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## 29. Historical Impacts of Geothermal Resources on the People of North America

by  
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*Abstract:* The Indians of North America considered hot springs as sacred places, and they were great believers in the miraculous healing powers of the heat and mineral waters. Hot spring areas were also known as neutral ground, places where warriors could go and rest unmolested by other tribes. Even though archaeological finds date the Native American presence at hot springs over 10,000 years ago, there is no recorded history of this prior to the arrival of the Europeans in the 1500s.

Many legends concerning geothermal activities are part of Native American oral history, such as those about Madam Pele, the Hawaiian goddess of volcanic fire, and the story of the battle between Skell and Liao describing the eruptions of Mount Mazama (Crater Lake) and Mount Shasta.

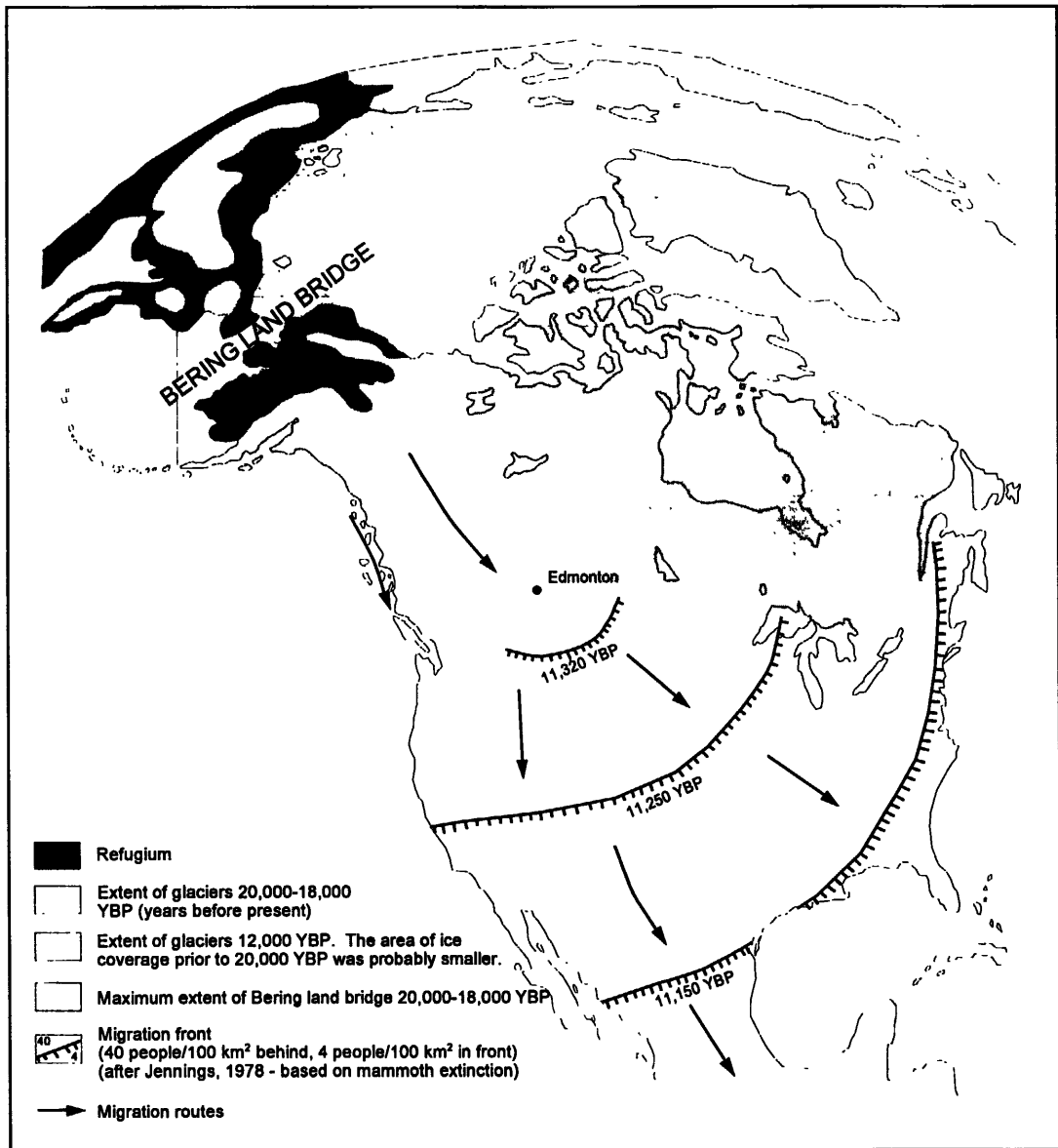
### INTRODUCTION

THE HISTORY OF GEOTHERMAL USE PRIOR TO THE INDUSTRIAL Revolution centers itself mainly in the volcanic region of Western North America. A few isolated locations are also found in the middle and eastern part of the continent. The use of geothermal resources during this period was by Paleo-Indians and Indians, also referred to as Native Americans. Even though archaeological finds date Native American presence at hot springs for over 10,000 years, there is no recorded history prior to the arrival of Europeans in the 1500s. Rock paintings (pictographs) and rock carvings (petroglyphs) are the only sources of writing available for study; and, as far as the author knows, none depict geothermal phenomena. With the Europeans' discovery of geothermal phenomena, such as volcanoes and hot springs, the ownership and use patterns changed considerably and many became commercial operations. Thus, the use of geothermal springs and related phenomena has gone through three stages of development in North America: use by

Indians as sacred places, development by early European settlers to emulate the spas of Europe, and use in modern times as places of relaxation and fitness and as energy sources for heating and cooling.

## EARLY SETTLEMENTS

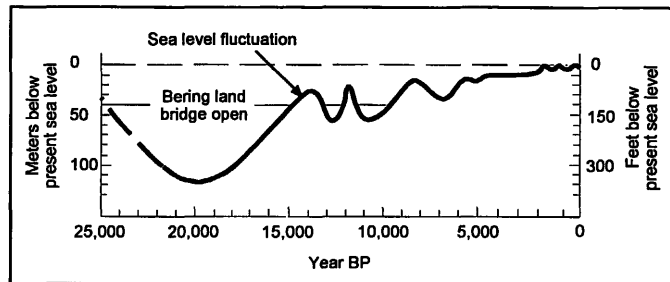
THE TIME OF THE FIRST HUMAN INCURSIONS INTO NORTH AMERICAN IS SUBJECT TO DEBATE; however, it is generally associated with Beringia, the land bridge between Siberia and Alaska



Bering land bridge, *Beringia*, after Jennings, 1978. Reprinted with permission

that was formed during the Pleistocene epoch. In the last stage of this glacial period, the Wisconsin or Weichsel glacial advance, so much of the ocean's water was tied up in glaciers that the oceans were about 100 m lower. As a result, a dry land bridge up to 2000 km wide formed between the Bering and Chukchi Seas. The land bridge probably existed from 50,000 to 40,000 and from 25,000 to 14,000 years ago. It vanished altogether about 8000 B.C. (Jennings, 1978).

Small bands of hunters from Eastern Asia probably followed game migrating eastward across this wide area characterized by long winters, short summers, and continual winds. However, the summer thaw exposed many



Beringia chronology, after Jennings, 1978. Reprinted with permission

marshy areas and lush meadows, conditions somewhat attractive for migrations. The ice-free summer bridge led into the ice-free interior of Alaska called *Refugium*, The Refuge (Jennings, 1978). Here the first Paleo-Indian site was discovered, the oldest dated site in North America: Old Crow Flats near the Alaskan-Canadian border is dated between 40,000 and 25,000 years old, depending upon the reference (Dumond, 1978; Fagan, 1985).

Later, ice-free corridors opened into the central portion of North America between the Cordilleran and Laurentide ice sheets. This corridor is estimated to have existed before 18,000 and after 12,000 years ago. It passed into the central plains around present-day Edmonton, Canada. More recent evidence points to a second ice-free route along Canada's western coast (Recer, 1997). A human skull dating from about 7800 B.C. was found recently on Prince of Wales Island. The route along the coast was opened when about 60 meters of the continental shelf was uplifted by the weight of 2500 meters of ice atop the coastal range, deforming the land like someone sitting in the middle of a waterbed. The route was open for about 2,000 years and closed about 9,500 years ago. Some advanced parties of Paleo-Indian hunters, pursuing game such as mammoth and bison, may have moved into the central plains as early as 20,000 to 25,000 years ago, as evidenced by dated sites in the Ohio Valley (Meadowcroft Cave) and by hunted remains found as far south as Mexico. The dates of these sites are questionable, with the first well-attested settlement dated at 13,000 B.C. (Fagan, 1985). However, significant groups of Paleo-Indian hunters of the Llano and Folsom-Plano groups had only moved as far as Edmonton by 9500 B.C.

The “Old North Trail,” as this ancient route into the United States is now called, started in Canada near Edmonton and extended south along the eastern slopes of the Rocky Mountains, near present-day Calgary, Alberta, and Helena, Montana, before splitting in two. One branch went into Central Utah and the other into Central Colorado near Denver and Pueblo (Stark, 1997). This route is known to be over 3000 km long and may have been used by humans for 10,000 years, according to archaeologist Brian Reeves (Stark, 1997). The route, included in the oral history of the Blackfeet Indian Nation, was probably used until the 1930s; portions of it can still be



The Old North Trail, after Peter Stark, *Smithsonian*, July 1997

identified by travois ruts, tipis rings, and stone cairns. It was a trade route for carrying obsidian and chert from quarries in Wyoming and Montana to Canada. The trail is now under consideration as an entry in the National Register of Historic Places by the Montana Historic Preservation Office.

The earliest documented sites were Paleo-Indian sites, such as Clovis and Folsom, New Mexico; Lindenmeier, Colorado; Borax Lake, north of San Francisco; Tule Springs, near Las Vegas, Nevada; and Fort Rock Cave and Alvord Lake, in Eastern Oregon. They date from 11,000 to 9000 B.C. The Paleo-Indians are best known to have existed in the Great Plains and the Great Basin provinces. About 9,000 to 10,000 years ago, the Paleo-Indians were replaced by specialized hunter-gatherer cultures, or Indians. Most of Canada, due to the Cordilleran ice sheet, was not occupied until this time. Numerous sites are dated after this period, but plains and basin sites are difficult to find due to the migratory nature of the Indians searching for game.

The Indians dominated North America until they were essentially replaced by the Europeans in the east in the early 1700s and in the west around the mid-1800s.

The debate is not over. Recent language and DNA research suggests several migratory waves have existed, some as early as 30,000 to 40,000 years ago (Cole, 1998). This is supported by the discovery of a 12,500-year-old settlement in Monte Verde, Chile, which would have taken Asian settlers at least 6,000 years to reach. These southern settlers may have spread north after the last ice age (14,000 to 22,000 years ago) as a new wave of migrants was arriving across the Bering Strait, interacting with them. A final wave, the ancestors of modern-day Eskimos, arrived from Asia about 5,000 years ago, staying in what are now Alaska, Canada, and Greenland. Some speculate that human arrival in the New World occurred as early as 250,000 years ago (Perlman, 1998).

## INDIAN LEGENDS

**M**ANY LEGENDS WERE TRANSMITTED ORALLY FROM GENERATION TO GENERATION BY THE Native Americans. Some are still recited by these peoples, but others survive because they were modified and recorded by early European settlers. Some legends depict quite accurately geologic events that took place hundreds and even thousands of years ago, with the addition of various gods and people to explain why the events occurred. The legends interpreted geologic processes as part of a unified world view that blended physical and spiritual components. Mountains were not simply inert piles of rock; they were living presences with distinctive personalities. In native traditions, heaven, Earth, and human consciousness were bound together in a rhythm of life, a sense of wholeness. The new discipline of geomythology studies ancient myths that reflect natural events such as earthquakes and volcanic eruptions (Harris, 1990). Several noted legends related to volcanic phenomena and to hot springs are retold here.

### *HAWAII—THE GODDESS PELE*

**P**ELE RULES THE VOLCANOES OF HAWAII, AND PEOPLE HAVE NO POWER TO RESIST HER. SHE IS *Pele-honua-mea* of the sacred land, *Pele- 'ai-honua*, eater of land, and *Ka- 'ula-o-ke-ahi*, the spirit of the redness of the fire. In folklore she may appear as a tall, beautiful young woman or as an old woman, wrinkled and bent with age, sometimes accompanied by a white dog. When enraged, she may appear as a woman aflame or as pure flame. Her personality is volcanic:

unpredictable, impulsive, given to sudden rages and violence. Hers is both the power to destroy and the power to create new land (Kane, 1987).

When Pele came to the island of Hawaii, seeking a permanent home, she found another god of fire already in possession of the land. Ai-laau was known and feared by all the people. *Ai* means the “one who eats or devours”; *laau* means a “tree or forest.” Therefore, Ai-laau was the fire god devouring forests who, by reputation, often laid waste to the districts of Southern Hawaii by lava flows and fire. Even though he was destructive, he was also part of the creative forces, for he built islands for future life through volcanic activity. Ai-laau was the fire god who formed the Hawaiian Island chain that Pele was later to visit. When Pele came to Hawaii, she desired to see Ai-laau, to find a resting place at the end of her journey. But he had left in fear of her, as he had seen her toiling by the sea. Pele thus made her home in his place, the crater of Kilauea (Westervelt, 1963).

Numerous legends surround Pele’s wanderlust, her reasons for traveling to the Hawaiian Islands from the South Sea islands called *Ka-la-kee-nui-a-Kane*. Some reasons were peaceful and others were based on quarrels with her family. She usually lands on Kauai and works her way down the chain to the big island of Hawaii. Several of the legends are reported by Westervelt (1963). The one that follows was reported by Kane in 1987.

Tradition states that Pele came, as did the Polynesian discoverers, in a sailing canoe from the ancient homeland in the islands of the Tahiti group. She was said to have been driven from this ancestral home by her elder sister, goddess of the sea and water, for seducing her husband. Her first landfall was in the northern islands of the Hawaiian archipelago. Pele needed a deep pit for her home wherein the sacred fires could be protected. However, her sister always followed and put out the fire, and Pele moved southeastward along the island chain, digging new craters. Each effort was flooded out by her sister. Today on the old island of Kauai, the craters have become wet swamps. Volcanic events become progressively younger as we move like Pele, down the island chain toward the big island of Hawaii. This myth coincides with the modern geological theory of plate tectonics, which suggests the Hawaiian Islands are built in assembly-line fashion as the ocean floor slides northwestward over a “hot spot” in the oceanic crust.

Since Pele’s sister Na-maka-o-Kaha’i was older, she was also more powerful, for water was believed to be more powerful than fire. The two finally locked in battle on the island of Maui and Pele was torn apart. A hill named *Ka-iwi-o-Pele* (“the bones of Pele”), standing at the site



Madam Pele and her sister Na-maka-o-Kaha'i. By Herb Kawainui Kane, 1987. *Reprinted with permission*

Hale-a-kala, which last erupted in 1790 but was most active 400,000 to 800,000 years ago. After our presentation, a native Hawaiian elder stood up and lectured us for over an hour on volcanic geology from Pele's point of view. He warned that drilling on Maui would bring Pele back from the island of Hawaii and cause destruction to the residents of Maui.

Pele still lives in the hearts and minds of the native Hawaiians. Her personification is in the natural phenomena of volcanic activity. Hawaiians refer to her as Tutu Pele (an affectionate term for grandparents) and look upon her with respect. In a recent eruption where lava destroyed part of the village of Kalapana, a Hawaiian resident who had lost his land said, "I love my home, live here all my life, and my family for generations. But if Tutu like take it, it's her land" (Kane,

of the battle, is believed to be her mortal remains. With Pele's death, her spirit was freed and elevated to godly status, taking flight to the island of Hawaii. Her permanent home is on Mauna Loa, the Earth's largest mountain, with an elevation of over 9000 meters—about 4000 m above sea level and 5000 m below.

This legend was brought home to the author during a lecture tour over several of the islands where the use of geothermal energy was discussed. Our lecture group was on Maui, the island just northwest of Hawaii, and we were proposing as part of a geothermal project to drill on the slopes of the volcano



1987). As part of the respect for Pele, older Hawaiians still offer her the first 'ohelo berries picked, before eating any themselves. Some still bring gifts of flowers, food, and drink and set them on the rim of Halema'uma'u crater within the Kilauea caldera. They also refrain from any acts that might be disrespectful to Pele. Tourist who have taken souvenirs of rock home with them from Hawaii Volcanoes National Park have often returned the rocks to the National Park Service with notes describing misfortunes that have occurred since their removal. They hope by this action to be released from Pele's terrible spell.

### *OREGON—THE BATTLE OF LLAO AND SKELL*

**A**MERICAN INDIANS COMMONLY ATTRIBUTED NATURAL CATASTROPHIES TO THE ACTIONS OF INVISIBLE spirits who controlled the physical world. The Klamath Indians of Southern Oregon devised a remarkable myth to explain the origin of Crater Lake (Harris, 1990). This legend was told to a young soldier in 1865 by Lalek, an aged Klamath chief. He emphasized that the story was ancient, from a time when his people lived in rock houses and white men ran wild in the woods. The story explains the cataclysmic eruption of Mount Mazama, its collapse, and the formation of the Crater Lake caldera about 7,700 years ago.

It is a story about Llao, Chief of the Below World, Skell, Chief of the Above World, and Loha, a beautiful young woman. Llao saw this woman one day when standing atop Mount Mazama and begged her to return with him to his lodge in the underworld. Even though he promised her eternal life, the young maid refused to accompany him. Because her people would not force Loha to accept Llao's offer, he thundered angrily and tried to destroy her people with fire. Skell came to the rescue by descending from heaven to the summit of Mount Shasta, which is 200 km south of Mount Mazama. In the battle that followed, the sky glowed and turned dark, the Earth shook, and fire flowed from Llao's mountain, burning the forests. Loha's tribe, driven from their home, was forced to flee south into the waters of Klamath Lake.

Two brave medicine men tried to save their people by hurling themselves into the fiery mouth of the underworld. Noting their sacrifice, Skell again shook the Earth, causing Llao's mountain to crash down upon him. When finally the dark clouds of ash cleared and light had returned, the lofty peak was gone, replaced by a giant hole. The curse of fire was lifted and the caldera gradually filled with rainwater, forming Crater Lake. This myth is similar to the Greek story of Hades, god of the underworld, who pursued the maiden Persephone and carried her away to his underworld kingdom.

The Llo-Skell myth closely describes the geologic events that occurred in the formation of the Crater Lake caldera. It states correctly that Mount Mazama did not lose its summit by blowing itself apart but by emptying much of its underground magma reservoir, allowing the volcanic cone to collapse. The eruption in the Crater Lake caldera formed the cinder cone called Wizard Island, which represents the maid Loha. The myth also describes frequent eruptions of Mount Shasta over the last 10,000 years, as Skell visited Shasta often, starting fires upon each visit.

*WASHINGTON—MOUNT ST. HELENS*

**A**N OLD KLICKITAT INDIAN MYTH TALKS ABOUT THE VOLCANIC STRUGGLE BETWEEN MOUNT Adams (Phato) and Mount Hood (Wyeast), sons of the Great Spirit, who fought each other because of their love for a beautiful Indian maiden Loo-wit. Chief Phato ruled the land north of the Columbia River and Chief Wyeast the land south in Willamette Valley. The Great Spirit built a bridge over the Columbia (Bridge of the Gods) so that the families of the two brothers could visit each other. With time, the two peoples quarreled, and the Great Spirit punished them by keeping the sun from shining. After a time the Great Spirit felt sorry for the people and gave them fire through an old woman who had kept herself from the wrongdoing of her people. As a reward, she was turned into the beautiful maiden, Loo-wit.

Wyeast and Phato grew jealous of each other over Loo-wit, becoming so angry that they fought. Their people also fought each other and many were killed. The Great Spirit was so angered by the fighting that he broke the Bridge of the Gods, which collapsed into the Columbia River. He changed the two chiefs into mountains—Mount Hood and Mount Adams—and they continued to quarrel. Their fighting caused sheets of flame to burst forth from the peaks, and they hurled hot rocks at each other. Many of the rocks fell into the river and formed the narrows at The Dalles. Lo-wit was changed into a snow-capped peak—Mount St. Helens—which still has the youth and beauty promised by the Great Spirit [ed. note: this was written before the 1980 eruption]. The rocks and white water where the Bridge of the Gods fell are known as the Cascades of the Columbia (Clark, 1953).

Considerable evidence suggests that such a massive earthen dam did exist, temporarily blocking the Columbia's flow. Radiocarbon dating reveals that the slide occurred about 1100 A.D., triggered by an earthquake. About two cubic kilometers of rock buried nearly 36 square kilometers of the Columbia Gorge, creating a natural dam more than 60 meters high. It may have taken years for the impounded water to overtop the dam and wash most of it away.

Meanwhile, it served as a land bridge for the Klickitats, Willamettes, and other tribes who enjoyed easy access to each other's property, as reflected in the legend (Harris, 1990).

### *OREGON—MOUNT HOOD*

**A**CCORDING TO LEGEND, MOUNT HOOD ONCE TOWERED SO HIGH THAT WHEN THE SUN SHONE ON its south side a shadow stretched north for a day's journey. Inside this majestic mountain was a lodge of evil spirits who sent forth streams of liquid fire to destroy the Indians' homes. In those days the Indians were taller than they are now, as tall as the pine and fir trees, and their chief was such a giant that his warriors could walk under his outstretched arms.

In a vision, the chief was told he must conquer the evil forces that lived in the mountain to prevent his people from being annihilated. The brave chief climbed the mountain and found a large hole at the summit from which fire and smoke poured out. He hurled boulders into the opening in the hopes of killing the evil spirits, but they threw the boulders back, now heated red hot, along with smoke and fire. The heated rocks rose toward the sky and fell a long distance away. The exchange continued for many days, and when the chief looked down in the valley he saw that it was desolate, choked with lava and ash. Grief stricken, he sank to the Earth and was buried by a stream of lava. Some of the tribe survived, but their starving children and grandchildren did not grow as tall, and their descendants will only be restored to their former height when a great chief comes who can conquer the demons of fire in the mountain. Today the chief's sorrowful profile, with its distinctive scalp lock, can be seen halfway down the northern side of the mountain, appropriately called the "Chief's Face" (Clark, 1953; Harris, 1988).

### *MONTANA—SLEEPING CHILD HOT SPRINGS*

**S**LEEPING CHILD HOT SPRINGS IS IN THE ROCKY MOUNTAINS SOUTH OF MISSOULA, MONTANA. The beauty of this hot springs was discovered by the Nez Perce Indians in the 1870s. Chief Joseph of the Nez Perce led his tribe out of the reservation and through the Lolo Pass into the Bitter Root Valley, fleeing General Howard and a group of soldiers. Trying to avoid a confrontation, Chief Joseph split his tribe into smaller groups. One group traveled through Sleeping Child Creek. Facing a possible battle, they left their infants by the hot springs. When they returned, the infants were safe and peacefully sleeping, protected by the natural hot springs. And so Sleeping Child Hot Springs got its name.

MONTANA—LOLO HOT SPRINGS

IN THE SAME AREA AS SLEEPING CHILD HOT SPRINGS, WEST OF MISSOULA, MONTANA, IS LOLO Hot Springs, which were known and used extensively by local Indians. The hot springs were noted by Lewis and Clark in 1806 on their return east, after traversing the rugged area near Lolo Pass (Bergon, 1989). Lewis described the hot springs in his journal entry for June 29, 1806 [grammar, spelling, and capitalization of the original text are retained]:

“these warm springs are situated at the base of a hill of no considerable hight on the N. side and near the bank of travellers rest creek which at that place is about 10 yards wide. these springs issue from the bottoms and through the interstices of a grey freestone rock, the rock rises in iregular mas[s]y cliffs in a circular range around the springs on their lower side. immediately above the



**SLEEPING CHILD**  
**HOT SPRINGS RESORT**

MISSOULA, MONTANA  
HOT SPRINGS RESORT  
HAMILTON, MONTANA

Poster from Sleeping Child Hot Springs. *Reprinted with permission*

spring on the creek there is a handsome little quamas plain of about 10 acres. the prinsipal spring is about the temperature of the warmest baths used at the hot springs in Virginia. In this bath which had been prepared by the Indians by stoping the run with stone and gravel, I bathed and remained in 19 minutes, it was with difficulty I could remain thus long and it caused a profuse sweat two other bold springs adjacent to this are much warmer, their heat being so great as to make the hand of a person smart extremely when immerced. I think the temperature of these springs about the same as the hottest of hot springs in Virginia. both the men and indians amused themselves with the use of a bath this evening. I observed that the indians after remaining in the hot bath as long as they could bear it ran and plunged themselves into the creek the water of which is now as cold as ice can make it; after remaining here a few minutes they returned again to the warm bath, repeating this transision several times but always ending with the warm bath.”

The Virginia springs Lewis referred to were in Hot Springs, Virginia, where spring temperatures range between 36° C and 41° C (Lund, 1996). Lolo Hot Springs, today with a well developed pool and resort on the edge of a wilderness area, uses 43° C and 47° C water from two springs.

### *WEST VIRGINIA—WHITE SULFUR SPRINGS*

**A** LARGE, HISTORIC, HEALTH-ORIENTED MINERAL SPRINGS RESORT, THE GREENBRIER, OCCUPIES 2600 hectares in an upland valley of the Allegheny Mountains near the West Virginia-Virginia border. The natural mineral waters have a temperature of 17° C. The resort and spa have a 200-year history (Lund, 1996). Originally, the forests near the springs were inhabited by Shawnee Indians, who hunted around the springs in a small marsh with salt deposits, which attracted animals. Early European settlers reported the Indians valued the curative powers of the hot spring waters.

In 1778 a Mrs. Anderson, on hearing the benefits of these mineral waters, was carried 25 km on a litter to the springs in an attempt to cure her chronic rheumatism. In the Indian custom, a tree was felled, hollowed out as an improvised tub, and filled with spring water heated with hot stones. Mrs. Anderson bathed in the water and drank from the spring. In a few weeks the pain from the rheumatism receded, and the news of her recovery spread rapidly to other settlers in the region. As a result, numerous log cabins were built around the spring in the next few years to house crowds of visitors. Later this developed into a rustic spa at Bowyer's Sulfur Springs, which by the early 1800s was a "grand" resort (Conte, 1989; Lund, 1996).

An Indian legend about these springs speaks of two young lovers who came to the valley to escape the notice of their elders. Catching them, an enraged chief shot two arrows, one killing the boy and the other barely missing the girl. Where the second arrow hit the ground, a sulfur spring appeared and legend says that when the last drop of water is drunk from the spring, the lovers will be restored to life (Conte, 1989).

### THE INFLUENCE OF HOT SPRINGS

**T**HE INDIANS OF NORTH AMERICA CONSIDERED HOT SPRINGS AND FUMARoles AS SACRED PLACES. This was one of their mysteries of the universe or *Wakan Tanka* in the Lakota/Dakota/Nakota

language, meaning “Great Mystery,” “Ultimate Mystery,” “The Unknowable,” or “Great Sacredness” (Mona, Dakota Indian Nation, 1996). They were great believers in the miraculous healing powers of heat and mineral waters. Every major hot spring in the United States and Canada has a record of Indian usage.

Hot springs were regarded as neutral grounds, places where warriors from any tribe could rest unmolested and recuperate from battle. Often the spring was guarded jealously, kept secret from the Europeans as long as possible. Sometimes battles were fought between Indians and settlers to preserve these rights. The “Fountain of Youth” sought by early Spanish explorers, such as Ponce de León and Hernando DeSoto, perhaps evolved from accounts of healing properties of hot spring waters (Lund, 1993).

An example of a battle fought over a hot spring is recorded on a sign near Evan’s Plunge in Hot Springs, South Dakota (Lund, 1997):

“Long before the white man discovered the valley of healing waters, the Sioux and Cheyenne Indian tribes fought for possession of the natural warm water springs. Legend tells us that the battle raged on the high peak above the springs and the Sioux emerged victorious.

“The mammoth spring at the end of the interior of the plunge is known as the ‘Old Original Indian Springs.’ Here the Indians drank and bathed in its warm healing water.”

The early European settlers in the 1700s and 1800s used the natural hot springs. Later, they realized their commercial value and developed many into spas in the European tradition. Many spas were successful, such as those at Saratoga Springs, New York; White Sulphur Springs, West Virginia; Hot Springs, Virginia; Warm Springs, Georgia; Hot Springs, Arkansas; Calistoga, California; and Harrison Hot Springs, British Columbia. However, the United States had neither governmental, trade union, or social security programs nor a national health insurance program that supported such spas. Thus, in spite of the proven benefits of spa therapy, the United States lagged behind many other countries in developing mineral springs, even ones owned by states and the Federal government. By the 1940s, the interest in spas languished, and most of the majestic resorts declined and closed. Recent interest in hot springs, in soaking and in physical fitness, has renewed spa development.

Examples of some of the early uses of hot springs by Native Americans and early European explorers follow.

## GEORGIA—WARM SPRINGS

**W**ARM SPRINGS IS THE MOST FAMOUS OF GEORGIA'S SEVEN KNOWN HOT SPRINGS. IT HAS THE largest flow rate—up to 58 liters per second—and an average temperature of 31° C. The main mineral constituent is bicarbonate. For the local Creek Indians, the springs were probably a place for healing where the Indians of all tribes were allowed to bring their sick and wounded to drink the waters and bathe in the mud. The Iroquois Indians from New York (1500 km north) visited the Creeks in Georgia, calling the area “the land where the waters are warm.” A number of trails maintained by the Indians ran through the area. The trails were used by all travelers, many of whom stopped at the springs. Later, the trails became military and post roads, and a number of taverns with rustic accommodations were built along them, including one at Warm Springs in the early 1800s.

Settlers obtained the land in 1825 in a treaty signed with the Lower Creek Indians. The original springs were called Meriweather Warm Springs, after General David Meriweather of Revolutionary War fame. After several stages of commercial development, the springs became the site of a polio treatment center, made famous by President Franklin Delano Roosevelt (Lund, 1993 and 1996).

## NEW YORK—SARATOGA SPRINGS

**S**ARATOGA SPRINGS IS ABOUT 40 KM NORTH OF ALBANY, NEW YORK, JUST SOUTH OF Adirondack Park. About 18 springs discharge 13° C carbonated mineral water along the Saratoga fault between Whitehall and Albany, a distance of 105 km.

The springs have been used in spas for drinking and bathing, considered a cure for everything from skin disorders to digestive problems. The water and carbon dioxide are bottled and sold commercially. The Mohawk and Iroquois Indian tribes used this area for hunting and frequented the springs, especially High Rock Spring. The Mohawks, a fierce warrior tribe, fought to defend their hunting grounds around the springs on many occasions. They called the area Kayaderosseras. Other tribes probably used the springs, which were on the path between Quebec and the Mohawk Valley.

The first written record of the springs was in 1642, when the Mohawks, returning from a raid on Quebec, brought with them a Jesuit priest whom they had captured. They stopped by a spring



Mohawk Indians at High Rock Springs, New York, from Swanner, 1988. *Reprinted with permission*

and were refreshed by the bubbling waters. There is an unsubstantiated story of Sir William Johnson being carried to the springs in 1767 by Mohawk braves for treatment of a wound he had received in the Battle of Lake George in 1755. Probably the first settlers to visit the spring were surveyors in the 1760s. Perhaps people were attracted to the area by the great number of animals who came to lick the salt deposits. The spring was included in the Kayaderosseras Patent in 1771 and purchased by European settlers. After a number of different ownerships and overexploitation, a majority of the land was taken over by the

State of New York and is now administered as a state park (Swanner, 1988).

### ARKANSAS—HOT SPRINGS

**H**OT SPRINGS, ARKANSAS, WAS ONE OF THE MOST POPULAR COMMERCIAL SPA AREAS IN THE United States, created to imitate the great spas in Europe—so popular that in 1832 it became a Federal reservation and finally, in 1921, a national park. It is the only national park in the United States created just to protect hot springs for spa use. This natural geothermal resource consists of 47 springs producing a total of about four million liters per day of 61°C water.

The United States National Park Service estimates that humans have used the Arkansas hot springs for at least 10,000 years. The “Valley of the Vapors” was an honored and sacred place to the Indians, who believed it the home of the “Great Spirit” who brought forth the healing warmth of “Mother Earth,” warming the waters by his breath. Like many North American hot springs, this was neutral ground where warriors of all tribes could rest and bathe peacefully. Stone artifacts found near the springs show that the Indians used the waters extensively. When



early European explorers and East Coast settlers pushed the Indians westward, the Quapaws and part of the Cherokee Nation wandered into the area. Legend reports that DeSoto or one of his scouts from the 1541 expedition was the first European to visit the site. Evidently, DeSoto was in the area for he claimed the territory for Spain, and in the late 1700s, French trappers, hunters, and traders were familiar with the area (Bedinger, 1988).

The French actually ruled the area until 1763 when the territory west of the Mississippi was ceded back to Spain. It was retaken by France in 1800 under Napoleon Bonaparte and finally purchased by the United States as part of the Louisiana Territory in 1803. During this period no written records are known of travels to the hot springs, but the springs were probably visited many times, for crude log cabins and huts were found at the site in 1804. The spring water was first analyzed in 1804 and permanent settlements began in 1807. The first settler, a plantation owner named Jean Emanuel Prudhomme, was introduced to the springs for his health by the Natchitoches Indians, and remained in the area for a year. The springs became famous for curing ailments and in 1830 the first bathhouse was opened for visitors. The Federal reservation followed and the development peaked in the early to middle 1900s. The National Park Service still controls the geothermal resource and commercial development in the park of about 2000 hectares (Lund, 1993 and 1996).

#### *WYOMING—THERMOPOLIS*

**T**HERMOPOLIS, A GREEK WORD FOR “HOT CITY,” IS LOCATED IN NORTH-CENTRAL WYOMING AT the mouth of the Wind River Canyon, about 160 km south of Yellowstone National Park. At least eight hot springs have created large travertine terraces along the river in the area. The Big Horn Spring, called the largest mineral hot spring in the world, flows at a rate of 120 liters per second at a temperature of 56° C.

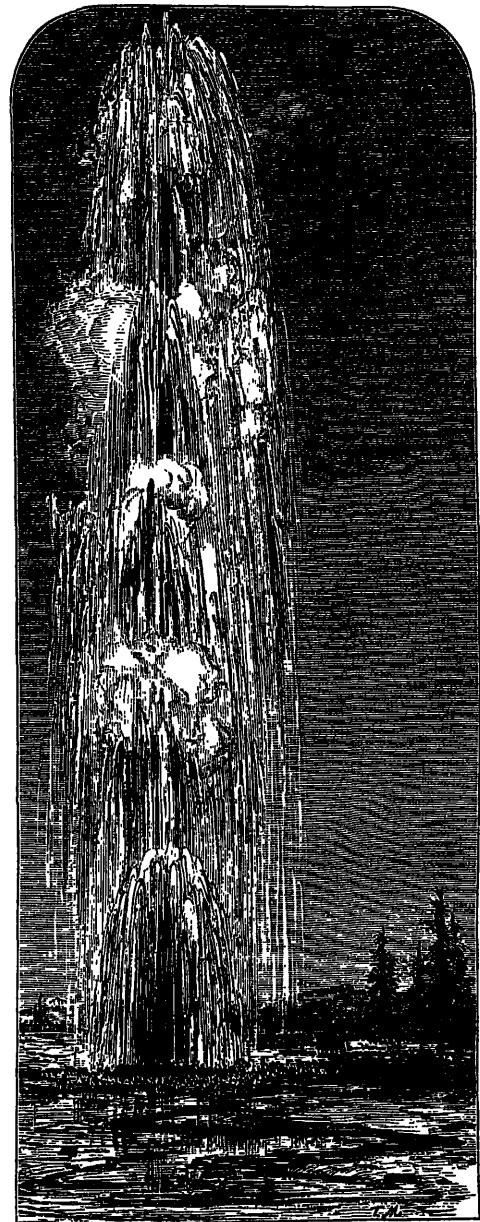
Based on evidence associated with Legend Rock petroglyphs in the sandstone cliffs about 40 km northwest of town, Indians have lived in the area for at least 2,000 years. The hot springs were known as “healing waters” and *Bah-gue-wana* or “smoking waters” by the Shoshone. Chief Washakie of the Shoshone tribe (who later signed the treaty with the Federal government) reportedly had a bathhouse erected over Black Sulfur Springs at Thermopolis. The Big Horn Spring was included in the Shoshone Indian Reservation Treaty of 1868 and became known for “health giving properties.”

The United States Congress was asked to set the area aside as a national park or reservation, and in 1896, the Federal government signed a treaty with the Shoshone and Arapahoe Indians to allow public hot spring use. One-fourth of the water from the Big Horn Spring was set aside for free public use, and spring management was given to the State of Wyoming in 1897. The springs became Hot Springs State Park, and the State Bathhouse was built to fulfill treaty conditions. Today, Hot Springs State Park provides geothermal water to commercial establishments such as the Pioneer Center (a retirement home for state residents) and The Gottsche Rehabilitation Center (a center for therapy) (Lund, 1993 and 1996).

#### WYOMING—YELLOWSTONE NATIONAL PARK

SINCE 1808, WHEN JOHN COLTER DESCRIBED THE HOT springs of “Colter’s Hell,” attention has focused on Yellowstone. Explorers “discovered” many of the springs early in the 1800s following Colter’s visit, which was reported in a series of articles by N. P. Langford in *Scribner’s Monthly* (1871). Nathaniel Langford was one of nine Montanans who undertook an exploration of Yellowstone in 1870. They spread word of their “discovery” through newspaper articles, a Congressional report, and Langford’s lecture tour to several cities, for he had an agreement with Jay Cooke to publicize Yellowstone. Cooke was the financial agent for the Northern Pacific Railroad, which wanted to encourage tourism in the American West. Eventual public interest in the preservation of the many spectacular thermal features in Wyoming’s northwestern corner found by Colter led to the 1872 establishment of Yellowstone National Park, the nation’s first.

Surprisingly, the local Indians knew little of Yellowstone’s geothermal features and seldom visited the area. The local Shoshone, called *Tukuarika* or, more commonly,



The Great Geyser of the Fire-Hole Basin. *Thomas Moran, reprinted with permission of Scribner, a Division of Simon & Schuster from SCRIBNER'S MAGAZINE, vol. ii, no. 2, New York: Charles Scribner's Sons, 1871*

“Sheepeaters,” were alone in permanently occupying the area. Even they knew nothing about the spectacular Firehole Geyser Basin and exhibited more astonishment and wonder than any of the early Europeans guided into the area (Chittenden, 1895).

The country probably was *terra incognita* for the vast body of Indians who dwelt around it, and Europeans generally thought that “superstitious fears” kept the Indians away. However, the reasons reported by Chittenden in 1895 appear more practical:

“There was nothing to induce the Indians to visit the Park country. For three-fourths of the year that country is inaccessible on account of snow. It is covered with dense forests, which in most places are so filled with fallen timber and tangled underbrush as to be practically impassable. As a game country in those early days it could not compare with the lower surrounding valleys. As a highway of communication between the valleys of the Missouri, Snake, Yellowstone, and Bighorn Rivers, it was no thoroughfare. The great routes, except the Bannock Trail already described, lay on the outside. All the conditions, therefore, which might attract the Indians to this region were wanting. Even those sentimental influences, such as love of sublime scenery and a curiosity to see the strange freaks of nature, evidently had less weight with them than with their paleface brethren.”

Early trappers and mountain men had visited the Geyser Basin in the early 1800s and some wrote reports appearing as early as 1842. Most of their stories were discounted as exaggerations and not believed. James Bridger, who had visited the area often as early as 1824, described many of the thermal features in the 1840s. Although determined to have his narratives published, no one would accept his stories. In 1856, the editor of the *Kansas City Journal* had written an article using Bridger’s description, but the editor’s friends ridiculed the whole thing as incredible and the story was suppressed. The editor, Colonel R. T. Van Horn, said Bridger told him that the Geyser Basin “was a place where hell bubbled up.” The Colonel was very interested in the matter at the time and took notes of the conversation. Unfortunately, the notes never saw print after a man who claimed to know Bridger told the editor that he would be laughed out of town if he printed “any of old Jim Bridger’s lies.” Years later, Van Horn apologized to Bridger (Chittenden, 1895).

#### WYOMING—GUERNSEY

**E**VEN THOUGH GUERNSEY IS THE LOCATION OF ONLY A FEW SMALL SPRINGS NEAR THE SOUTHEASTERN corner of Wyoming, these are probably the most famous thermal features in the state. Although early immigrants may have heard vague tales of “Colter’s Hell” and of Yellowstone country, thousands had actually seen Guernsey Springs. To the immigrants of the famous

Oregon Trail, this spring was a welcome landmark, a place to soak sore feet and wash dusty clothes—and it was appropriately named “Immigrants’ Washtub.” In 1858, soldiers at nearby Ft. Laramie set up a lime kiln and used the limestone from which the springs rise. The springs then became known as “Lime Kiln Springs.” Today, the 21° C springs serve as watering holes for cattle (Breckenridge and Hinckley, 1978).

#### CALIFORNIA—CALISTOGA

LOCATED ABOUT 120 KM NORTH OF SAN FRANCISCO, CALIFORNIA, THIS RESOURCE IS AT THE northern end of the famous Napa Valley and at the southern end of The Geysers Geothermal Field. The area is noted for numerous fumaroles and hot springs and the surface temperatures are near 100° C. The area was settled first by the Southern, Central, and Western Pomo, the Western and Northern Wappo, and the Lake Miwok Indians. All spoke different languages and had distinct cultures. These early peoples came from a wide area to use the natural hot springs, fumaroles, and heated muds to soothe aches and pains. To Native Americans, this was *Tu-la-ha-lu-si*, “the beautiful land,” and the hot spongy turf was *Coo-lay-no-maock*, “the oven place,” according to a local historian. As in many western geothermal areas, the Indians were first to use and appreciate geothermal resources. They took cinnabar from local deposits to use for red war paint, and later mercury ore was mined by settlers (Archuleta, 1977).



The Indian Hot Springs Ground at Calistoga, from Archuleta, 1977. Courtesy of the Sharpsteen Museum, Calistoga, California

In the early 1800s Spanish explorers looked for a mission site in this area, which they naturally called *agua caliente*, “hot water,” a name given to many other geothermal locales in the Southwestern United States. The missionaries planted valley fields with grape vines—the fruits

destined for sacramental wines—and sowed golden mustard, still blooming in orchards and vineyards each spring. In 1862, Samuel Brannan established a resort and spa in Calistoga similar to the one at Saratoga Hot Springs in New York. The name “Calistoga” came from a misspoken phrase in a public address by Brannan about the locale. Meaning to say “the Saratoga of California,” he instead intoned “the Calistoga of Saraformia,” and the name stuck. Today, the well known spa community is in the heart of the Napa Valley wine country.

### *BRITISH COLUMBIA—HARRISON HOT SPRINGS*

**G**EOTHERMAL RESOURCES IN CANADA ARE MAINLY IN BRITISH COLUMBIA, AND ONE OF THE most famous locales is Harrison Hot Springs, about 80 km east of Vancouver. The springs and resort are referred to as “The Spa of Canada.” Two hot springs, at 50° and 65° C, are located near the southern end of Lake Harrison. The Indians knew of the springs and of Keekwully Tybee, who sent up the medicine waters all hot from below. Believing the springs of boiling water (*Warum Chuck*) were of supernatural origin, they regarded the hot water in the lake with reverence and awe. The Indians believed that whoever drank the water received mystical powers of endurance over others. Some of the stories say the waters will boil as long as there is sickness in the land. The natives referred to the lake as Lake Qualts, which means “hot water” (Rendall, 1981).

The springs were probably discovered by Europeans in 1859, when one of a nearly frozen group of miners sailing on the lake toppled into the water from weakness. He was so happy in the warm water that the rest joined him before they continued their journey. In the late 1800s, a hotel and bathhouse were built adjacent to the springs. Springs literature boasted that the hot sulfur springs provided “a sure cure for paralysis, rheumatism, syphilis, diabetes, neuralgia, skin diseases, mercurial poisoning, dipsomania, and all diseases of the womb, liver, and kidneys, besides many other maladies to which human flesh is heir.” Today, The Harrison Hot Springs Hotel, without the promise of cures, operates as a luxury resort at this location.

### *ALASKA*

**I**NDIANS AND ESKIMOS THROUGHOUT ALASKA, FROM THE SEWARD PENINSULA TO THE SOUTHEASTERN islands, were aware of geothermal springs. Kruzgamepa Hot Springs, 80 km north of Nome, now called Pilgrim, was used for bathing years before settlers arrived. People visiting Chief Shakes Hot Springs, near Wrangell in Southeastern Alaska, still use the wooden cribs

placed there by the Tlingit Indians before the Russians arrived. Some springs held mystical powers, such as Kilo Hot Springs in North-central Alaska. The pools at Hooniah or Tanakee Hot Springs, one of the best known resorts in the early part of the century in Southeastern Alaska, are used by Native Americans today, although the resort is still quite rustic (Markle, 1979).

When the Russians began colonizing Alaska, they followed the Indian example of leaving most hot springs as they found them. Most Russian and early American settlements were not near a geothermal resource. This was due in part to the nomadic fur traders who did not tarry long at any one place. They traveled mainly along the coast and most of the springs were inland. In the late 1800s, with the discovery of gold, many of the hot springs were developed by miners who had moved inland. Chena, Manley, and Circle Hot Springs in the Fairbanks area are examples of miner-developed spas still operating today. Many others have declined and are little used today.

## THE INFLUENCE OF VOLCANOES

### *ARIZONA—SUNSET CRATER*

**A**BOUT 1075 A.D., THE ERUPTION OF SUNSET CRATER EAST OF FLAGSTAFF, ARIZONA, SPREAD a blanket of volcanic cinders and ash over a large part of the lands occupied by the Sinagua Indians, whose living patterns changed markedly because of it. After the initial disruption, the Sunset Crater cinder fall is thought to have provided moisture-conserving mulch that made the area more attractive for dry farmers to grow maize. The larger number of sites in the immediate posteruptive period and the appearance of artifacts from other Indian tribes (Anasazi, Mogollon, and Hohokam) suggest that there was large-scale migration from neighboring areas at this time (Lipe, 1978).

### *OREGON—MOUNT MAZAMA*

**P**EOPLE HAVE INHABITED EASTERN OREGON SINCE ABOUT 9000 B.C. HOWEVER, EVIDENCE OF this occupation all but disappeared after the eruption of Mount Mazama around 7,700 years ago, when Crater Lake was formed and a layer of volcanic ash and pumice over eight meters deep in places blanketed the landscape. No significant reoccupation of the area occurred until

about 3000 B.C., and at that time tools, baskets, and plant food resources changed markedly (Aikens, 1978). The eruption of Mount Mazama was carbon-14 dated based on charred sandals found buried beneath pumice and ash in Fort Rock Cave, about 100 km northeast of the mountain.

#### *WASHINGTON—MOUNT ST. HELENS*

**M**OUNT ST. HELENS HAD THREE RECENT MAJOR STAGES OF VOLCANIC ACTIVITY, FROM ABOUT 10,000 to 8710 B.C., about 1900 to 450 B.C., and intermittently between 800 and 1850 A.D. (Davis, 1995). Others report the intermediate episode lasted from 4000 B.C. to 1700 A.D., with three major periods each lasting 500 to 700 years (Lewarch and Benson, 1991). Long-term land use by Native Americans began around 5000 B.C. and continued for about 3,000 years. Then a break in occupational density appeared, perhaps a function of large-scale vulcanism on Mount St. Helens. There is a lack of radiometrically dated artifacts between 1640 B.C. and 160 A.D., even with an increasing population level in the surrounding plateau region of Washington and Oregon. Tephra deposits have been measured nearly a meter deep in some places due to the volcanic eruption, which would substantially limit occupation of the area. Dated components occur again after the first century A.D.

#### *HAWAII—KILAUEA*

**I**N 1790, THE RULE OF HAWAII WAS CONTESTED BY SEVERAL CHIEFS. THE TWO MAIN CONTENDERS were Keoua, considered a dangerous upstart by the other chiefs, and Kamehameha, the future



Keoua's army destroyed by the eruption of Kilauea. By Herb Kawainui Kane, 1987. *Reprinted with permission*

ruler. After several inconclusive battles on the big island of Hawaii, Keoua was returning to his home district with his army, accompanied by wives and children of the soldiers. They were walking along the flank of Kilauea volcano when part of Keoua's army was completely destroyed by a rain of hot ashes, rocks, and poisonous gases from the mountain. Badly shaken by this disaster, no doubt believing the Pele had turned against him, Keoua lost the will to continue the war and Kamehameha became the ruler (Kane, 1987).

#### USE OF VOLCANIC AND HOT SPRING MATERIAL

INDIANS HAVE FASHIONED OBSIDIAN AND BASALT INTO TOOLS AND WEAPONS SINCE THE FIRST migrations into Western North America. The implements and extensive middens of obsidian flakes can be found throughout the west, protected from "pot hunters" by Federal law. Muds colored by sulfur and mercury deposits were used to decorate pottery, skins, and rock surfaces with pictures or writing (pictographs and petroglyphs). Using obsidian hydration rates measured on freshly fractured pieces, prehistoric sites can be dated as far back as 800,000 years ago (Fagan, 1985).

#### *ARKANSAS—HOT SPRINGS*

THE TUNICAS INDIANS OF THE CADDO NATION LIVED AROUND THE PRESENT-DAY HOT SPRINGS National Park in Arkansas. For centuries, they mined a very hard, evenly textured flint called novaculite (a form of silica similar to chert) in quarries adjacent to the hot springs. The Indians used it for arrowheads, spearheads, and tools. Europeans mined novaculite to make whetstones, and this "Arkansas Stone" is still mined outside the park, highly prized for its uniform sharpening characteristics (Bedinger, 1988).

#### *CALIFORNIA—COSO*

OBSIDIAN WAS ALSO HIGHLY PRIZED BY THE INDIANS OF CALIFORNIA FOR TOOLS AND WEAPONS due to the sharp cutting edges that could be fashioned. Obsidian deposits were available on the volcanic Great Basin side of the Sierra Nevada and obsidian was traded across the mountains, west into California's vast Central Valley. Such materials have been dated as early as 3000 B.C.



One source, located near Coso Hot Springs in Southern California on the grounds of the China Lake Naval Weapons Center (also the site of a geothermal power plant), had inclusions of white cristobalite, an amorphous silica. Samples from this source have been found throughout the Central Valley. The author was at this site in the 1960s, amazed at the large obsidian deposit and midden. The author later discovered obsidian pieces from the site at nearby Little Lake, attributed to the Pinto culture estimated to be between 2,500 and 7,000 years old. Other obsidian trading, moving east to west across the Cascades, occurred from a source in Newberry Crater, Central Oregon.

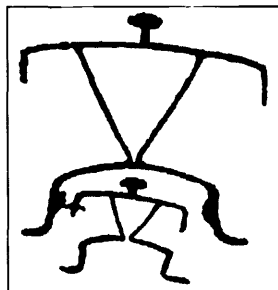
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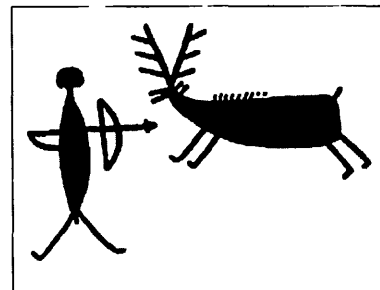
### Rock Writings

Petroglyphs (rock carvings) and pictographs (rock paintings), together called rock writings, are abundant throughout Western North America and Hawaii. Their ages and meanings are generally a mystery, as present-day North American Indians and native Hawaiians have lost the oral history associated with these figures. Most are carved or painted on volcanic rocks, mainly basalts such as those found on the Columbia River plateau and in Hawaii, but some welded tuffs (fused volcanic ash) have been used at Lava Beds National Monument in California. The basalts most commonly used were cooled pahoehoe lava (ropy in form) or columnar basalts, both fairly fine-grained, providing a smooth surface on which to incise or paint.

No figures show hot springs, geysers, or volcanoes, which seems unusual as these phenomena were noticeable and certainly influenced the lives of early inhabitants. Why is this so? Discussions with personnel at the Bishop Museum in Hawaii and others indicate that the reasons appear to be cultural. The common people made the rock writings, and they mostly depicted items associated with everyday living: animals, people, hunts, battles, trails, birth, water sites, and even a surf boarder (Cox and Stasack, 1970; Martineau, 1973). Such rock writings could represent ancient “chat rooms,” bulletin boards, or places to record and boast of achievements. We know these early peoples didn’t understand the causes of eruptions and other mysterious volcanic phenomena, and the priests and shamans may have prohibited the common people from depicting them, feeling that rock writings were beneath their social status. Thus, through cultural forces, we are left with no known rock illustrations of geothermal manifestations.



Family Hawaii (Kaeo trail)



Rock Island, Washington

## OHIO—HOPEWELL

OVER 136 KG OF WORKED OBSIDIAN FRAGMENTS WERE FOUND AT THE HOPEWELL BURIAL SITE IN Southern Ohio. These included between 250 and 500 magnificent spears, probably made about 2,000 years ago. No obsidian deposits are found in the Midwest, and the source of this obsidian was traced to what is now Yellowstone National Park, about 2500 km to the northwest. Many other unusual items such as copper, mica, galena, and chlorite also have been found in these burial sites, reflecting the wide geographical knowledge of much of the Eastern United States that some early inhabitants possessed. Trade helps to explain the apparent speed with which new ideas and techniques moved across long distances (Griffin, 1978).

## CALIFORNIA—CALISTOGA

THE INDIANS AT THE NORTHERN END OF THE NAPA VALLEY, WHERE THE HOT SPRINGS AND fumaroles are found, used obsidian from nearby Glass Mountain to trade for fish and other sea products from the coastal Indians. Indians came from all over to the curative waters of *Coo-la-no-maock*, “the oven place,” and built sweat houses over hot pools. The Indians also traded cinnabar, used for vermilion war paint, and settlers later mined the ample mercury deposits in the area.

## CONCLUSIONS

NORTH AMERICAN INDIANS HAVE A LONG HISTORY OF UNDERSTANDING GEOTHERMAL PHENOMENA and using its resources, going back at least 10,000 years. Many hot springs, geysers, and fumaroles were sacred places to Native Americans, who had a special respect and understanding of the natural environment. Unfortunately, much oral history and many legends about these features have been lost, leaving us with archaeological evidence, speculation, and a few legends told to and recorded by early European settlers.

Many geothermal sites are used today by Native Americans, and these uses must be considered in environmental impact studies, such as ones undertaken for California geothermal power projects at Coso in Southern California and Medicine Lake at Glass Mountain in Northern California. At Coso, during the environmental study phase, the developers considered Indian hot springs use because, in the words of Earl Lent of the Owens Valley Paiute-Shoshone, “Coso is

not merely a word or a geographic location. It is a place of healing and, perhaps most important, it is a crucial link between our people and the way and culture of our ancestors.” Coso is known for the spirituality of the springs, Indian burial locations, and its status as a prayer site. Native Americans were concerned that any geothermal development might affect the spirituality of the prayer site and that activity might cause unwanted intrusion, such as noise, during ceremonies that occur four to twelve times a year. The developers were able to work out a solution with the Indians, and the geothermal power project is operating.

In conclusion, the present trend of hot spring users to “get back to nature” and preserve and protect natural geothermal resources is not unlike the philosophy of our earliest settlers.

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The Witches' Cauldron near The Geysers  
Resort Hotel, Thomas Moran, 1873 after one  
half of a stereopticon view by Eadweard  
Maybridge, 1870