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Geothermal Energy—Network of Geoplutonic Power Plants

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Abstract: The article presents the concept of a network of geoplutonic power plants, the total capacity of which would correspond to the general energy needs of the entire region. A scenario of a regional economy is presented, provided with electricity produced from a clean source, without pollutant emissions. Thus, a vision of solving the energy crisis resulting from the planned elimination of fossil energy sources is presented. Such an opportunity appeared after solving the technological problems of deep drilling, exceeding 10 km. The new technology involves extracting heat from HDRs (Hot Dry Rocks) and heating the fluid circulating in a pipe in a closed circuit. The temperature at a depth of 10 km is determined by the regional geothermal gradient. Temperature is in the range of 200-400 ℃. This is already a zone of degassing magmatic solutions and exothermic chemical reactions. In general, it can be argued that the heat flux density is a function of the distance from magmatic intrusions.

Key words: Plutonic energy, geothermal energy, renewable energy sources.

1. Introduction

In the Earth's climate system, geothermal energy is not a competitive source of heat in relation to solar energy. The effective energy of solar radiation is 341 W/m^2 and the average heat density of the Earth is only 0.092 W/m^2. Treating these numbers as unchanging quantities is a mistake. The phenomenon of Earth's heat should be treated as a variable state in the process of Earth's evolution [1-4]. Geothermalism is a development phenomenon that began relatively recently, 200 million years ago, together with the expansion of the globe. Studies on the evolution of the Earth lead to the conclusion that geothermalism is an expression of the evolution of the globe and the geothermal gradient is a function of the distance from the magmatic intrusion. With this approach to the problem, the fight against global warming resembles the noble attitude of the knight of La Mancha. A more real motivation to tackle renewable energy sources is the energy crisis. Technological progress has led to the emergence of various methods and installations for the management of renewable energy sources.

Among the renewable energy sources: solar, wind, biomass and geothermal energy, plutonic energy deserves special attention, being a component of geothermal energy and distinguished by its orientation to deep subsoil, close to magmatic phenomena. To characterize the subject of the research, an analogy of the energy source at a depth of 10 km with the thermal conditions in the Icelandic volcanism zone can be used. Geoplutonic energy is a special field of geothermal energy, which has its source in the Earth's core. According to the theory of primal forces of nature, the enthalpy of the entire system and the ionization of matter increase with the increase in the mass of the globe, and the product of this spontaneous process is hot plasma [4]. Periodic plasma eruptions are the cause of the formation of basaltic magma and intrusions igneous. Thermal phenomena tend to increase. The adopted geotectonic theory, which also takes into account the cosmological aspect, negates the views on the iron-nickel core of the Earth, which explain the existence of geothermal phenomena with the phenomenon of "relict heat" [3, 5]. Wikipedia says that

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in 2019, the installed capacity of geothermal energy was 118.8 GW. To the greatest beneficiaries of geothermal energy are countries with active volcanism, hydrothermal springs and geysers. In order of installed capacity potential, these are: USA, Indonesia, Philippines, Turkey, New Zealand, Mexico, Italy, Kenya, Iceland, Japan.

- In colder areas, geoplutonic energy is an opportunity to use such a rich source of heat. Such an opportunity appeared after mastering the technology of directional drilling to a depth of 10 km. There is a need to formulate energy policy assumptions, the aim of which will be to search for optimal solutions. Each solution has its advantages and disadvantages. Until recently, I thought that nuclear energy was the optimal solution, information about plutonium energy changed my view. The choice of geothermal, plutonic energy was based on the following arguments:
- Clean technology, no impact on the environment;
- Guaranteed achievement of the production target (temperature > 200 ℃);
- Constant availability of a heat source;
- Flexible investment schedule.

2. Economic Aspects of Geothermal Energy

The importance of geothermal energy was repeatedly emphasized in the seminar discussions. In 2016, Bohdan Żakiewicz, an oil drilling expert and constructor of deep directional drilling, was invited to the seminar of the National Fund for Environmental Protection and Water Management. During the discussion, it was stated that the issue of optimal use of geothermal resources is becoming extremely topical and prospective from the point of view of the country's energy security. Chairman of the Polish Geothermal Association, Prof. J. Zimny, stressed the importance of geothermal energy for self-sufficiency and energy security. In the drawing (Fig. 2), the geoplutonic plant project by B. Żakiewicz [6]. The technology assumes the extraction of heat from hot rocks, at a depth of 10 km, without contact with the external environment. The object consists of a bundle of directional holes radiating from a single point. According to economic analyses, plutonic energy is more advantageous than coal and nuclear energy. Consiliari Partners ensures the construction of a single geoplutonic power plant within a few months. Geoplutonic energy is a relatively simple and reliable technology, with no surprises. One of the most important advantages of geothermal energy is its constant availability, as it is a renewable energy source, independent of weather conditions. Unlike energy sources such as nuclear or fossil fuels, geothermal energy does not emit any pollutants. The technology uses a hot fluid that returns in the same pipe as the cold one. As a result, the risk of breaking the hydraulic system is eliminated and the technology can be used even in earthquake-prone regions. This technology uses working fluids that are a much more thermally efficient alternative to water. Thermal energy is constantly available and renewable. It is an environmentally friendly and sustainable, pollution-free alternative to fossil fuels and nuclear energy (Fig. 1).

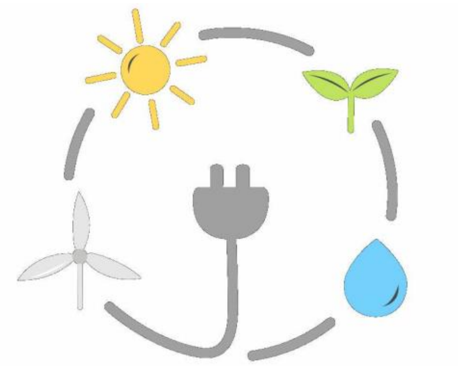


Fig. 1 Renewable energy sources: wind, sun, biomass, hot water.

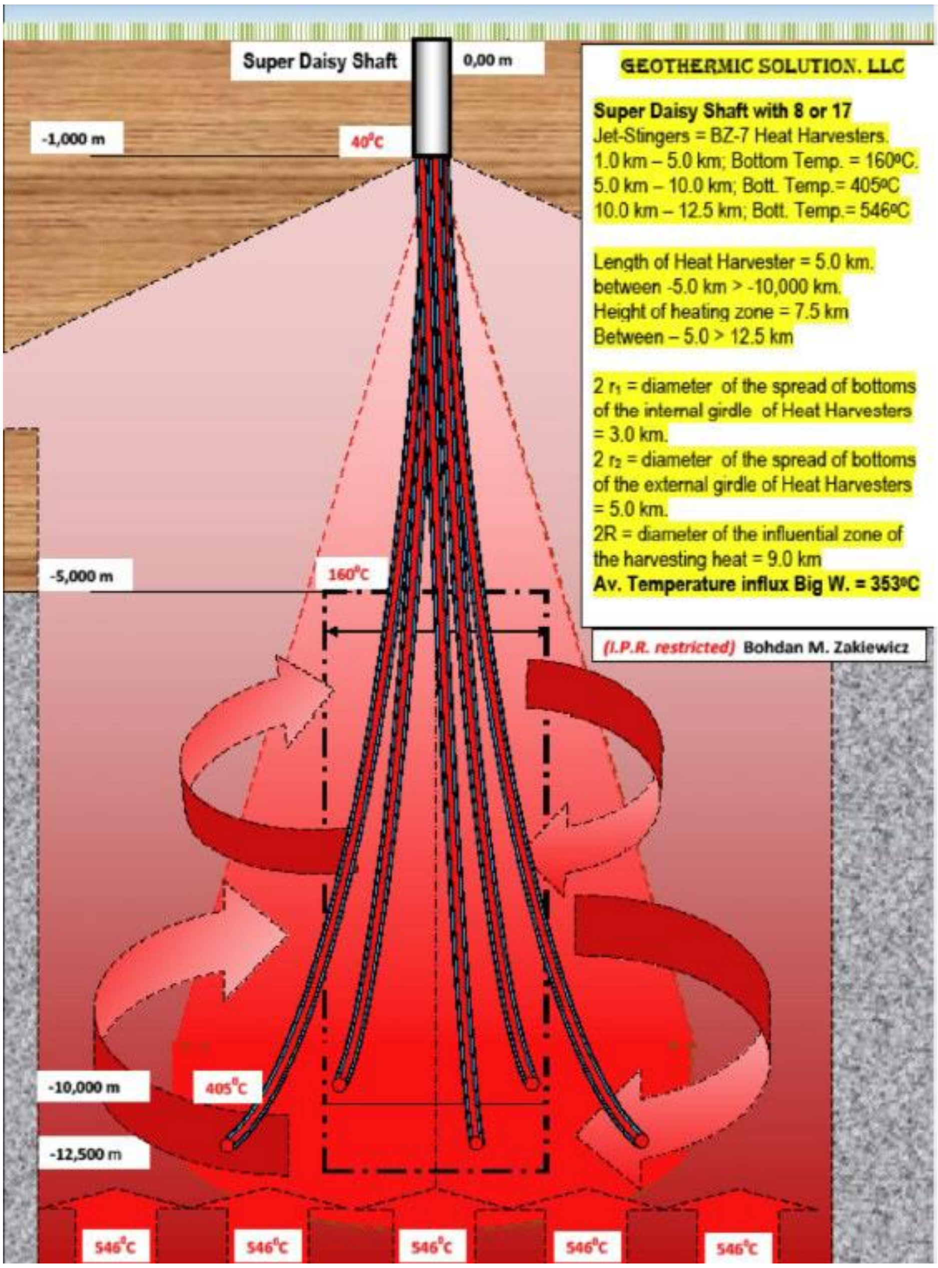


Fig. 2 Construction of the undergroud part of the geoplutonic power plant [6].

The importance of energy from renewable sources, especially geothermal energy, was the subject of discussion at the Seminar of the Faculty of Oil and Gas Mining, University of Science and Technology (AGH), Kraków [7, 8]. In the inaugural paper, Prof. Jan Ziaja, stated, quote: "The energy crisis in the world, and in particular in Europe, is an undeniable fact" [9]. The gallopingly rising prices of standard energy carriers, i.e. coal, crude oil and natural gas, prompt the intensification of the search for alternative energy sources. One of the ways to obtain energy are ground (borehole) heat exchangers. This technology has been developing dynamically for many years. Both vertical borehole heat exchangers and horizontal ones are known [9, 11]. Geothermal energy is gaining in importance because it is cost-effective, reliable, sustainable and environmentally friendly. This is directly related to the heat coming from the Earth.

3. Earth's Heat Source

Physics defines heat as energy that spontaneously passes from a hotter to a cooler body. The heat flow is called thermal energy flow. Heat can only be transferred from the system to the environment when there is a temperature difference between the system and the environment. The flow of energy takes place under the influence of differences in the temperature of bodies and always runs from a body with a higher temperature to a body with a lower temperature. The parameter for evaluating the energy potential of the system is enthalpy (Fig. 3).

The process of Earth's evolution is characterized by a steady increase in global energy potential (enthalpy), which is a function of the globe's mass, gravitational pressure, cosmic ray energy, and heat from the decay of natural radioactive elements [4]. In the process of structural changes of matter, ionization forces and nuclear forces are revealed. The effect of the processes thermal, post-magmatic, is visible in the geothermal profile (Fig. 4).

According to the laws of thermodynamics, the temperature increases as we approach a heat source. The maximum temperature is in the very center of the globe, so that is where the Earth's heat source is. The evolutionary sequence begins with the accretion of cold galactic matter and the formation of clusters of matter from cold asteroids, through rocky globes with a warming core and hot gas giants to neutron stars. Evolutionary changes occur under the action of the same forces of nature.

The phenomenon explaining the transformation of a rocky planet into a gas giant is the concentration of hydrogen, coming from the degassing of magma, in the Earth's exosphere [1]. As the amount of magma produced increases, hydrogen atoms, which are more than 90% present in fresh magma, form the outer hydrogen zone of the atmosphere.

During the 4.6 billion years of the Earth's existence, the structure of matter has changed under the influence of acting forces, and the heat of the globe appeared as a result of endothermic geological processes. For the first billion years, the Earth was a cold globe with no

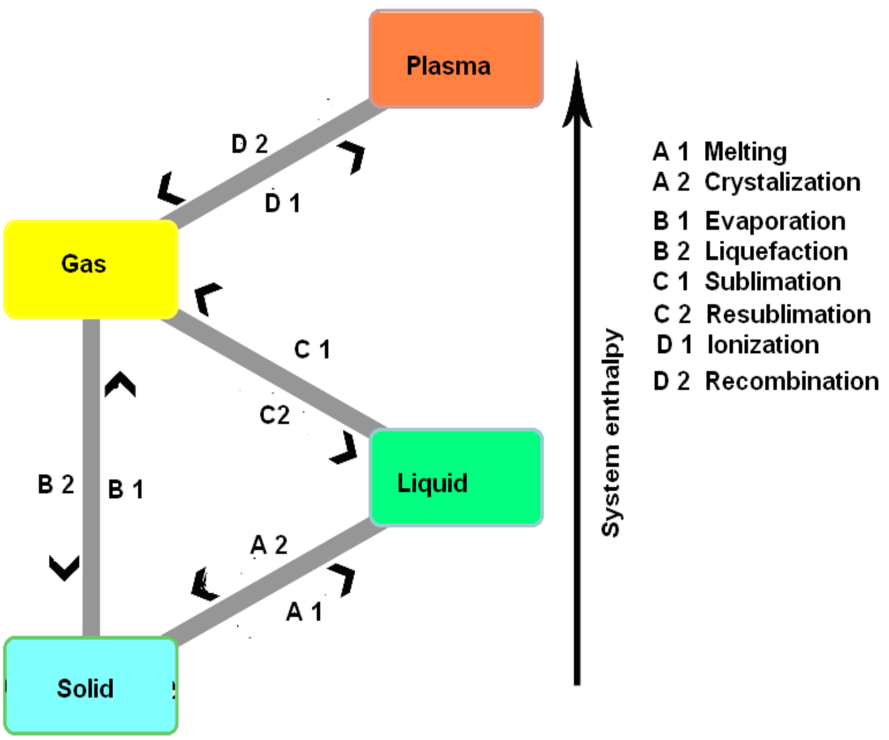


Fig. 3 The relationship between the structure of matter and the energy potential of the system (enthalpy).

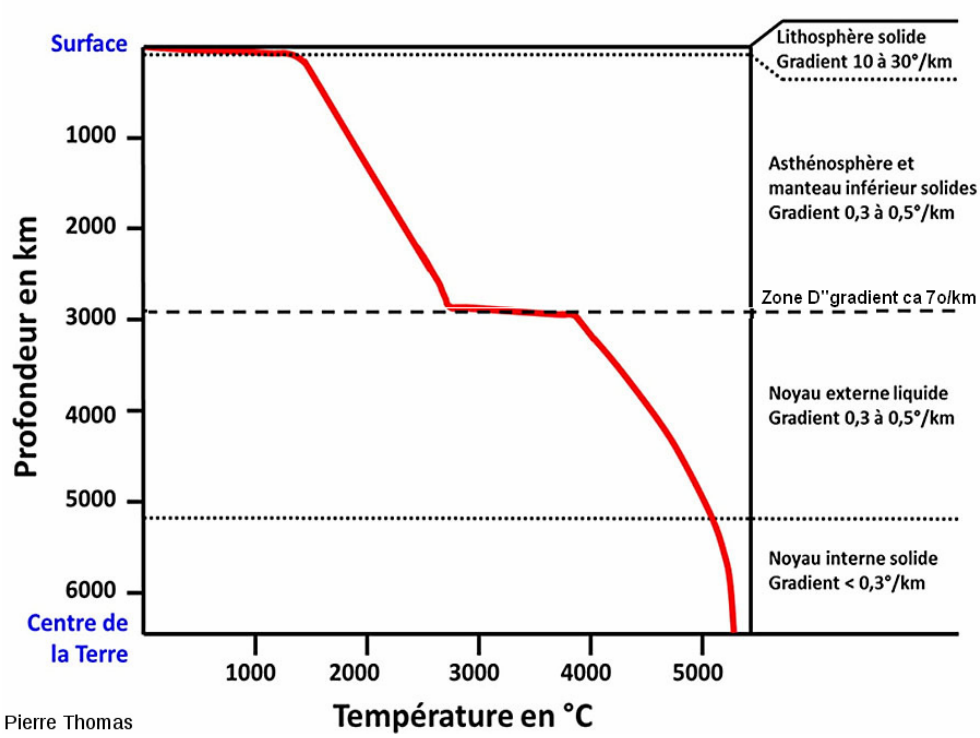


Fig. 4 Geothermal profile of the Earth. [planet-terre.ens-lyon.fr.]

atmosphere or seismic activity. Traces of paleomagnetism and primitive bacterial forms, dated to 3.8 Gy, indicate the beginning of thermal processes in the Earth's core. The increase in the mass of the globe causes a constant increase in gravitational pressure as potential energy, and then an increase in kinetic energy, temperature. The constant increase in the enthalpy of the globes and the spontaneous formation of the hot core result from the loopback paradox. The increase in the mass of the globe increases the force of gravity, and therefore increases the mass of the globe, including the stars.

The spontaneity of the geothermal process consists in a constant increase in the mass of the globe, the density of matter and temperature. The result is an increase in enthalpy. 3.8 bilion year BP, a layer of low-temperature plasma formed, which caused structural changes in matter and the generation of an electromagnetic field.

Around 4 bilion year BP, a magnetic field appeared, which proves that there was an ionization of matter and the formation of a plasma in the center of the globe. Determining The next phase was the local initiation of thermonuclear reactions. For billions of years, this was a state of latent activity in the Earth's core, when the plasma pressure was less than the gravitational pressure and magnetic field strength. The beginning of the plasma eruption into the [D"]\zone occurred around 500 million years ago as the plasma pressure overcame gravity and the first global rifts formed. The expansion of the globe, manifested by a tenfold increase in volume without increasing the mass of the globe, accelerated by 200 million years ago (Fig. 5).

After reaching a state of high plasma pressure in the reactor chamber, there is a phenomenon of irregular eruptions of hot plasma, outside the nucleus, into the D zone. The recombination process is the reverse of the ionization process. Orbital electrons are completed and elements are formed.

According to the ionic composition of the hot plasma, basaltic magma is formed, which is an alloy of all elements from atomic number 1 to 92.

The addition of an electron to a proton causes the volume of the resulting hydrogen atom to increase. A proton with a diameter of 0.000017 Å, after capturing an electron, forms a hydrogen atom with a diameter of 1.1 Å, which increases the diameter of the particle 64,705 times (Fig. 6). The volume of particles of matter increases millions of times. The resulting rock mass stresses are so great that they cause the uplift of the Earth's mantle, the formation of fissures, magmatic intrusions and volcanic eruptions. Gaseous hydrogen rapidly evolves in the pneumatolite phase from post-magic solutions and reacts with elemental carbon and its oxides to form methane and juvenile water.

In the temperature range of 400-600 ℃, the magma is degassed. Due to the fact that hydrogen constitutes 90% of the elemental composition of the magma in the recombination process, the degassing effect is felt in the ground as strong seismic tremors. In the period of 200 million years, the volume of the Earth's globe has increased tenfold: it has increased from 9.2E+10 km^3

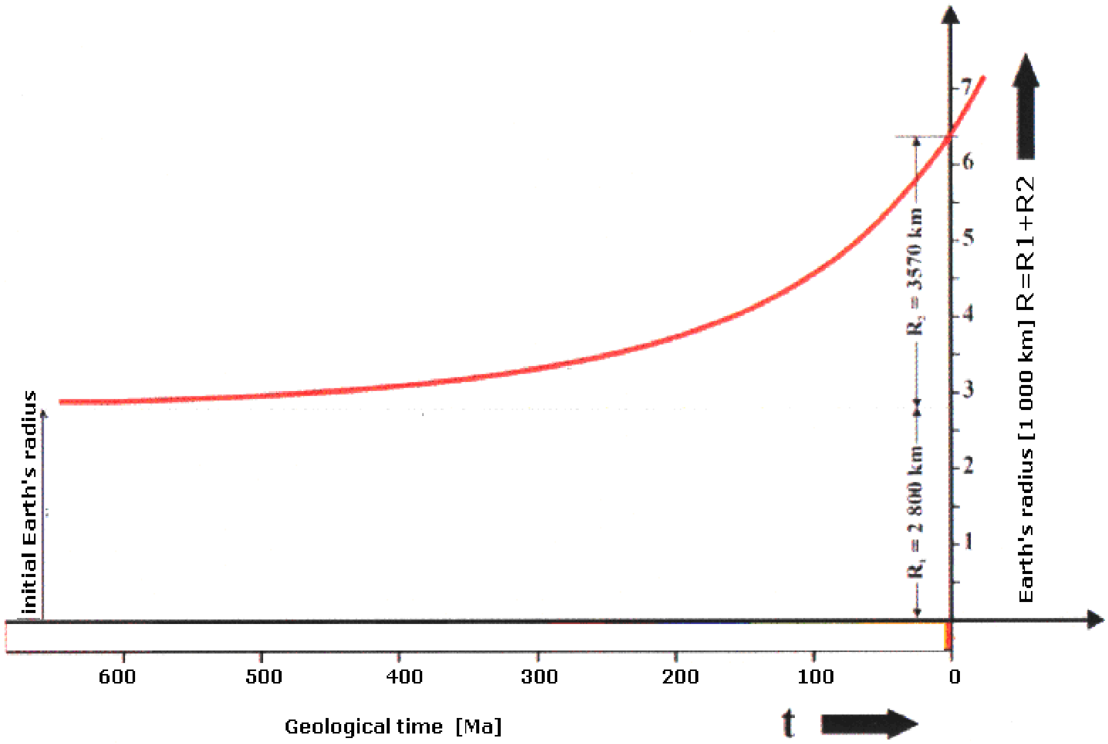


Fig. 5 Growth curve of the radius of the expanding Earth (red. Jan Koziar).

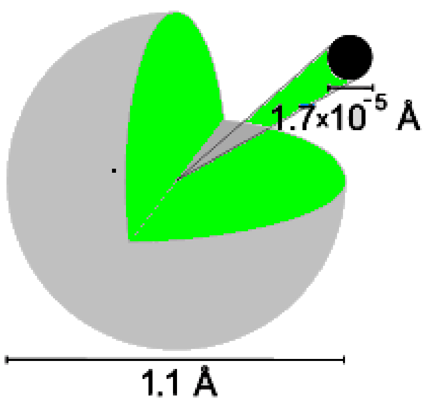


Fig. 6 Dimensions of the hydrogen atom and its nucleus—the proton.

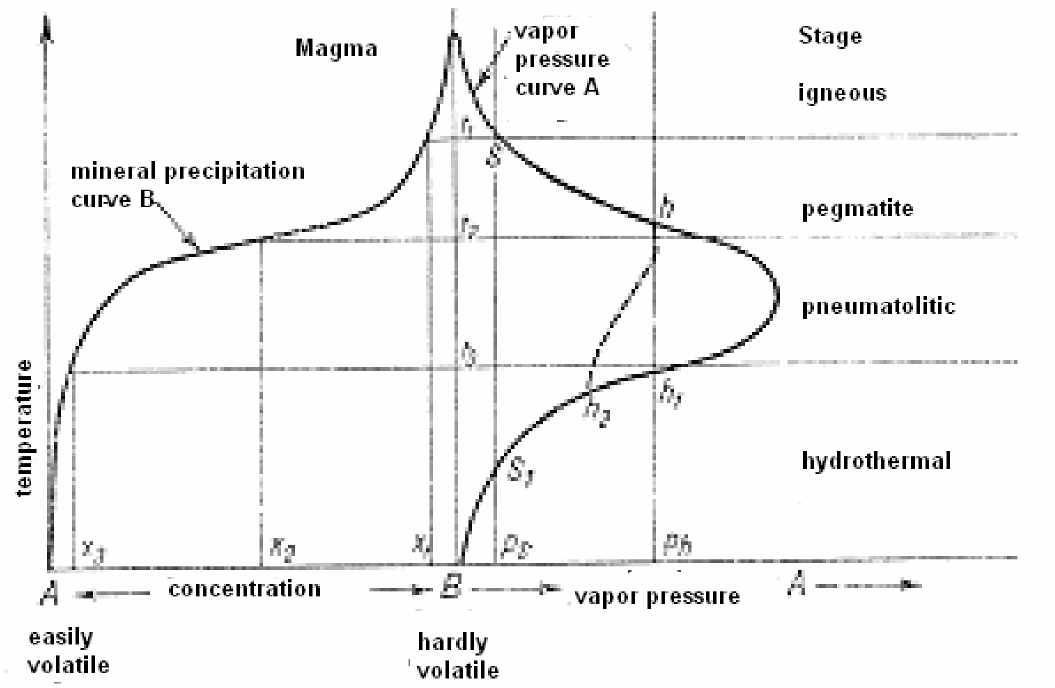


Fig. 7 Niggli's post-magmatic stages.

(Earth radius $R1$ = 2,800 km) to the current 1.08E+12 km^3 (Earth radius $R2$ = 6,373 km). Thus, there was an increase in the volume of the globe by 9.88E+11 km^3 and this is the volume of basalt magma that was produced in the process of plasma recombination. Ocean plates, formed by basaltic magma, cover more than 70% of the globe's surface.

The increase in enthalpy corresponds to the formation of a low-temperature liquid spot and then, using the electromagnetic properties of this plasma, the formation of a hot plasma. In thermonuclear reactions taking place in the Earth's core, the product is hot plasma with a temperature of up to 8,000 ℃ and a density of up to 16 g/cm^3. Under plasma overpressure conditions, plasma erections to zone D" occur, where exothermic reactions of plasma recombination take place. Generally, the source of heat is the hot plasma of the fusion reactor in the Earth's core, which in the process of recombination transforms into magma. In zone D" the temperature of the magma decreases by a thousand degrees (2,700-3,700 ℃). The effect of structural changes is basaltic magma and chemical reactions between the newly formed elements. Then compounds such as carbon oxides, water, methane are formed [5].

The dominant component of the forming magma is hydrogen, which is released from the hot melt at a temperature below 600 ℃ (Fig. 7). In the case of a volcanic outflow, the degassing of the basaltic magma occurs at the surface and the hydrogen gas accumulates in the exosphere. An additional source of heat is the reactions of igneous gases:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{energy}$$

4. Geothermal Technologies

In current practice, the following geothermal technologies are most often used (Fig. 8):

- Low-temperature geothermal heat pump
- Medium temperature geothermal energy thermal water
- Excited geothermal systems

In the first case, it is a heat pump that extracts heat using two liquid circuits with a heat exchanger. The installation has the advantage that it is a source of renewable energy, without pollution. Installation of low power, intended for individual recipients. The heat pump uses low-temperature geothermal energy accumulated in the ground and underground waters, and then transfers the heat energy (the temperature of the medium is raised to approx. +60 ℃) to the central heating and hot water systems.

The second type of installation concerns thermal water intakes, usually to a depth of 3 km, brines with high mineralization and significant radioactivity [5].

The mineral composition of the brine in Piekary, at a depth of 2,900 m, is dominated by sodium, calcium and magnesium chlorides. The temperature exceeds 100 ℃.

The radioactivity of the brine was found:

- Radon Rn-222 49.1 Bq/dm^3
- Gamma activity 229.9 Bq/dm^3
- Beta activity 332.8 Bq/dm^3

This level of radioactivity in thermal waters is the norm. Extensive research has shown that in geothermal stations, in the atmospheric air, the radon concentration index Rn-222 depends on the amount of brine drawn and is about 11 Bq/MW.

In this model of the inode of the hydrothermal station to a depth of 3 km, apart from the problems with radioactivity and limited water resources, there is one more drawback, i.e. too low temperature for power generation generating electricity and the need to inject brine into the deposit. A water temperature of over 175 ℃ is required for the power plant.

An example of problem solving is Geothermal Soultz in France (Fig. 9).

After reconstruction and drilling to a depth of 5 km, the geothermal station entered the zone of HDR (Hot Dry Rocks). This is the reaction zone of light elements, coming from the degassing of the magma. Soultz geothermal is located in the area with the above ground temperature. The map shows the temperature at a depth of 5 km (Fig. 10).

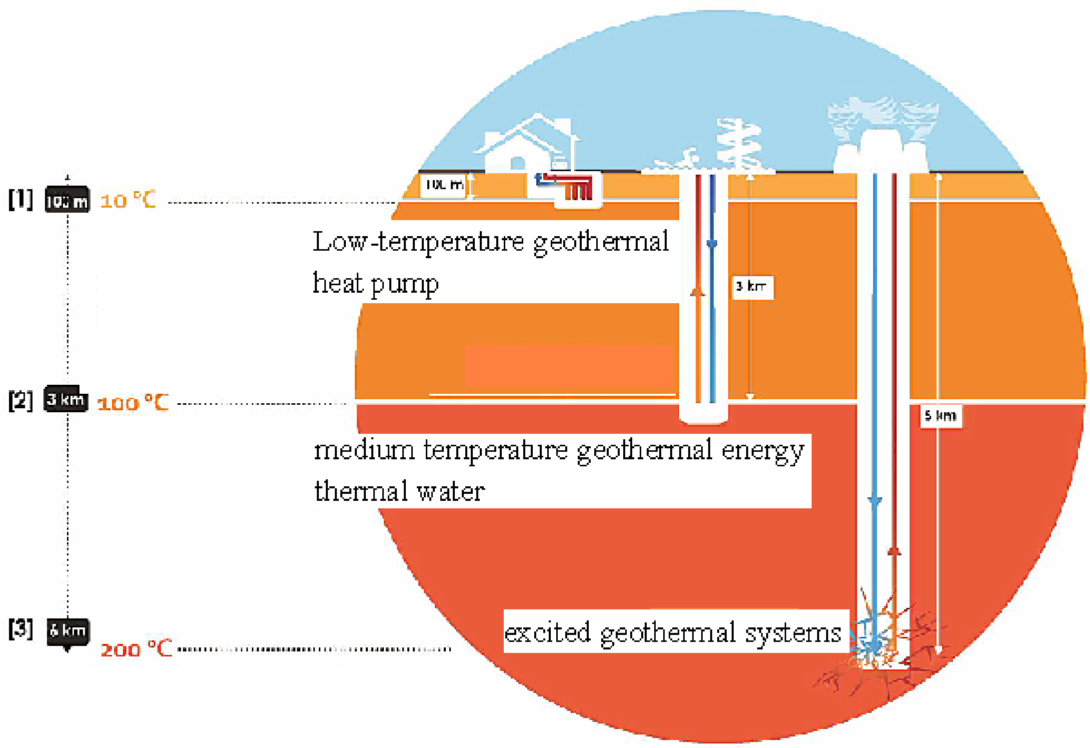


Fig. 8 Geothermal systems (PGI (Polish Geological Institute) Warszawa, Gąsiewicz with team) [10].

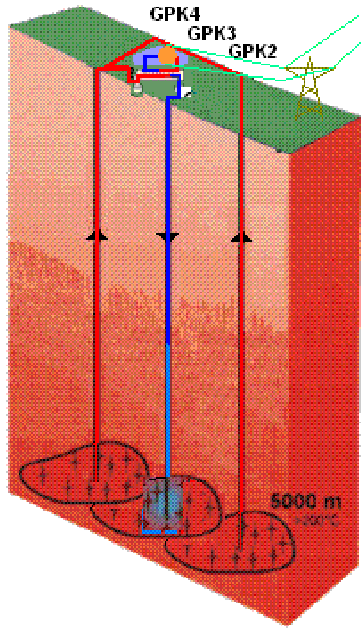


Fig. 9 Geothermal Soultz (France).

Level	1 (1989-1997)	II (1997-)
Reservoir depth	3,500 m	5,000 m
Temperature	168 ℃	202 ℃
Power plant type	Binary Cycle Power	Flash Steam Power Plant

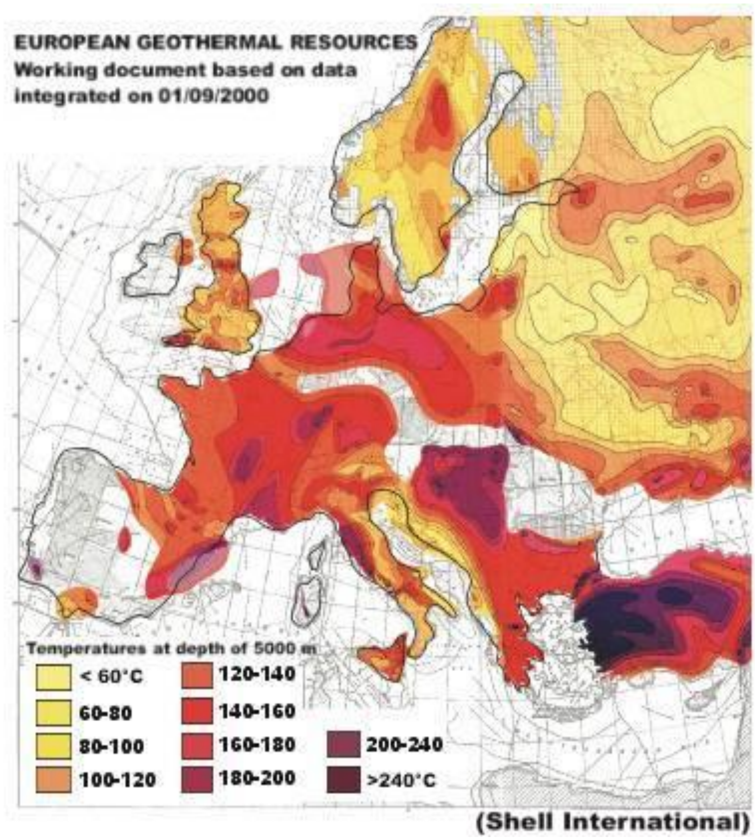


Fig. 10 European geothermal resources.

In the absence of water in the rocks, following the methodology of using hot water, separate holes were made to pump cold water into the deposit and other holes to take in heated water. In order to improve the permeability of the rocks, procedures interfering with the environment were performed, including rock crushing using the explosive method. These treatments caused earthquakes, felt on the surface of the land.

Temperature measurements taken in boreholes show that the geothermal gradient is a linear function in the depth range of 30 m-10 km and probably remains the same up to a depth of 30 km. The determined gradients are in the range of 20-40 K/km (Fig. 11).

With an average geothermal gradient of 30 K/km, the temperature of the rocks at a depth of 10 km is 300 ℃.

The plutonic power plant technology, using a medium with a temperature of over 200 ℃, does not have such negative features, it was developed and patented by an expert in the field of oil drilling, Prof. Bohdan

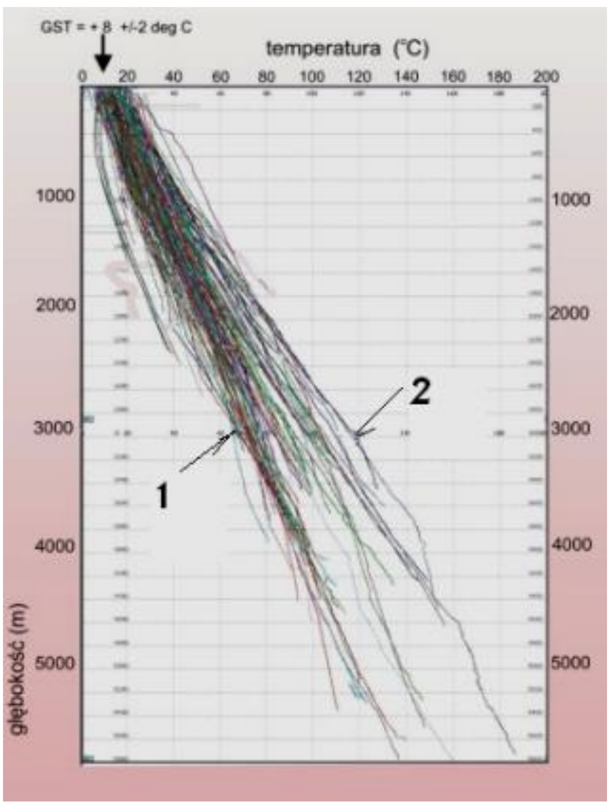


Fig. 11 Geothermal gradient.
(1) 23 ℃/km; (2) 40 ℃/km.

Fig. 12 Oklahoma Geothermal (photo: Wikipedia).

Żakiewicz [6]; from Consiliori Partners, who is the expert of Geo Plutonic Power Supply Chain) (Fig. 12). The originality and advantage of this technology lies in the use of a heat pump in the center of geoplutonic power plants. Clean thermal energy is taken from a renewable source, without any negative impact on the environment. Drilling platforms are adapted for drilling to a depth of 10 km. In the zone of great depths, the source of heat is guaranteed. The advantages of plutonium energy include its constant availability, as it is a renewable energy source independent of weather conditions. At a depth of 10 km, heat is available practically anywhere in the world, which means that it is possible to build a deep-water GPP plant anywhere.

As part of the Geo Plutonic Power Generation program, several GPP facilities were made:

- Oklahoma, more than 10 km deep;
- Qatar, depth 12.3 km, completion time 35 days;
- Sakhalin, depth 12.3 km, completion time 60 days.

Contrary to nuclear energy, which requires longer preparations and is a complicated and risky undertaking, geoplutonic energy is a relatively simple technology.

RTC (Renewable Thermal Collaborative) serves as the leading coalition for organizations that are committed to increasing renewable heating and cooling at their facilities and dramatically reducing carbon emissions.

Based on data from existing deep-water power plants, the cost per kWh of electricity produced is less expensive than any other electricity generation technology available today. Deep thermal power plants have a high efficiency factor [6].

5. The Concept of a Regional Network of Geoplutonic Power Plants

According to data from 2019, in Poland, the installed capacity from all energy sources was 47.5 GW, including the share of hard coal and lignite was 70%, renewable energy sources 20%, natural gas 5.7% and other sources 4.3%.

The idea of solving the climate problem and the energy crisis is to build an GPPgeo-plutonium power plant in each poviat. Comparing the energy demand with the capacity of a single GPP plant shows the need to build about 500 facilities. ((Fig. 13).

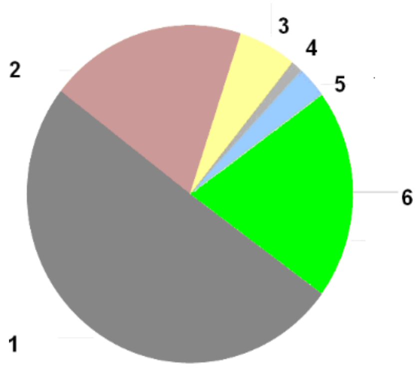
Costs of building the national network of geoplonic power plants, fully covering the energy needs:

- Total power demand of: 50 GW
- Number of 100 MW stations: 500 stations
- Unit cost of 1 MW: $4 million
- Overall cost of the network: $200 billion

Geoplutonic power plants GPP are a renewable source of energy independent of external conditions. Deep water power plants have comparable investment costs to nuclear power plants, they do not have the problem of radioactive contamination of the environment and the disposal of radioactive waste, which should be taken into account in the comparative analysis. According to data from existing deep-water power plants, the cost of electricity produced is comparable to or lower than electricity generated in other technologies.

Fig. 13 Administrative division of the country.

	2019 data		Forecast	
Energy source	Power (GW)	%	Power (GW)	%
1. hard coal	23.9	50.4		
2. lignite	9.3	19.6		
3. natural gas	2.7	5.7		
4. other industrial elements	0.6	1.2		
5. peak-pump	1.4	3.0		
6. renewable energy sources	9.5	20.1	47.5	100



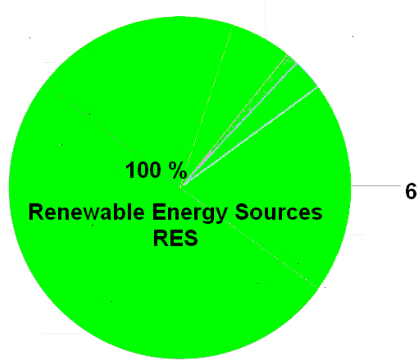


Fig. Sources of energy in Poland

As of 2019 Forecast

Fig. 14 Share of energy sources in the national economy (Poland).

- The cost of building a 100 MW deep-water CHP plant is USD 400 million, i.e. USD 4 million for 1 MW.
- The cost of a 1,600 MW nuclear power plant is EUR 7.5 billion, i.e. EUR 4.69 million for 1 MW.
- Geothermal energy is independent of weather conditions, does not emit pollutants, so it solves the problem of radioactive waste and CO_2 standards. Resignation from conventional energy sources will make actions against climate change unjustified and will eliminate the energy crisis.

At a depth of 10 km, heat is available virtually anywhere in the world, which means that geoplutonic power plants can be built throughout the region, creating a national power grid. Contrary to nuclear energy, which requires longer preparations and is a complicated and risky undertaking, geoplutonic energy is a relatively simple technology.

One of the advantages of geothermal energy is its constant availability, as it is a renewable energy source independent of weather conditions. At a depth of 10 km, heat is available practically anywhere in the world, which means that it is possible to build a deep-water GPP plant anywhere. One of the advantages of geothermal energy is its constant availability, as it is a renewable energy source independent of weather conditions. At a depth of 10 km, heat is available practically anywhere in the world, which means that it is possible to build a deep-water GPP plant anywhere. In any case, economic criteria should be taken into account [11].

6. Conclusions

The concept of creating a network of geoplutonic power plants is a hypothetical model of an energy system that meets the conditions of sustainable development, without anthropo pressure. The assumptions of the model assume full coverage of energy needs from renewable energy sources.

The concept of a network of geoplutonic power plants is a response to the energy crisis, limited supplies and high prices of natural gas, as well as exclusion from the use of fossil fuels. The emergence of several different technologies in the field of renewable energy sources requires comparative analyses in order to select the optimal solutions. Each of these technologies has its advantages and disadvantages. Geoplutonic power generation is close to perfect, without flaws. The limitation in its use resulted from technical difficulties in drilling deep, over 10 km, and conflicting views on the source of the Earth’s heat.

The phenomenon of geothermalism has been the subject of several publications in which it has been shown that geothermalism is an expression of the evolution of the globe and the heat of the earth in the lithosphere is a function of the distance from the magmatic intrusion. With regard to the drilling technique, it seems that the difficulties with deep directional drilling have been overcome and the costs of drilling work have been made realistic. The best proof of the advantages of geoplutonic energy is the power plant in Oklahoma, which has been operating for over 50 years.

Preliminary analysis of investment costs indicates that investing USD 200 billion in geoplutonic energy can fully cover the energy needs of a large region. The cost of building the infrastructure of the geoplutonic power plant network as well as the cost of electricity production in the plutonic technology is lower than in other technologies. A network of geoplutonic power plants can replace all other energy sources and ensure energy self-sufficiency of the region.

The advantage of the concept is the flexibility of the implementation of the investment plan. The construction of each facility, which takes several months, is a separate investment that does not require any special arrangements. The preparation of a geological project is a standard formality in this case. The exceptions are areas threatened by a high reservoir pressure gradient. An example is the zone of tectonic faults near Poznań, where the reservoir pressure gradient is 2.25 atm/10 m.

The cost of the investment is:

- 30 MW plant: USD 162 million
- 100 MW plant: USD 400 million

The dispersion of the CHP plant makes it possible to resign from high-voltage transmission lines and thus to reduce transmission losses. The underground location of the heat pump provides natural protection for the installation.

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