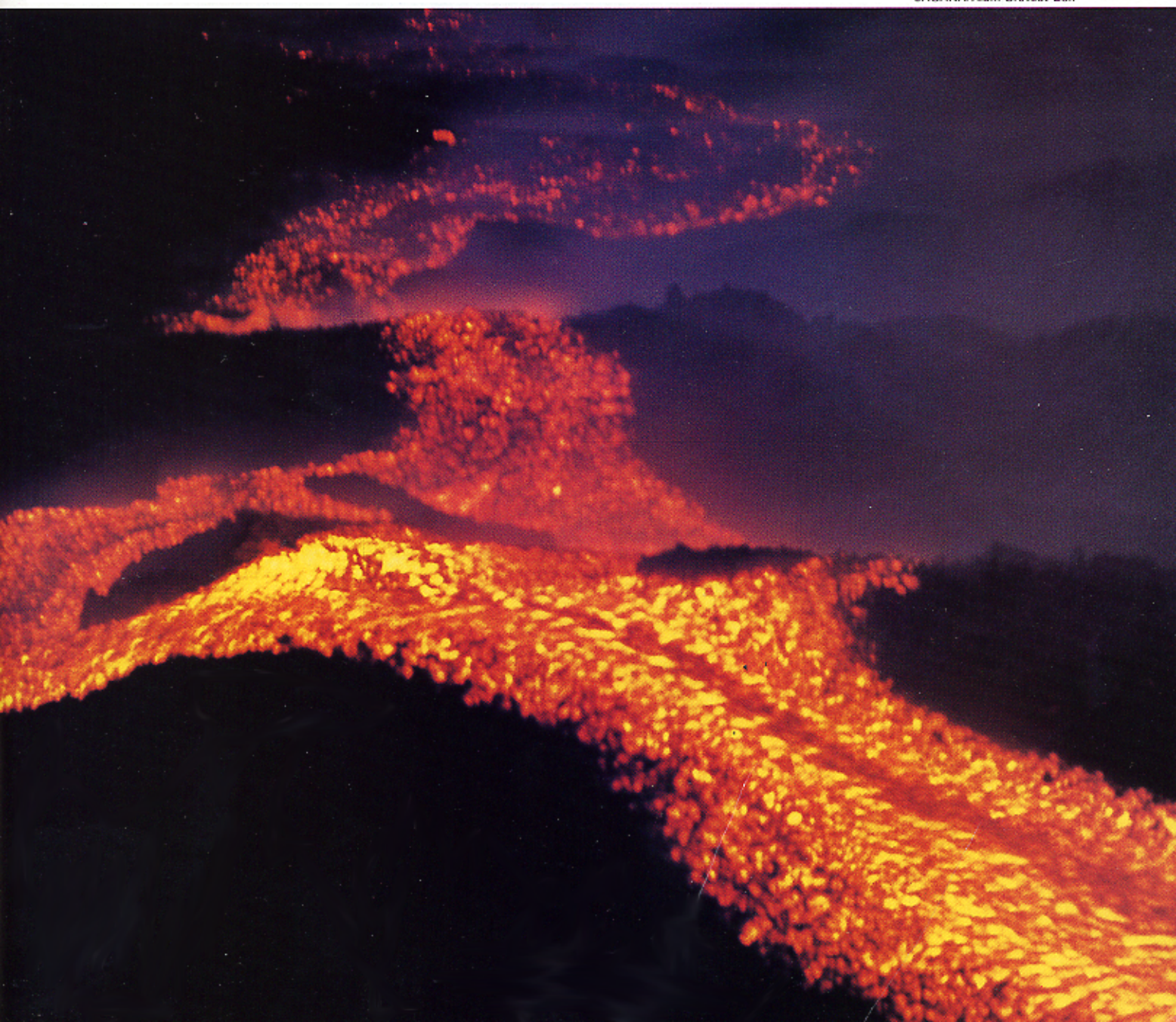
volumes of magma. This molten material fills the chambers under the volcanoes in the isthmus and emerges in eruptions there. For the Andean volcanoes from Colombia to Chile, similar conditions are created by subduction of the Nazca plate under the mass of the South American continent.

Another effect of the pressure of the Cocos plate on the Caribbean plate is frequent earthquakes along the Pacific coast belt, which runs parallel to the Middle-American trench. These tremors have several times brought devastation and death to isthmian populations. The capital cities are built on highly exposed ground, except for Tegucigalpa, Honduras, which nestles among inland mountains. The chronicles since the Spanish Conquest indicate that San Salvador, for example, has been visited by seven demolishing earthquakes, the most recent last

October; Old Guatemala City by four; Cartago, the earlier capital of Costa Rica, by another four; and in the present century Guatemala City and Managua have each been struck by two earthquakes.

The persistence in the dangerous volcanic regions of the Central American isthmus of dense populations dating back to pre-Columbian times is due, quite simply, to the high fertility of volcanic soils, in which a wide variety of tropical crops can be grown. The pre-Columbian dwellers used to grow maize, beans, pumpkins, cacao and other plants in the same soils that today yield cotton, coffee and sugarcane, and provide good grazing for cattle, all of which constitutes the basis of the economies of the isthmian republics. In recent years El Salvador and Nicaragua have learned to harness the abundant geothermal energy of volcanoes and are thereby becoming

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The majestic Fuego volcano near the colonial town of Antigua in Guatemala, *below*, is another active cone. Living in the shadow of a volcano can be a risky business, but slopes in Guatemala, *above*, and around the region are contoured with cultivated rows that take advantage of the rich, fertile soil

less dependent on imports of petroleum-based fuels. Also, the material ejected by volcanoes is being used to construct buildings and roads, while the spectacular sight of the awesome edifices of volcanic cones reflected in placid lake waters is one of the mainstays of the tourist trade.

Living in the shadow of a volcano is a calculated risk that Central Americans accept. Lava flows, cinder showers, avalanches, muffled subterranean noise and other telluric events have failed to deter or distract the current inhabitants of the region from further populating and working their exposed but fertile lands. There is a close interdependence between men and the mountains, which is rooted in the remote past. The aboriginal peoples worshipped and venerated these mountains of fire and smoke, which they saw as the abodes of legendary beings or tutelary divinities whose wrath burst forth in eruptions, earthquakes, droughts and other calamities, and who had to be placated. The superstitions that persist among the Indians who still dwell at the feet of volcanoes, and of the campesinos who cultivate their slopes, include accounts of fabulous beings that dwell within them, survivals of the ancient fears of their ancestors.

The volcanoes and peoples of Central America have been bound up with each other since time

Byron Crader/© Ric Ergenbright Photography



immemorial. Spanish chronicler Juan Torquemada took down from Indian informants in 1580 the account of an ancient migration from Mexico to Nicaragua. Several tribes that had lived in oppression and paid heavy tribute to another more powerful people threw off their yoke by taking flight in a mass exodus to the lands of modern Central America, where they founded several settlements and came to be known as the Pipils and Chorotegas. The last to leave the Mexican region were the Nicaraos, who set out on the southward trek guided by a prophecy that drove them to seek their new land at a place where an island with two volcanoes stood in the middle of a freshwater lake, as a sure sign that they had arrived at their destination. After many wanderings they came to the shores of the present Lake Nicaragua, from which they saw the confirmation of the legend as they gazed upon the island of Ometepe ("two mountains," in Nahuatl), from the middle of which rose the two proud peaks of the volcanoes named for Omeyatecīhuatl and Omeyateite, the tutelary cosmogonic couple. Since then Ometepe has been a kind of island sanctuary, and from the archaeological standpoint it is the richest and most attractive island in the lake. The Nicaraos brought the Nahuatl language to the region, introduced the cultivation of cacao, and instituted propitiatory sacrifices beside the craters. The motifs of their pictography, pottery and statuary recall the Toltec pantheon.

Slightly west of the lake rises the Masaya volcano. Its crater is a wide, deep cavity at the bottom of which a pool of incandescent lava frequently forms and releases a dense, opaque fumarole. The phenomenon closely resembles the pattern of the volcanoes on Hawaii, and its slopes are mantled in black, rough, congealed lava flows. "A petrified sea of ink," according to the description left by Ephraim G. Squier, a diplomat and explorer who traveled through Central America toward the middle of the last century.

Masaya, also called Popogatepe by the Indians, was the first active volcano to be explored and described by the Spaniards in this Hemisphere. Its lava flows and fumaroles date back to before the Conquest. According to the account left by the celebrated chronicler of the Indies Gonzalo Fernández de Oviedo, who climbed it in 1529, the crater offered the splendid spectacle of lava boiling in the bottom. His guide, the cacique of a nearby village, told him the legend of a phantasmagorical crone who would appear in the midst of that burning hell. She was a kind of Indian pythoness who came forth from the roar and roil of the lava to receive tribute from the Indians and bestow her counsel upon them. The Indians worshipped her with sacrifices of young women and children, who were hurled into the crater in propitiatory rites. The Spanish clerics de-

stroyed the temples in her honor that had stood on the crater's rim and replaced them with crosses intended to exorcise the demonic hag, whom they accused of inciting rebellion against the conquistadores. The friars, who called the volcano the "mouth of hell," forbade the Indians to climb up to the crater, but required the Spaniards to look upon the boiling lava as a penance. "I do not believe there is any Christian man who, remembering that there is a Hell, does not feel fear and repent of his sins at the sight of that. . . ." opined Fernández de Oviedo in his famous *Historia general y natural de las Indias* (General and Natural History of the Indies.)

Karl Sapper found at the summit of Tajumulco—which at 13,816 feet is the highest mountain in Central America—vessels and offerings that had been left there by the Mam Indians of western Guatemala as gifts to their pagan gods. The high volcanoes of the isthmus were also climbed by the priests of the 16th century, although for the quite different purpose of sprinkling holy water over the smoking craters and baptizing them with the name of Christian saints. It is said that when monks attempted to baptize a certain volcano in Nicaragua, the mountain rumbled. The frightened friars stumbled helter-skelter down the slopes and precipices without completing the ceremony. Since then, the volcano has been known by the resonant, onomatopoeic name of Momotombo.

Spanish gunners made gunpowder with sulfur taken from volcanoes. A greedy cleric, Blas del Castillo, believed he had found in the lava of Masaya a mine of molten gold. Fernández de Oviedo tells that he had himself tied to a platform and lowered almost 1,000 feet to the bottom of the crater to take a sample. Using a pot and iron chain, he was able to draw out some of the gleaming, tempting material only to find, to his disappointment, that it was not gold but sulfur-coated black cinder.

Alexander Humboldt, the learned explorer and geographer, commented on these daring adventures associated with the volcanoes of the Central American lands, which he always regretted never having visited. "We must agree that in our day no traveling naturalist, however great his zeal for science, has ever embarked on enterprises as dangerous as those undertaken at the beginning of the 19th century to take sulfur and gold out of the maws of fiery volcanoes."

However, despite all the discoveries science has made since then, and especially the prodigious strides made in the 20th century, the volcanoes of Central America still guard their secrets jealously. □

Nicaraguan geographer, naturalist, explorer and writer, Jaime Incer is the author and translator of several books on the geological history of his country.