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34. Andean Cultures and Geothermal Phenomena in Historical Chronicles

by
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Abstract: Active volcanoes, salt deposits originating from hot brines, hydrothermal minerals, and other geothermal by-products contributed significantly to the formation and development of indigenous cultures in the Andean Cordillera of South America prior to the Spanish Conquest in the 16th century. Based on archaeological findings and written descriptions dating from colonization, this chapter explains the use of natural heat and its by-products by the Andean people. It also describes habits and myths that formed in this region because of volcanic eruptions, earthquakes, and high-temperature manifestations. These phenomena, associated with imposing volcanic mountains, exerted an influence on the Andean peoples, both in the formation of religious sentiments and the development of a unique conception of the world.

The Andean Cultures and the Physical Environment

"The Inca called their sprawling realm Tahuantinsuyu, or 'Land of the Four Quarters,' and on the eve of Columbus' Caribbean landfall it probably surpassed Ming China and the Ottoman Empire as the largest nation on Earth [see map above]. Stretching down the mountainous Andean backbone of South America for more than 5500 km, it was the biggest native state to arise in the Western Hemisphere, and also the largest empire of antiquity ever to develop south of the equator. By dint of armed conquest the masters of Tahuantinsuyu governed the most rugged mountain chain on the face of the Earth, second only to the Himalayas in height and harshness. To the west their sovereignty reached over the dry Atacama Desert; to the east it included the flanks of the Amazon rainforest. Inca legions—like their Roman counterparts—marched far beyond the frontiers of civilization to dominate barbarian tribes and heterogeneous societies. At its height, the

imperial capital of Cuzco exercised rule over Northern Chile, upland Argentina, Bolivia, Peru, Ecuador, and Southern Colombia. No contemporary Andean nation compares in magnitude or prosperity, and the great wealth of Tahuantinsuyu fostered its downfall" (reprinted with permission from *The Incas and Their Ancestors* by Michael E. Moseley, 1992, published by Thames and Hudson Inc., copyright 1992 Thames and Hudson Ltd., London).

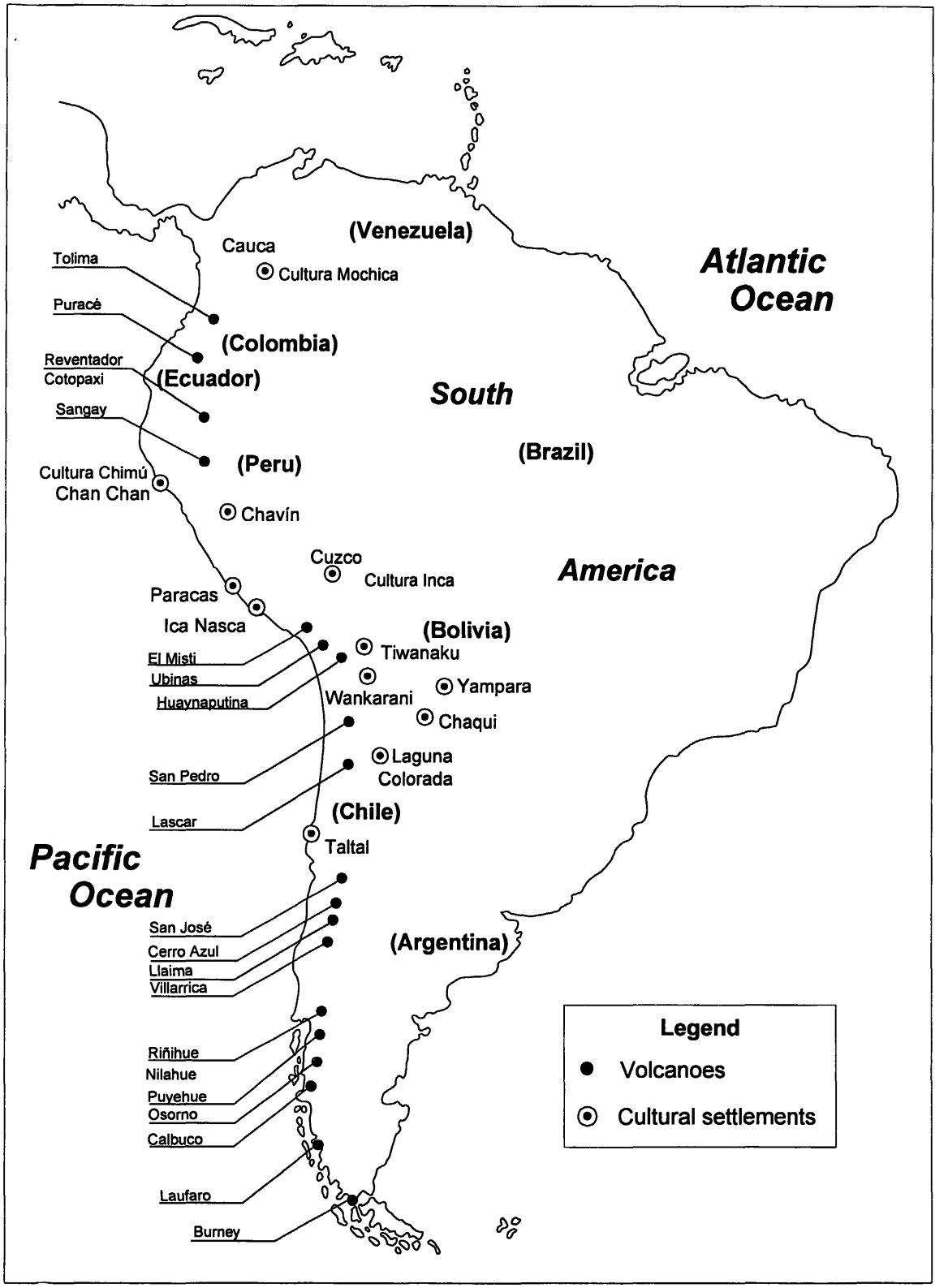
Andean cultures that grew under Inca rule between the 2nd and the 16th centuries A.D. developed over a very wide territory, covering the Andean highlands of South America from Southern Colombia to the Maule River in Chile at an elevation of 3500-4000 m, including the western and eastern slopes of the Andean Cordillera and the adjoining lowlands. These are referred to as the Pacific and Amazonian Yungas, respectively. The Andean Cordillera was thus an imposing cultural barrier between the eastern and western lowland regions. The desert-like region of Atacama in Northern Chile was also under Inca rule.

The vast territory of the Inca Empire corresponds, as a whole, to a sector of the Pacific Ring of Fire. Of the many active volcanoes found here, the most important are Tolima, Puracé, Cotopaxi, Chimborazo, Sangay, El Misti, Ubinas, San Pedro, Ollaü, San José, Cerro Azul, and Llaima in the northern segment, and Villarrica, Riñihue, Nilahue, Puyehue, Osorno, and Calbuco in the far south. The volcanoes resulted from the collision between the Nazca and the South America plates, a collision that also triggered countless earthquakes—many disastrous—in recent geological times and in the present.

Prehistoric Times

The first human settlements in South America probably occurred in the Middle Paleolithic, between 50,000 and 70,000 years ago. The most ancient sites identified so far are those of Viscachani (Bolivia), Taltal (Chile), and Patagonia (Argentina), dating back 30,000 years. Handmade objects found at these sites include scrapers, arrowheads, axes, and many other stone tools. Radiocarbon dating of organic materials at the sites places human populations at about 37,000 years ago.

Among the Paleolithic pre-ceramic deposits, Viscachanensis, Ayampitensis, and Quila Quilense have been analyzed in detail. The stone tools found there are about 30,000 years old and show that people of that time were already using silica, quartzite, black flint, obsidian, and other hard



Main volcanic complexes and principal prehistoric and Inca cultural settlements in South America.

rocks to manufacture arrow points, choppers, spear points, knife blades, and one-sided polished splinters. These objects resemble those found in North American sites (Sandia, Trenton, Tule Springs, and Nevada) and suggest that the same manufacturing techniques were used (Ibarra Grasso, 1956 and 1958).

The Andean Cultures, Where and When They Developed
(Ibarra Grasso and Querejazu Lewis, 1986; Escalante, 1994)

- Viscachani (pre-ceramic), Bolivia; 28,000-8000 B.C.
- Mojocoyense, Bolivia: 8000
- Ayampitense, Argentina: 4000-3000
- Laguna Colorada (Lipez pre-ceramic), Bolivia: 3000
- Quila Quilense, Bolivia: 2000(?)
- Valdivia, Ecuador: 1000
- Kotosh, Peru: 2000-1000
- Chavín, Peru, 1000
- Tiwanaku (rustic), Bolivia: 1000-300
- Chiripa, Bolivia: 500-300
- Wankarani, Bolivia: 500-300
- Tiwanaku (classic urban and expansive imperial), Bolivia: 100 B.C.-1000 A.D.
- Mochica, Peru: 200
- Nasca, Peru: 300
- Wari, Bolivia; 500
- Los Maitas, Chile: 500
- Chimú, Peru: 1000
- Kolla, Lupaka, Pakaxa, Mollo, Karanga, Charca, Chicha, Huruqui, Chaqui, Yura, Collas, and Incas, various Andean countries: 1200-1500

Thus a number of products of volcanic origin, together with other materials directly or indirectly related to geothermal resources, played an important role in the development of early Andean cultures of South America. Moreover, igneous rocks such as diorite, andesite, and basalt were used to make many items and to construct many great pre-Hispanic monuments, such as those at Tiwanaku and Cuzco, which date back to 374 and 724, respectively (Ponce Sanjinés, 1970; Avila Salinas, 1975).

Geothermal Phenomena, Hot Baths, and the Use of Geothermal By-Products

Indirect proof of the relationship established between some ancient Andean peoples and the surface manifestations of geothermal resources is suggested by the location of several sites in areas with important natural manifestations. This is the case, for instance, of Viscachani, Laguna Colorada (Lipez cultures), Wankarani, and Chaqui (Ibarra Grasso and Querejazu Lewis, 1986; Ponce Sanjinés, 1970). It is easy, therefore, to argue that native peoples of the Andean region had already started to use natural heat and a number of geothermal by-products.

At several locations—Cuzco and Cajamarca in Peru; Huscarán and Puente del Inca, near Mendoza in Argentina; and Tarapaya in Bolivia—important Inca findings and construction works have been studied carefully. These sites offer direct proof of the care, knowledge, appreciation, and value the Incas granted the hot springs because of their healing properties. Evidence also suggests that the hot springs influenced Inca social customs and religious practices.

Not only the thermal springs but volcanic eruptions, hydrothermal deposits, and earthquakes must have had an important effect in attracting or discouraging the settlement of Inca villages, at least in the cold highlands where these types of manifestations frequently occur. Many travelers to the Andes chronicled the abundant geothermal events. These self-appointed historians included Catholic missionaries and monks, fortune seekers, and others who followed the Spanish conquistadors. López de Gómara, for example, was personal secretary to Hernando Cortés and one of the more prolific chroniclers. He described the 1533 eruption of the Pichincha volcano in Peru: "For many days ash expelled from the volcano of Quito fell over [the Inca villages nearby] and was thrown a distance of more than eighty leagues [a league is 5572.7 meters].... It throws so much fire and makes so much noise when it boils that it can be seen at a distance of more than one hundred leagues; and, as [the Incas] say, [the noise of the explosion] frightened people more than one caused by shocking thunder and lightning..." (1553).

De Gómara also described other geothermal phenomena, such as the 1541 earthquake in Quije, close to the Cayambe volcano in present-day Ecuador. This is where Gonzalo Pizarro, half-brother of Francisco Pizarro, conqueror of Peru, had arrived during his ill-fated quest for El Dorado, the "land of cinnamon and gold": "On the road to Quijos, north of Quito...the Earth trembled terribly and more than sixty houses crumbled in ruins...the Earth was fractured in many places.... There was so much thunder and lightning that [Pizzarro's soldiers] were frightened..." (1553).

Some of the writers were indigenous Incas, such as Garcilaso de la Vega, son of a Spanish soldier and an Inca princess, who wrote about the earthquakes and volcanic eruptions that occurred in Chile in 1599 and in Peru in 1600. Thick ash, he explained, blanketed the area surrounding Arequipa for about 20 days, measuring about one meter thick in some spots, more than two meters in other places, and everywhere "at least one fourth of a yardstick." In addition

to heavy ash fall, residents suffered severe damage to crops, cattle, and orchards. Vineyards, wheat fields, and fruit trees—barren of branches and fruit— were buried in locations thousands of kilometers from Arequipa, and all livestock—cows, sheep, goats, and pigs—perished, either buried by ash or starved due to lack of pasture. In addition, many houses collapsed under the ash load, although some were saved because the owners diligently shoveled ash from the roof.

The eruption was accompanied by "great lightning and thunder," audible at distances of 150 to 200 kilometers around Arequipa. The heavy ash fall brought darkness to the land: "the sun in those days had darkened so much, that even at noon candles had to be lighted..." (1609).

In describing the territories conquered by the Inca Capac Yupanqui, de la Vega wrote about the hot springs of Tapacari, a province with many springs of water so hot "that nobody can keep his hand in it even for the time it takes to say *Ave Maria*." The odoriferous sulfur steam was visible from great distances. In addition to the hot springs, the area also contained "other springs with very cold and savory water," from which the Cochabamba River originated.

Cieza de León, a self-taught seeker of fortune, extensively traveled the Andean Cordillera and recorded his observations in *Crónica del Perú* (*A Chronicle of Peru*), written in the mid-16th century. He described several geothermal phenomena, particularly volcanic eruptions and the presence and use of hot brines in many Andean localities. In the province of Quimbaya, for example, a volcanic peak in the Sierra Nevada, the great Andean mountain range, threw "a great quantity of smoke" into the air. This mountain is the source of many rivers, including the Tacurumbi and the Cegue. Between these rivers lay brine sources, which formed fanciful formations as they flowed into the rivers.

Indeed, de León seemed fascinated by the indigenous peoples' methods for salt extraction and their uses of hot brines. From the catchment basin of the Santa Marta River, populated by Coconucos Indians, he witnessed "many *bocas de fuego* ['fire mouths' or erupting volcanoes] on the tops of the Sierra...." Hot water flowing down the slopes was a source of salt for the Indians, as were the rivers in the interior Popayán province. The local people extracted the salt and used it for cooking. Salt was so plentiful in the lakes and rivers of Peru, "that they can meet with the demand of all kingdoms of Spain, Italy, France, and other major parts of the world..." (1550).

De León also embarked on a series of study tours. On one trip from Cartegena, with graduate Juan de Vadillo, they were running out of water and supplies when they reached a small lake with black, salty water. The travelers, "in the need that teaches great things to men, took some water from the lake and poured it into hot pots, and this gave flavor to [their] meals...." Later, they learned that the Indians took the waters from this lake in large pots and boiled it to produce a black salt "not so good tasting" but one useful for cooking meals.

In Cori, located on the outskirts of Villa de Acerma, the Indians found brine ponds next to a rushing river. They boiled the water to produce salt cakes. These were of "very pure salt, excellent and as special as that obtained from the salt mines in Spain...." In the nearby province of Caramanta, a local hot spring flowing inside a fresh water river was also a source of salt, and springs in the towns of Mungia and Canupata yielded hot brines. In fact, noted de León, production was prolific: "they obtain so much salt, that we saw houses almost full of it..." (1550). Near Juanja, a "whitish rock outcrop," probably hydrothermal encrustations, marked the mouth of a hot brine source.

De León's travels took him ever deeper into the Peruvian countryside. On a journey between Villa de Pasto and Quito, he came upon the ruins of an Inca fortress called *Lumichaca* or *Rumichaca*, which means "stone bridge" in Quechua, the Inca language. Nearby he found a hot spring with scalding water: "if one puts his hand into [the water] in no way can he afford to keep it in for a long time due to the high heat with which the water flows out..." (1550).

Closer to Quito, de León visited Mulahalo, a former recruitment center for Inca warriors, which, in former times, was a bustling town with many inns and supply depots. A volcano was nearby, and the Indians told stories of destructive eruptions with stones and ash leveling towns in the surrounding area. Legend has it that, "before the eruption, one saw infernal visions and heard frightful voices...." This was confirmed by Don Pedro de Albarado, leader of a Spanish army in Peru, who witnessed an eruption with his soldiers.

Like their counterparts in other geothermally active areas of the world, the Incas used hot springs for thermal bathing. The chroniclers described the myriad palaces and temples erected near thermal sites: "After the Incas conquered this province of Cajamarca...they constructed a number of palaces and a temple to the Sun.... In these palaces there were many things to see, especially some baths, very good ones, where the lords and the dignitaries were used to taking baths while staying there...." While it is not known whether these baths were supplied with

natural hot water, it is likely that the nearby thermal springs fed the baths. Inca buildings and a hot water pool in a stone enclosure were near another town, Jauja. The Inca lords and their wives used the water for daily bathing (de León, 1550).

De León found a similar arrangement in Bilcas, the central part of the Inca Empire located between Guamaga and Cuzco. A stone temple to the Sun dominated the town's main square, which was bisected by a lined " huge ditch channeled with much delicacy." These were "secret baths" for the Inca lords and their ladies. While de León did not specify whether or not the ditch served as a canal for natural hot water, the proximity of thermal springs suggests that it was likely used for collecting and channeling thermal waters. The baths may also have represented a centralized balneological establishment for Inca aristocracy.

Overall, de León concluded that thermal bathing for the Incas was ubiquitous: "Likewise, in many localities of the Inca Empire there were countless sources of hot water that the natives used, and still use at present, to take baths.... I myself have seen many of them everywhere I walked..." (1550).

Garcilaso de la Vega also wrote about Inca thermal bathing. When the Spanish conquered King Atahuallpa, in the province of Cajamarca in December 1531, they discovered a sumptuous royal bath occupied by "five thousand women who, despite being sad and helpless, enjoyed themselves with the Christians..." (1609). The baths were probably supplied with hot water from nearby thermal springs. In addition, they found tents, clothes and linens, and beautiful silver and golden artifacts that they plundered.

According to Francisco de Jerez, personal secretary to Francisco Pizarro, the royal palace of Cajamarca also included hot pools used for bathing: "four rooms surrounded the internal patio of this palace where a decorated pool could be seen, which was fed by two conduits: one conveying cold water and the other supplying natural hot water from a mountain source. During the day, the royal family stayed in one of the four rooms.... The walls were varnished with a brilliant red lacquer and the framework of the ceiling was painted the same color. Close to the royal residence there was another pool, also supplied with hot and cold water, surrounded by stone steps. It was used by the people for bathing..." (Baudin, 1943).

At least three writers referred to the Incas' therapeutic use of thermal waters. Vasquez de Espinosa, in writing about the valley of Cochabamba, noted that three villages, Santiago del

Thermal Baths, Rich and Splendid

"All the royal palaces had gardens and orchards for the Inca's recreation. They were planted with all sorts of gay and beautiful trees, beds of flowers, and fine and sweet-smelling herbs found in Peru. They also made gold and silver models of many trees and lesser plants: they were done in natural size and style with their leaves, blossoms, and fruits, some beginning to sprout, others half-grown, and others in full bloom....

"There were also large and small animals carved or hollowed out of gold and silver: rabbits, mice, lizards, snakes, butterflies, foxes, and wild cats (they had no domestic cats). There were birds of all kinds, some perched on trees as if they were singing, while others were flying and sucking honey from the flowers. There were, too, deer and stags, lions, tigers, and all the other animals and birds that bred in the country, each being set in its natural surroundings to give greater similitude.

"In many palaces, or even in all of them, they had baths, consisting of great tubs of gold and silver, for washing in: water was brought to them through pipes of silver and gold. And wherever there were natural hot springs, they also made very rich and splendid baths. Their other wonders included piles and heaps of firewood, done in gold and silver, as if they were stocks for use in the palace."

Royal Commentaries of the Incas and General History of Peru, by Garcilaso de la Vega, trans. Harold Livermore. © 1966, University of Texas Press. *Reprinted with permission*

Paso, Sipi Sipi, and Tiquipaya, had "very good and healthy thermal waters." Ill people bathed in them "to recover their health..." (Guzmán, 1973).

Another chronicler, Vicente Cañete y Dominguez, described the mineral waters of the Tarapaya lagoon located atop a small hill about 1.7 km from Potosí. With a circumference of about 400 meters, the lagoon had a small creek flowing from it: "The lake is very deep; its waters are supplied by healthy hot springs that serve for bathing. At the center of the lagoon a boiling source can be seen, whereas on both sides of the creek there are other sources of hot water. These have a lower temperature, but they still are warm enough for bathing.... It is said that this lagoon swallows down all those who venture to take a bath in it.... For sure, these hot waters are mineral and healthy; however, it is not known why they have such healing properties and how they have kept their heat for so many centuries..." (Guzmán, 1973).

Garcilaso de la Vega described high-temperature manifestations and hydrothermal by-products, including a hot water lagoon in the Lipez region, a sector of the Andean highland covering Southern Bolivia. At Tumaquifa, about 2 km from the mines of San Cristobal de Achocolla, a small lagoon on a low hill was used for dysentery treatments:

"In the center of the lagoon the water boils frenetically, and water jets with steam can be seen that are sometimes small and other times high with a great and dreadful noise.... I was truly frightened just to see the tumultuous boiling of the water, but there are some people who dare even to reach its border. The water is so turbid that it looks like mud. [The lagoon] has a small outflow through which the water flows, encrusting the rocks with much red salt; then it streams into a *guayco*

['gully'] where it rushes away very fast. The red encrustations are a kind of very strong salt that, because of its metal content, is much stronger and more beneficial than common salt; it has also been tested as a good cure for dysentery. It may be that [this salt] contains a mixture of red alum that makes it more efficacious.... Near this lagoon, a vein of 'Judaic stone' [probably malachite] outcrops and plenty of copper minerals are around..." (1609).

In addition to curative properties, some thermal waters had a ritualistic significance. For example, the fortress of Pukaramarka, about 60 km from Cuzco near the banks of the Urubamba River, had a special bathing place reserved for use by *ñust'as* ("virgins"). This bath was fed by natural thermal water and bathing here probably had some ritualistic significance for the young ladies before their marriages (Lara, 1976).

Some events related to geothermal manifestations were regarded as ominous portents and thus received the chroniclers' attention. Montecinos, secretary to the Viceroy of Peru, wrote a monograph entitled *Viejas Memorias Históricas del Perú* (*Old Historical Memories of Peru*) that described the pre-Inca kings of Peru called the Amautas. Referring to the great-grandchild of the famous King Tupaj Yupanqui, Montecinos stated that: "At the times of the 61st [pre-Inca] king...many bad omens, comets and earth tremors had occurred.... According to legend, there is a celebrated cave in the area where it is said with all certainty that earthquakes were never felt, nor were pestilence or tremors." Nonetheless, by the reign of the 63rd king, nobody could remain in Cuzco because of the strong earthquakes that destroyed many buildings, both in the city and surrounding areas. The quakes caused flooding as rivers were rerouted, destroying some cities that had withstood the earthquakes. As a final coup, the area

Llicancahur volcano and Laguna Verde on the Southern Bolivian plateau. Here and in the neighboring lands of Southern Bolivia, the Lipez culture developed some 5,000 years ago. *G. Rico Calderón*

was then devastated by a plague that killed "countless people." These events caught people unawares, since they subscribed to the superstitious belief of the kings that Cuzco "was the only place where no natural catastrophe and pestilence could occur" (Bingham, 1972).

The Incas used hydrothermal minerals for trade and currency. An excavation at Cuzco, according to Bingham (1972), yielded 29 obsidian pebbles, slightly larger than regular marbles, that were apparently used for counting. Since oral tradition does not account for an eruption near this location, the volcanic pieces were imported from another place. Obsidian, along with chalcedony and rock crystal, was also a currency in Peru and Chile during Inca times (Latcham, 1909). These geothermal resources—such as obsidian, silica, and rock crystal—were traded during the time of the Classic and Expansive Tiwanaku culture (100 B.C.-1000 A.D.), and there was, as Baudin explained, "widespread commerce of the ceramics made in Bolivia, which were largely exported to present-day Ecuador. Moreover, large quantities of decorated pieces were exported to the [Pacific] coastal areas..." (1943).

Religious Aspects and Geothermal Phenomena

As in other areas of the world, the first religious feelings in the Andean region probably developed after observing exceptional natural events. The tremendous force of volcanic eruptions and earthquakes contributed to the formation of popular belief in the existence of supernatural forces ruling these phenomena. Early Andean populations probably believed in and revered superhuman entities capable of triggering or stopping, at will, volcanic eruptions and earthquakes.

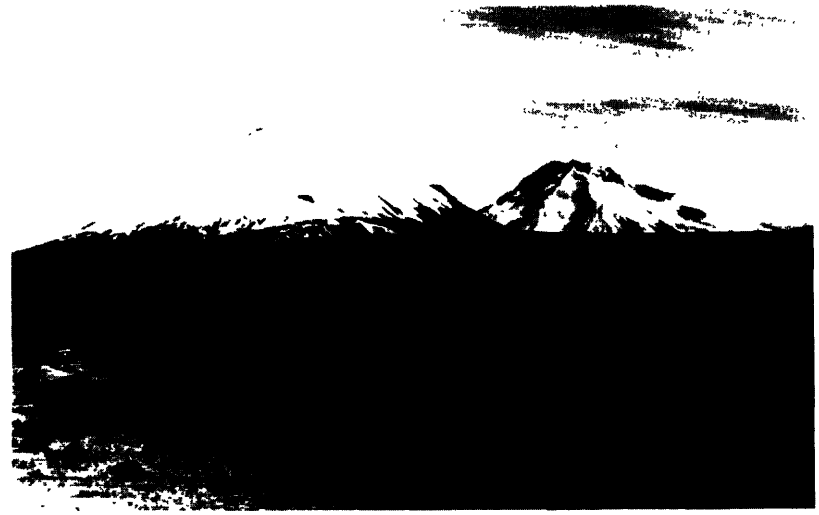
These initial religious stirrings were gradually refined over centuries until they became the basis of a complex pantheon that included not only the entities governing geothermal phenomena but many others as well. During Inca times, these beliefs became an integrated perception of the whole world: a true model of the universe in which each natural phenomenon had its own divinity and was explained by the logic of a supernatural sphere.

A major god of the Inca pantheon was Pachacamac, or Pachak'amaj, the creator of the world (Lara, 1976), or, as Garcilaso de la Vega more poetically stated, the god "who gives soul to the universe" (1609). In earlier times, Pachak'amaj was also regarded as *wak'a,* "lord of the earthquake," as a way to explain the frequent earthquakes along the Pacific coast. Pre-Inca

populations built a grand temple dedicated to him on the Peruvian coast, in a town which now bears the god's name. Lara (1976) recounts an old legend relating the god to the Earth's movement: "The earthquake was under his governance, and to produce an earthquake it was enough for him to only move his head. When he becomes irritated, the whole world moves...however, he does not move his face at all. Should he only turn his body half around, this would suffice to cause the end of the world. The myth says that one of the sons of the *wak'a*, named Llayawankupa, was proud to proclaim: 'I am the son of Pachak'amaj, the god who shakes the Earth....'"

Pachak'amaj produced earthquakes when he was displeased or irritated by the behavior of people (Guzmán, 1973). To placate the god and ensure his protection, the Incas sacrificed animals—up to 10,000 llamas in one ceremony at Cuzco—and people. According to Juan Polo de Ondegardo, by royal decree many young women were sacrificed "under the necessary condition that they had to be virgins.... Moreover, extraordinary sacrifices were made by the Incas during that main feast called Tyri...if there had been an earthquake, or a noticeable sun or moon eclipse, or a volcanic eruption..." (Guzmán, 1973). Victims were entombed in mountain caves or hurled from cliffs or high peaks.

Another religious precept important to Inca theology was *huaca*. *Huaca* was, according to Baudin (1943), "everything that was above the ordinary: a high mountain top, a strange beast, a rare flower...." A *huaca* was sacred, "a divine manifestation in everything, a miracle in every phenomenon." De la Vega mentioned that the Sierra Nevada range was *huaca*, as were the very highest mountains in it, and therefore "most admirable to all those who look at it with attention..." (1609). Antonio de La Calancha, an Augustinian monk born in Bolivia and educated in Lima, wrote that, "Besides others, the idols worshiped by these Indians were the permanent



The Payachata volcanoes, near the border of Bolivia and Chile. Volcanoes and permanent snow lines, here above 5000 m, were two natural features worshiped by the Incas. *R. Iriarte*

snow lines of the mountains, and especially those having the highest altitude.... In particular...they used to make many [human] sacrifices and worship the Illimani Cullcachata [the volcanic massif of the Cordillera Real, near La Paz, Bolivia].... In these mountains the devil gave the Inca his answers, and the oracles issued from those mountains were continuous..." (Guzmán, 1973).

According to Murra (1975), the snow-capped volcanoes of Cotopaxi and Chimborazo played an important role in the myths of the creation of all volcanic complexes called *Colorados*: "The tempest is a god who lives in the high mountains of the Andes and roars when he becomes drunk.... He has a sword that he draws to produce lightning.... The Indians of Quito worshiped the high mountains of their land, considering them deities, animated with the same feelings as a human being...."

Finally, worthy of mention is an event from the bloody battle of Tiocajas between the Incas and the Spaniards: "Huaina Capac, a son of the Inca king...had succeeded in reconquering Cajamarca.... The battle then continued all day long, and the Spaniards would have retreated if a providential eruption of Cotopaxi had not scared the Indians, who withdrew..." (Baudin, 1943). This behavior suggests that the Incas considered the volcanic eruption as a warning sign addressed to them by a supernatural entity that deserved great respect and veneration.

Concluding Remarks

Until the mid-16th century, written documents tracing the development of Andean cultures during Inca and pre-Inca times were unavailable. For these times, the only sources of information on lifestyles, traditions, and relationships that Andean natives established with their physical environment are the results of relatively recent archaeological work.

The first written accounts of these relationships, particularly the rapport between Andean populations and geothermal phenomena, are chronicles by missionary friars, geographers, and others who followed the Spanish armies on their military expeditions in the northern and western sectors of South America. These chronicles, however, were only partially based on direct observations of actual situations; in many instances, they were distorted and embellished with descriptions of prior events gleaned from the oral histories of local people. Furthermore, one must consider that the European chroniclers were not accustomed to natural phenomena of such

imposing magnitude, particularly the violent force of some geothermal manifestations: catastrophic earthquakes, huge volcanic eruptions, and geyser-like jets of water and steam.

There is little doubt that all these phenomena, associated with the harsh environmental conditions of the cold highlands and thick-forested lowlands, have deeply influenced the development of the Andean cultures since prehistoric times. Two forms of geothermal influence can be identified, one pragmatic and the other spiritual. The pragmatic influence includes using thermal waters for bathing, processing hot brines for salt, manufacturing volcanic products into tools, using volcanic materials for buildings, and extracting hydrothermal compounds for practical applications. The spiritual influence is reflected in the meanings attributed by the Andean populations to manifestations of the Earth's energy, which were thought to represent supernatural entities. Such reactions to geothermal phenomena were gradually internalized, taking root in people's minds and spirits. They contributed significantly to the development of a unique, complex model of the Andean universe.

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Volcanic rock was used to fashion *moai*, Easter Island statues (whose natures were conjured by the words of Chilean poet Pablo Neruda in his poem, *The Rose Apart, Easter Island*, 1973) and *ahu*, the platforms on which the statues were raised. *Craig McNamara, 1971*