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32. An Overview of the Historical Aspects of Geothermal Influences in Mesoamerica

by
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Abstract: Mesoamerica is a zone with ubiquitous geothermal manifestations that have always influenced the lives of its inhabitants through the increased fertility of volcanic soils and the damage inflicted on lands, settlements, and crops by volcanic eruptions and earthquakes. Some materials of igneous origin, like obsidian, were of utmost importance for the region's peoples. However, the influence of geothermal phenomena went beyond material implications to affect even religious matters.

The Europeans coming to this area reacted to the geothermal manifestations with awe, which was soon followed by attempts to explain their characteristics with scientific theories current at the time or to exploit them. We summarize the interactions, both on utilitarian and nonmaterial planes, between mankind and geothermal phenomena in Mesoamerica.

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INTRODUCTION

INDUSTRIAL EXPLOITATION OF GEOTHERMAL RESOURCES DID NOT start in Mesoamerica until the second half of the 20th century, so we will refer to geothermal energy in its broadest sense, mentioning the utilization its inhabitants made of the Earth's heat or igneous materials, and also the way in which phenomena, such as earthquakes or volcanic eruptions, influenced the lives of those peoples, their societies, and their beliefs.

To establish the early history of geothermal influences in Mexico, Central America, and the Antilles is a very difficult task for various reasons, mainly because our sources are fragmentary and often distorted. Besides, it was not until the studies of Knorosov and Proskouriakoff that Maya inscriptions were deciphered properly. Before that, we had only second-hand transcriptions made by early missionaries who considered the beliefs of the aboriginal populations to be the work of demons. On the other hand, although the native inhabitants of

Mesoamerica left proof of their perception of geothermal phenomena in their place names and in their theogony, they were not much interested in utilitarian aspects, so they left very few records of the world that surrounded them.

THE PEOPLING OF MESOAMERICA

IN 1589, THE SPANISH JESUIT JOSÉ DE ACOSTA ADVANCED THE IDEA THAT AMERICAN INDIANS had first come from Asia by land and, perhaps, by a short sea voyage. This is still the opinion commonly held, with the majority of experts dating the first human occupation to about 11,000 years ago, and some of them fixing it as far back as 25,000 years ago.

In any event, America was first colonized by modern humans that had already acquired many skills and presumably had developed systems of beliefs. Evidence from archaeological findings, anthropological measurements, analyses of mitochondrial DNA, and studies of comparative linguistics all agree that Mesoamerica was originally settled by the *Amerind* peoples on their migrations from Asia. After an archaic epoch in which the land was settled for the first time, the interval of human occupation is divided into three periods. The earliest one, termed *Preclassic* (or *Formative*), was from about 4,000 to 1,800 years ago. The next period, the *Classic*, extends to about 1,100 years ago, and the *Postclassic* period ends with the Spanish Conquest in the 16th century.

THE REGION

MESOAMERICA IS A LAND OF VERY INTENSE TECTONIC ACTIVITY, SO ITS FIRST COLONIZERS WOULD have become acquainted with seismic, volcanic, and geothermal manifestations very soon. Chronologically, their first contact with these phenomena should have occurred in the Imperial and the Mexicali Valleys, where they could not have overlooked the conspicuous hot springs, mud volcanoes, steam jets, and mineral efflorescence. Similar manifestations also should have been evident to those arriving at the Neovolcanic Belt further south, with its 3,000 volcanic cones, abundant hydrothermal deposits, and numerous hot springs (Suárez Arriaga and Cataldi, 1993).

In Central America, the situation is comparable: Guatemala, with peaks such as Santa María and Fuego and lakes formed in volcanic craters, like Atitlán and Amatitlán; Honduras, with Conchagua and others; El Salvador, with its central valley so affected by seismic activity that it is known as the *Valley of the Hammock*; Nicaragua, with Momotombo, Negro, and Santiago volcanoes; and Costa Rica, with the steaming grounds of Rincón de la Vieja and the peaks of Poas and Irazú, to name only a few from a long catalogue of tectonic and thermal manifestations. We know that they were of importance to the early settlers in the region, because close to the manifestations it is common to find offerings dating from the very early Preclassic period.

From the *Popol Vuh, The Mayan Book of the Dawn of Life*, written in Quiché by Maya elders at the time of the Spanish Conquest.

“And this Seven Macaw has two sons: the first of these is Zipacna, and the second is the Earthquake.

“And this Zipacna, this is the one to build up the great mountains: Fire Mouth, Hunahpu, Cave by the Water, Xcanul, Macamob, Huliznab, as the names of the mountains that were there at the dawn are spoken. They were brought forth by Zipacna in a single night.

“And now this is the Earthquake. The mountains are moved by him; the mountains, small and great, are softened by him.”

Note: Fire Mouth is thought to be Volcán de Fuego, 19 km southwest of Antigua; *Hunahpu* to be Volcán de Amatenango, 5 km north of Volcán de Fuego; *Cave by the Water* to be Volcán de Agua, 11 km south of Antigua; and *Xcanul* to be Volcán Santa María, 9 km south of Quezaltenango. *Xcanul* is also the generic term for *volcano* in the western part of the Quiché-speaking region.

John L. Stephens wrote in 1834 on a trip to Antigua, “The last eruption of the Volcán de Fuego took place about 12 years ago, when flames issued from the crater and ascended to a great height...but it can never burst forth again; its crater is no longer la Boca del Infierno, or the Mouth of the Infernal Regions, for, as a very respectable individual told me, it has been blessed by a priest.”

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INFLUENCE OF GEOTHERMAL ACTIVITY ON MESOAMERICAN PEOPLES

WEATHERED VOLCANIC SOILS, BECAUSE OF THEIR ENHANCED FERTILITY AND ABILITY TO RETAIN moisture, allow the growth of a dense and varied flora that supports abundant animal life. These elements make an area attractive to people, from nomadic hunter-gatherers to intensive farmers (Grayson and Sheets, 1979). The end result is that people concentrate around places with geothermal activity and, in so doing, expose themselves to potentially disastrous volcanic eruptions and earthquakes. The impacts of these events on the environment and on the societies

established around them vary, depending on the magnitude of the event and its precise nature and characteristics. The impacts also depend on components related to the social organization of the settlers, their hazard perception, land use, and so on.

The pre-Columbian Mesoamerican societies were no exception. The influence of geothermal activity is exemplified by the volcanic eruptions of Xitle, Arenal, and Ilopango. The latter's eruption five centuries ago may have ended southeastern Maya civilization and allowed people from Northern Guatemala to seize lucrative trade routes. Some Maya lowland sites, like Barton Ramie in Belize, apparently received refugees from that event, whose sudden arrival may have produced not only agricultural adaptations, but greater political centralization and class differentiation as well (Sheets, 1979).

The Maya living 1,400 years ago in Cerén, in what is now El Salvador, also experienced the impacts of geothermal activity. A rapid series of explosive eruptions took place within two kilometers of their village when rising magma encountered ground water. Buildings were demolished and then buried by ash and pumice, preserving details of domestic Maya life: dirty dishes, pots full of food, and footprints in ash—all suggesting people fled the town (Fink, 1993). These cases agree with the studies made in Costa Rica by Sheets (1984) at Arenal, and Hurtado de Mendoza and Alvarado (1988) at Miravalles regarding the possible influences of volcanic eruptions on the socioeconomic, agricultural, and artisanal development of the pre-Columbian local inhabitants. Their research has shown how human populations are driven away during and immediately after major volcanic episodes and then return, reattracted to the area.

Besides anthropological evidence, we have direct indications of how pre-Columbian Mesoamerican inhabitants were aware of geothermal phenomena. For example, many volcanoes in the area still bear autochthonous names, such as Iztaccíhuatl (*iztac*, “white”; *huatl*, “woman”), Popocatépetl (*popoca*, “steaming”; *tepetl*, “hill”), Citlatépetl (*citlali*, “star”; *tepetl*, “hill”); and some of the extant codices, like the *Nutall*, the *Tellerianus Remensis*, and the *Cuauhtinchán*, bear these representations in hieroglyphics. Many towns have Indian names referring to some geothermal characteristic of the place: for example, Atotonilco (*a[tl]*, “water”; *totoni[li]*, “hot”; *co*, “place”) signifies “place in the hot water” in Náhuatl. In Mexico, there are about 25 villages with that name. Also, there is a town named Puruándiro and a zone called Pathé; both names mean “place in the hot water” in the P’urhépecha and Otomí languages, respectively.

Codices hold expressive hieroglyphics for place names and for Mexican volcanoes. For Atotonilco (“place in the hot water”) a drawing is used of a pot placed over fire. The volcano Popocatepetl is a simple bell-shaped curve with lava erupting from the top. In one drawing, the lava, shooting straight into the air, resembles leaves colored in and fastened asymmetrically to a corn-like stalk. A second drawing is more free-flowing. The erupting lava “leaves” are outlined—not colored in, unaffixed to a stem, and depicted as tear-like curves shot out against the sky. Eruptions of Popocatepetl were caused by the “departed spirits of wicked rulers whose fiery agonies, in their prison house, caused the fearful bellowings and convulsions in times of eruption,” according to a legend recounted by William Prescott.

Two hieroglyphics for Citlatépetl, which means “star hill,” depict a plan view of the volcano. On the first, the caldera with erupting lava is shaped as an eight-pointed star, colored in, and engulfed by a decorative circle representing the slopes of the volcano. The second hieroglyphic of the volcano has two parts. The plan view just described is drawn at the top of a vertical line seemingly suspended in air and swaying slightly. At its base, the line enters a small rectangular shape with tiny asymmetrical blocks at the surface depicting an earthquake. The hieroglyphic reads, “Citlatépetl was smoking when the Earth trembled.”

INFLUENCE OF GEOTHERMAL ACTIVITY ON MESOAMERICAN RELIGION

THE OVERPOWERING MAGNIFICENCE OF GEOTHERMAL PHENOMENA AND THEIR CONNECTIONS WITH areas of bountiful resources, or else with death and devastation, made the ancient inhabitants of Mesoamerica quite naturally associate these manifestations with powerful gods who had to be propitiated. Consequently, archaeological caches frequently are found near places of geothermal activity. For example, Stone (1941b) describes a place called *Peroles Calientes* in the Black River Valley on the northern coast of Honduras, which “must have been a very important one to the natives, for the quantity of pottery to be found there is immense.”

Food seems to have been the principal article offered to the hot water gods, because pot upon pot was placed upright, some within others, with the best pieces directly positioned under a hot waterfall. On the southern flank of Miravalles volcano in Costa Rica, offertory remains were discovered close to a lava outcrop that the ancient inhabitants revered. An additional example is that of the cache found under a stratum of volcanic sand on the slopes of Irazú volcano, also in Costa Rica. It amounted to more than 400 objects, including male and

female figures, offering tables, and heads made from volcanic rock, plus some 100 wooden articles preserved from weather and insects by the layer of volcanic sand (Stone, 1941a).

These examples do not show whether these people believed there was a god residing at the place with the geothermal manifestations, or if they worshiped the phenomena themselves. Then again they may have perceived the geothermal manifestations as attributes of a god or representing the forces and elements the god controlled. This is what we have with Huehuetéotl, the oldest of the gods, who controlled fire from his dwellings at the “world’s navel” that is, the Earth’s center, or with Xiuhtecúhtli, who united the fires of Earth and Sun. Tláloc was the rain god, but he could bring volcanic eruptions also, so he could produce rains of water or fire. Tezcatlipoca, whose name means “Smoking Mirror (Obsidian Mirror),” was the omnipotent deity of fate, both beneficial and destructive. Tlazotéoltl Ixcuina was the goddess of carnal love and natality, who ruled over steam baths, and Itzpapálotl, whose name means “Obsidian Butterfly,” was the goddess associated with Earth and fertility. These deities were not perceived by pre-Columbian peoples as clear-cut individuals, but as complexes of closely related gods or goddesses and attributes.

RAW MATERIALS OF VOLCANIC ORIGIN

MANY OF THE ARTIFACTS MANUFACTURED BY THE EARLY MESOAMERICANS WERE MADE FROM volcanic materials: silica, flint, basalt, and very especially, from obsidian. Obsidian, a volcanic glass that fractures in flakes with sharp edges, was particularly good for making knives, spear or arrow points, scrapers, needles, and similar utensils. It is interesting to note that the Náhuatl name for obsidian is *itztli*, which means knife. Obsidian blades have been found at practically all Mesoamerican sites. When obsidian was not available locally, it was traded, as the following examples show. In El Salvador at Chalchuapa, the remains were discovered of a large shop for manufacturing knives. However, the obsidian flakes found there are from Ixtepeque volcano in Guatemala, some 50 kilometers away. Also, the obsidian knives found in Honduras at Copán were imported because no natural deposits of obsidian are known in that area.

Volcanic rock was used widely, as is exemplified by the cache already mentioned found on the slopes of the volcano Irazú, the tombs with lids made out of laminar volcanic formations (*lajas*), and the sepulchral stelae carved on columnar basalt on the flanks of Miravalles volcano in Costa Rica (Ryder, 1983).

INDIRECT REFERENCES

SPANISH MISSIONARIES AND CHRONICLERS HAVE LEFT TRANSCRIPTIONS OF INDIAN LEGENDS AND traditions that they collected, and in many of these one can find references to geothermal phenomena. For example, a myth recounting the migration of peoples searching for Tamoanchán says they “were looking for mountains: some white mountains and some smoking mountains.” Would it be too farfetched to believe that these people were consciously trying to find for themselves a country fertilized by volcanic deposits and well irrigated by water from melted snow? In another example, a number of writers from the beginning of the Spanish colonization, like Fray Bernardino de Sahagún (1534) and Diego Muñoz Camargo (1540), tell in very similar words of signs that forewarned King Moctezuma II of the coming of the Spaniards. One of the omens, the *Fifth Prodigy*, seems to correspond to a phreatic explosion in the lake on the outskirts of the Aztec capital Tenochtitlán, now Mexico City (Burgassi et al., 1992).

The Aztecs believed that our world had passed through different epochs, called “Suns,” and that each previous epoch ended with a cataclysm. They knew the last epoch as the *Fifth Sun*, which presumably is the one in which we are now living, and they said that “in it, there will be earthquakes.” A prior epoch, the *Third Sun*, was the “Sun of the Fire Rain. And it happened that during it, there rained fire. And those who were living at the time burned out. And at the time, it rained sand also. And they say that in that Sun, it rained the pebbles that we now see, that the *tezontle* stone boiled and that the boulders reddened.” It is hard not to conclude that we have here the description of a devastating volcanic event, one narrated by a frightened survivor and later transmitted orally for generations.

THE POST-COLUMBIAN ERA

THE MEDITERRANEAN BASIN HAS BEEN TECTONICALLY ACTIVE SINCE THE MOST REMOTE TIMES, so the first Europeans to arrive in Mesoamerica were already acquainted with geothermal manifestations, either first-hand or by reference. Most of them probably had never been exposed to phenomena of the magnitude and frequency of those they witnessed in the New World. Their reaction was awe, as can be seen in the books of Juan de Cárdenas (1591), Bernal Díaz del Castillo (1568), Francisco López de Gómara (1552), and Suárez de Peralta (1589). An interesting narration is the one by Pedro Castañeda Nájera (1560) relating the

discovery by the Melchor Díaz expedition of geothermal manifestations adjacent to a lagoon now named la laguna Vulcano. The area is near geothermal power plants now at Cerro Prieto Geothermal Field, the largest geothermal installation in Mesoamerica. According to the chronicler, “as they were walking, they arrived into dunes of boiling ash, so that nobody could advance through them...the land trembled.”

Sometimes, the Spanish writers tried to provide an explanation of an event’s origin, one in many cases of real scientific value, as happened with the description of the geothermal gradient offered, probably for the first time in history, by Gonzalo Fernández de Oviedo (1526). In other instances, they did not content themselves with theorizing about geothermal phenomena, but sought to gain first-hand knowledge. A few examples were the attempts to sample the lava of the Masaya volcano by Fray Blas de Iñesta in 1551, or the different ascents of Popocatépetl while in eruption, the first one by soldiers of Diego de Ordaz, then the unsuccessful one by Antonio de Betanzos, and the one by Fray Bernardino de Sahagún, who, accompanied by four or five Spaniards, ascended to its very mouth “and there were very big flames, and it boiled as a cauldron, and this bad thing expelled a large amount of sulfur stone...and, from very far away, one sees the smoke leaving, as in a furnace, except that the amount was huge.”

The influence of geothermal events on the lives of Mesoamerica’s inhabitants continued after the Conquest. On repeated occasions, earthquakes and related catastrophes demolished colonial cities. That was the case with Antigua, or Santiago as it was originally known, the capital of Guatemala that was destroyed by earthquakes in 1773; the present-day Guatemala City was inaugurated capital of the country in 1776. Cartago, the former capital of Costa Rica, was so ruined by an earthquake in 1841 that only 100 houses and a church were left standing and the capital was reestablished in San José. After San Salvador, the capital of El Salvador, was destroyed by an earthquake in 1854, the capital was moved to Santa Tecla, which then took the name of Nueva San Salvador. Yet, illustrating the principle that people dismiss the risks from a potentially disastrous event if they are obtaining some benefit by doing so, the nation’s capital was relocated again at San Salvador in 1859. The city again suffered heavy damage from earthquakes in 1873 and 1907. Special mention shall be made of Mount Pelée on the Caribbean island of Martinique. After two innocuous active events in 1792 and 1851, the volcano erupted violently on May 8, 1902, completely destroying the City of Saint-Pierre and killing 30,000 people.

Regarding the exploitation of minerals and heat associated with geothermal manifestations, we know of a few notable instances, the most famous one being the mining of sulfur deposits on Popocatepetl. Suárez de Peralta reported in 1589 that the Indians obtained this material from the volcano skirts, and it is legendary that soldiers under Diego de Ordaz took from its crater the sulfur needed by Cortés' army to manufacture gunpowder. These deposits were mined until February 19, 1919, when the company working them exploded a dynamite load that was too large. The explosion provoked an earthquake and a volcanic eruption, resulting in the death of 17 workers. In another curious case, the Nicaraguan authorities extended a permit in 1551 to one Juan Alvarez to excavate the volcano Masaya and extract the molten gold that, he thought, was collected in the depth of its crater.

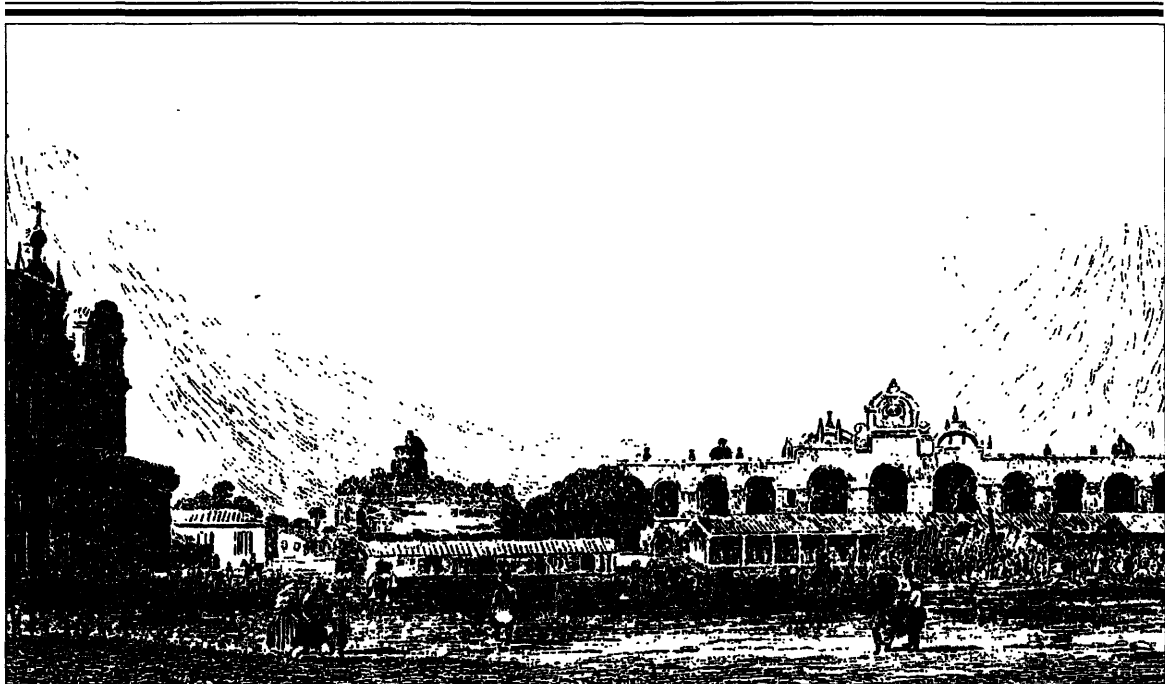
Mining Sulphur from Popocatepetl

"The Spaniards, five in number, climbed to the very edge of the crater, which presented an irregular ellipse at its mouth, more than a league in circumference. Its depth might be from eight hundred to a thousand feet. A lurid flame burned gloomily at the bottom, sending up a sulphurous steam, which, cooling as it rose, was precipitated on the sides of the cavity. The party cast lots, and it fell on Montaña himself [their leader] to descend in a basket into this hideous abyss, into which he was lowered by his companions to the depth of four hundred feet! This was repeated several times, till the adventurous cavalier had collected a sufficient quantity of sulphur for the wants of the army. This doughty enterprise excited general admiration at the time. Cortés concludes his report of it [in the early 1500s] to the emperor with the judicious reflection that it would be less inconvenient, on the whole, to import their powder from Spain." From *History of the Conquest of Mexico*, by William Prescott, 1873

Also, pools of thermal waters were used for their therapeutic properties by the original settlers and Spanish conquerors, alike. For example, the Baños del Peñón ("Baths of the Boulders"), located in the boundaries of the present-day Mexico City airport, were renowned for healing many ailments.

SUBSEQUENT TESTIMONIES

DURING THE 19TH CENTURY, AND NOTWITHSTANDING THE PROBLEMS IN THE MESOAMERICAN region, many foreigners came to visit for different reasons, and many of them left reports about the notable volcanic and seismic activity. For example, Henry Ward (1827), the first British ambassador to Mexico, confirmed that Popocatepetl is an active volcano and speculated on the effects of a sudden thawing of its snow cap due to a "violent eruption." He offered as endorsement to his ominous conclusions the report of a similar event witnessed by Alexander von Humboldt in Ecuador at Cotopaxi in 1802. In the course of a trip that Mr. Ward made in 1827 to inspect mines in the central part of Mexico, he crossed the Pathé River. Around it, he



Great Square of Antigua, Guatemala.

Antigua Destroyed
by John L. Stephens, 1841

“Yet this city [Antigua, Guatemala], surrounded by more natural beauty than any location I ever saw, has perhaps undergone more calamities than any city that was ever built.... At the corner of the street was the ruined church of Santo Domingo, a monument of the dreadful earthquakes which had prostrated the old capital, and driven the inhabitants from their home.

“On each side were the ruins of churches, convents, and private residences, large and costly, some lying in masses, some with fronts still standing, richly ornamented with stucco, cracked and yawning, roofless, without doors or windows, and trees growing inside above the walls. Many of the houses have been repaired, the city is re-peopled, and presents a strange appearance of ruin and recovery. The inhabitants, like the dwellers over the buried Herculaneum, seemed to entertain no fears of renewed disaster. I rode up to the house of Don Miguel Manrique, which was occupied by his family at the time of the destruction of the city, and, after receiving a kind welcome, in company with Seftor Vidaury walked to the plaza.

“The print above [by Frederick Catherwood] will give an idea, which I cannot, of the beauty of this scene. The great volcanoes of Agua and Fuego look down upon it; in the centre is a noble stone fountain, and the buildings which face it, especially the palace of the captain general, displaying on its front the armorial bearings granted by the Emperor Charles the Fifth to the loyal and noble city, and surmounted by the Apostle St. James on horseback, armed, and brandishing a sword; and the majestic but roofless and ruined cathedral, three hundred feet long, one hundred and twenty broad, nearly seventy high, and lighted by fifty windows, show at this day that La Antigua was once one of the finest cities of the New World, deserving the proud name which Alvarado gave it, the city of St. James of Gentlemen.

“This was the second capital of Guatemala, founded in 1542 on account of the destruction of the first by a water volcano. Its history is one of uninterrupted disasters.... ‘Many severe shocks of earthquakes were felt at different periods; the one in 1565 seriously damaged many of the principal buildings; those of 1575, 76, and 77 were not less ruinous. On the 27th of December, 1581, the population was again alarmed by the volcano, which began to emit fire; and so great was the quantity of ashes thrown out and spread in the air, that the sun was entirely obscured, and artificial light was necessary in the city at midday.

“The year 1585 and 6 were dreadful in the extreme. On January 16th of the former, earthquakes were felt, and they continued through that and the following year so frequently, that not an interval of eight days elapsed during the whole period without a shock more or less violent. Fire issued incessantly, for months together, from the mountain, and greatly increased the general consternation. The greatest damage of this series took place on the 23d of December 1586, when the major part of the city again became a heap of ruins, burying under them many of the unfortunate inhabitants; the earth shook with such violence that the tops of the high ridges were torn off, and deep chasms formed in various parts of the level ground.

“On the 18th of February, 1651, about one o’clock, afternoon, a most extraordinary subterranean noise was heard, and immediately followed by three violent shocks, at very short intervals from each other, which threw down many buildings and damaged others; the tiles from the roofs of the houses were dispersed in all directions, like light straws by a gust of wind; the bells of the churches were rung by the vibrations; masses of rock were detached from the mountains; and even the wild beasts were so terrified, that, losing their natural instinct, they quitted their retreats, and sought shelter from the habitations of men.

“The year 1717 was memorable; on the night of August 27th the mountain began to emit flames, attended by a continued subterranean rumbling noise. On the night of the 28th the eruption increased to great violence, and very much alarmed the inhabitants. The images of saints were carried in procession, public prayers were put up, day after day; but the terrifying eruption still continued, and was followed by frequent shocks, at intervals, for more than four months. At last, on the night of September 29th, the fate of Guatemala appeared to be decided, and inevitable destruction seemed to be at hand. Great was the ruin among the public edifices; many of the houses were thrown down, and nearly all that remained were dreadfully injured; but the greatest devastation was seen in the churches.

“The year 1773 was the most melancholy epoch in the annals of this metropolis; it was then destroyed, and, as the capital, rose no more from its ruins.... About four o’clock, on the afternoon of July 29, a tremendous vibration was felt, and shortly after began the dreadful convulsion that decided the fate of the unfortunate city.... On the 7th September there was another, which threw down most of the buildings that were damaged on the 29th of July; and on the 13th December, one still more violent terminated the work of destruction.... A meeting was convoked for the purpose of collecting the sense of the inhabitants on the subject of the removal.... It was resolved to make a formal translation of the city of Guatemala to the Valley of Las Vacas. The king gave his assent to this resolution on the 21st of July, 1775.... On the 29th of July, 1777, a proclamation was issued in Old Guatemala, commanding the population to remove to the new city within one year, and totally abandon the remains of the old one.’

“Such is the account given by the historian of Guatemala concerning the destruction of this city; besides which, I saw on the spot Padre Antonio Croques, an octogenarian, and the oldest canonigo in Guatemala, who was living in the city during the earthquake which completed its destruction. He was still vigorous in frame and intellect, wrote his name with a free hand in my memorandum book, and had vivid recollections of the splendor of the city in his boyhood, when, as he said, carriages rolled through it as in the streets of Madrid. On the fatal day he was in the Church of San Francisco with two padres, one of whom, at the moment of the shock, took him by the hand and hurried him into the patio; the other was buried under the ruins of the church. He remembered that the tiles flew from the roofs of the houses in every direction; the clouds of dust were suffocating, and the people ran to the fountains to quench their thirst. The fountains were broken, and one man snatched off his hat to dip for water. The archbishop slept that night in his carriage in the plaza. He described to me the ruins of individual buildings, the dead who were dug from under them, and the confusion and terror of the inhabitants; and though his recollections were only those of a boy, he had material enough for hours of conversation.

“In company with the cura we visited the interior of the Cathedral. The gigantic walls were standing, but roofless; the interior was occupied as a burying-ground, and the graves were shaded by a forest of dahlias and trees seventy or eighty feet high, rising above the walls. The grand altar stood under a cupola supported by sixteen columns faced with tortoise shell, and adorned with bronze medallions of exquisite workmanship. On the cornice were once placed statues of the Virgin and the twelve apostles in ivory; but all these are gone; and more interesting than the recollections of its ancient splendor or its mournful ruins was the empty vault where once reposed the ashes of Alvarado the Conqueror.”

From Incidents of Travel in Central America, Chiapas and Yucatan, Vol. I., courtesy Dover Publications, Inc.

noticed many “hot springs of mineral waters from which dense sulfurous vapors rose.” Precisely in this area, the first geothermal power plant of Mesoamerica was installed in 1959.

Although there are many other references to the geothermal phenomena of Mesoamerica published in the 19th century, we will end by mentioning one especially well known, the study on “Les Geysers de Ixtlán” that Paul Waitz presented at the 10th International Geological Congress in 1906. This paper was among those consulted by the first Mexican geothermicists, like Jorge Isita Septién, Luis de Anda, and Héctor Alonso, whose work made possible modern geothermal development in their country.

CONCLUSIONS

THE DISTINCT MANIFESTATIONS OF TERRESTRIAL heat—hydrothermalism, volcanic eruptions, earthquakes, and igneous mineral deposits—always have affected the lives of Mesoamerica’s inhabitants in definitive ways. At a fundamental level, the existence of geothermal activity in an area can decide whether or not its occupants will live or die. But geothermal manifestations also have less categorical influences. They can affect utilitarian aspects, as when people profit from the increased fertility of volcanic soils, exploit igneous materials, and use hot springs to bathe or heal. On a nonmaterial plane, they can foster the advancement of scientific theories to explain geothermal phenomena, the proposal of philosophical

Plumbing Fiery Liquor for Gold in Masaya

John L. Stephens, while traveling in Nicaragua, visited the volcano Masaya in 1841 and relates these two stories in his book *Incidents of Travel in Central America, Chiapas and Yucatan, Vol. II*. The story of the descent down the crater surely occurred around 1551. Perhaps one of the two Spaniards involved was Alvarez, the man permitted by the Nicaraguan government to explore it.

Stephens wrote, “Among the recorded wonders of the discoveries in America, this mountain was one; and the Spaniards, who in those days never stopped half way in any matter that touched the imagination, called it El Infierno de Masaya, or the Hell of Masaya.

“The historian, in speaking of Nicaragua, says, ‘There are burning mountains in this province, the chief of which is Masaya, where the natives at certain times offered up maids, throwing them into it, thinking by their lives to appease the fire, that it might not destroy the country, and they went to it very cheerful.’

“In another place he says, ‘There is another Mouth like that of a Well about a Bowshot over [from Masaya’s crater], the distance from which to the Fire is about a hundred and fifty Fathoms, always boiling up, and that mass of Fire often rises and gives a great Light, so that it can be seen at a considerable Distance. It moves from one Side to the other, and sometimes roars so loud that it is dreadful, yet never casts up anything but Smoke and Flame.

“‘The Liquor never ceasing at the Bottom, nor its Boiling, imagining the same to be Gold, *F. Blas de Ñesta*, of the Order of *St. Dominick* [*sic*], and two other *Spaniards*, were let down into the first Mouth in two Baskets, with a Bucket made of one Piece of Iron, and a long Chain to draw up some of that fiery Matter, and know whether it was Metal. The Chain ran a hundred and fifty Fathoms, and as soon as it came to the Fire, the Bucket melted, with some Links of the Chain, in a very short Time, and therefore they could not know what was below. They lay there that Night without any Want of Fire or Candles, and came out again in their Baskets sufficiently frightened.’” *Courtesy Dover Publications, Inc.*

The Ornamented Baths of Peñón

Around 1840, Frances Calderón de la Barca, Scottish wife of the Spanish ambassador to Mexico, visited the ancient, famous Baths of Peñón. She describes the baths in her book, *Life in Mexico*. Today the baths are gone, their former site part of the Mexico City airport.

“We drove out to the Peñón, a natural boiling fountain, where there are baths, which are considered a universal remedy, a pool of Bethesda, but an especial one for rheumatic complaints. The baths are a square of low stone buildings, with a church—each building containing five or six empty rooms, in one of which is a square bath. The idea seems to have been to form a sort of dwelling-house for different families, as each bath has a small kitchen attached to it.... People still flock there for various complaints. When one goes there to bathe, it is necessary to carry a mattress, to lie down on when you leave the bath, linen, a bottle of cold water, of which there is not a drop in the place, and which is particularly necessary for an invalid in case of faintness—in short everything that you may require. A poor family lives there to take charge of the baths, and there is a small tavern where they sell spirits and pulque; and occasionally a padre comes on Sunday to say mass in the old church.

“We were amused by meeting there with General ___ and his family, who had brought with them a whole coach-load of provisions, besides mattresses, sheets, etc. The road to the Peñón crosses the most dreary plain imaginable. Behind the baths are two volcanic hills; and the view of Mexico and of the great volcanoes from this is magnificent. It is the most solitary of buildings; not a tree to be seen in its environs; these volcanic rocks behind—Mexico fronting it—the great lakes near it—to the right Guadalupe—to the left San Ángel, San Agustín, and the mountains which bound the valley. The Indian family who live there are handsome...and the girl who attended me at the bath spoke an extraordinary jargon, half Spanish, half Indian.... The water is extremely warm, and my curiosity to try its temperature was very soon satisfied.

“These boiling springs are said to contain sulphate of lime, carbonic acid, and muriate of soda, and the Indians make salt in their neighbourhood, precisely as they did in the time of Moctezuma, with the difference, as Humboldt informs us, that then they used vessels of clay, and now they use copper caldrons. The solitary-looking baths are ornamented with odd-looking heads of cats or monkeys, which grin down upon you with a mixture of the sinister and facetious rather appalling.”

Life in Mexico, by Frances Calderón de la Barca, edited and translated by Woodrow Borah. Copyright by the Regents of the University of California, published by the University of California Press

developments related to the Earth’s heat in a general way, and the creation of complete plutonic theogonies.

In recent years, specialists of diverse disciplines—but mostly geologists and engineers working with geothermal exploitation, anthropologists, and historians of science and technology—have addressed this subject, and there is a growing bibliography. We hope that the study of the history of relationships between people and geothermal phenomena will continue for a long time.

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Geothermal stories are included in the oldest existing manuscript describing P'urhépecha life in Michoacán, Mexico, written between 1539 and 1541, about 20 years after the Spanish Conquest. This illustration from the frontispiece depicts a Franciscan friar (probably the author) presenting the manuscript to the Spanish Viceroy Mendoza, who had commissioned it. Important P'urhépecha leaders in Spanish dress stand behind the friar. *The Library of Congress*