

NOTICE CONCERNING COPYRIGHT RESTRICTIONS

This document may contain copyrighted materials. These materials have been made available for use in research, teaching, and private study, but may not be used for any commercial purpose. Users may not otherwise copy, reproduce, retransmit, distribute, publish, commercially exploit or otherwise transfer any material.

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specific conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.



18. Using Geothermal Waters in France: The District Heating System of Chaudes-Aigues from the Middle Ages

by
Jean Pierre Gibert
Florence Jaudin

Abstract: This is the story of how Chaudes-Aigues, in Cantal, France, has used its geothermal waters for nearly six centuries. Tax records for supplying natural hot water to dwellings in Chaudes-Aigues date from the 14th century. Water from hot springs gradually came to be used for an increasingly wide variety of purposes. Today, the Chaudes-Aigues geothermal heating network services 150 homes in the winter and, during the season of health cures, supplies spas with water for therapeutic purposes.

INTRODUCTION

DEEP IN THE VALLEY OF THE REMONTALOU RIVER, Chaudes-Aigues, at the southern edge of Auvergne in the Central French massif, a region inhabited since prehistoric times, has one of the hottest natural thermo-mineral springs in Europe: 82° C.



General view of the spa town, Chaudes-Aigues.

The main spring, called *le Par*, is one of about 30 gushing springs located in a small area. From mid-October to the end of April, 150 homes are now heated by hot water flowing through a 5 km network of pipes from five of these springs. Houses built on the spring field itself use the hot water directly below their floors for heating. The first writings describing this hot water use date back to the 14th century.



Present view of the old thermal spring, *le Par*, at Chaudes-Aigues.

Thus this small town has a rich geothermal history. In 886, the area around Chaudes-Aigues was evangelized. Lord Bodon gave the “villa du *Par*” (le Par villa) to the chapter of Saint-Julien de Brioude. The name *le Par* dates back more than 10 centuries. According to traditionally accepted etymology, the word “par” comes from *parer les cochons* (“to clean pigs”). Another possible etymology is a word found in several medieval texts: *parare*, which means to prepare wool. *Parare* was also used during the 14th century to mean “care for, treat, cure.”

1300-1400

CHAUDES-AIGUES, KNOWN BY VARIOUS NAMES (*CALIDAE AQUAE* OR *AQUAS CALIDADES* IN LOW Latin, or *Caldas Aygues* in *Langue d’Oc*, then used in Southern France), started to develop rapidly. A 1334 *terrier*, a register of real property listing the names of vassals or tenants, with

details of their holdings, services, and rents, mentions distribution of hot water in houses three times. One tenant owes his lord five *sous*, the monetary unit used in Southern France at that time, “for the hot water which is taken in the public road between Adrien Brugier’s house below the baths and R. Mercier’s house and for the pipe....” Two other tenants of *la place* (“the square”) each owe five *sous* for bath water, one for his house and the other for his building. This is the earliest recorded reference to Chaudes-Aigues’ use of geothermal waters for heating.

1400-1500

CHAUDES-AIGUES, NOW GROWN LARGE ENOUGH TO BE CALLED ONE OF THE “GOOD TOWNS OF the high country of Auvergne” with the right to send a representative to the “Auvergne States,” was the subject of an ownership dispute between the Counts of Armagnac to the south and the Dukes of Bourbon to the north.

According to a 1474 *terrier*, the distribution of thermal water was widespread, and about 20 “hot houses” are mentioned: “These concessions are numerous. Almost all of the inhabitants of the *rue du Par* (‘Par Street’) or of *la place* have the right to draw water at its source, above the pool, in the *futdyras* (‘wooden pipes’)....”

Innkeepers, barbers, apothecaries, and several leading citizens had similar rights. For instance, a barber named Jean Neuvéglise, who had his shop in the lower sector of *la place*, near the town gate, was allowed to draw hot water from the spring *le Par* “with his ancient servitudes...” above the bath, whereas Jean Roux, despite his position as bailiff, was permitted to “tap hot water for his house on the *rue du Four* only in the dispensary of the apothecary next door, and only holds the rights in a precarious manner; therefore, he has agreed to give them back to the Duke whenever asked to do so...” (Felgères, 1890).

The hot water network was used not only to heat houses; it also had industrial applications: “The inhabitants of Chaudes-Aigues like to work and are very industrious. They profit as much as possible from their hot waters.... They wash wool in the spring water before spinning...and treat textiles with the spring water, as well...” (Berthier, 1810).

Other mentions of hot water usage at Chaudes-Aigues are included in the 1474 *terrier*: “Etienne Bouniol, miller, acknowledges his right to draw hot water in the wall next to the

gate of the square and to draw it to his mill in La Vernède...,” and “Astruge Ferrande, from Saint-Julien, draws, at the same spot, the hot water that comes from the pool on the square along the wall, and carries it to his mill in order to triturate, card, and finish his textile products...” (Felgères, 1890).

This same *terrier* clearly stipulates the relationships between the inhabitants and the weavers of Chaudes-Aigues: “Therefore, for the convenience of the textile industries, the other users are required to return their bath water to a collector canal which flows from the spring *le Par*, crosses the square and runs along the wall before flowing through a hole in the wall and into the stream gravels. It is here tapped and carried to the various mills by a series of aqueducts, several of which cross the stream...” (Felgères, 1890).



Piercing pine tree trunks to make pipes. Hand-halved pine trunks have been used to channel thermal waters since the 14th century.

Starting in the 14th century, hot water was distributed via pinewood pipes, hollowed out with a long auger and fitted together. Another use of the hot waters at Chaudes-Aigues, which has endured through the ages, was for health treatments. The *terriers* of 1334 and 1474 make numerous references to the *bàynh*, a large public spa fed by the spring *le Par*.

This spa became a popular center for hydrotherapy in Europe, as the following passages from the Bishop of Saint-Flour indicate: “People come in crowds from many parts of the world to regain their health at Chaudes-Aigues...” (Bertrand de Cadoèn, 1426), and “In 1400, the consuls of Saint-Flour paid to send a pauper named Guillaume Girbal there...to cure him from *pelsicadura*...” (Felgères, 1890). *Pelsicadura* is an ancient term indicating a malady of the skin, perhaps psoriasis.

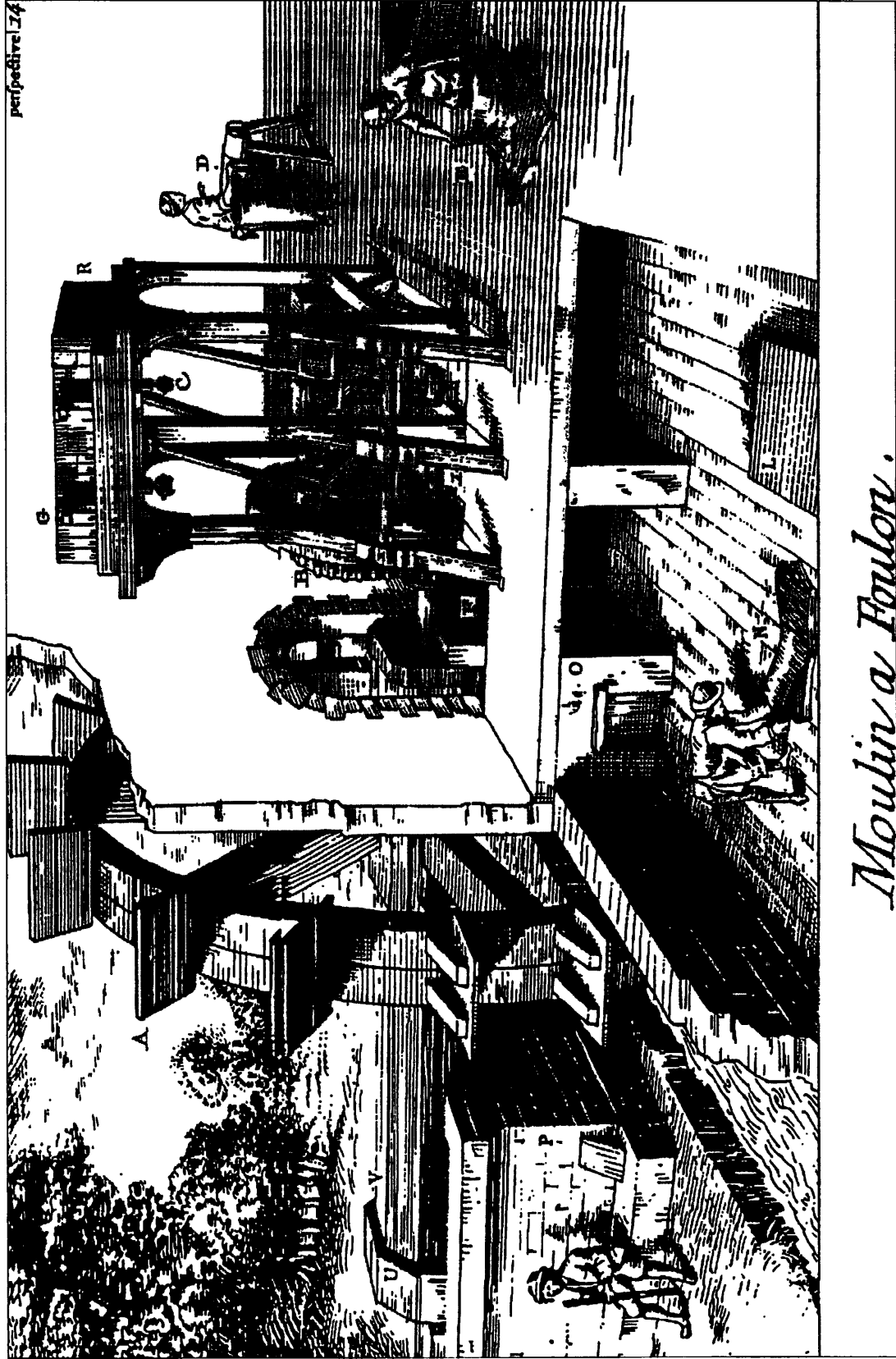
The site became particularly renowned for the treatment of paralytics, similar to its current specialization as a spa to treat rheumatism. In 1440 Gilles Bouvier, first herald of Charles VII, wrote that the most frequented spas of his time were Forges, Barbotan, and Chadesaigues [*sic*]. Moreover, Felgères wrote that “Paralytics and lepers, especially, are taken there for cure....”

1500-1600

THE TOWN OF CHAUDES-AIGUES WAS BURNED IN THIS PERIOD DURING THE RELIGIOUS WARS. The wealth of the ancient barony dwindled, and municipal freedoms were lost.

During the 16th century, the technique of water distribution to the mills was refined further, as was the use of wooden pipes. In 1545, Philander described the distribution methods: “Part of the hot water is drawn off through channels from the baths and the springs and is conveyed out of town by means of half-pipes of wood; hot water is then used to degrease and treat textiles, which are piled in wooden washtubs and struck energetically with hammers and pestles. The rest of the hot water is recuperated at the foot of the mountain and scooped up by the buckets of a spatulated water wheel moved by the cold-water stream that flows nearby....”

Another traditional use for the thermal waters is deeply rooted in the history of Chaudes-Aigues. Down through the centuries, visitors to the town noted that the inhabitants used the hot water for cooking. Philander reported that “the inhabitants used the principal spring to cook eggs, pluck chickens, remove the hair from baby pigs, and from the heads and feet of sheep, and heat up meats until they lose their bad taste....” In 1605, Jean Banc wrote that the waters at Chaudes-Aigues “are so hot that people cook eggs perfectly....”



Moulin a Foulon.

Artist's impression of a water mill. From the encyclopedia *Diderot-Alembert*.

Philander also mentioned an open-air public bath: “In this town, very hot waters spring out with great force from various spots. The water of the main spring, as soon as it falls in the pool, is drawn off by an underground pipe to a public, open-air bath....” Neither the *terrier* of 1615 nor any other later documents, however, mention this specific pool; apparently, it dried up between 1545 and 1615. Baths were also taken in small covered pools inside buildings.

In addition to the existence of public baths, Philander described methods of thermal bathing: “I saw exudations done in two ways in the town of Chaudes-Aigues in Auvergne.... First of all, hot water is conveyed through open lateral canals to little rooms they fill with very hot steam; afterwards, water flows to the bathing pools. You are free to choose one of these two ways for exudation, but I don’t know if you would be able to remain without harm in one of these steam rooms because the heat is suffocating inside them, and there is no exit other than a little door. But this is not the only use they make of this water....”

In addition to the springs used for public or private baths, others supplied water to some private homes located very near the mountain and to nearby inns.

1600-1700

THE 17TH CENTURY USHERED IN AN ERA OF DECLINE IN THE USE OF HOT WATER AT CHAUDES-AIGUES. However, using hot water for bathing resisted the passage of time. In *The Renewed Memory of the Marvels of Natural Waters in Favour of French Nymphs* (1605), Jean Banc wrote: “The truth is that the thermal baths [at Chaudes-Aigues] are the baths used for the longest period of uninterrupted time in France; they are very neatly and cleanly equipped in private homes. For the most part, hot water is derived by canals from the nearby springs, as one wishes....”

In 1623, Jean Passenaud, an apothecary living on *la place*, acknowledged two-thirds of the hot water pipes branching off from the main pipe that gathered the water from *le Par* spring “next to the pillory on the square.” He was allowed to draw “the water to his bath without being able to convert it, contrary to customary usage, and afterwards [he had to] return it to the main pipe.”

The woolen industry, too, started to decline significantly during the 17th century. The *terrier* of 1623 indicates that “the quantity of *cazals* [‘houses’] fallen in ruins that one can see in all the

neighborhoods attests that here, like elsewhere, civil discord has accomplished its mission of death. The number of mills has dropped from 15 to 4..." (Felgères, 1890).

1700-1789

IN 1787 LEGRAND D'AUSSY WROTE ABOUT THE THERAPEUTIC VALUE OF CHAUDES-AIGUES' HOT water: "Capable of acting on the human body because of their iron, gas and heat content, these waters can provide sick people not only with a drink cure but also with steam baths, hot-water baths and showers. Outside of the area, however, they are unknown...." Soon after, the health spas underwent a progressive decline. Those frequenting the spas imposed such a hardship on the community that in 1790, the mayor of Chaudes-Aigues, Mr. Sauret, declared to the Regional Department, "the town is incapable of feeding all of the disreputable and sick people who flock to the hot springs..." (Felgères, 1890). The last spa, *le Barlier*, closed in 1792.

In 1787, the Municipal Government of Chaudes-Aigues sent a report to the Provincial Assembly in an attempt to obtain authorization and funding to establish a hydropathic center and a charity workshop, which would involve restoring and modernizing the pipe network. However, the pipe network had been repaired and further developed a few years before. The 1775-1778 municipal accounts of the mayor, Jean Devèse, mention repairs on the main pipe from the spring *le Par* and on the Gravier pipe.

In the 1787 report, the Municipal Government proposed the construction of woolen and paper mills to help revitalize the town. In his 1890 treatise, Felgères explained the strategies of such an undertaking: "There might be nowhere else in the realm a town more well suited to such an establishment. The waters are hot enough for all these operations. Several sources of hot water can be seen along the river. It would be easy to increase their number. A little help from the Provincial Assembly would eliminate begging and vagrancy, which have increased in Chaudes-Aigues because of idleness...."

The distribution of hot water to private homes had also been extended to almost all of the town in these years: "A certain volume of water is gathered at *le Par* spring, flows under the roadbeds through wooden pipes, and then through private pipes, and is distributed to the ground floor of

each house.... The houses on the other side of the river have their own pipes which cross the river on a bridge...” (Legrand d’Aussy, 1787).

The technique used for domestic heating was very similar, or even identical, to that used now, as described by Legrand d’Aussy: “At the entrance of most houses there is a stonework pipe with a sluice gate, and in the middle [of each of these houses] there is a small pool covered by a removable stone.... The water flows in through the pipe, circulates in the pool, thus heating the tile, and then flows back out to the river. By opening or closing the small sluice gate, the regulation of the hot water flow rate, and thus of the desired temperature, is obtained. When room temperature reaches the desired level, and one no longer wishes to increase it, the gate is closed and the water does not enter the house but flows directly into the river....”

Hot water also made the workers’ lot more bearable. Bonnet de la Bragesse wrote in 1782 of the advantages workers experienced by laboring in geothermally heated locations: “The hard-working craftsman should not fear that his hands will be numbed by cold, dropping the shuttle that is his livelihood. It is also in these heated rooms that women and children gather, sitting on the tile, to knit with the rapidity acquired by habit of a skill learned at a young age....”

After 1750, the woolen industry gained new life, and the wool was treated by pressing and pestling by foot or pestles the raw textiles in a washtub of hot water. In 1765, Ballainvilliers wrote of the desirability of Chaudes-Aigues products: “There is a considerable trade in caddis, a light woolen twill manufactured 18 inches and 4 lines wide, which corresponds to five twelfths in Paris. This material, which is well suited for linings, is sold by the length, 32 ells long in Parisian measure. The wool is woven by women and children, both in the town and in the surrounding villages, and then is finished by the weavers. The merchants in Chaudes-Aigues and Rhodéz buy the material in its natural state in the fairs and markets of the town and, after having it dyed and dressed, send it to the neighboring provinces, especially to Lyons, where most of the material is used. Some merchants simply buy the treated material and send it off. A large quantity of bulky-knit woolen stockings are also made in the town and in the surrounding villages. They are known for their good quality. These stockings are mostly worn by common people and the *petit bourgeois*. Some of the higher classes, however, also wear these stockings to keep their legs warm....”

The literature of this period also details many accounts of the culinary use of hot water, such as the following:

- “These thermal waters are used to treat the caddis, and to blanch the heads and feet of calves and sheep.... This water is said to preserve the green color of vegetables when they are cooked, and is also used to make very good bread. It is said that the inhabitants of Chaudes-Aigues have taken every possible advantage from the waters...” (Bosc d’ Antic, 1771).
- “Women bearing jugs come continually to fetch water and occasionally there is even a crowd. At meal times, the women of the common people come to prepare their food along the canal. In a pot, they put slices of bread and a little butter and salt. They fill up the pot with spring water, put it in the canal as they would for a *bain-marie* [double boiler], and in less than half an hour the soup is ready. People come to cook eggs, remove the hair from pigs, pluck chickens, etc. The hot water is also used to make bread, and for ordinary uses...” (Legrand d’ Aussy, 1794).

The years of physical therapy at Chaudes-Aigues culminated eventually in a physical therapy center. In this regard Ballainvilliers (1765) wrote: “This town is renowned for its hot waters. Their temperature is too high for bathing; therefore, paralytics and cripples can use these waters only after they have been left to cool in pools....”

1789 - 1900

WITH THE FRENCH REVOLUTION IN 1789, THE FRENCH REPUBLIC EMERGED AND ANY PREVIOUS privileges were abolished. At Chaudes-Aigues, a local administration replaced the lord and declared that hot water should be used exclusively for purposes of public interest. Consequently, the distribution of hot water was reorganized to enable domestic heating in the town.

The users were given the responsibility of withdrawing water from the hot springs and maintaining the pipes. However, Chevallier noted in 1868 that users were too haphazard: “People drew water in a disorderly fashion and without moderation from *le Par* spring, and carried it to their homes. They then passed it on to several neighbors, asking them to contribute for the expenses. This led to a confusion of rights, quarrels and sometimes also ill-founded shortages of



Pig hide depilation was undertaken with geothermal waters at the beginning of the 20th century.
Chaudes-Aigues Council

hot water....” Forty years earlier, Chevallier had written that from this disordered distribution of hot water, the streets “had become like cesspools, so that they were difficult to cross. From the puddles, putrid vapors emanated which were harmful to the health...” (Chevallier, 1828).

Furthermore, the pipes were not well maintained, as Legrand d’Aussy (1794) explained: “I will not mention the annoyance caused by all of this water that, during the course of the year, makes the town dirty and muddy. A much more serious inconvenience, however, results from the continuous release of steam from pipes, which necessarily makes the air unhealthy....”

In an attempt to clean up what threatened to become a public health menace, the mayor of Chaudes-Aigues determined in 1817 that “the chief district engineer had to draw up a plan establishing the elevation of the spring that should be used. He had then to build a large reservoir at the highest point aimed at collecting all of the water of *le Par* spring, and after this reservoir had been built he had to plan the distribution of hot water to each neighborhood, using pine-wood pipes that should run down both sides of the streets, so that the pipes no longer had to cross under the roadbeds.... In this way, some seven eighths of the approximately 350 houses of the town could be supplied with hot water, and there was no longer any degradation, nor were there cesspools or any other cause of insalubrity that could be attributed to the distribution of

the water.... The administration then appointed a fountain-keeper to be in charge of the day-to-day maintenance of the reservoir and of the hot water network. He only took orders from the Municipal Government, and in this way the most perfect operation of the water-distribution service was attained...” (Chevallier, 1868).

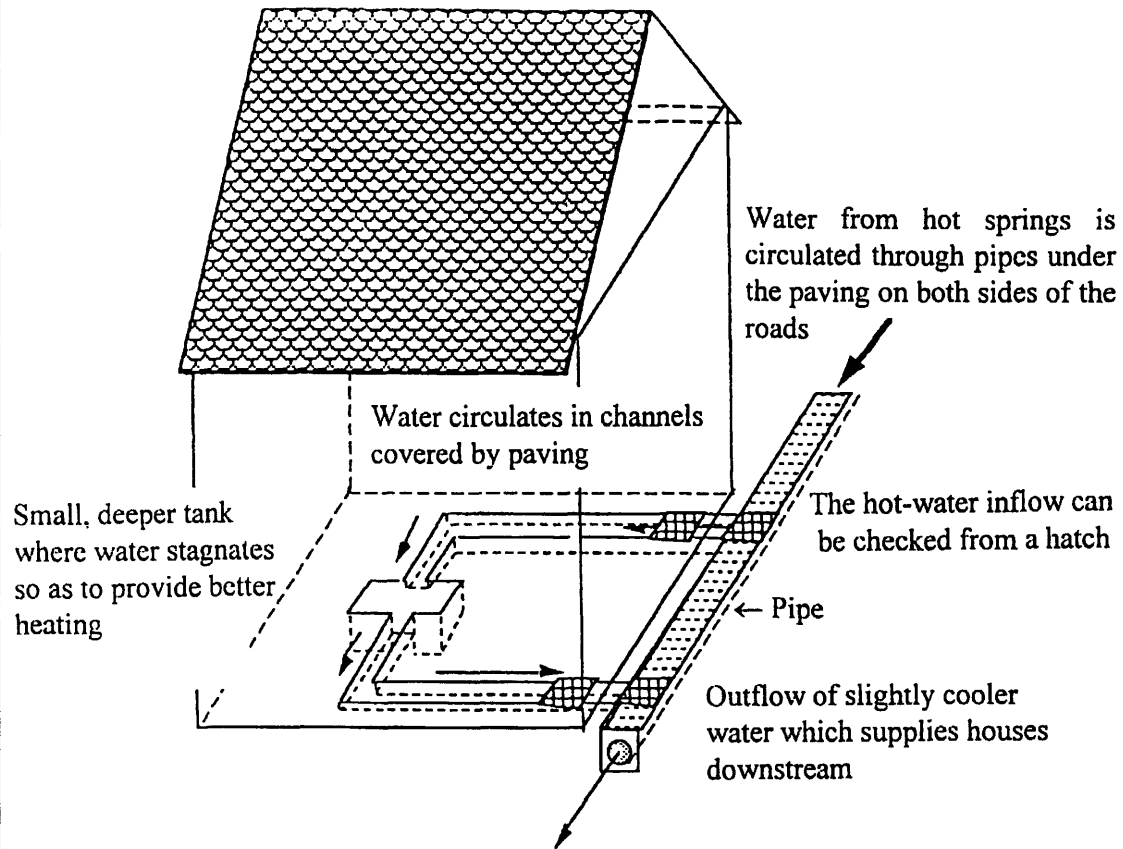
Nevertheless, these installations did cause some problems, as reported in the November 9, 1851, minutes of the Municipal Council: “The mayor informed the Council that there had been innumerable complaints and disputes, the object of which were the poorly defined obligations of the fountain-keeper. He [the mayor] then expressed the urgent need to draw up clear-cut regulations aimed at establishing the obligations of the fountain-keeper in maintaining the reservoir, the pipe network, the collectors, the fountains and the sinks, as well as channeling cold and hot water....” Consequently, the Council issued a set of regulations; Article 7 stipulated that “the fountain-keeper is no longer the only person authorized to supply wooden pipes for hot water. Private individuals, too, if informed with fair advance, can supply the wooden pipes....”

However, the gravity-driven distribution network of the hot water and the district heating system was not changed. The hot water continued to flow “under the floors of the houses, where there is a series of small pools that slow down the speed of the flow, and the houses are heated by the heat drawn from the pools. These pools are covered by large slabs, carefully cemented to prevent the humidity of the steam from entering the rooms. By means of faucets or plugs, inhabitants can, at will, increase or decrease the heat depending on the volume of water; they can even shut down completely the water inlet to their homes. The apartments heated in this way are very sought after during the winter. The room temperature may even be rather high, from 22° to 26° C, depending on how well the dwelling is sealed...” (Bouillet, 1834).

Regarding the industrial use of hot water, Berthier (1810) wrote: “The town of Chaudesaygues [*sic*] has long been devoted to the manufacture of textiles and woolen stockings, which are very renowned. Wool is washed in the spring water before spinning and, instead of treating textiles with clay, as is done elsewhere, they use this water. Without knowing its composition, people guessed its alkaline nature, and used it to its best advantage....”

In the early part of the 19th century, numerous scientific and medical studies were conducted on the therapeutic uses of hot water. Following the initial observations of doctors Grassal, Verdier, Bremont, and Mathieux, two medical theses with similar titles (*Dissertation on the Thermal*

A total of 250 houses are heated, from 1 October to 30 April, by water from five geothermal springs through 5 km of piping



Sketch of the domestic heating system at Chaudes-Aigues in the 19th century.

Waters of Chaudes-Aigues and Dissertation on the Mineral Waters of Chaudes-Aigues) were presented on the same day, July 17, 1833, by Mr. Bonniol and Mr. Podevigne.

The water cures of Chaudes-Aigues gained new strength and became increasingly popular in the 19th century. After Felgères' hydropathic establishment, those of Clavières, Voissier, Verdier, and Fabre opened one after the other. The number of people taking the waters for a cure increased from only a few dozen in 1820 to several hundreds in the 1830s, and reached a thousand during the 1850s.

The use of the waters for cooking continued: "The poor come to prepare their meals at the spring itself. Indeed, there are no detrimental effects on health; the waters seem to be healthy for there are very few sick people in the area, the blood is good, and the young girls have a freshness and a sparkle which is rarely seen elsewhere..." (Berthier, 1810).

RECENT DEVELOPMENTS (1900-1980)

FROM THE BEGINNING OF THE PRESENT CENTURY, WATER DISTRIBUTION TECHNIQUES STABILIZED and public administrative and management conditions improved. On November 21, 1920, the Municipal Council established an annual usage fee: "The heated houses are to be divided into three categories depending on their temperature.... An [annual] fee per square meter of heated surface for each of these categories is established: 3 francs for category 1, 2.5 francs for category 2, and 2 francs for category 3. Each house will pay the fee according to the category in which it will be classified, and to the number of square meters of surface heated.... The surfaces heated will be measured in three ways: 1) for houses with M-shaped pipes, or for pipes which crisscross the house several times, the heated surface will be determined by multiplying the length of the heating pipes by the width of the heated areas; 2) for houses with A- or V-shaped pipes, the same calculation will be used, but the surface is to be reduced by one third; 3) for those houses which are crossed only once by the pipe, the calculation will be done by measuring the length of the pipe and multiplying it by 1 meter.... Furthermore, there will be a minimum charge of 10 francs per house; this means that those houses that, according to the category in which they have been placed and their heated surface, would normally pay less than 10 francs, shall nevertheless have a 10 francs fee to pay...." Although the payment system was complex, methods were introduced to help calculate the amount due by each house for the use of hot water.

The usage fee, however, did not resolve legal issues. Since the distribution system, while occasionally improved, had not substantially changed through the centuries, many disputes and lawsuits among houses and neighborhoods occurred, as the following examples illustrate:

- "The construction and maintenance of pipes were the responsibility of the users, but the lord had to supply the necessary wood. To put an end to the complaints and abuses for which this supply was a pretext only, this rule was abolished in the *terrier* of 1615 and was replaced by a reduction of rents... (Felgères, 1890).
- "In 1787, the inhabitants of the neighborhood of Saint-Joseph (below the church) sued those of a neighboring street, accusing them of retaining the hot water, mixing cold water with the water they rendered, obstructing pipes, etc. Verification was done, [but since] the pipes were intact, there had been no manipulation of the water system. The plaintiffs were then ordered to pay the law-suit costs..." (Felgères, 1890).

- “I heard the inhabitants of Chaudes-Aigues complain about the poor maintenance of pipes and distribution of water to the houses...” (Legrand d’Aussy, 1794).

The minutes of the Municipal Council of August 13, 1854, Article 5, specified, “It is expressly forbidden to have even the smallest opening for drawing water inside of the heated houses. The same quantity entering [each house] must be returned with no loss of heat other than that occurring during its passage, and this loss must not exceed 2°C....” Following development work, several neighborhoods still complained of poor distribution. The Municipal Council of February 12, 1855, therefore stated that the Council itself had “attempted to act as a good father, dividing the piece up among his children....” One can hardly be more paternalistic.

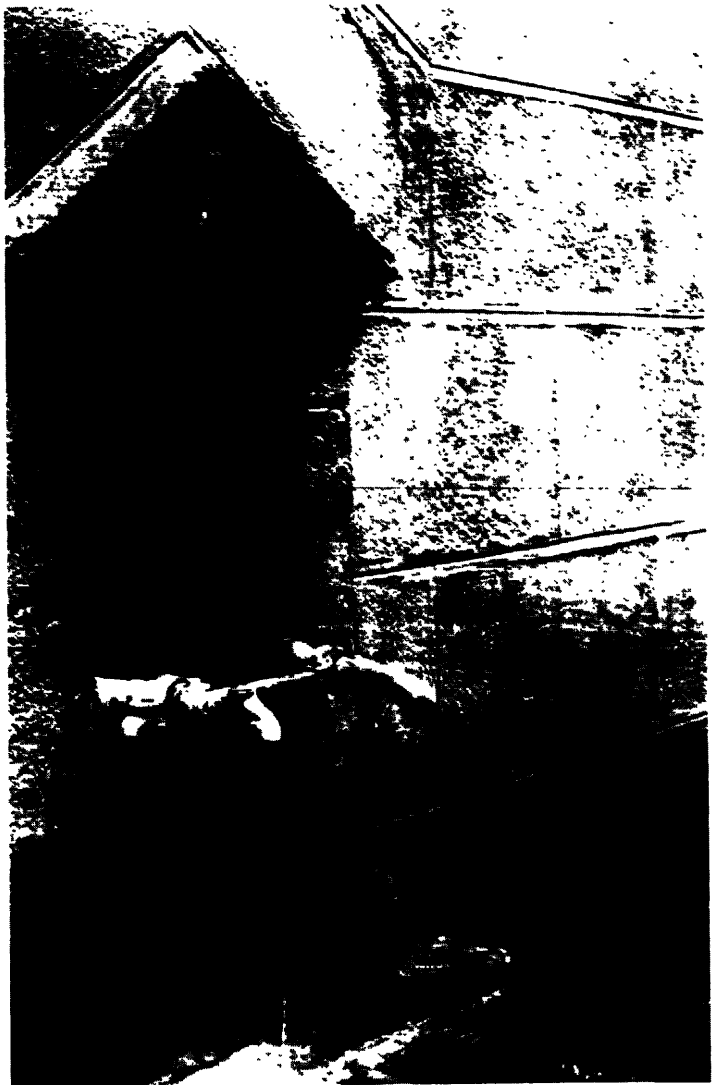
Nevertheless, the temptation of withdrawing hot water from the public pipes into private homes did not disappear. Nearly a century later, on November 21, 1920, the Council determined that “inlet gates enabling this withdrawal must be closed before February 5 of the following year....” To enable drawing of hot water into private houses or buildings for uses other than heating, the Municipal Council installed two street fountains to be used as public collection points of hot water. These old fountains still exist today, alongside five newer fountains of the same type.

Until the 1950s, the hot water flowed through pinewood pipes, hollowed out with a long auger and fitted together; the flow rate was regulated in lead basins. The disadvantage of using these pipes for collection and distribution was the rapid clogging by carbonate scaling. Streets were continually dug up to unclog and replace pipes. For this reason, between 1955 and 1960, the Municipal Council of Chaudes-Aigues decided to adopt a new collection system and improved distribution techniques.

The first technique, installing iron pipes, did not yield good results. Due to the severe climatic conditions in the area and the temperature of the hot water, the pipes rusted very rapidly from the outside. Not until PVC pipes were able to resist temperatures of about 70°C was a solution found. The whole hot water distribution network for domestic heating was modernized some 20 years ago using PVC pipes, and hand-excavated holes now allow maintenance personnel to easily reach the shallowly buried pipes and either unplug or replace them, without digging up the streets.

The first central heating system, fed by a heat exchanger, was installed in a primary school in 1957. This was followed in 1959 by a heater installed in a private home. Because this technique

allows heat to reach upstairs floors with no scaling problems, it has been used in 10 buildings since 1959. Currently, 150 homes use geothermal heating, but many individual houses are still heated by the old system. Now, as in past centuries, “the only houses without steam rooms are those located above the spring area.... Most of the houses nearest to the spring do not draw their water from the pipes, but have their own private springs for heating...” (Legrand d’Aussy, 1794).



Public geothermal fountain.

Finally, as regards ambient conditioning by natural heat, worthy of mention is the case of a homeowner who wanted to have both a cellar and a floor heating system. He built a copper basin under the ground floor of his home and covered it with a tile floor. The thermal water circulated in the copper basin, heating both the apartment rooms and, in a moderate way, the cellar.

Other notable developments follow:

- In 1902, the first hydropathic establishment, which had remained closed for many decades, was reopened by Mr. Ginisty, an inhabitant of Chaudes-Aigues.
- In 1928, a public wash house fed by a thermal spring was built.
- In 1934 a new therapeutic establishment, the *Thermes du Par*, was built and

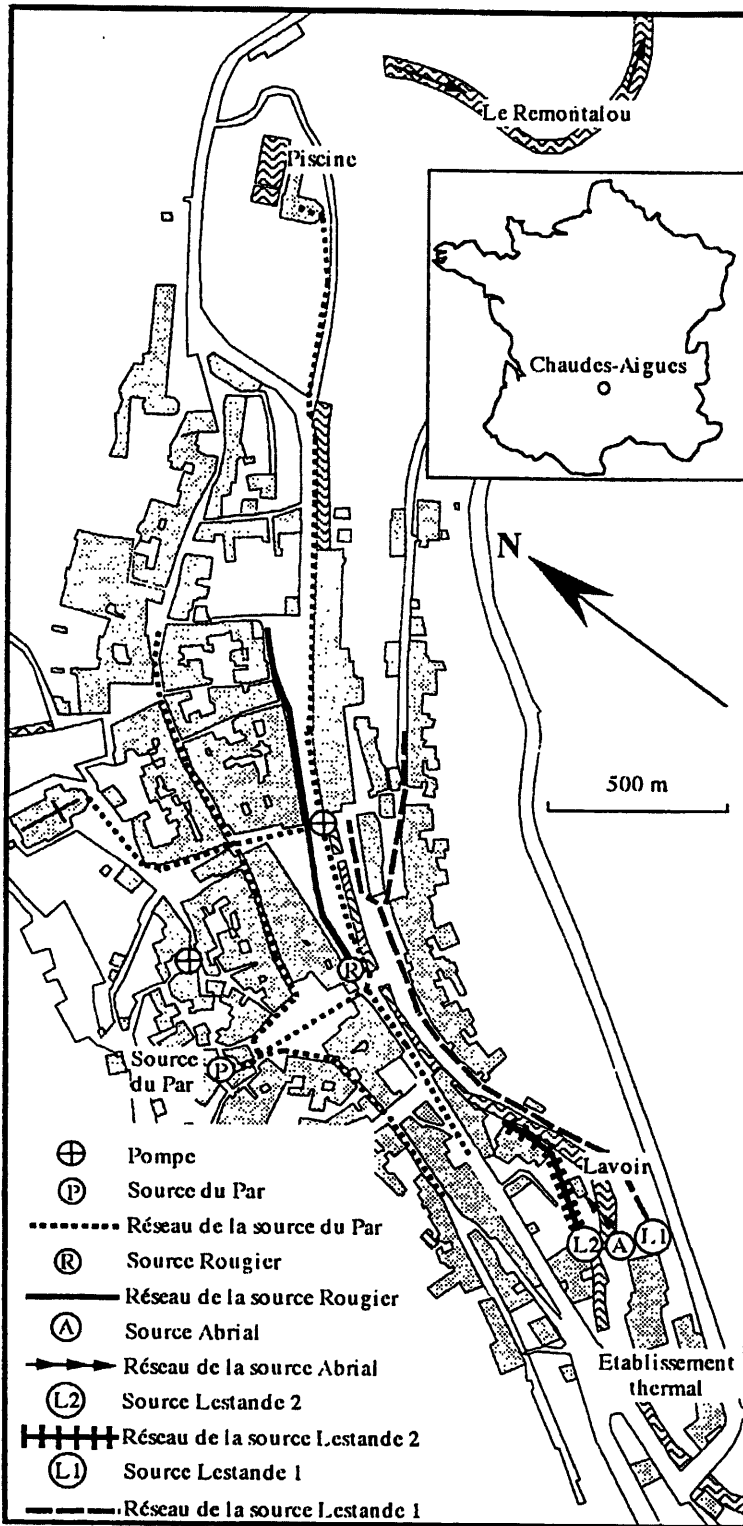


Diagram of the recent heat distribution network at Chaudes-Aigues.

immediately found a very receptive market.

- In 1964, a second therapeutic establishment replaced the first one.
- In 1964, a heat exchanger was installed and is still being used to heat a swimming pool to a temperature of 24°C.
- In 1972, a well drilled by the BRGM found 74°C water with a flow rate of about 100 liters per minute (~6 m³/h). The discovery came just in time to meet the fast growing need for hot water, for the popularity of Chaudes-Aigues spas had spread throughout Western Europe.
- The first heat pumps appeared in 1976.
- In 1978, a 20 kilowatt micropowered electrical station, using Freon as a secondary fluid, was tested successfully.



Public wash house supplied by thermal waters.

CONCLUSION

SEVERAL NEW USES OF CHAUDES-AIGUES THERMAL WATERS HAVE BEEN DEVELOPED IN THE PAST two centuries. Among the most successful projects were a greenhouse for vegetables built in the 18th century and a dry-steam room in the Felgères' establishment used to incubate eggs. The inventor of this incubation system, Mr. Darcet, was awarded a medal by the *Société d'Encouragement*.

A long history on the use of natural heat can be traced back to this little town in Auvergne. Its inhabitants gradually have learned how to distribute geothermal waters and many ways to use their physical and chemical characteristics:

- Human comfort: home heating, cooking, and laundry
- Health care: thermal balneotherapy for various maladies and hydropathic cures
- Industry and crafts: scouring wool

For all these reasons, Chaudes-Aigues was considered to be the ideal site for the Museum of Geothermics and Water Cures, inaugurated in the spring of 1993.

CITED AND SELECTED REFERENCES

- Azemard, A. 1863. *Proceedings of the Congrès Archéologique de France*, 30th session; Rodez, 2 June 1963. Rodez Imprimerie de Carrère Ainé.
- Ballainvilliers. 1765. Etat de l'Auvergne en 1765 présenté à M. de l'Averdy. In *Tablettes historiques de l'Auvergne*. Bouillet, J. B. Clermont-Ferrand.
- Banc, J. 1605. *La mémoire renouvelée des merveilles des eaux naturelles en faveur des nymphes françaises*. Pierre Sevestre, Paris.
- Berthier, J. 1810. *Journal des mines*.
- Bonnet de la Brageresse. 1782. Mémoire manuscrit sur les eaux de Chaudes-Aigues. *Mémoire de l'Académie de Médecine*.
- Bosc d'Antic. 1771. Examen des eaux thermales de Chaudes-Aigues. In *Oeuvre de M. Bosc d'Antic*.
- Bouillet, J. B. 1834. *Description historique et scientifique de la Haute Auvergne (Département du Cantal)*. Baillière, J.B., Paris.
- Chevallier, A. 1828. *Essai sur les eaux de Chaudes-Aigues, Département du Cantal, et analyse chimique des eaux thermales de cette ville*. Rapport sur un mémoire, fait au Ministère de l'Intérieur, par l'Académie Royale de Médecine. Imprimerie Royale.
- Chevallier, A. 1868. *Notice sur Chaudes-Aigues, ses eaux minérales et leurs applications*. Mémoire manuscrit.
- Clos (du). 1675. *Observations sur les eaux minérales de plusieurs provinces de France*. Académie Royale des Sciences.
- Felgères, C. 1890. *Histoire de la baronnie de Chaudes-Aigues depuis ses origines (XIe siècle) jusqu'en 1789*. Aurillac.
- Lecoq, H. 1836. *Chaudes-Aigues et ses eaux thermales*.
- Legrand d'Aussy. 1794. *Voyage fait en 1787 et 1788, dans la ci-devant Haute et Basse Auvergne*. Letter 31.
- Philander. 1545. Commentaire sur vitruve. In *Vitrusium*. Book 5, Chapt. 10.

The Authors:

Jean Pierre Gibert
2 Voie Du Wissous
21300 Massy France
Telephone: 33.1.69.82.72.46
Fax: 33.1.69.81.72.46

Florence Jaudin
BRGM
BP 6009
45060 Orléans Cedex 2
France
Telephone: 33.2.38.64.31.61
Fax: 33.2.38.64.33.33
E-mail: f.jaudin@brgm.fr



"In the presidential residence church at Bessastadir on the Alftanes Peninsula near Reykjavik there is a stained glass window, showing the incident during the voyage of St. Brendan when he and his followers witnessed a volcanic island emerging out of the ocean, most likely during a submarine eruption on the Reykjanes ridge. 'Believers in God, stand firm in faith unfeigned. We are now at hell's gates,' St. Brendan said, making the sign of the cross and praying, 'Lord Jesus Christ deliver us from this island.' The original painting on which this stained glass window is patterned is by an Icelandic painter, Finnur Jonsson (b. 1892). The boat shown here is not a leather boat (*curragh*), but a wooden hull boat, riveted together with nails. Some people believe that the Irish were also able to build that kind of wooden boat just as the Vikings did."

These tales were written down about three centuries after St. Brendan died, and as a saint he was associated with several marvelous incidents and miracles, strengthening people's faith in his powers. The account of the voyages, probably handed down by oral tradition and written down in the sagas, was in fact a composite of historical fragments from voyages by Irish monks over a period of two centuries or more. The stories are recorded in *Navigatio Sancti Brendani*, composed in Latin by an unknown Irish writer, most likely in the 9th century. To all appearances, the book contains a report on a single voyage during the years 565 to 573. *Photo and text from Iceland - A Portrait of Its Land and People, by Hjálmar R. Bárðarson, 1989. Printed with permission*
