

Basic Principles of Geothermal Balneology and Examples in the United States

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ABSTRACT

People have used geothermal and mineral waters for bathing and their health for many thousands of years. Great spas, where balneology is usually practiced, have a long history, often stretching back to Roman times, and today they are still popular in Europe and Japan. The Indians of the Americas considered hot springs as sacred places and believed in the healing powers of heat and mineral waters. Today in the United States, people visit spas to improve their health and appearance, to get away from the stresses of work, and to refresh and revitalize their body and mind. The emphasis and purpose of spas, along with the successful planning and development, are discussed, as are the importance of water and mud to enhance the experience. Typical spa designs are suggested based on experiences in the U.S. Several U.S. spas are described as examples: Warm Springs, Oregon (*Kah-Nee-Ta*), Calistoga, California, and Thermopolis, Wyoming.

1. INTRODUCTION

People have used geothermal water and mineral waters for bathing and their health for many thousand of years. Balneology, the practice of using natural mineral water for the treatment and cure of disease, also has a long history. Based on archeological finds in Asia, mineral water has been used for bathing since the Bronze Age, about 5000 years ago. The Jews of the Middle East have used many hot springs in connection with religious rites in Egypt. The Greeks, Turks and Romans were famous for spa development from Persia to England. The word "spa" traces its origin to a town near Liège in southern Belgium near the German border. Here, an iron master used a spring of iron-bearing water in 1326 to cure his ailments. He founded a health resort at the spring called *Espa* (meaning fountain in the Walloon language). *Espa* became so popular that the word known in English as *spa* became the common designation for similar health resorts around the world (Lund, 1996).

Great spas have a long history, often stretching back to Roman times. Bath in England, for instance, was originally known as *Aquae Sulis*; Baden-Baden in Germany as *Aquae Aureliae*; and Aix-les-Bains in France as *Aquae Allobrogum* (Rockel, 1986).

Especially in Europe and Japan, the use of medically supervised spas has long been accepted. They are used for treatment and preventive therapy. The former Soviet Union had 3500 spas and some 5000 reconditioning centers, all administered and run by the state. In Slovakia and the Czech Republic, there are 52 mineral water health spas and more than 1900 mineral springs, where every year about 220,000 citizens are granted free spa treatment for three weeks, paid for by the national health insurance program. The most famous ones are Karlsbad in the present Czech

Republic and Piešťany in Slovakia. Many of these spas are being privatized today and are dependent on income from visits by persons from outside the country. In Rotorua, New Zealand, the Queen Elizabeth Hospital used various mineral waters and hot spring muds to help soldiers from the WWII Pacific wars to recuperate from battle injuries. In Japan, there are over 2500 spas used by over 150 million visitors every year. Some of these international uses are documented by Hotta and Ishiguro (undated), Lund (1992 and 1996), in "Stories from a Heated Earth" (1999), and the *Geo-Heat Center Quarterly Bulletin* (1993). The Indians used every hot spring in the Americas, and most were considered sacred places. Records of these uses go back for over 10,000 years. Montezuma, the great Aztec leader, spent time at a spa, *Aqua Hedionda*, to recuperate from his strenuous duties; it was later developed into a fashionable spa by the Spaniards (Salgado-Pareja, 1988).

2. WHAT IS A SPA?

The word "spa" is also used as a Latin abbreviation for: S = *salud*, P = *per*, A = *aqua*, or "Health through Water." In Germany, they refer to the "Kur", which does not mean just a cure, but instead is a series of treatments over time including baths, taking (drinking) water, massage, exercise, mud baths, etc.

For the sophisticated European of the nineteenth century, a spa was much more than just a health resort. The famous spas of France, Germany and Britain were elegant social and cultural centers. Most who took the cure ["kur"] did not do so primarily for medical reasons, but to see and be seen by high society (Rockel, 1986).

Other definitions include (DeVerville, 1998):

"The spa is the social aspect of using water therapeutically."

"The spa is a natural space and place with a perspective on time."

"A spa is a space with a purpose, through a plan, by a purpose, for a period of time."

Spas today can have many forms and emphasize certain treatments. Sarnoff, (1989) classifies American spas as follows:

1. Intensive fitness spas – where fitness buffs can train and tone "to the max" in minimum time.
2. Rejuvenation spas – where you can take advantage of the latest beauty treatments for a younger-looking you.
3. Weight-loss spas – where you can vacation and shed those unwanted pounds at the same time.

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4. Athletic camps – where excellent sports programs and exercise classes can be had at a very affordable price.
5. Mineral springs or “magic muds” resorts - where health-giving waters and the oldest, most aristocratic spa traditions await you.
6. New Age retreats – where you can renew your psychic and spiritual self as well as physical well being.
7. Gustatory hideaways – where you can enjoy and learn about the best in healthful, nonfattening, gourmet fare.

Thus, in summary the purpose of a spa is to provide (DeVierville, 1998):

1. Water (therapeutic through heat and minerals, including muds).
2. Movement (exercise, massage and fitness).
3. Herbal (medical benefits)
4. Dietary (proper food and drink).
5. Life style pattern.

And a spa, to be successful, must have (DeVierville, 1998):

1. Hygiene (cleanliness)
2. Service
3. A unique attraction, such as scenery, special water, special mud, special cure, special food, unique location, unique facility, etc.

3. WATER AND MUDS

A spa originates at a location mainly due to the water from a spring or well. The water, with certain mineral constituents and often warm gives the spa meaning from one or more of the following points of view (De Vierville, 1998):

1. Religious, mythical, symbolic
2. Social, political, economic
3. Aesthetic, artistic, literary
4. Philosophical, scientific, technological and medical

Mineral waters, when analyzed, are found to contain a great many substances; although, some of them occur only in very minute quantities. The most important ones, from a therapeutic point of view, are sodium, magnesium and iron, carbonic acid, sulphur, and perhaps sulphuric acid (www.1911encyclopedia.org).

According to the most generally received opinion, the skin's surface does not absorb any portion of the salts in a mineral-water bath, although it may absorb a little gas; and neither salts nor gases have any action on the system except as stimulants of the skin and partial action on the respiratory organs. President Franklin D. Roosevelt found that the visits to the “Little White House” at Warm Springs, Georgia, where he soaked in the warm mineral waters, did give him some respite from his polio. He found that he was

able to move his lame legs under water. It was probably due to the buoyancy of the water and the massaging action of the carbon dioxide bubbles in the water (Lund, 1996).

Drinking considerable amounts of cold water reduces the temperature of the body, diminishes the frequency of the pulse, and increases blood pressure temporarily. Therapeutically, drinking large quantities of water tends to provide a general washing out of the organs. This produces a temporary increase in certain excretions, augmented diuresis, and a quantitative increase of urea, of sodium chloride, and of phosphoric and sulphuric acids in the urine. On the other hand, warm water is better absorbed by the stomach and has a higher therapeutic action than cold water (www.1911encyclopedia.org).

Mineral water containing various mineral and gases has become extremely popular today all over the world. It is a multi-million dollar industry, where a gallon of mineral water costs considerably more than a gallon of gasoline. At Karlsbad Spa (Karlovy Vary) in the Czech Republic 12 main springs provide 70°C water which is piped into a colonnade (cooled to 30°C) at 12 drinking stations. Water is drunk through the handle of special cups carried by visitors (Fig. 1). Tradition says that the “thirteenth spring” is a local alcoholic drink, a herbal liqueur developed in 1807, called *Karlovarska Becherovka* (Lund, 2000).



Figure 1. Drinking water at Karlsbad Spa.

Associated with most spas is the used of muds (peloids) that are either found at the site or imported from special locations. As an example, at Piešťany in Slovakia, there is a special laboratory that tests muds or clay for their mineral content and their therapeutic benefits. The muds are stored in tanks and “cured” for maximum benefits. The three classifications of muds are:

1. Pure mineral (fango, mud) – neutral
2. Mainly mineral (sea mud or liman) – alkaline
3. Mainly vegetable peloid (moor, peat) – acid.

The spas at Calistoga, California, use a mixture of volcanic ash and peat moss for their “muds” (Fig. 2) (Lund, 1979).

The skin effects of mud are:

1. Increasing the body temperature
2. Lowering the blood pressure

- Influencing the mineral metabolism and blood chemistry.



Figure 2. The author and his son having a geothermal mud “bath” at a Calistoga, California spa.

Even though hot mudpacks have been touted for many ailments, the recommended uses for local treatment are (DeVierville, 1998):

- Chronic arthritis
- Fibrositis
- Neuritis, sciatic syndrome
- After treatment of fractures
- Sport and industrial injuries.

4. TYPICAL SPA DESIGNS

There are many types of designs for spas, depending upon the local culture, the unique character of the location, and what the developer is trying to achieve in terms of atmosphere, service and type of clientele. Two basic types, with an emphasis on the use of geothermal water will be presented here. The first (Fig. 3) is one originally proposed for Hawaii (Woodruff and Takahashi, 1990) and is similar to ones in Calistoga, California. This design, which includes living quarters surrounding the various bathing and soaking pool, lends itself to feature native plants and material in the landscaping and construction. Also, food and drink can be provided, along with small shops and a fitness room for a health and fitness program. The enclosed pool area would provide privacy, but also allow easy access to and from the living area.

The second design (Figure 4) was also proposed for Hawaii (Woodruff and Takahashi, 1990). This design emphasizes private, semi-private and public bathing and soaking facilities. This is also typical of the design for the Polynesian Pools in Rotorua, New Zealand. This design does not include living quarters, but these could be added at a separate location and could be individual cottages. The semi-private and private pools could then be used by a single family and rented on an hourly basis. This would also be appropriate in cultures where bathing in public is less accepted.

Both of the above designs could be uncovered, completely enclosed or each individual pool covered with a temporary roof for use in inclement weather. Uncovered pools are extremely popular in the evening under a star-lit sky.

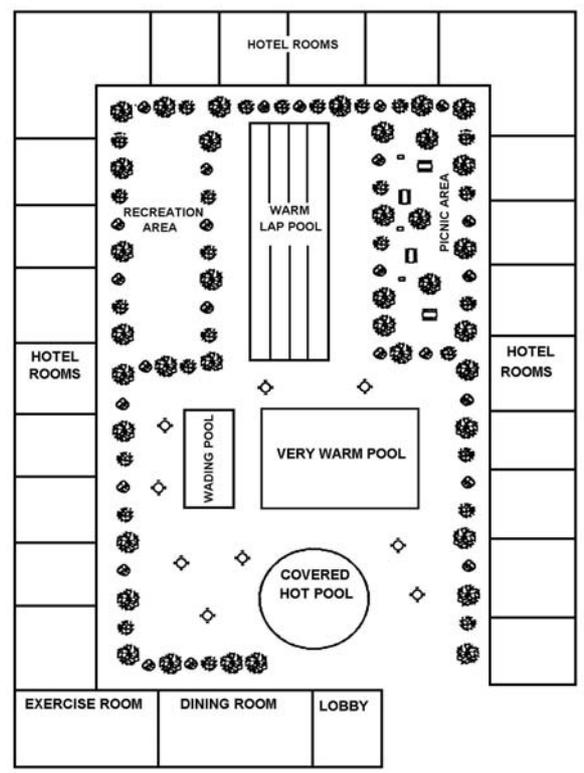


Figure 3. General scheme of a modern geothermal spa located in California (Woodruff and Takahashi, 1990).

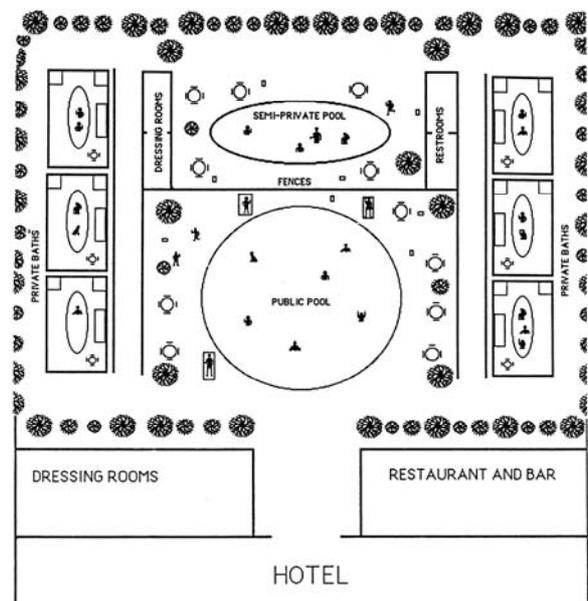


Figure 4. Design for a geothermal spa offering private, semi-private, and public bathing facilities (Woodruff and Takahashi, 1990).

5. HOT WATER USE AND SPA DEVELOPMENT IN THE UNITED STATES

In the United States, the use of natural springs, especially geothermal ones, has gone through three stages of development: (1) use by Indians as a sacred place, (2) development by the early European settlers to emulate the spas of Europe, and (3) finally, as a place of relaxation and fitness.

The Indians of the Americas considered hot springs as a sacred place of Wakan Tanka (“Great Mystery” or Great Sacredum” in the Lakota language) and thus, were great believers in the miraculous healing powers of the heat and mineral waters. Every major hot springs in the U.S. has some record of use by the Indians. They were also known as neutral ground, where warriors could travel to and rest unmolested by other tribes. Here, they would recuperate from battle. In many cases, they jealously guarded the spring and kept its existence a secret from the arriving Europeans for as long as possible. Battles were fought between Indians and settlers to preserve these rights. The early Spanish explorers, such as Ponce de Leon and Hernando DeSoto, were looking for the “Fountain of Youth,” which may have been an exaggerated story of the healing properties of one of the hot springs.

The early European settlers in the 1700 and 1800s found and used these natural hot springs, and later realizing their commercial value, developed many into spas after the tradition in Europe. Many individual developments were successful such as at Saratoga Springs, New York; White Sulphur Springs, West Virginia; Hot Springs, Virginia; Warm Springs, Georgia and Hot Springs, Arkansas. However, the U.S. did not have the government, trade unions, social security and a national health insurance program to support these developments. Thus, in spite of the benefits of spa therapy that had been proven successful in Europe and elsewhere in the world, the U.S. lagged behind in the development of these mineral springs even though state and the federal government acquired some. By the 1940s, the interest in spas languished, and most of the majestic resorts went into decline and closed.

Increasing consumer interest worldwide, resulting in high growth in revenues and profits, has recently stimulated the health and fitness industry. Health spas and resorts, representing a major part of the health and fitness industry, have grown in popularity and offer high investment potential in the United States. Revenues from spas in the U.S. presently are estimated at \$10 billion annually. The number of spa-goers was projected to grow from 31% of the adult population in 1987 to 45% in 1997. Recent figures (1997) show that the U.S. attendance at spas as increased 87% and in Canada, the increase has been 20% yearly for the last nine years – amounting to \$650 million in sales. Most spa attendance in the U.S. is from the 30 to 49 age group (60%), with the under 30 increasing and the over 50 decreasing in attendance. Women make up most of the resort-based spa-goers at 74%. The two items most enjoyed by all at U.S. spas were: “Rest and Relaxation” (65% of attendees) and “Being Pampered” (60% of attendees). Men used resort-based spas for “rest and relaxation” and “exercising and getting fit”; whereas, women liked “being pampered”. The most traditional type of health spa is the geothermal spa, featuring baths and pools of natural hot mineral waters. They have become oases of tranquility (Monteson and Singer, 1998).

This recent interest in hot springs= soaking and physical fitness has renewed the development of spas in the United States. This natural way of healing and the “back to nature” movement has in many ways rejected formalized spa medical treatment developed in Europe. In fact, the average person in the United States knows little of spa therapy and its advantages, as many of the medical claims have been outlawed in the U.S. and natural waters have needed chlorination or other chemical treatment. The main reason people in the U.S. go to geothermal spas are to improve their health and appearance, to get away from

stresses, and to refresh and revitalize their bodies and minds. Unlike European spas where medical cures of specific ailments are more important, U.S. spas give more importance to exercise, reducing stress, lifting depression and losing weight. Of recent interest is the development of “health conservancies” to preserve natural areas for health and fitness activities.

The use of mineral and geothermal waters has developed along three lines in this country: (1) the more plush hot springs resorts with hotel-type services and accommodations, (2) commercial plunges or spring pools and soaking tubs with perhaps a snack bar or camping facilities, and (3) the primitive undeveloped springs without any services (Sunset Magazine, September 1983). Many resorts and natural hot springs have an informal dress code while soaking, including nude bathing. They have satisfied health department requirement for chemical treatment by allowing the water to continuously flow through without treatment. Several publications have been written on the subject, documenting these facilities and their use. In the case of the resorts, two books are available: “The Best Spas” by Van Itallie and Hadley, 1988, and “The Ultimate Spa Book” by Sarnoff, 1989. Plunges and hot springs are well documented in several publications, such as: “Great Hot Springs of the West” by Kaysing, 1990; “Hot Springs and Hot Pools of the Northwest and Eastern States” by Loam and Gersch, 1992, and “The Hiker’s Guide to Hot Springs in the Pacific Northwest” by Litton, 1990. A recent series of “Touring Hot Springs” books for the states of California and Nevada, Colorado, Arizona, New Mexico, Washington, and Montana and Wyoming have been published as *A Falcon Guide* (1997-2002).

6. LOCATION AND CHARACTERISTICS OF THE U.S. SPAS

There are over 115 major geothermal spas in the USA, and many smaller ones along with thousands of hot springs (1,800 reported by NOAA, 1980). The majority of these are located in the volcanic regions of the western states; but several famous ones still exist in the east. The major spas are estimated to have an annual energy use of 1.531×10^{12} kJ, or an equivalent of 340 thousands barrels of oil (BOE). Details of some of these U.S. spas are presented in the *Geo-Heat Center Quarterly Bulletin*, Vol. 14, No. 4, March 1993, and Vol. 21, No. 3, September 2000, and in Lund, 1996. Thermal waters in geothermal spas vary greatly in composition from place to place. Table 1 shows some analyses of the major constituents of water from thermal springs and wells in several locations. The notation “n/a” indicates that no value was available and does not necessarily mean that components were absent. Concentrations are in mg/L. The composition of average seawater is included for comparison (Woodruff & Takahashi, 1990).

Interest in spas in the U.S. was not entirely lacking after the turn of the century, as both the federal and state governments became owners and managers of several important ones – most notably Hot Springs National Park in Arkansas. Established in 1921, it is the only national park in the U.S. created just to protect hot springs for spa use. This natural geothermal resource consists of 47 springs producing about four million liters of 61°C water daily. Legend reports that Hernando DeSoto, a Spanish explorer, or someone from the 1541 expedition were the first Europeans to visit the site (Lund, 1993 and 1996).

Three examples follow: Thermopolis, Wyoming, Calistoga, California and Warm Springs (*Kah-Nee-Ta*), Oregon.

Table 1. Composition of Waters from Several Locations (mg/L).

	(1)	(2)	(3)	(4)	(5)	(6)
Na	4.0	326.2	520	690.0	290.0	10500
K	1.5	89.6	82	15.0	0.08	380
Mg	4.8	121.6	38	0.2	0.08	1270
Ca	45.0	624.0	150	210.0	34.0	400
Cl	1.8	217.6	n/a	1300.0	106.0	19000
SO ₄	8.0	n/a	420	170.0	491.0	2650
SiO ₂	42.0	24.0	58	96.0	n/a	n/a
HCO ₃	165.0	n/a	n/a	17.0	n/a	140

(1) Hot Springs, Arkansas (2) Thermopolis, Wyoming
 (3) Indian Springs, Colorado (4) Belkap Springs, Oregon
 (5) Desert Hot Springs, California (6) Average sea water

6.1 Thermopolis, Wyoming

This resort and hot springs are located at the mouth of the Wind River Canyon, approximately 150 km southeast of Yellowstone National Park. The major geothermal attraction in the area is the Hot Springs State Park with the 120 L/s Big Horn Spring. Nearby is the Fountain of Youth resort using natural mineral water from the historic Sacajawea Well flowing at the rate of 60 L/s. At least eight hot springs in the area have created large terraces along the river. These terraces are composed chiefly of colorful lime and gypsum layers known as travertine. The springs, claimed to be the largest mineral hot springs in the world, flow at a temperature of between 22 and 56°C with a total dissolved solids of 2400 mg/L. The early history of the springs include use by Indians; however in 1896, a treaty was signed between the Shoshone and Arapaho Indians and the federal government which gave the public use of the hot springs. The management of the springs was later turned over to the state of Wyoming, forming Hot Springs State Park. Today Hot Springs State Park consists of little over 420 hectares of irrigated lawn and developed area within the 26-square km park, providing geothermal bathing in the State Bathhouse and free water to six other facilities. Among the facilities providing hot water is the Pioneer Center for retired state residents and the Gottsche Rehabilitation Center specializing in helping stroke victims, closed head and spinal injuries, bed sores, cellulating problems, and burn victims (Lund, 1993 and 1996).

6.2 Calistoga, California

This northern California area was originally settled by the Pomos and Mayacmas Indians for at least 4000 years ago. Early peoples came from miles around to use the natural hot springs, fumaroles, and heated muds to soothe aches and pains. They also built sweat houses and used the local cinnabar for red war paint. To them, this was the “beautiful land” and “the oven place.” In the early 1800s, the Spanish explorers visited the area looking for a possible mission site. They referred to this site as “Agua Caliente.” Sammuel Brannan, in the 1850s, envisioned a resort and spa similar to Saratoga Hot Springs--and thus, the name came when he misspelled during a speech, combining California and Saratoga (Archuleta, 1977). He spent an estimated half a million dollars developing the “resort,” with his Hot Springs Hotel opening in 1862. Around the turn of the century, over 30 resorts existed in the surrounding area, including bathhouses, mineral springs,

and resort hotels. By 1930, many of these resorts had closed due to financial hardship, fires and lack of maintenance. About 15 years ago, Calistoga again became a “boomtown” with six major spas and resorts in operation. All of these resorts have their geothermal water supplied from shallow wells around 60-m deep with temperature from 77 to 93°C. The water for the pools and baths is cooled to 27 to 40°C, and some have mud baths using the local volcanic ash and peat moss. Calistoga also has a mineral water industry and is adjacent to the Napa Valley wine industry (Lund, 1996).

6.3 Warm Springs (Kah-Nee-Ta), Oregon

The Kah-Nee-Ta swimming pool is located on the Confederated Tribes of Warm Spring Reservation in north-central Oregon (Fig. 5). The 243,000-ha reservation was formed in 1879 and settled by Paiutes, Warm Springs and Wasco tribes. A resort, which includes a lodge, recreational vehicle village with condominium, tepees, a swimming pool and more recently a gambling casino, is located adjacent to the Warm Springs River. A large swimming pool, several hot tubs, a spa and a Tribal Bath House are all heated by water from a nearby spring. The spring provides 25 L/s of 53°C of bicarbonate, sodium-chloride water that flows into holding tanks under the pool building. The two hot tubs are kept at 40°C and the 2,000-cubic meter outdoor pool at 32°C to 34°C. The spring water is pumped through sand filters to removed iron oxide and algae. The pools water is chlorinated and then treated before being discharged to the Warm Springs River. No attempt has been made to provide space heating to any of the buildings (Lund, 2004).



Figure 5. The pool at Warm Springs, Oregon.

8. CONCLUSIONS

There has been a revitalization of spas and their use in the United States in recent years. Over the last few years, there has been an increase in the number of spas at resorts and a corresponding increase in attendees. Today’s spa guests look mainly for the relaxation aspect at a resort and like to balance this with some exercise. They use resort-based spas to have a massage, be pampered, relax and be refreshed. They also seek sufficient exercise equipment and facilities so they can maintain the fitness regimen that they have at home. The shift in market demand is being driven by the aging Baby Boomers – those in the 30-49 age group (Monteson and Singer, 1998).

Geothermal waters, found throughout the western states and at selected locations in the east, are popular for the unique characteristics of this natural water. Geothermal water has been used extensively for hot pools and baths in the United States, but not for heating or cooling the structures at these spas. Space heating was attempted in the past at many resorts, however, with mixed results. Pipes would corrode or plug with deposits and require frequent repairs,

replacement and cleaning. The expense was high and, thus, “natural” space heating was usually replaced with conventional fossil-fuel systems. Today, we at the Geo-Heat Center, and other geothermal experts, understand and solve these problems on a routine basis. The cost of installing the proper equipment and safeguards are more than offset by the savings in annual heating costs over fossil fuels. The Geo-Heat Center has a technical assistance program funded by USDOE providing free preliminary engineering and economic design and analysis of any use of a resource for heating and cooling.

Of interest, is the recent scandal in Japan concerning some of their hot springs used for bathing (The Associated Press, 2004). The Japanese media has revealed that artificial coloring and even tap or heated well water have been used at some of the country’s most famous spas, prompting government investigations and threatening to dampen a budding recovery of the domestic tourism industry. This is a scandal that has hit at a tradition that is very close to the Japanese heart, as bathing is considered sacrosanct in that country. The author is sure that this is an international feeling as well. Hot spring bathing is “sacred.”

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