

HISTORICAL NOTES ON THE DISCOVERY AND DEVELOPMENT OF GEOTHERMAL RESOURCE IN LARDERELLO (TUSCANY REGION, ITALY)

HISTORIA ODKRYCIA I ROZWOJU GEOTERMII W LARDERELLO (TOSKANIA, WŁOCHY)

THE DISCOVERY OF GEOTHERMAL PHENOMENA

The first exploitation of geothermal phenomena in southern Tuscany is referred to EtruscanRoman period, but other discoveries, as prehistoric handmade objects and a sepulchre of Bronze Age, demonstrate that geothermal phenomena were well known since the presence of first men in this area. Prehistoric men approached geothermal phenomena by fear and respect seeing in them the expression of underground divinity.

It is proved that Etruscan knew very well the therapeutic benefits of warm water springs: in the area there were many thermal baths whose ruins are still visible today. Romans, as their usual custom, inherited the habits of subdued population, from Etruscan (and Greeks as well) they learned to use thermal baths not only for therapeutic benefits but also as a meeting place.

In Tabula Itineraria Peutingeriana, that is a copy from 13th century of a Roman document of 3rd century a.C. (considered the 1st road map), are drawn the main thermal baths of the area and among these Aquae Populoniae and Aquas Volaternas, one of which corresponds to archeological site of Bagnone in Sasso Pisano. It is possible that the two "Aquae" were also pharmaceutical laboratories, as seems to be proved by archeological excavations in Bagnone, where many medications were prepared using geothermal fluids to supply heating for the process. In archaeological site of Roselle excavations gives evidence that at the same age of Bagnone's laboratories, geothermal hot fluids were used here for indoor environmental heating. The substances present in water were Sulphur, Nitrum Volaterranum (boric acid) used both for medicine and preparation of protective sheath for pottery and for soldering of metals. Some substances, already present in nature, were artificially prepared in laboratory,

as “Vetriolo Azzurro” or “Vetriolo from Cipro” that is a copper sulphate useful as disinfectant, and “Vetriolo Verde o Romano”, a iron sulphate useful as pesticide.

These products were traded also as “palle da cani” (balls for dogs) that were small amount of clay collected on the borders of warm springs, enriched of boric acid and sulphur, and dried, they were known all over Roman territory. Once those little balls were melted in a bowl of water, they were useful to cure skin diseases common to men and dogs, and also as beauty care mask with the addiction of olive oil, to stretch wrinkles on the face. During Middle Ages there was a reduction in communication and a technological regression that lead to decline of thermal baths and a more local use of product from geothermal water springs. People feared these phenomena again: for instance the whole valley of Larderello was called Valle del Diavolo (Evil’s valley) and the nearest village to the geothermal phenomena, Montecerboli derives its name from Latin Mons Cerberis, that means the mount where Cerbero, the three-headed dog who watches the gate of hell, lives.

However, as a mark that the activity was carried on, some agreements between the Bishop and the merchants of Volterra can be found in the town’s archives, needed to allow the use of “lumaie”, the heat sources, for exploiting heat in different processes. At the beginning of

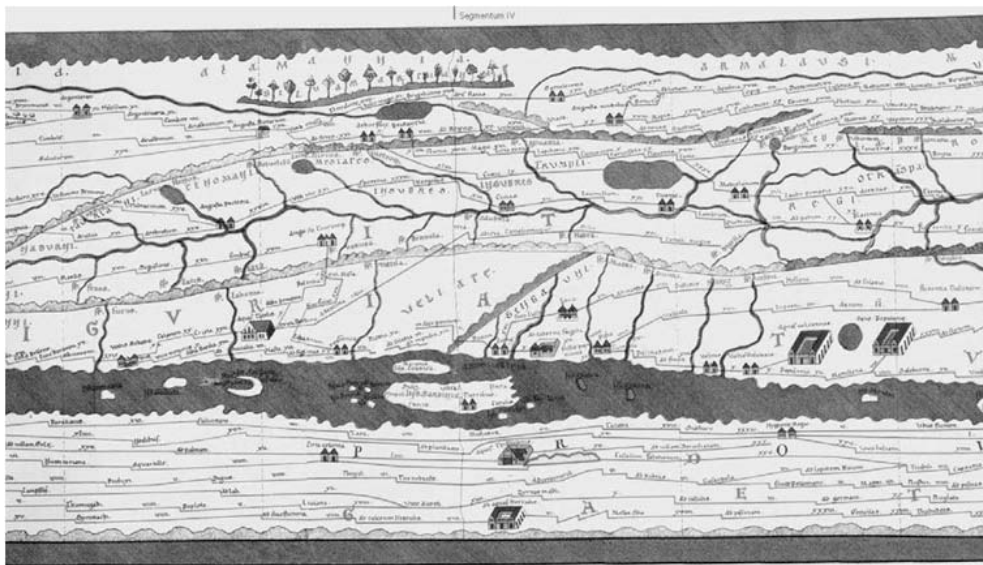


Fig. 1. The Tabula Peutingeriana is a document of 13th century that reproduces an original document from 3rd-4th century about the itineraries of the Roman Empire. It is made up of 11 sections that show all Roman settlements, mountain rivers of all the Empire. In Larderello area the document shows a many thermal baths

Rys. 1. Tabula Petingeriana – XIII-wieczny dokument będący reprodukcją dokumentu z III-IV wieku, pokazującego drogi w Cesarstwie Rzymskim. Składa się z 11 części ukazujących rozkład rzymskich osad i górskich rzek. Według tego dokumentu w rejonie Larderello znajduje się wiele kąpielisk termalnych

Renaissance geographers and doctors as Falloppio, Ugolino da Montecatini, and Girolamo Savonarola, expressed great interest for thermal baths of this area, and this therapeutic activity restarted, above all with the development of Bagni ad Morba, the favourite thermal baths of Lorenzo De Medici and his Family. Benoccio Capacci from Siena discovered the presence of Alum, essential item for processing wool in Florence's factories. Many quarries were opened in the area and two wars were fought between Florence and Volterra to control them.

18TH AN 19TH CENTURY DEVELOPMENTS

In the second half of 18th century, by the will of Granduca of Tuscany, Giovanni Targioni Tozzetti, after a thorough analysis of resources of territory, begun the first studies on the nature of Geothermal phenomena. In 1777, Uberto Francesco Hoefer, who was the manager of pharmacy of Granduca, discovered boric acid in Lagone Cerchiaio of Monterotondo and Lagone of Castelnuovo. Few years before, one of the main scientist of that age, Paolo Mascagni, from Pomarance, began to study geothermal phenomena. He visited those sites many times and he examined both waters and mud found around the big lakes. In two diaries ("Commentari") of 1779 and 1799 he confirmed the discovery of boric acid in all natural phenomena of the area and theorised about the possibility of extracting it from water using the same natural heat by burying boilers in the terrain. In 1810 he obtained a patent right for processing the borax.

Mascagni's suggestions were used in 1812 by dr. Santi Tastoni together with his company who tried to produce boric acid and borax from big lakes of Montecerboli and Monterotondo, but the company was terminated in few years. In 1815 a second company improved the production process and exported 3555 kg of boric acid to France between 1817 and 1818. In the same year, Pomarance Municipality let the big lakes to a group of French businessmen, who created a company called "Ved. Chemin Prat, Lamotte, Larderel e Comp". The company set up many factories in Montecerboli, Monterotondo, Castelnuovo and Lustignano that at the beginning had a great production up to 50 tons of boric acid per year, but later came up against almost insurmountable problems. The extraction of boric acid from geothermal water needed a large amount of heat that was supplied by wood. When the level of production increased the surrounding woods were not enough and became necessary buying more wood from other areas. Moreover the Granducato (the main local authority) set higher taxes and the initiative almost failed. By common decision the company was terminated in 1827, and the young De Larderel bought it all by himself.

The new idea of De Larderel was an improvement of Mascagni's theory: he proposed to use the geothermal heat piping the steam of natural emissions. He invented a cover for big lakes ("laghi coperti") and a system to pipe steam through insulated pipes towards boilers. At the same time he thought about using natural steam as driving force and how to find it by drilling. In 1836 the famous French chemist Payen advised Larderel against drilling activity because he had been struck by the result of small wells few meters deep.

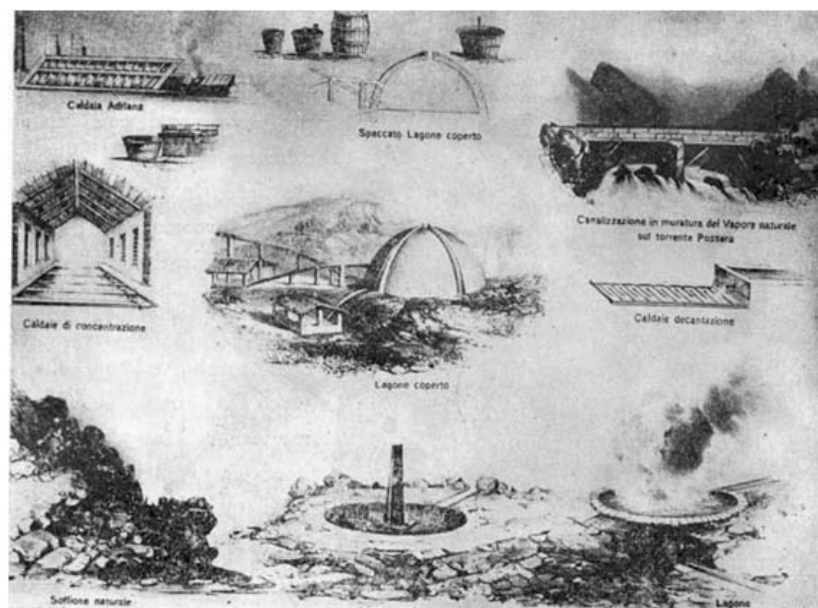


Fig. 2. The picture shows “lagoni coperti” (covered big lakes of geothermal hot fluids) and the most important devices of early borax production. At the bottom of the picture are shown the main natural phenomena, in the centre the Lagone coperto, and at sides different kind of boilers and pipelines

Rys. 2. Fotografia przedstawia „lagoni coperti” (przykryte kopułą duże jeziora z solanką geotermalną) oraz urządzenia służące do produkcji boraksu. U dołu ryciny przedstawiono głównie naturalne zjawiska geotermalne

DE LARDEREL INNOVATIONS

Only after 1840, when perforation technology had been experimented for years by other engineers, Francesco Larderel came back in this activity. After 1850 the method was innovated by the use of raised worktop, winch supplied by natural steam, and other technologies that few years later were adopted in petroleum drilling. The invention of Caldaia Adriana, that allowed a faster collecting of boron, lead to an increasing of production. In 1850 the Factory of Boric Acid (“Fabbrica dell’Acido Borico”) was made up of 9 buildings in an area of 300 m² with 108 employees, but thanks to satellite industries there were many more people employed by that factory. De Larderel received the title of Conte di Montecerboli and the right to name by his own name the area where the 1st factory was borne, that he called Larderello. In Larderello a General Regulation of work was established in 1849, to protect workers and their families as a kind of welfare state. Every worker received health care and a pension when he wasn’t able to work anymore. Sons were sent to school and had the opportunity to inherit the father’s job. If the worker died at work widows were employed

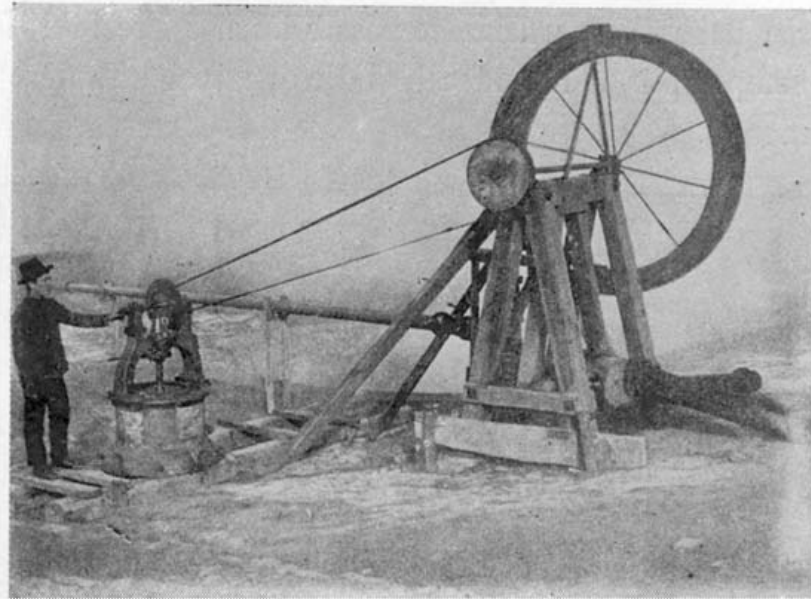


Fig. 3. De Larderel was the 1st who studied the use of geothermal steam as driving force around 1836. But at his time the technology of drilling wasn't ready for this purpose. By the end of 19th century, thanks to the care of Prince Piero Ginori Conti the technology to use geothermal steam as driving force was fully developed

Rys. 3. W 1836 roku De Larderel jako pierwszy badał wykorzystanie pary geotermalnej jako siły napędowej. Jednakże w ówczesnych czasach technika wiercenia nie była jeszcze przygotowana do realizacji tego rodzaju prac. Dopiero pod koniec XIX wieku, dzięki wsparciu Księcia Piero Ginori Conti technologia wykorzystania pary geotermalnej jako siły napędowej została w pełni rozwinięta

in the factory. Someone defined those measures as a romantic paternalism, but this contract had a big value at that time.

By the end of 19th century, thanks to innovations due to the care of Prince Piero Ginori Conti, son-in-law of Florestano De Larderel, chemical production was diversified in different products as boric talc, the use of steam as driving force was strengthened and some civil buildings were heated by geothermal energy. The 4th July 1904 were switched on the first bulbs using natural steam to activate a piston engine connected to a dynamo. This was the beginning of electricity production by geothermal energy, defined as geothermal electricity. In 1906 and 1908 two piston engines were installed in the first electrical power station to supply electricity to factories and civil buildings. In 1912 all small companies that produced boric acid were grouped together in "Società boracifera di Larderello" and the first Tosi-Ganz turbine of 250 kWp with indirect production cycle was installed.

After the 1st World War a Geological Office was created to do geophysical test bore in order to allow a better development of drilling activity. This led to a great increase in steam production, many other power station were built in the area increasing the electricity power up to 12150 kWp and boric acid production to 4800 tons/year.

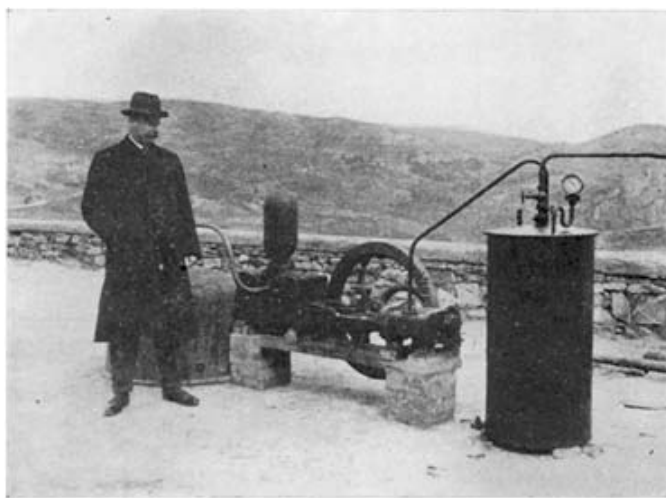


Fig. 4. In 1904, the Prince Piero Ginori Conti switched on the first bulbs using geothermal energy. This event set the birth of geothermal electricity

Rys. 4. W 1904 roku Książę Piero Ginori Conti po raz pierwszy zaświecił żarówkę wykorzystując do tego energię geotermalną. Wydarzenie to uznawane jest za narodziny energii elektrycznej wytworzonej z geotermii

In 1939 was built the big power station of Larderello 2, also with indirect production cycle, made up of 6 groups of 10 MW. In 1943 the company Larderello SpA was created and



Fig. 5. During the 70s, due to oil crisis, the production of geothermal energy was increased and the 5th January 1972 the Travale well n. 22 started its production

Rys. 5. W latach 70-tych XX wieku ze względu na kryzys paliwowy, zanotowano wzrost produkcji energii geotermalnej. 5 stycznia 1972 r. rozpoczął swoją produkcję otwór Travale -22

other power stations were activated leading to an electricity power of 132 MWp and 6500 ton of boric acid per year.

In 1950 there were 6 power stations and 211 MWp installed, in 1957 started the 1st drilling on Monte Amiata, leading to a new power station in Bagnone two years later.

In 1963, when Enel bought Larderello SpA, there were 11 power stations and 311 MWp of power installed.

To face the oil crisis of the 70s there was a new push on geothermal energy by drilling wells even more deep and by enlarging geothermal sites. The reinjection of fluids was started at first to obey to new local laws then to reactivate no more productive wells. Thanks to years of experiments and chemical checks to study a process to refuel the reservoir and regenerate the geothermal resource, scientific bases to define geothermal energy as renewable source were created. Today there are 33 power plants with a total power installed of 882,5 MWp and an energy production of more than 5 billion kWh per year.

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