DIRECT USE OF GROUND HEAT FOR SPECE HEATING AND COOLING, IN THE LOW ENTHALPY GEOTHERMAL ENERGY AREAS PRESENT A CONTRIBUTION IN COUNTRY ENERGY SYSTEM

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ABSTRACT

In the paper a detailed analyze of the shallow ground heat resources in Albania, in particularly in Korça city, and ways for direct use of this energy concretely for heating in Albania is presented. Direct use of the ground heat by Borehole heat Exchanger-Geothermal Heat Pump for space heating and cooling, was programmed to develop in Albania.

Keywords: Geothermal energy, space heating, geothermal heat pumps, direct use, heat flow,.

1. INTRODUCTION

Large numbers of geothermal energy of high and low enthalpy resources, a lot of mineral water sources represent the base for successfully application of modern technologies in Albania, to achieve economic effectively. There are many thermal springs and wells. Their water has temperatures that reach values of up to 65.5°C.

At present, the thermal waters of some springs and wells are used only for health purposes.

The geothermal situation of low enthalpy in Albania offers three directions for the exploitation of geothermal energy (Frasheri et al. 2003):

Firstly, space heating and cooling

Secondly, integrated and cascade use of geothermal waters energy

Thirdly, greenhouses and aquaculture installations.

Direct use of the environmental friendly geothermal energy must be realized by integrated scheme of geothermal energy-heat pumps and solar energy, and cascade use of this energy.

The most important direction is space heating and cooling. The Earth Heat can be use for space heating and cooling by modern systems Borehole Heat Exchanger-Geothermal Heat Pumps.

In the paper is presented a detailed analyse of the shallow ground heat resources in Albania, in particularly in Korça city, and ways for direct use of this energy concretely for heating in Albania.

2. PRESENTATION OF THE PROBLEM

The energy crisis prevailing in the Albania, the increased demand in energy for heating and cooling of premises, the gradual implementation of European standards of premises' heating, are all decisive factors raising the awareness in order to contribute in finding optimal solutions to this critical situation. Actually, the electric energy consummation for heating is 1 375 GWh/year, or 23.8 % of the total electric energy production in Albania (Fig. 1) (National Agency of Energy, Tirana, 2003). The situation becomes more problematic because the use of natural gas for heating emits large quantities of CO_2 in the atmosphere.

In the developed countries such as the Member States of the European Union, in the United States, Japan etc., particular attention is given to the use of renewable energies, among them the geothermal energy (Lund. J.W., et al. 2005, Rybach L., et al, 2005). The Earth's heat is a great source of energy, renewable and friendly to the environment. Direct use of the ground heat by Borehole heat Exchanger-Geothermal Heat Pump represents a modern system for space heating and cooling (Lund J.W., et al. 2005, Rybach L., et al. 2000, 2004).

Alike elsewhere in the world, in Albania the subsurface ground layers contain heat. This energy can be successfully exploited in heating the public premises (offices, hospitals, libraries, theatres, airports etc.) as well as private premises (houses and apartment buildings), using the modern systems of Borehole-Heat Exchanger-Geothermal Heat Pumps.

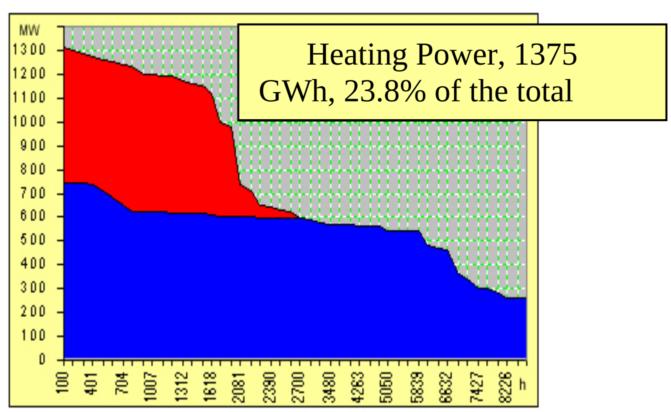

Fig. 1. Yearly electric energy consumption without and with space heating, for 1999 y. (National Agency of Energy).

Two types of shallow heat sources exist: ground heat and underground waters heat. Consequently two kind of technology is possible to applied:

Firstly, ground-source and Borehole heat Exchanger-Geothermal Heat Pump or ground-couplet (closed loop),

Secondly: underground water system – Geothermal Heat Pump (open loop).

Ground coupling is used where insufficient well water is available or where quality of the well water is a problem. Multiple Heat Exchangers are installed in large public premises.

Actually, in Albania have set up only first four installations of geothermal heat pumps systems. In order to develop direct use of this renewable geothermal energy and environmental friendly ground heat for space heating and cooling in Albania, we have introduced the idea of building a demonstrative installation for heating and cooling purposes of the important public building in Tirana and in other Albanian cities, ex. University Campus, Hospital, Secondary School, etc. (Frasheri et al. 2003, Frashëri A. 2008, Frashëri A. et. al. 2008). It will be of great professional satisfaction if this proposal will find application. It will contribute in solving the problematic issue of heating and cooling of premises in Albania.

The implementation of this project contributes in raising the awareness of the public administration, of the business and scientific communities, to make use of this economically optimal solution for heating and cooling of premises. The public administration should introduce the necessary tools and incentives for enabling the entering into the market of such modern and environmentally friendly systems. The business community should have in consideration and invest in installation of these Borehole-Heat Exchanger-Geothermal Heat Pumps, making way for new businesses. The universities should teach about these modern systems and insists on their applicability.

3. A WORLDWIDE EXPERIENCE

In 26 European countries and United States there are installed 570 000 installations BHE-HP, with a power of 12 KW each, for heating and cooling of houses, but also there are thousands installations with a power of up to 500-1500 KW for heating of institutions and of apartment buildings (Lund J. W., et al. 2005, Rybach L., et al. 2005). In Germany there are 50 000 installations. Switzerland is a typical example with 21 000 installations, with a pump power from 19-40 KW, which exploits the heat of nearsurface earth layers with a temperature of 10oC. In Switzerland, in 1980 the production of geothermal energy by these systems was 70 GWh, in 1999 it is increased up to 365 GWh. Japan (Japan Times, Jan. 21, 2003), using the geothermal energy of subsurface ground layers saves up to 40% of the total energy. The expenses necessary to carry out this project will be paid within 10 years. Two thirds of the building costs, valued up to 10 million yen for the government and local authorities support each installation.

Ground-couplet systems have been used in Northern Europe for many years. Actually, these modern systems in use, highly effective and with low consume of electric energy, technologically advanced and environmental friendly, are gaining huge popularity (Rybach L. et al, 2000).

Borehole-Heat Exchanger-Geothermal Heat Pump systems are developed even though has a construction cost 30-40 % higher than the conventional heating by gas. There are several reasons for this:

Economical considerations. Actually, the cost of installing the Borehole-Heat Exchanger-Geothermal Heat Pump is higher than the conventional fuel installations. Nonetheless, the annual cost of "fuel" of the Borehole-Heat Exchanger-Geothermal Heat Pump (Electric energy for the heat pump and circulating pump) are considerably lower than the fuel of the conventional heating by gas. ***For the coefficient of performance 3, is saved up to 66% of the electrical energy.*** Consequently, the payback of the Borehole-Heat Exchanger-Geothermal Heat Pump system is shorter than the durability of using the other heating system.

Environmental considerations. Borehole-Heat Exchanger-Geothermal Heat Pump is an environmental system that does not emits CO2 ("greenhouse effect"), therefore the proprietor avoid paying the tax on emittance of CO2 gas, which is under discussion in the countries of the European Community.

Governmental support. The Japanese government has invested 200 USD for every kW of the Pump of Geothermal Energy, with an upper limit of 5 200 USD.

4. GROUND GEOTHERMAL ENERGY RESOURCES IN ALBANIA

Heat quantity, temperature at Earth surface, and geothermal gradient in shallow geological section, are conditioned by geographical location, geomorphological conditions (Earth surface dip and position in relation by Sun), ground and bedrocks lithology, specific heat and humidity, season and weather. According to the multy annual meteorological surveys result that in average is 140,000 calory.cm^{-2} heat from solar radiation of the ground during the summer at the plane areas of the Albania. Heat quantity reaches 120,000 calory.cm^{-2} at northeaster mountains regions [Gjoka L., 1990].

Thermal field distribution and geothermal gradient values in the ground at shallow geological section are conditioned that at the depth 100m the temperatures reaches from 16oC up to 18.8^{o}C at plane areas in the Ionian tectonic zone and in Peri Adriatic Depression (Fig. 2). The areas with a temperature between 18 °C and 19 °C are located at Kolonjë-Divjakë-Kryevidh, Vlorë and Sarandë-Delvinë zones (Frashëri A., et al. 2004, 2008).

There are some particularities in the distribution of the temperature at the depth 100m:

Temperature in subsurface ground at littoral area:

Minimal temperature is 16.60 ^{O}C

Maximal temperature is 18.80 ^{O}C

Average temperature is 17.80 ºC

Temperature in subsurface ground at western plane-hilly area:
Minimal temperature is 17.15 ºC
Maximal Temperature is 18.41 ºC
Average Temperature is 18.0 ºC

Temperature in subsurface ground at hilly-mountains regions:
Minimal temperature is 6.70 ºC
Maximal temperature is 18.60 ºC
Average temperature is 14.75 ºC

In plane area of Albania, example in the Tirana field (Rinasi), the temperature is 15.5 °C, up to logging depth 31 m, in the Quaternary deposits (Fig. 3) (Frashëri et al. 2003). According to the well-known data, the layers at the depth from 0-8-10 m have a temperature, which is conditioned by solar radiation energy. During the winter, the temperature is lower than during the summer. Below, the ground temperature is constant during the year, because don't have the influence from solar radiation. Depth limit of the solar radiation influence zone is not unique. Lateral changes up to 0.5 °C are observed in the 500m distances, for the same time. These lateral changes are conditioned by lithology of the Quaternary loose deposits. The belt of the constant temperature continues up to the depth 50 m in the mountain regions of the Albania.

According to the analyse of the geothermal regime of the shallow geological section is concluded that is possible to use the ground heat for the space heating and cooling, applied modern Borehole Heat exchanger – geothermal Heat Pump.

Ground geothermal energy has heated the underground water reservoir (Fig. 3,4). In Tirana underground water basin are following temperatures:

Water temperature of the Quaternary gravel layer is 14-15 °C,

Water temperature of the Quaternary sandstone layers is 15-16°C

Consequently, concluded that water of the Tirana underground basin can be a heat source for the geothermal pumps.

5. ECONOMIC EVALUATION OF THE PROPOSED SCHEME HEATING OF UNIVERSITY "FAN NOLI", KORÇA CITY

Total heated surface, for three-floors:1200 m^2
Heating system: Borehole-Heat Pump-Radiators
Heating capacity 134 KW
Heating period 1836 hours

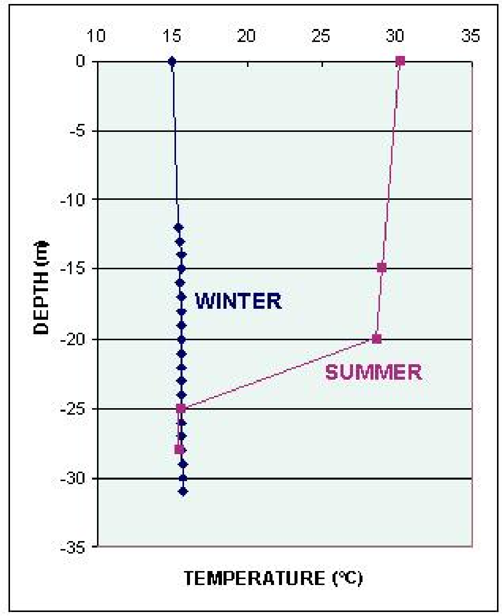

Fig. 3. Thermolog of the Rinasi borehole

Heating system, there are analyzed three variants:
a) Borehole-Geothermal Heat Pump
b) Borehole-Heat Exchanger-Geothermal Heat Pump
b) Oil Fired Boiler

Installed cost for:
a) Borehole-Geothermal Heat Pump 58.101Euro
b) Borehole-Heat Exchanger-Geothermal Heat Pump 121.123
c) Oil Fired Boiler 16.579

Specific Installed cost for:
a) Borehole-Geothermal Heat Pump 59.3 Euro/m^2
b) Borehole-Heat Exchanger-Geothermal Heat Pump 109.3
b) Oil Fired Boiler 15.6

Yearly expenses for the oil for boiler and electric Energy for geothermal heat pumps:

- Oil for boiler 39.960 Euro
- Electric energy for Borehole-Heat Exchanger-Geothermal heat pump system 26.970
- Electric energy for Borehole-Geothermal heat pump system 24.814

Payback period for the installed cost for:

- Payback period of Borehole-Heat Exchanger Geothermal heat pump system 2,2 years
- Payback period of Borehole-Geothermal heat pump system 4,9

Installed cost can be covered only by expenses savings for boiler fuel.

In fig 5 is presented the graphic of the installed costs and yearly expenses for the oil and electric energy for the geothermal heat pumps for space heating for different heating systems.

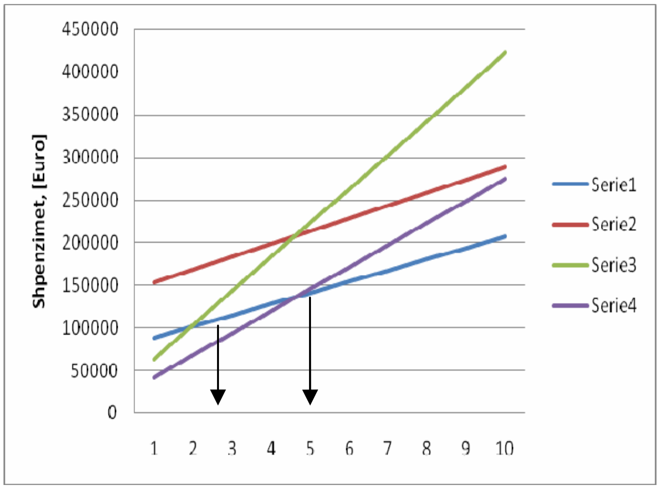

Fig. 5. Installed costs and yearly expenses for fuell and electric energy for the geothermal heat pumps for space heating for different heating systems.
Legend: Serie 1: Borehole-Geothermal Heat Pump system , Serie 2: Borehole-Heat Exchanger Geothermal Heat Pump system ; Serie 3: Boiler system, oil price 1,2 Euro/liter; Serie 4: Boiler system, oil price 0.8 Euro/liter.

Fig. 6 shows the cumulative yearly expenses for the fuel and electric energy for heating system works.

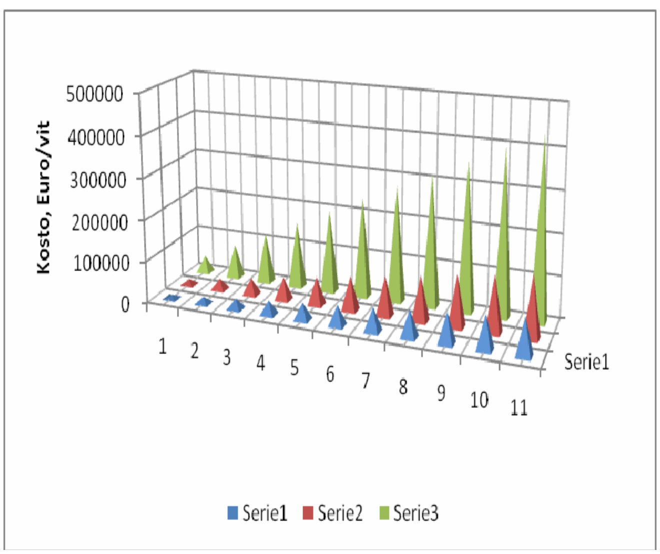

Fig. 6. Cumulative yearly expenses for the oil and electric energy for the geothermal heat pumps for space heating for different heating systems (in Euro).
Legend: Serie 1: Borehole-Geothermal Heat Pump system , Serie 2: Borehole-Heat Exchanger Geothermal Heat Pump system ; Serie 3: Boiler system.

In the fig. 7 is presented the plots of the differences of yearly cumulative expenses for the fuel and electric energy for the geothermal heat pumps for space heating and installation costs for different heating systems.

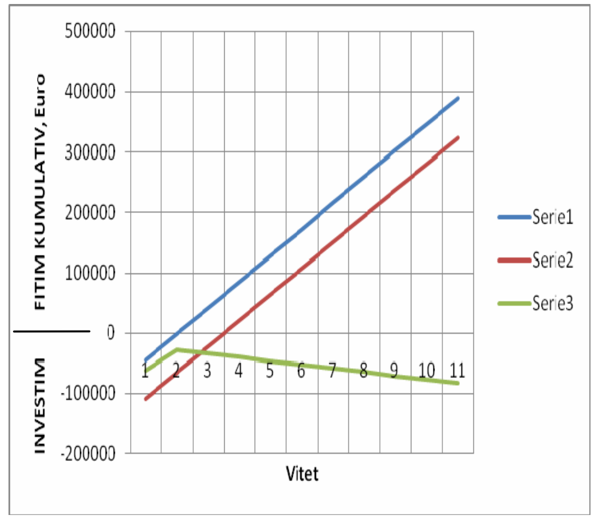

Fig. 7- The plots of the differences of yearly cumulative expenses for fuel and electric energy for the geothermal heat pumps for space heating and installation costs for different heating systems (in Euro).
Legend: Serie 1: Borehole-Geothermal Heat Pump system , Serie 2: Borehole-Heat Exchanger Geothermal Heat Pump system ; Serie 3: Boiler system.

Price of heating energy for the geothermal system results 3,45 Lek/kWh (0,0265 Euro/kWh) and 5,81 Lek/kWh (0,0446 Euro/kWh) respectively for Borehole-Geothermal Heat Pump system , Serie 2: Borehole-Heat Exchanger Geothermal Heat Pump system; in the same time for the boiler system the price results 16,9 Lek/kWh (0,13 Euro/kWh), consequently 4,9-2,9 time more expenses (fig. 8)

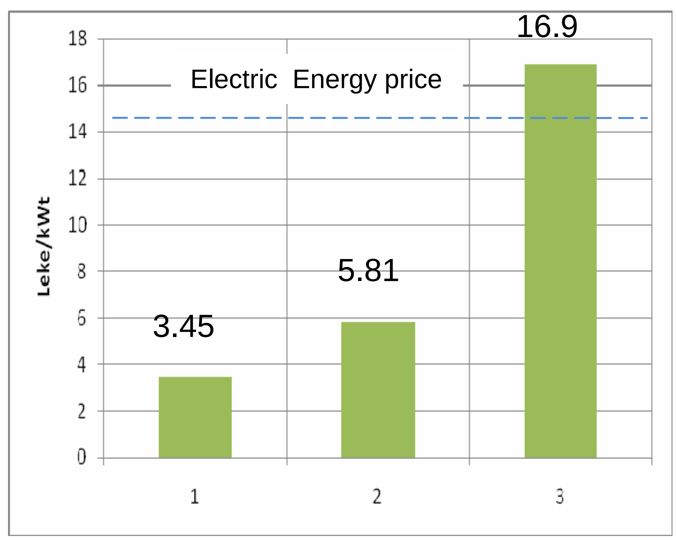

Fig. 8. Cost in Lek/kWh for space heating of the University of Korça building, for the payback period.

Legend: Serie 1: Borehole-Geothermal heat pump system , Serie 2: Borehole-Heat Exchanger Geothermal heat pump system ; Serie 3: Boiler system.

According to this analyze and graphics of the fig. 5-8, results that geothermal heating and cooling system is more economic system that boiler system.

6. CONCLUSIONS

a) The heating problem and its economic solution is an important task, taking into consideration the current severe energetic crises. One of the ways out is the use of geothermal energy. In Albania there are many high-rise building, which are still projected to include oil or gas fired boiler systems, as well as with air conditioning units. Air conditioning units heat all public institutions. The hospitals, dorms, hotels are heated by oil and gas fired boilers. It is the ripe time to move out of such practices, which do not provide for long term sustainable solutions to the heating and cooling problems in Albania.

b) Direct use of the geothermal energy for space heating/cooling can be contribute to improve country energy balance.

c) It is the right time to introduce systems using renewable energy shallow sources such as the geothermal energy: .

d) Geothermal space heating/cooling systems represent not only high economical efficiency but are environmental friendly.

Based on these conclusions, in the condition of the intensive building's construction in Albania and energetic crisis, are important two recommendations:

Firstly, the geothermal systems must have the priority for space heating/cooling of the new public and private buildings (industrial, and residential, etc.),

Secondly, the geothermal systems must have the priority during the re-construction of the heating/cooling systems of the hospitals, schools, dorms, hotels, etc., which are heated by oil and gas fired boilers.

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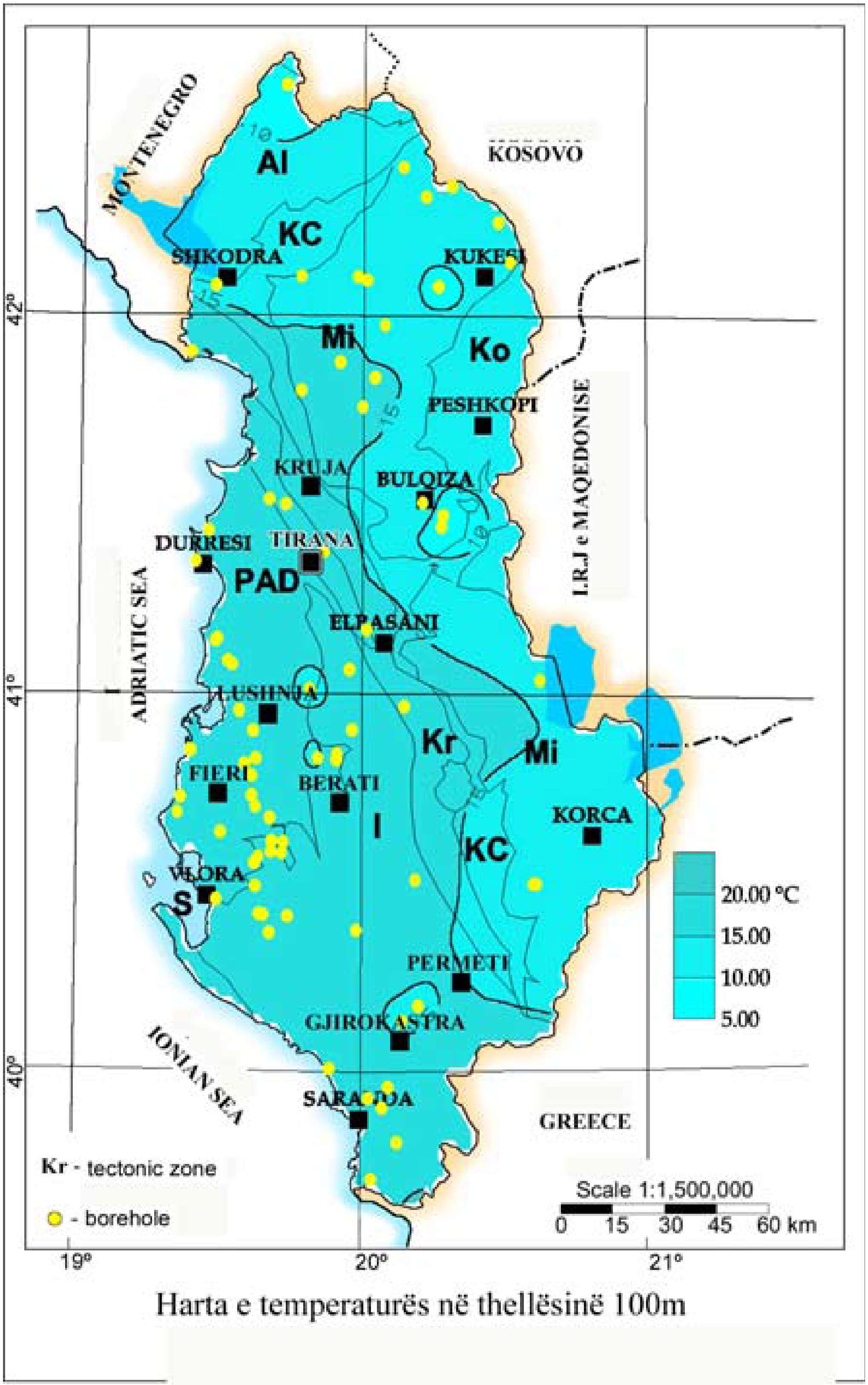

Fig. 2. Temperature map of Albania, at the depth 100 m.

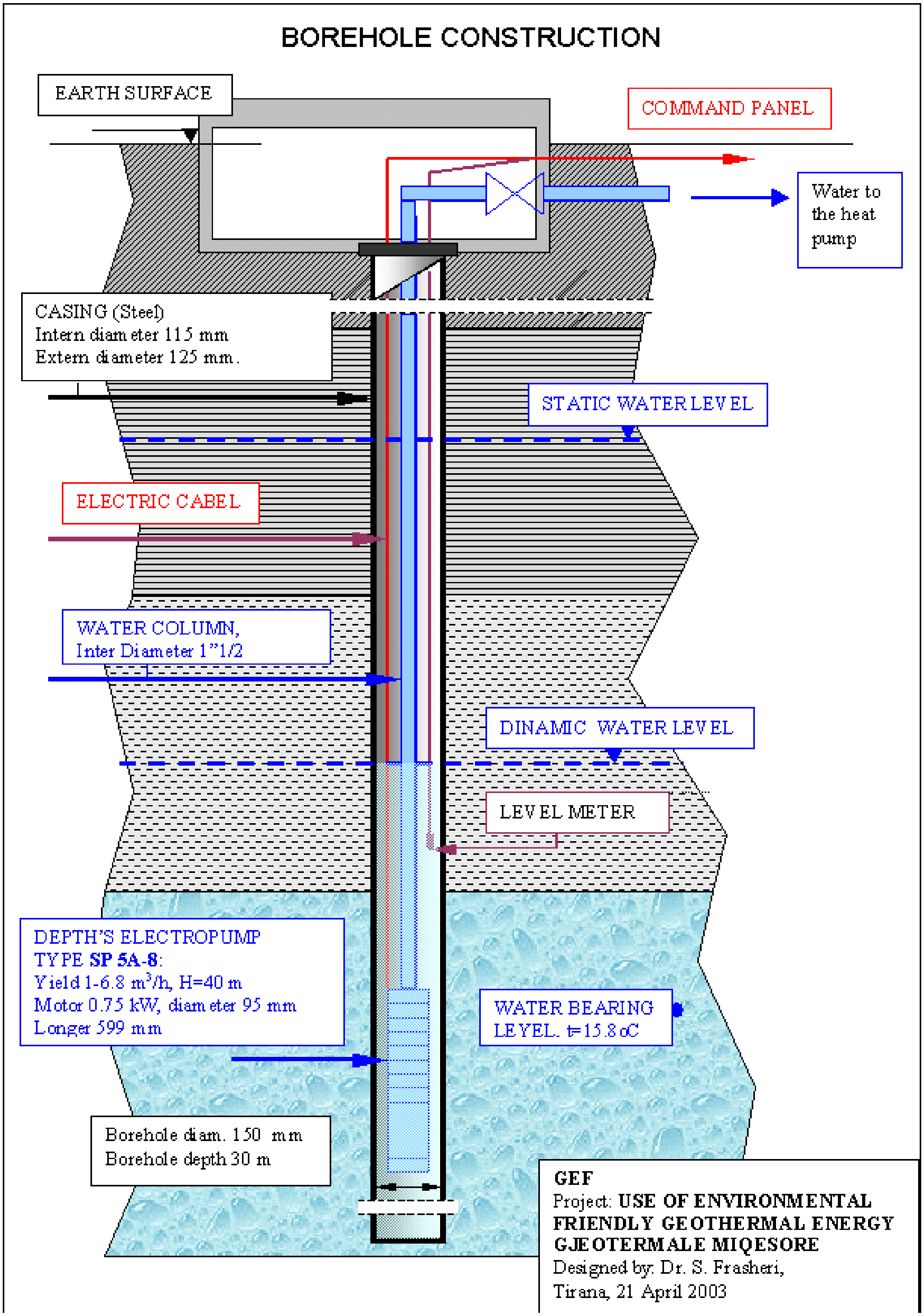

Fig. 4. Shallow Heat Source of Quaternary aquifer in Tirana Field region and borehole construction for water pumping to the Geothermal Heat Pump.

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