

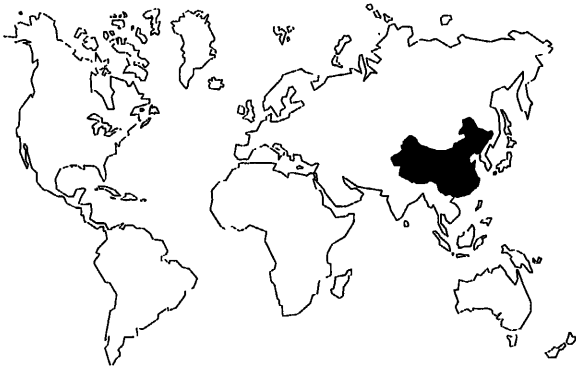
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## 23. Historical Aspects of Geothermal Waters in China

by  
Wang Ji-yang

*Abstract:* China has a long history of using geothermal waters. Early peoples used hot springs for irrigation and domestic purposes. During the Han Dynasty, salt was extracted from thermal waters in the Zigong area of Sichuan Province. In the Ming Dynasty, Li Shi-zhen, a famous medical doctor, used hot spring waters for treating diseases. This chapter discusses historical aspects of geothermal waters used in China, including legends and myths about hot springs, hot springs used for recreation and luxury, tea and wine culture at hot springs, and hot spring use for medical treatments.

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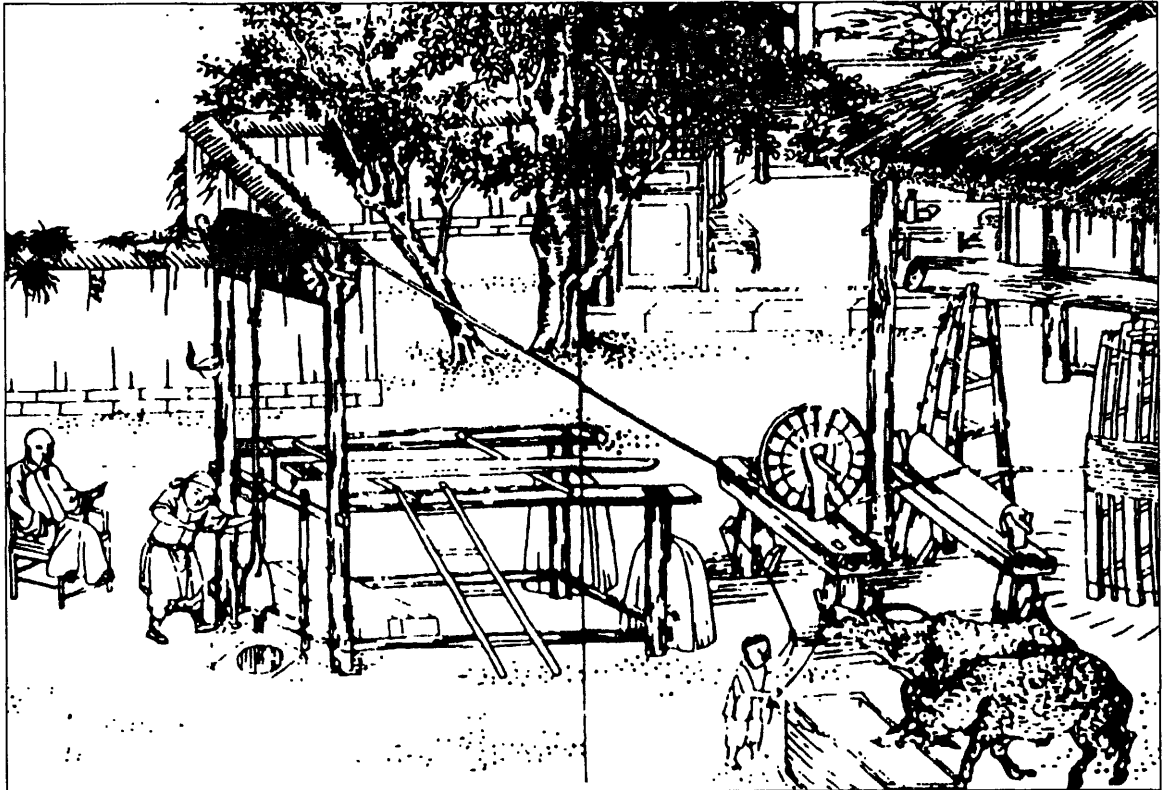
### INTRODUCTION

CHINA HAS OVER A 3,000 YEAR TRADITION OF USING GEOTHERMAL waters. Although early peoples used hot springs for irrigation (both for heat and water) and domestic purposes, such as washing clothes and cooking food, most hot spring use has focused on disease treatments and recreation. Li Shi-zhen, a famous medical doctor from the Ming Dynasty (1368-1644), advised people, "If you get ill, go to a hot spring area and take a bath." In Xiaotangshan, a hot spring area near Beijing, two thermal water pools were sunk in 1666, the fifth year of the Emperor Kangxi of the Ching Dynasty, for the Empress Dowager Cixi, especially for her bathing. In Huaqingchi, a hot spring area not far from Xi'an City, the ancient capital of the Tang Dynasty, quite a fancy bathing house was built for the private use of the Imperial Concubine, Yang Gui-fei.

While using hot spring waters, early peoples tried to understand the origin, the genesis of the springs. Li Bai, the great poet in the

Tang Dynasty, wrote, “Where underground fire exists, there must be hot springs.” Another great poet from the Song Dynasty (1127-1279), Su Shi, said, “Where fire-mountain exists, there would be boiling springs.”

In addition to hot springs, thermal waters were used for salt extraction in some inland areas where sea water salt was not available. During the Han Dynasty (206 B.C.-220 A.D.), salt was extracted from thermal waters in Zigong City, Sichuan Province. Afterward, the city became the major salt-supply area for southwestern China, gaining the name of “Salt Capital.”



Drilling for hot brine with cable tools in Zigong City during the Yuan Dynasty about 1200 A.D. This may be one of the world's first depictions of drilling. *From Energy in China, published by the Ministry of Energy, 1989*

## LEGENDS AND MYTHS ABOUT HOT SPRINGS

**A** NUMBER OF LEGENDS AND MYTHS ABOUT HOT SPRINGS EXIST FROM THE EARLY DAYS OF Chinese civilization. Although there were no divinity cults, several mythical stories exist in Chinese history. This is the most famous:

There appeared a magic hot spring, called the “Fairy Spring,” northwest of Lishan Mountain near Xi’an City. The hot spring was magical and could treat almost every kind of disease.

However, before you got into it, you had to pray to the hot spring by sacrificing animals, such as oxen, pigs, and sheep; otherwise, your disease could not be treated but became even worse. One day, Qin Shi-huang, the first Emperor in China of the Qin Dynasty (221-206 B.C.), traveled to that spring and jumped into the hot spring water quickly, without praying. Quickly, Qin Shi-huang felt uncomfortable and found that his skin was swollen. At that instant, a fairy girl emerged from the hot spring waters and asked Qin Shi-huang to apologize. Qin Shi-huang apologized for not following the rule of the hot spring and he prayed. Immediately, he felt well again and enjoyed the hot waters.

Another magical hot spring was found in Zhejiang Province. During the Tang Dynasty, the daughter of the governor of Zhejiang Province became seriously ill and no treatment could be found. After she went to the hot spring and took a bath, the disease was gone and she recovered rapidly.

A third magical hot spring was on Lushan Mountain in Jiangxi Province. This spring was very good for skin and sexual diseases. It is believed to be the only hot spring in China recorded as treating sexual diseases in ancient times.

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*This famous poem describes an era of Chinese history when both mankind and nature bled, a time when the hills were red with war and the volcanoes with erupting fire.*

### The Red Hills

by Pao Chao (died 466 A.D.)

Red hills lie athwart us as a menace in the west,  
 And fiery mountains glare terrible in the south.  
 The body burns, the head aches and throbs:  
 If a bird light here, its soul forthwith departs.  
     Warm springs  
     Pour from cloudy pools  
 And hot smoke issues between the rocks.  
 The sun and moon are perpetually obscured:  
     The rain and dew never stay dry.  
 There are red serpents a hundred feet long,  
     And black snakes ten girths round.  
 The sand-spitters shoot their poison at the sunbeams:  
     The flying insects are ill with the shifting glare.  
 The hungry monkeys dare not come down to eat:  
     The morning birds dare not set out to fly.  
 At the Ching River many die of poison:  
 Crossing the Lu one is lucky if one is only ill.  
     Our living feet walk on dead ground:  
     Our high wills surmount the snares of Fate.  
 The Spear-boat General<sup>1</sup> got but little honour:  
 The Wave-subduer<sup>2</sup> met with scant reward.  
 If our Prince still grudges the things that are easy to give,<sup>3</sup>  
 Can he hope that his soldiers will give what is hardest to give?<sup>4</sup>

<sup>1</sup>Hou Yen (1st century B.C.)

<sup>2</sup>Ma Yüan (1st century A.D.)

<sup>3</sup>Rewards and titles

<sup>4</sup>Life

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From *ONE HUNDRED SEVENTY CHINESE POEMS*, translated by Arthur Waley. Copyright 1919 and renewed 1947 by Arthur Waley. Reprinted by permission of Alfred A. Knopf Inc.

## HOT SPRINGS FOR RECREATION AND LUXURY

THE MOST FAMOUS HOT SPRING USED FOR LUXURIOUS RECREATION WAS HUAQINGCHI HOT SPRING from the Tang Dynasty. Development started at the hot spring with bathing and treatment facilities built in the Qin Dynasty. In 644 A.D. of the Tang Dynasty, a palace called *Tangquan*, which means “thermal spring,” was built around the spring, which is at the foot of Lishan Mountain. In 747 the name of the palace was changed to *Huaqing*, “glorious purity,” meaning that the water looked crystal clear and was sweet tasting, and everybody would be kept young forever by drinking the spring water everyday and bathing in it all the time.



*Huaqing* (“glorious purity”) hot spring in the foothills of Lishan Mountain. The most luxurious imperial palace during the Tang Dynasty was Huaqing Palace, built in 747. *Drawing by V. Svalova*

This palace was the most luxurious imperial palace in the Tang Dynasty. The Emperor Tang Xuan-zong and his beloved Concubine Yang Gui-fei visited it often, spending most of their leisure time there and taking a daily bath. Lines from the poem “Changheng,” by Bai Ju-yi, a famous poet of that time, vividly describe the luxurious life of Emperor Tang and Concubine Yang at Huaqing Palace: “It feels so good bathing in Huaqing hot spring in the early days of the still-cold spring season, and the spring water can clean everything out of the body, even the ‘make-up’ of Concubine Yang.”

Another famous place for luxurious hot spring recreation is the Xiaotangshan hot spring area, 25 kilometers north of downtown Beijing. This hot spring area was first recorded in *The Annals of the Yuan Dynasty*, about 800 years ago. Since then, the royal family, the noble lords, and high-ranking officials in the Ming (1368-1644) and Qing (1644-1911) Dynasties have visited this area often and even built mansions here. Two hot spring pools were sunk in 1666, and the remains of the Empress Dowager Cixi's bathing pool still can be seen.



Close-up of two hot spring pools in the Xiaotangshan hot spring area near Beijing. The pools were built in 1666, the fifth year of Emperor Kangxi of the Ching Dynasty, for the Empress Dowager Cixi. Drawing by V. Svalova

## TEA, WINE, AND LIQUOR CULTURE AT HOT SPRINGS

IT IS WELL-KNOWN THAT THE SO-CALLED “TEA, WINE, AND LIQUOR CULTURE” IN CHINA HAS A long history and that high-quality waters were—and still are—of significant importance for good tea, good wine, and good liquor. The most famous Chinese liquor, *Maotai*; the high-quality Chinese beer, *Qingtao*; and *Zhangyu*, a good wine, are all made from the spring water. In ancient times, people also used hot spring water for tea, such as hydrogen sulfide hot spring water from Huangshan Mountain in Anhui Province. It was believed that tea made from this water was good for the health.

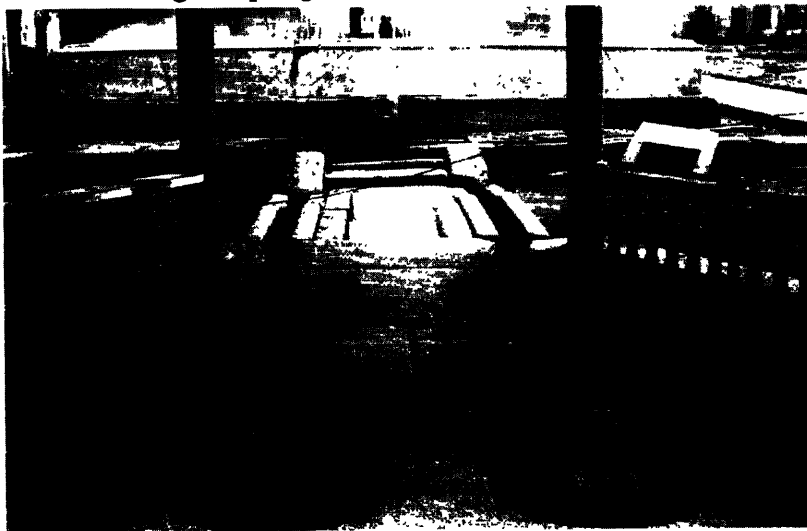
In Hangzhou City, famous for the beautiful West Lake and an excellent green tea, *Longjing*, which means “dragon’s well,” there exists a famous spring called *Hupao*, “running tiger.” The

spring water is so clear, pure, and sweet that the *Longjing* tea made here is marvelous. It is said in Hangzhou that the “two uniques” (*Longjing* tea and *Hupao* spring) make the West Lake more beautiful. The Japanese tea ceremony may have derived from the ancient Chinese tea culture.

In Zunhua County, Hebei Province, a famous hot spring called *Tangquan*, which means “hot-water spring,” is located east of the Eastern Royal Tombs of the Qing Dynasty. Legend says that the Emperor Tang Taizong of the Tang Dynasty stayed here while on an expedition to the east. He bestowed on the spring the name *Fuquan*, “lucky spring,” after watching his soldiers take a bath here and recover quickly from illness and fatigue. To celebrate, he gave a banquet near the hot spring and used the flowing hot spring water of



*Hupao* (“running tiger”) spring in Hangzhou. Drawing by V. Svalova



*Liubeiting* (“floating cup pavilion”), next to the hot-water pool of *Tangquan* (“hot water spring”) spring in Zunhua County, Hebei Province.

about 60° C to warm the liquor. Soon after, the *Fuquan* Temple was built, and the *Fuquan* mansion plus the spring pool followed. In addition, a pavilion called *Liubeiting* (“floating cup pavilion”) was built next to the spring pool in memory of the event. From the photo, it can be seen

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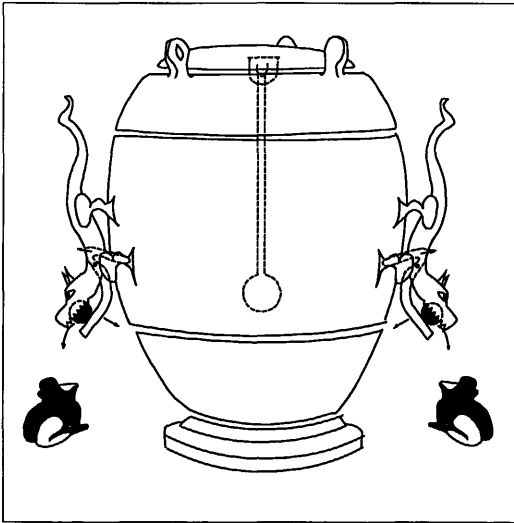
## FROM DRAGON TO FROG: THE FIRST EARTHQUAKE RECORDER

The first instrument to record earthquakes known in any detail was a scientific device invented in about 132 A.D. by a great Chinese scientist of the Han Dynasty, Zhang Hen. His invention was called a seismoscope, which, unlike a seismograph, did not record the complete history of the earthquake, only the direction of the strongest impulse.

The instrument was beautiful. Golden metal dragons were affixed upside down at intervals around a large golden vessel and golden frogs with open mouths stretching upwards were placed on the floor beneath each dragon. Balls were held in the dragons' mouths, which were probably connected by linkages to a vertical pendulum, as shown in the drawing. Shaking from earthquakes would release a ball.

For example, an earthquake moving from right to left would move the container to the left (assuming it is attached to the floor). However, the pendulum would remain stationary (Newton's 1st law of motion) and strike against the right side of the container, hitting the linkage and opening one dragon's lower jaw. This would allow the ball to fall into the frog's mouth, recording the direction of the quake. The linkage in the cross section is unknown but assumed, based on records.

It was reputed that when the device was first brought to the Chinese court, a ball fell into a frog's mouth one day but no earthquake was felt. Zhang Hen was in disgrace. Days later, a horseman came racing up from a distant place in the direction of the fallen ball, telling of a great earthquake: the seismoscope had worked. Zhang Hen was elevated again to a position of respect, but the use of his instrument seems to have died out in a short while.



*Text by John W. Lund based on a reference from Earthquakes by Bruce A. Bolt, published by W.H. Freeman and Company, New York, 1993.  
Drawing by Toni Boyd and John W. Lund*



A seismoscope displayed at an exhibit in San Francisco, California.



that a cup holding liquor or wine warms up while floating from one side of the pool to the other. This is an unique aspect of Chinese culture from ancient times. One can imagine how fantastic such a banquet would be!

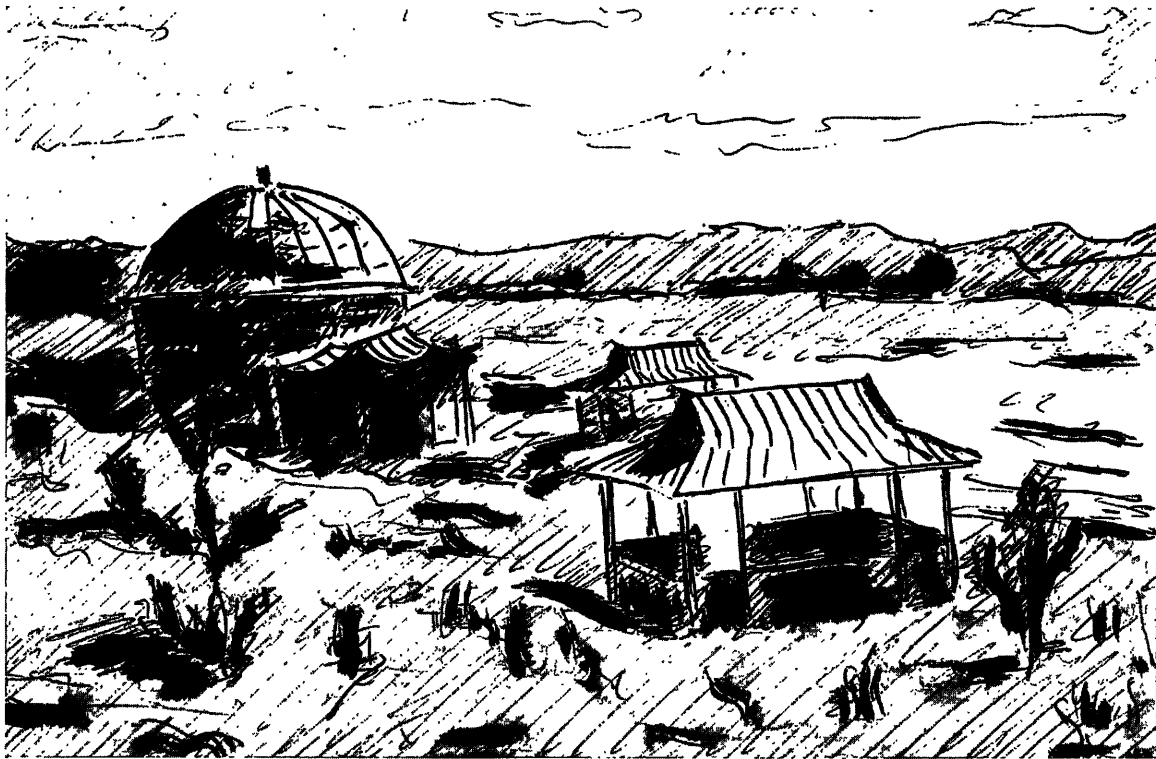
Another interesting story about Chinese wine and liquor culture and hot springs comes from Western China, along the “Silk Road” to Europe. A famous spring there, called *Jinquan* (“golden spring”), is in Gansu Province on the edge of Jiuquan County. During the West Han Dynasty (140-117 B.C.), the great general Huo Qu-bing commanded his soldiers to move quickly to the west and win the war. Wudi, an emperor of the Han Dynasty, gave liquor for the victory celebration. Clearly, it was impossible to share the liquor with so many soldiers. Instead of drinking alone, General Huo decided to pour the liquor into the spring water and share the “spring-liquor” with the whole army. Since then, the spring has been called *Jiuquan* (“liquor spring”) and has become more and more famous as the story has spread.

#### HOT SPRINGS FOR TREATMENTS

IT IS CLEAR, THEN, THAT HOT SPRINGS OFTEN CURE DISEASES AND IN EARLY DAYS PEOPLE USED HOT springs to treat various diseases. With time, people studied the effects of hot spring water on human beings and tried to interpret the mechanism of “water-body” interaction using the theory of Chinese traditional medicine. For instance, Ban Gu of the East Han Dynasty thought that hot springs belonged to “fire,” of the so-called “Five Behaviors of the Universe” (gold, wood, water, fire, and soil). Therefore, the “cold” diseases, such as arthritis, rheumatism, and digestive diseases, must be treated with hot spring water. On the other hand, the “fever” diseases, such as typhoid and yellow fever, should never be treated with hot springs. Sulfur hot springs are very good for skin diseases, because skin diseases are always treated with sulfur alone in traditional Chinese medicine.

In Inner Mongolia, a “holy” hot water spring, the Arsan, has a temperature of about 50°C. The spring water is effective for treating fibrous tissue syndrome, arthritis, and psoriasis. As a result, the local herders believe it is “holy water.”

*Tanggangzi*, which means “hot water hill,” is the hot spring most famous for medical treatment in China. It is in the southern suburb of Anshan City, the largest steel-producing city, in Liaoning Province. The spring was found in 644 of the Tang Dynasty, and a county called *Tangchi*, “hot



*Arsan* (“hot holy water”) hot spring in Inner Mongolia. Drawing by V. Svalova

water pond,” was set up around the hot spring area in the Liao and Jin Dynasties. During the Qing Dynasty, more and more people came here for bathing and hot mud treatments. In 1950, a sanitarium was built here, and today the Tanggangzi Sanitarium is a well-appointed physiotherapeutic hospital, one of the largest physiotherapeutic centers in China.

## CONCLUSION

**T**HUS CHINA HAS USED GEOTHERMAL WATERS FOR OVER 3,000 YEARS. HOT SPRINGS WERE GENERALLY regarded as valuable natural gifts and many cities, towns, and villages have grown up around hot spring areas. The most famous ones are the cities of Fuzhou and Zhangzhou, and the former is now the capital of Fujian Province.

Fuzhou has a “hot spring” street in the central downtown area of the city, and local residents have used the hot spring water for bathing since the early days of settlement. Zhangzhou City is located in the so-called “Golden Triangle” of southern Fujian Province. Many people living in Taiwan have emigrated from here, and Mrs. Akino, the former president of the Philippines, originally came from the Zhangzhou area. Several years ago, she made a short visit to her

hometown and took a hot spring bath. Today, Zhangzhou is the biggest Chinese center for nonelectrical uses of geothermal resources. Besides spas and bathing houses, fish farming and vegetable drying are the main activities.

The only Chinese hot springs inspiring terror and fear are found in Taiwan and in the Tengchong volcanic area of southwestern Yunnan Province. Located about 12 kilometers west of Taipei (Taipei) City, Beitou hot spring is famous for its Geothermal Valley (Hell Valley) because of its mystical, terrible nature. Geologically, Beitou hot spring is related to the Datun active volcano and has a number of high-temperature geothermal manifestations, which gave the valley its name. However, the Beitou hot spring water is very good for treating beriberi, favus of the scalp, and scabies because the water contains a lot of sulfur. Historically, sulfur mining in Taiwan was concentrated in the Datun volcanic zone, including the Beitou hot spring area. The earliest record of sulfur mining in Taiwan occurred in the Yuan Dynasty, about 800 years ago.

A second hot spring with a slightly mystical nature is situated in Tainan County of southern Taiwan. Celebrated for its “Water-Fire-in-One” spectacle, hot water with a temperature of about 75°C and natural gas gush out of a fracture at the same time. If the gas is ignited, flames will burn and flicker on the water surface, forming a “Water-Fire-in-One” picture.

Hot springs and other geothermal manifestations, such as “sulfur pond” (or “boiling pot”), “hot sea,” and “frog mouth” fumarole, from the Tengchong volcanic area in southwestern Yunnan Province on the border with Burma and close to Thailand, are most spectacular and scenic but never cause any fear or terror. The same thing is true for the many geothermal manifestations in Tibet, such as geysers, steaming ground, and hydrothermal explosions.

#### ACKNOWLEDGMENTS

**T**HE AUTHOR IS INDEBTED TO DRs. RAFFAELE CATALDI AND JOHN LUND. MY COLLEAGUES, PROFS. CHEN Mo-xiang, Wang Ji'an, and Liao Zi-jie, are thanked for providing material and valuable comments on the manuscript.

## SELECTED REFERENCES

Chen Yan-bin. 1993. *Hot springs in China*. Zhoughua Publishing House.

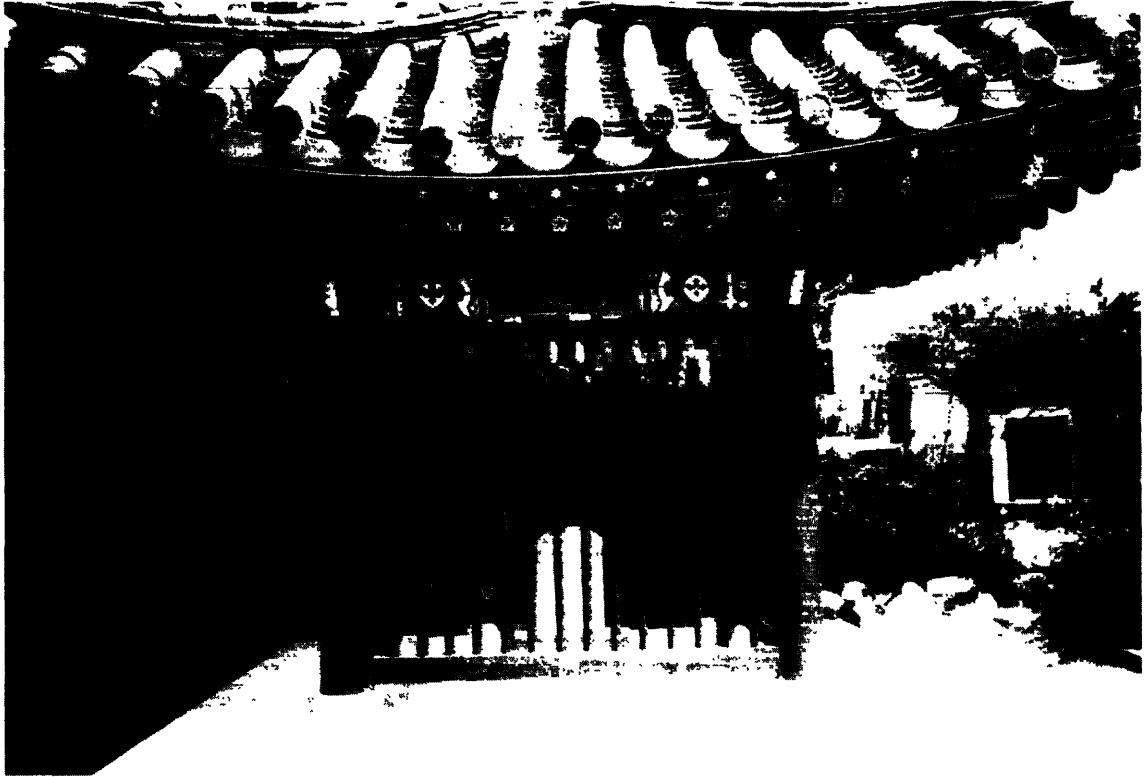
Hu Su-min, Lu Jin-kai, and Zhu Guang-jian. 1992. *Famous springs in China*. Geological Publishing House, Beijing.

Liao Zi-jie. 1975. The history of geothermal development in Taiwan. *Geological Review*, 31, no. 3, 285-288.

Li Zhong-zun. 1987. The history of discovery, exploitation and utilization of geothermal energy in China. In *Selection of Hydrogeology and Engineering Geology*. Geological Publishing House, Beijing.

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Commemorative Shinjeong Stele at Onyang hot spring.  
The stele was erected in the reign of King Songjong (1469-1494).

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