

ADAPTED FROM

OUR GEOTHERMAL LEGACY: A HISTORIC OVERVIEW, BY

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Views from down under-geothermal in perspective.

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Stellar origin of a thermal planet



Our Universe was born 15 billion years ago from a great explosion. Space dilated and billions of galaxies formed.

Each Galaxy contained billions of stars...









Stellar origin of a thermal planet



In one of those galaxies the Sun and the Earth were born 5 billion years ago. The Sun's immense corona was the energy source that fueled our corner of the Universe, the Earth also was a gigantic furnace. It was so hot that nothing could settle on it...



Stellar origin of a thermal planet



There was no water on the Earth's surface cast forth by continuous volcanic eruptions. Dense clouds of methane, ammonia and carbon dioxide covered the Earth for millions of years. Slowly the Earth cooled, but it was a desert: no animals, no plants, no life and no blue sky... its atmosphere contained no oxygen...



Geothermal origin of life



The original poisonous envelope cooled down, a new atmosphere developed, dominated by hydrogen H2 and carbon dioxide CO2. These atoms eventually rearranged themselves and joined together to form water vapor, oxygen and carbon [H2O + C + O2]. Suddenly, the first water drop and then the first rain came. Boiling hot water poured down for millions of years and so the oceans were formed.









Geothermal origin of life





Water was held to the Earth's surface as solid, liquid and gas. Water crept into each crack, filled up every empty space and the process of life began – all species evolving from chemosynthetic bacteria, carbon, heat and water.

It was in water that life began almost four billion years ago. Life could start in the oceans dark depths where sulfurous springs bubbled up, heated by the Earth's magma.

Geothermal origin of life



The first living beings were bacteria. They drew their energy from a chemosynthetic reaction [conversion of CO2 + nutrients into organic matter], H2S was the energy source. Oxygen was still a rare gas and a danger to living things. Expelled into the air, slowly it altered the atmosphere's character and its properties.

Evolution did not always proceed smoothly.There were several massive extinctions due most often to climate change. 530 and 250 million years ago about 80% of all the existing species died off. It is estimated that about 99% of all species that ever lived on Earth at different times, have disappeared.



Volcanism & migration – fluctuations of populations



Volcanism and migration fluctuations of populations occurred since prehistory.Volcanic activity determined alternate emigration- immigration fluctuations of ancient populations on Earth.

The East African Rift Valley was the cradle of humanity.









Volcanism & migration – fluctuations of populations



Humanity has always lived in a volcanic planet. Geothermal events affected mankind in several forms. It was a close relationship between humans, territory and volcanoes. Many "geothermal cultures" were influenced in their material and spiritual development.

For example, The Mesoamerican Area was very rich in active geothermal manifestations.There are many evidences that the civilization development in several Mesoamerican areas has been strongly conditioned by the occurrence of geothermal phenomena. Various human settlements occurred close to volcanoes.





WGC 2015, International Geothermal Association



The "Year Zero" of Geothermics



The Year Zero represents the cultural base of geothermal energy worldwide, mostly in Eastern Africa, the Mediterranean and the Mesoamerican areas, cradle of the world's most ancient civilizations. From the Late Neolithic geothermal development emerged from the darkness of the time into the dawn of the Metal Age and the light of the learned history.



Examples of what humans could observed & experienced between 3.6 My and 8000 years ago.



ne "Year Zero" of Geothermics



Functional rapport, including:

[*] : First contacts with geothermal phenomena and manifestations;

(A) : bathing in natural thermal waters and early use of volcanic stones ;

(B) : cooking food in very hot waters; and

(C) : initial therapeutic applications (fangotherapy, drying sores, heal and

tonify skin], refined use of volcanic stones (obsidian and other igneous rocks)

Thermal balneology



Thermal balneology was known in Asia Minor, South Europe and North Africa to Sumerians, Babylonians, Assyrians, Phoenicians, Hittites, Cretans, Miceneans, Illyrians, Macedonians, Egyptians, Numidians, Sicans, Etruscans, and Venetics.

During the peak period, thermal stations in Greece and in areas of Anatolia and peri-Mediterranean, included over 300 spas. The most famous were Epidauros, Aedipsos and Pergamon.



Tholos of St. Calogero (Lipari, Sicily) Bronze Age - 1600 B.C. Entrance of the tholos, used as sudatorium.



Pond of the tholos, probably used as a thermal pool.





Romans had no interest for thermal cures during the first centuries of their story. Their attitude changed radically by the III Century BC, when they assimilate all good habits of Etruscans, and understood the physical benefits and psychological reliefs owed to thermal baths.

Heating by hypocausts, conceived in Greece and elaborated in the I Century BC by the Roman architect Caius Sergius Orata for natural and artificial hot sources was named Orata's hypocaust system and was used in Roman thermal spas:

1) Heating room (fed by natural hot source or boiler);

2) opening in the wall to let steam passing from the heating room into the spa;

3) basement;

4) hypocausts;

5) alveolated channels to let hot air warm walls and adjoning rooms

Thermal balneology

Thermal spas spread over all Roman territories from the I Century BC. to the IV Century AD. Over 2000 spas were then operated in the Roman dominions, of which 1000 in the capital only. On the map you can see the location of the main spas fed by natural heat at the height of the Roman Empire [III Century AD].



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In the Roman territories, most public thermal spas represented a kind of a"club" with the following functions:

IN ALL SPAS

- Balneotherapy [bathing, sauna, fangotherapy];
- Esthetics [massage, shaving, combing, depilation, skin cure and toning, etc.];
- Wrestling, body-building, training exercises, etc.;
- Restaurants [formal and fast food];
- Information centres;
- Public and private meetings (political, cultural, business, etc.);
- Social events, resort and entertainments. IN SPAS ONLY WITH NATURAL HOT WATER
- Cult centres;
- Athletic games and other large sport events;
- Popular festivals;
- Regional and local markets.

Thermal balneology



Thermal cures in organized stations were practiced in that period mostly by elite and rich people: kings and queens, princes, popes and high-rank clergymen, powerful public officers, poets and writers. Many of them became sponsors of their favourite spa .

In important towns under the Muslim rule, thermal practice remained alive during the Early Middle Ages, and were improved. The most important localities for thermal bathing were: Instanbul, Budapest and Gerona.





The birth of geothermal technology



F. Larderel, was the most ingenious entrepreneur of the boric industry. He came on stage in 1818, monopolizing the exploitation of all hydrothermal manifestations of the Boraciferous region. Boric acid obtained by him and his sons using technological innovations: 36 tonnes (1818); 50 (1820); 125 (1829); 650 (1842); 1000 (1850), and 2000 (1860).

In addition to the boric compounds from the Larderello region, other by-products were harnessed later in Greece, Italy and Turkey: pure boric acid, ammonium carbonate and sulfate, borax, carbonic acid, talcum powder, sodium, alum, yellow sulfur, iron oxides, pozzolana, bentonite and travertine.

The birth of geothermal technology





Prince Piero Conti conceived the idea to harness the natural steam to produce electric energy at the end of the XXIV Century. The technical feasibility of the idea started in 1903. Since then, the geothermalelectric industry in the Boraciferous region developed by steps:

- 1904, first experiment of electric production. Five lamps of 5 watts each were lighted;
- *1913, first commercial power plant in the world [250 KWe capacity, fed by pure steam, to let boric acid be produced from natural steam;*
- 1916, two turboalternators of 3.5 MWe each installed at Larderello, indirect thermodynamic cycle to enable boric acid be extracted from the natural fluid produced.

The birth of geothermal technology



1923, 1st turbine [23 KWe] fed by natural steam, installed at Serrazzano;

1926-27, two turbines [600 & 800 kWe] were installed at Castelnuovo;

• 1930, a 3.5 MWe turboalternator was installed at Larderello. By Dec. 1930, the total installed capacity in the Boraciferous region was 11.9 MWe;

1939, 1st large power plant [Larderello 2], 6 units of 11 MWe each [ind. Cycle];

1940-43, 4 x 11 MWe units (ind. Cycle) at Castelnuovo, and 3 units (dir. Cycle) at Serrazzano and Sasso Pisano), for a total of 12 MWe. In December 1943, total installed capacity in the Boraciferous region was 123.9 MWe.



First exhausting-to-atmosphere geothermal turbine (direct cycle, 23 kWe). After two years of successful operation, it was moved to a technical school at Larderello to train personnel. This small unit was the only plant saved from destruction of all production wells and power plants occurred at Larderello during the 2nd world war in summer 1944.



Surprising similarities of geothermal uses developed at different places, in different times by different cultures;

Conclusions

The relationship between mankind and geothermal energy is rooted in prehistory. It probably started two million years ago in Africa, hundreds of thousands of years ago in the Mediterranean Area, and dozens of thousands of years ago in Mesoamerica;

The cosmic meanings of both water and heat have been universally recognized as signs of life. Cults devoted to all kind of waters, including thermal springs and geysers, are part of many ancient traditions;

• In different epochs, in diverse societies, thermal bathing became a daily practice of people of different social class and ethnic groups;

Now some of their descendants are developing and using SPAs, space heating/cooling and agricultural geothermal programs, while others are commercializing its by-products or building greenhouses and electrical power generation plants.



Geothermal energy has its roots into the prehistory of Earth. Today it represents a great energy source to meet our future needs.