1.
OUTLOOK ON PRINCIPLES FOR DESIGN OF INTEGRATED AND CASCADE USE LOW ENTHALPY GEOTHERMAL PROJECTS IN ALBANIA

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Abstract

Large numbers of geothermal energy of low enthalpy resources are located in different areas of Albania. Thermal waters are sulfate, sulfide, methane, and iodinate-bromide types. Thermal sources are located in three geothermal zones:

Kruja geothermal zone represents the zone with the biggess geothermal resources. Kruja zone has a length of 180 km. Identified resources in carbonate reservoirs are 5.9x108-5.1x109 GJ,

Ardenica geothermal zone located in the coastal area of Albania, in sandstone reservoirs.

Peshkopia gjeotermal zone is in the north-eastern area of Albania. Several springs are located there in the disjunctive tectonics belt of the gypsum diapir.

The geothermal situation in Albania offers three directions for the exploitation of geothermal energy:

- **First**ly, thermal sources of low enthalpy are natural sources or wells in a wide territory of Albania. They represent the basis for the successful use of modern technologies for a *complex and cascade exploitation* of this energy, achieving an economical effectiveness:

1. Use by SPA clinics for treatment of different diseases and by hotels for ecotourism.
2. Use by SPA clinics and hotels, greenhouses and aquaculture installations for hot water for heating and sanitary waters.
3. The extraction of chemical microelements.

- **Secondly,** the uses of the heat flow of shallow geological section for heating and cooling of the buildings.
- **Thirdly,** the use of deep abandoned oil and gas wells as "Vertical Earth Heat Probe".

Direct use of the geothermal energy is programmed to be realized using an integrated schema of geothermal energy, heat pumps and solar energy. Energy of the thermal waters will be realized in a cascade way, using it step by step, from high temperatures up to environ-mental temperatures.

Actually, in Albania, the study of the possibilities of exploitation of geothermal energy has begun. The aims of the project are to exa-mine, demonstrate and disseminate the positive technical and financial aspects of the transfer and utilization of innovative geothermal energy technologies in Albania.

Keywords: Geothermal energy, thermal water, geothermal gradient, heat flow.

1. INTRODUCTION

In Albania, a country rich in geothermal resources of low enthalpy and mineral waters, new technologies using of geothermal energy are still untouched. Large numbers of geothermal energy of high and low enthalpy resources, many of mineral water sources, and some CO2 gas reservoirs represent the base for successful application of modern technologies in Albania in order to achieve economic effectiveness and successful exploitation.

Actually, there are many geothermal, hydro-geological, hydrochemical, biological and medi-cal investigations, and studies of thermal and mineral water resources, carried out in Albania. The results of the geothermal studies carried out in Albania are presented in maps and geothermal sections.

Temperature maps have been compiled for different levels of up to 5000m depth.

Geothermal gradient, heat flow density and geo-thermal resources maps have also been developed. Natural springs with thermal waters and the geolo-gical structures with high water temperature have also been mapped. Generally, these investigations and studies are separated each from

the other. Their information and data will be used for studies and evaluations in Albania on a regional scale. These studies and evaluations are necessary to know, in a regional plane, the potential of the thermal and mine-ral water resources and geothermal market of Albania.

According to the results of these new studies, an evaluation for the perspective level of the best areas in the country will be necessary. After this evaluation, it will be possible to begin investment in these areas. Integrated exploitation and cascade direct use of the geothermal energy will be realized by an integrated scheme of geothermal energy, heat pumps and solar energy. This scheme has an environmental benefit by using renewable energies (geothermal energy, solar energy), new technologies (heat pumps) and energy savings (cascade scheme). A cascade scheme should be used to fulfill the thermal energy demand for the selected area in order to get the maximum benefit from geothermal energy.

Exploitation of geothermal energy will have a direct impact in the development of the regions, by increasing their per capita income and, at the same time, ameliorating the standard of living of the people. These investments will be profitable in a short period of time.

2. GEOTHERMAL ENERGY IN ALBANIA

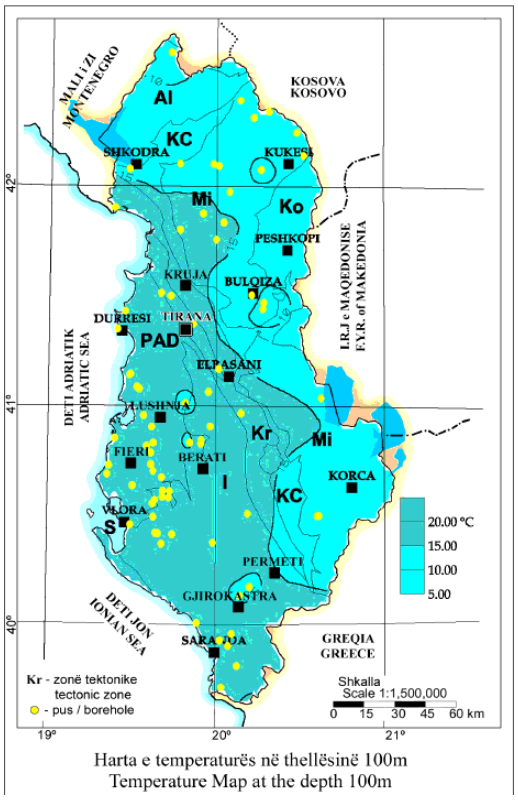
2.1. Methodic

The results of the geothermal studies carried out in Albania are presented in maps and geothermal sections. Temperature maps have been compiled for different levels of up to 5000m depth (Fig. 1, 2). Geothermal gradient, heat flow density and geothermal resources maps have also been drawn up. Natural springs with thermal waters and the geological structures with high water temperatures have also been mapped (Frasheri A. 1992, Frasheri A. et al. 1995). The water basins with higher average temperatures have been studies as well. The study of the possibility of exploitation of abandoned deep oil wells as "Vertical Earth Heat Probes" has already begun.

2.2 Geothermal Features

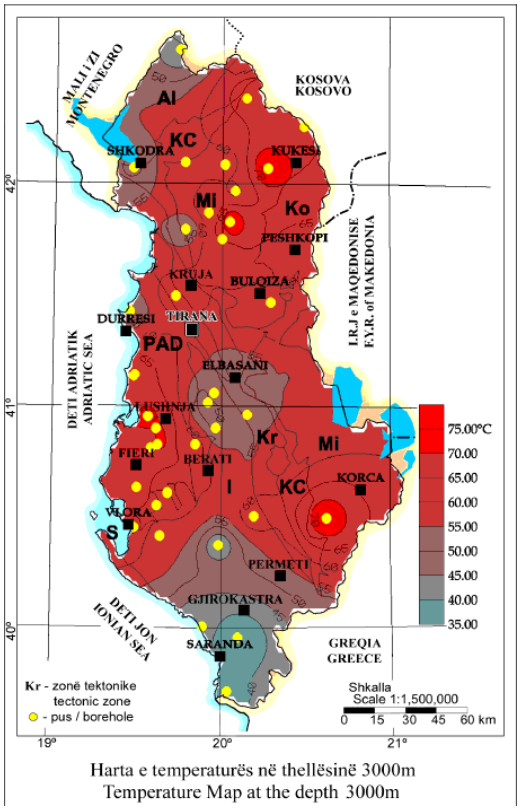
The Albanides form an integral part of the southern branch of the Mediterranean Alpine orogen. They are subdivided in two zones: the Internal and the External Albanides. The geology of Albanides creates the premise for the research and exploitation of natural geothermal energetic resources.

The greatest heat flow density with a value of 42 mW·m-2 is found in the center of the Preadriatic Depression (Fig. 3). In the east of the ophiolitic belt heat flow density reaches values of up to 60 mW·m-2 .



Harta e temperaturës në thellësinë 100m
Temperature Map at the depth 100m

Fig. 1. Temperature Map of Albania, at the depth 100 m.



Harta e temperaturës në thellësinë 3000m
Temperature Map at the depth 3000m

Fig. 2. Temperature Map of Albania, at the depth 3000 m.

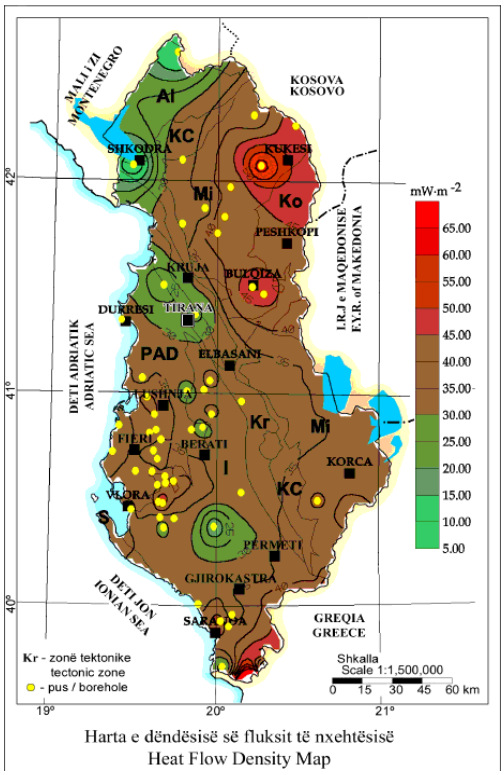


Fig. 3. Heat Flow Density Map of Albania.

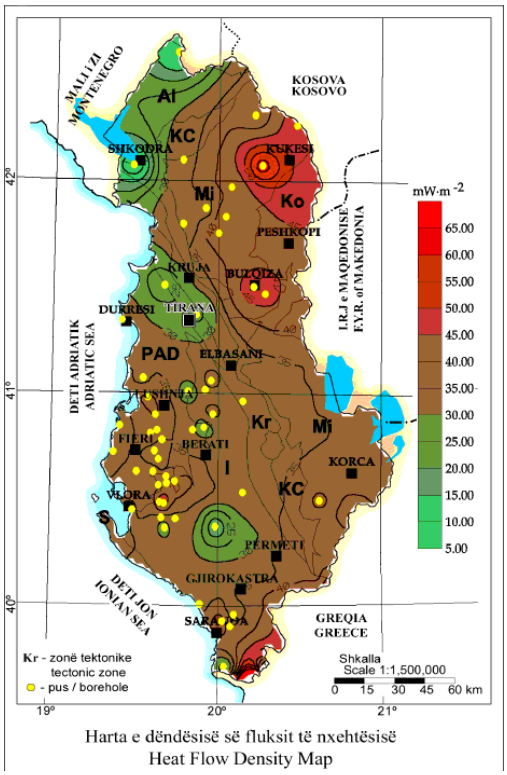


Fig. 4. Geothermal Spring and Wells in Albania

Thermal water sources and wells in Albania Table 1

Type of the source	Location	Tempe-rature (°C)	Salt (mg/l)	Yeild l/sec
Natural Spring	Llixha Elbasan, Peshkopi, Krane (Sarande), Langaric (Permet), Shupal (Tiranë), Sarandoporo (Leskovik), Tërvoll (Gramsh), Mamurras (Tiranë).	21-60	0.3-26	10-40
Deep wells	Peri Adriatic Depression and in the Kruja tectonic zone	29.3-65.5	1-19.3	0.9-18

The temperature at a depth of 100m ranges from 6.7 to 18.8°C, at an average of 16.4oC, and the temperature at the depth of 500m ranges from 21 to 27.7°C.The temperature increases to 105.8°C at the depth of 6000m. In the central

part of the Preadriatic Depression, there are many deep oil wells where the temperature reaches up to 68°C at a depth of 3000m.

The geothermal gradient has the highest value of about 18.7 mK·m-1 in the center of the Peri Adriatic Depression. Elsewhere, the gradient is mostly 15 mK·m-1. In the south of the country, the geothermal gradient has low values of 11.5-13 mK·m-1. Towards the northeastern and southeastern regions of Albania, over the ophiolitic belt, the geothermal gradient increases, reaching a value of 23.5 mK·m-1.

2.3. Geothermal Areas and Reservoirs

In Albania, there are many thermal springs and wells of low enthalpy (Fig. 4, Tab. 1) (Frasheri A. et al. 1997) .

These thermal water springs and wells are mainly near zones of regional tectonic fractures. Generally, the water circulates through carbo-natic rocks of the structures and evaporitic beds at some kilometers of depth. The water from the-se springs contains salt, absorbed gas, and orga-nic matter. Waters are sulphide, methane, iodine-bromium and sulfate types. The waters come from different depth levels (800-3000 m) of li-mestone reservoirs and

sandstone reservoirs. Thermal sources are located in three geothermal zones:

Kruja geothermal zone represents the zone with largest geothermal resources. Kruja zone has a length of 180 km. Identified resources in carbonate reservoirs are 5.9x108-5.1x109 GJ,

Ardenica geothermal zone is located in the coastal area of Albania, in sandstone reservoirs.

Peshkopia gjeotermal zone is locaden in the northeastern area of Albania. Several springs are located with disjunctive tectonics of the gypsum diapir.

3. DIRECTIONS FOR THE EXPLOITATION OF GEOTHERMAL ENERGY OF LOW ENTHALPY IN ALBANIA

The geothermal situation of low enthalpy in Albania offers the following directions for the exploitation of geothermal energy, which is unused until now. This exploitation will realized by an integrated scheme of geothermal energy, heat pumps, and solar energy, and cascade use of this energy (Frasheri A. 2000, Frasheri A. et al. 1997).

- **Firstly,** space heating and cooling using ground heat by the Borehole Heat Exchanger (BHE) in the shallow (about 100 m depth) boreholes.

The increased demand in energy for heating and cooling of premises, in the framework of the energy crisis in Albania, represent the great and important problem of the Energy System of Albania. Actually, the electric energy consum-ption for heating is 1 375 GWh/year, or 23.8 % of the total electric energy production in Albania (Fig. 5) (National Agency of Energy, Tirana, 2003). The situation becomes more problematic because the use of natural gas for heating emits large quantities of CO2 in the atmosphere.

Direct use of ground heat by the Borehole Heat Exchanger-Geothermal Heat Pump repre-sents a modern system for space heating and cooling (Lungt J. W. 1996, Rybach L. et al. 2000, 2004). Two types of shallow heat sources exist: ground heat and underground water heat. Consequently, two kinds of technology can be 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 exists or where the quality of the well water is a problem.

In order to make use of this renewable geothermal energy and environmentally 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 in Tirana (Frasheri et al. 2003). It will contribute to solving the problematic issue of heating and cooling of premises in Albania.

- **Secondly**, thermal sources of low enthalpy and of maximum temperature up to 80°C. These are natural sources or wells in a wide territory of Albania, from the South near the Albanian-Greek boundary to Northeast districts in Diber Region.

Thermal waters of springs and wells in Albania may be used in several ways:

Modern SPA clinics can use these for the treatment of different diseases and hotels, can also use these for thermal pools, to further the development of eco-tourism.

Such centres may attract many of clients, including many outside Albania, because of curative properties of these waters and also because they are situated in attractive areas near the sea side, mountains, or Ohrid lake. At the present, some SPA clinics using technology work in some geothermal springs and wells in Albania.

The oldest and most important is **Elbasani Llixha SPA,** which is located about 10 km south of Elbasani city and 61 km south-east of Tirana, in the central part of Albania. By national road communication, Llixha area is connected with Elbasani and Tirana. In the future, this area will be only 10 km from the highway Durresi- Skopje-Sofia- Istanbul, which is projected for construction and nominated as No. 8 European Corridor. This area has the opportunity to be frequented by a large number of people from different countries. These thermal springs from about 2000 years ago are well known. According to historic data, in Elbasani Llixha, thermal springs there have been a centre near of the old road “Via Egnatia" that has passed from Durresi to Constantinople. The number of Albanian patients treated for rheumatism and various illnesses in Elbasani Lixha SPA in maximum are 7899 person/year. All seven groups of the springs in Llixha Elbasani and Kozani-8 well geothermal area will have the possibilities for modern complex exploitation. The beautiful landscape of Elbasani Lixha area can be used not only for medical treatment but also as a tourist destination. This area is located near the very well know Ohrid Lake pearl or mountains Gjinari, with their fantastic forests and nice climate. Ishmi 1/b geothermal well is located in beautiful Tirana field, near the “Mother Theresa” Rinasi (Tirana) Airport, the Adriatic coastline, and Kruja - Skandergeg Mountain.

Benja and Sarandaporo thermal water areas and Postenani steam springs are located near the beautiful Vjosa River valley. Peshkopia geothermal springs area is located near of the Korrabi Mountain, the highest mountain in Albania (2753m). The beautiful landscape of Vjosa valley, near the Albanian-Greek border and Peshkopia area near of Debar region in Macedonia, will not only

be used as a thermal water bearing place for medical treatment, but also as a tourist destination.
2. The hot water can also be used also for heating of hotels, clinics and tourist centers, as well as for the preparation of sanitary hot water used in these facilities. Near these medical clinics and tourist centres, it is possible to build greenhouses for flowers and vegetables, as well as aquaculture installations (Popovki K. and Popovska Vasilevska S. 2002).
3. From thermal mineral waters, it is possible to extract very useful chemical microelements such as iodine, bromine, chlorine, and other natural salts necessary for the preparation of creams for the treatment of many skin diseases as well as for beauty care products. From these waters it is also possible to extract sulphidric and carbonic gas. It is possible to build installations to process of mineral waters.

Consequently, the sources of low enthalpy geothermal energy in Albania, which are, at the same time, the sources of multi-element mineral waters, represent the basis for succes-sful use of modern technologies for a *complex and cascade exploitation* of this energy, achi-eving economic effectiveness. Such develop-ments are also useful for the creation of new working places and the improvement of the standards of living for local communities located near thermal sources.

- **Thirdly,** the use of deep doublet or single abandoned oil and gas wells as the "Vertical Earth Heat Probe", to obtain geothermal energy. The geothermal gradient of the Albanian Sedimentary Basin has average values of about 18.7 mK·m-1. At 2 000 m depth, the temperature reaches a value of about 48°C. In these single abandoned wells, a closed circuit water system can be installed. Near these wells, greenhouses can be built.

THE PRINCIPLES FOR ALBANIAN GEOTHERMAL ENERGY MARKET ANALYSE AND DESIGN

Actually in Albania the study of the possibilities of exploitation of the geothermal energy has begun. Based on the above analysis, for the best area selected, a Feasibility Study will be performed to analyze three components: energy supply, environmental impact and financial aspects, and to suggest the best solution of the innovative geothermal energy utilization technology applications in that area.

For good preparation of the project and implementation of the project, in detail are determined:

Objectives of the market study for:
1. Space heating and cooling consumers.
2. Consumers for geothermal energy & thermal water integrale and cascade direct use (heat, spa, cooling, power production, drinking water, aquaculture, agriculture)
3. Geological risk, financial possibilities to cover geological risk.
4. Traffic connections.
5. Gathering information material and know-ledge dissemination as very important element of utilization of geothermal energy
6. Significance of the project proposal and its expected achievements

The integrated project includes:
1. Aims and objectives of the project.
2. Construction of the experimental units for exploitation of the geothermal energy:
3. Concrete detailed design for the implementation phase of the project.
4. Construction of thermal supply installations.
5. Application and transfer technology for a complex and cascade exploitation of geothermal waters energy
6. Methodology of project implementation
7. Economical-financial evaluations
8. Repayment of the credit
9. Feasibility Study

4. CONCLUSIONS

1. Albania has the resources of geothermal energy of low enthalpy, which is possible for integrated and cascade direct use as an alternative energy.
2. Resources of the geothermal energy in Albania are;
a) Natural springs and deep wells with thermal water, of a temperature up to 65.5°C.
b) Heat of subsurface ground, with an average temperature of 16.4oC and depth Earth Heat Flow.
3. Construction of the space-heating system, using shallow borehole heat exchanger (BHE)-Heat Pumps systems present the most important direction of the use of geothermal energy in Albania.

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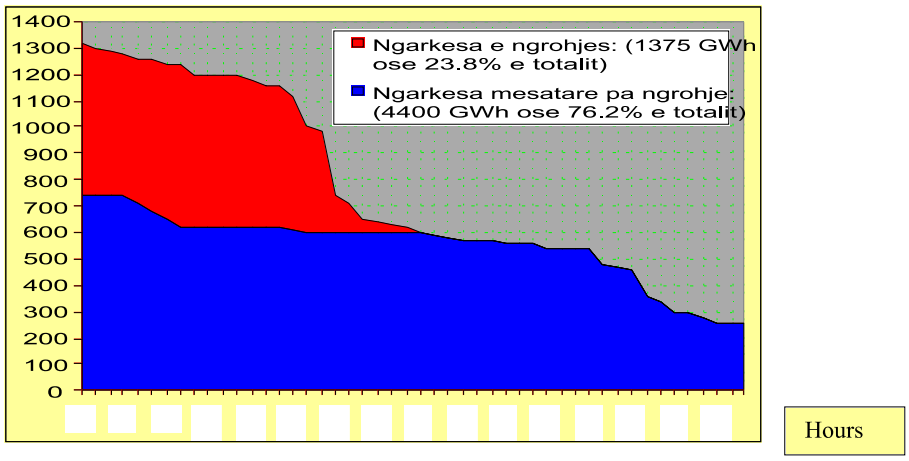

Fig. 5. Annual Electric Power with and without heating, 1999. (National Agency of Energy)