THE SOURCES OF GEOTHERMAL ENERGY IN ALBANIA

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KEY WORDS

Albania, geothermal energy, heat flow, geothermal gradient, thermal springs, energetic system.

ABSTRACT

In this paper there are treated the topics of the studying of geothermal energy sources in Albania and of the possibilities of their exploitation. Albania is a rich country in natural energetic sources. Mountain born rivers with plenty of water created the possibility of building a powerful chain of hydro-power plants. Oil, natural gas and coal are also important energetic source for Albania. The objective of this paper is to present the possibilities for the extension of energetic resources by using the geothermal energy. In addition for the Albania it is possible to use also the solar and wind energy. Geothermal studies in the past three years have shown the possibility of the exploitation of the geothermal energy.

1. INTRODUCTION

Albania is a mountainous Mediterranean country with numerous natural energetic resources. There are many rivers flowing from the mountains on which seven hydro-power plants have been built, with an installed power of 1427.1 MW (taken from the Albanian Encyclopedic Dictionary). This energetic system gives about 5260 GWh/year and the potential of the Albanian rivers is not exhausted (alone, two of the main rivers in Albania have a potential of about 10,000 GWh/year).

There are about 20 oil and gas reservoirs under exploitation in Albania, giving an average quantity of 1.2 Mt oil, but in the last few years, production has decreased and in 1993 only about 649.8 Kt of oil was produced. The oil and gas extracted is used to produce electrical energy, for transport, in the chemical industry and for heating and cooking. A thermo-power plant has been built for that purpose with an installed power of 160 MW.

There are tens of coal mines in Albania, giving a production of over 2 Mt of coal in 1984 and, in 1993, about 214.6 Kt of coal. Based on that coal there have been built some thermo-power plants used for local purposes and by the industry (mainly for steam) (Frasheri N, 1994).

The Albanian energetic system is based mainly on the electricity produced by hydro-power plants. The climate of Albania is a typical Mediterranean, with hot and dry summers. This climate makes the electrical system based on water resources of Albania very tenuous. The management policy of the ex communist government was very unreliable and, despite the planed economy, little attention was given to using the electricity according to timely plans. The major problem was with the export of electricity during the winters, it was done in such a way that little water was left in the reservoirs of the hydro-power plants to be used during the hot and dry summers. This policy exacerbated by capricious weather caused many problems during the Albanian summers, at a time when the thermo-power resources were limited.

In the current conditions, with a new Albanian economy, together with the transformations of the management of the existing energetic system,there has begun the study of other energetic sources. There are about 2484 hours/year with sun in Albania. The energy of solar radiation in Albania is about 129.3Kkal.cm^{-2}/year and there are great possibilities to use this source of energy. In the coastal districts the average speed of the wind is about 2.8 - 3.8 m /sec with maxima to 35-45m/sec. In other internal districts it decreases to 1.6-2.4m/sec (The Climate of Albania). There are many regions where the speed of the wind is several times greater than this, so wind is another important source of energy. In Albania there are many thermal water springs of low enthalpy with temperature up to 60°C. This indicates that there is also the possibility to using the geothermal energy.

2. METHODS, TECHNIQUES, MATERIALS, STUDY AREA.

Geothermal studies carried out in Albania are oriented to solve several problems.

Firstly, to study the distribution of geothermal field. There are measured the temperatures, the geothermal gradient and heat flow density in different depths.

Secondly, the study of the natural thermal water springs.

Thirdly, the study of the water basins having waters with higher temperature compared to the average yearly temperature of the zone.

The investigation of the geothermal fields of the Albanids is based on the temperature measurements carried out in deep wells, in boreholes and in mines, at different hypsometric levels.

The temperature in wells was recorded continuously. It was measured with resistance and thermistor thermometers. The average absolute error of the measurements was 0.3°C. The measurements were carried out in a steady-state regime with the wells filled with mud or water..The temperature was recorded downhole during the lowering of the thermometers. The recorded data was processed by using trend analysis of first and second degrees. The heat flow density was calculated using the formula:

$$q=(t_2-t_1)\,\lambda / h\ :$$

where t_1,t_2 are temperatures in 'C at two different depths of a difference " h in meters, λ is the thermal conductivity of the rocks in W/(°Km).

The chemical composition of thermal waters was found. The output of the springs and their hydrogeology was evaluated.

Geothermal studies have covered all the territory of Albania. In the western regions. where the oil and gas reservoirs are situated, temperatures have ken recorded in about 110 wells. In the north-cast and south-east regions ahout 15 boreholes have been studied. There were studied also 8 thermal water springs and thermal waters from 14 oil and gas wells were also analyzed.

3. RESULTS

The results oi the geothermal studies are presented as maps and as geothermal profiles. There have been drawn temperature maps for different levels down to 5000m depth. maps of geuthermal gradient and of heat flow density. There are mapped natural springs of thermal waters and the structures with high temperature waters. There are studied also the water basins with higher average temperature than the average of the regions. Studies have begun regarding the possibility of using abandoned deep oil wells as "vertical earth heal probes?

4. DISCUSSIONS

Thr Alhanids represent the main geological structures thal lie on the territory of Albania. They are located between the Dinarids in the north and the Helenids in the south, and together they form the Dinaric branch of the Mediterranean Alpine Bell.

In Alhanids there are rocks from Ordovician to Quaternary age. The structures in the Albanids are typically Alpine. they generally run SSE-NNW, are asymmetric and have a western vergence. Recumbent, overthrusted and overtwisted structures are found too. Generally their western flanks are affected hy disjunctive tectonics. The Alhanids are interrupted hy deep longitudinal and transversal fractures which affect the whole crust.

The Alhanids began their geological development in the Triassic over a Hercynian substratum. They were formed hy the Alpine orogenesis.

Alhanids are divided in two paleographical zones: the Inner Albanids and the Outer Alhanids. Regional geological and geophysical studies have outlined some isopic zones: Korabi (Ko), Mirdita (Mi) and Gashi (Ga) zones in the Inner Albanids and Alpine (Al), Krasta-Cukali (KC), Kruja (Kr), Ionian (J), Sazani (S) zones and the Preadriatic Depression (PAD) in the Outer Alhanids. In the Outer Albanids there is situated the Albanian Sedimentary Basin with a thickness up to about 12 km. In the Inner Albanids there is the ophiolitic belt with a thickness up to 14 km, overthrusted over the Outer Alhanids.

The Albanian Sedimentary Basin continues also onto the shelf of Adriatic sea.

The geology of Alhanids is the basis for the research and exploitation of natural geothermal energetic resources.

The study of the Geothermal field of the Albanids has been carried out on the basis of the temperature measurements in 120 deep oil and gas wells located in the Ionian zone. the Kruja zone, the Preadriatic Depression and in 15 boreholes in the ophiolitic belt in the Mirdila zone.

The temperature varies from a minimum of 12°C at a the depth 100m up to 105.8°C in a deplh of 6000m. In the central part of the Preadrialic Depression. there are many deep oil wells where the temperature reache 68°C at a depth of 3000m (fig.1). The isotherms run in a direction lhat fill the strike of Alhanids. The configuration of the isotherms is the same down to a depth of 6000m. Wilh increasing depth. the center with the highest temperature is displaces from south to east towards the center of the Preadriatic Depression and even farther coward the north-east coast

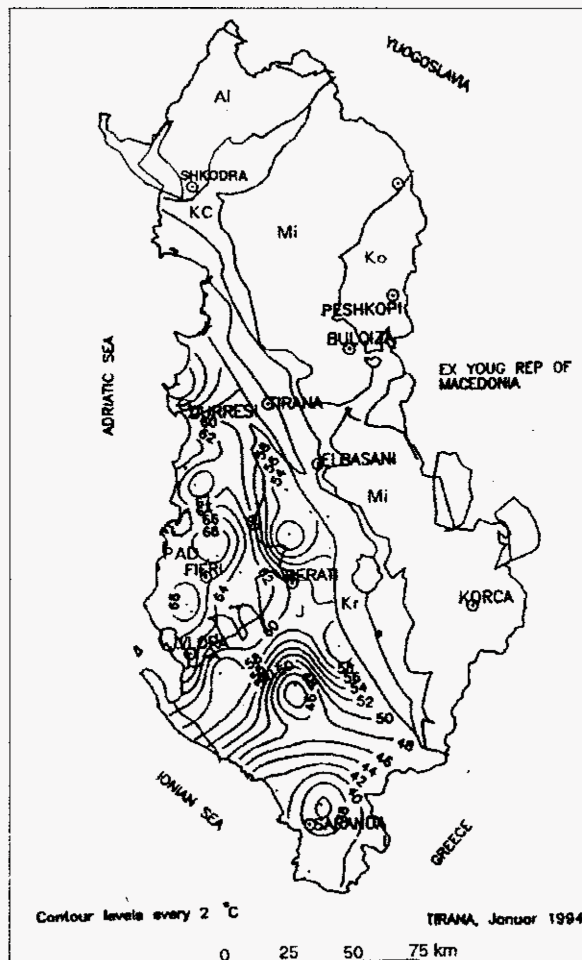

Fig. 1. Temperature at 3000m depth map of External Albanids
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The geothermal gradient ha.. its highest value ahout 18.7 mK/m in the center of the Preadriatic Depression. Elsewhere the gradient is mostly 15 mK/m. In the south of the country the gradient has low values 11.5-13 mK/m. The lowest values of the gradient (7-11 mK/m) are in the deep synclinal belts. Towards the north-cast and south-east regions of Albania, over the ophiolitic belt, the geothermal gradient increases reaching the value of 23.5 mK/m.

The heal flow density has its greatest values of 42 mW/m² in the center of the Readriatic Depression in a region between the cities of Fieri and Lushnja. In the eastern part of the ophiolitic belt the heat flowdensity has values up to 60 mW/m².

In Alhania there are man) thermal springs of low enthalpy. Their water has temperatures that reach values of 58°C (fig.2). In Table 1 there arc some data ahout the temperature of the watcr in these springs. These springs are situated mainly along regional tectonic fractures. The springs with hightest temperatures are situated in the Central Alhania, where thcrc are salt diapires too.

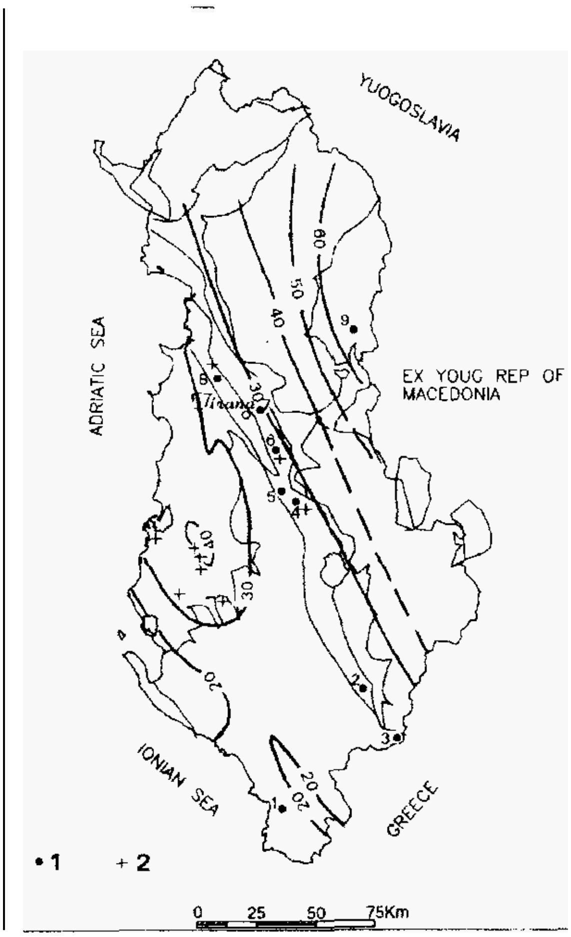

Fig. 2. Heat flow density map of Albania and the thermal water spring (1) and wells (2).
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Table 1. THE THERMAL SPRINGS IN ALBANIA

No. Springs	Location	Temperature (°C)	Salts mg/l	Output l/sec
1	Krane - Sarande	34		
2	Langarice - Permet	26-31	4	10
3	Sarandaporo - Leskovik	26.7	7	
4	Tervoll - Cramsh	2J		
5	Llixha - Elhasan	58	403	20
6	Kozan - Elhasan	57		
7	Shupal - Tirane	29.5		
8	Mamuras - Tirane	21	326	
9	Peshkopi	35-43	49	

In many deep oil wells there are thermal water outputs wilh temperatures that vary from 32°C to 60°C (fig.2). These waters are from different depths (800-3000m), from sandstone and irom limestone reservoirs (table 2).

The highest temperatures are in waters coming from limestone structures. About their hydrology today there *are* two alternatives, the waters are of fractured carbonatic reservoirs or lhey art! from great depths flowing into regional disjunctive tectonics. In some wells hot waters come from sandstone reservoirs of the Pliocene-Tortionian age.

Table 2. THE OIL AND GAS WELLS WITH THERMAL WATERS

No. of well	Name of well	Water temperature °C
1	Ishem 1/h	60
2	Kozan 8	52.7
3	Galigati 2	45-50
4	Buhullime 5	48-50
5	Marinze 120	40
6	Ballsh 52	3X
7	Ballsh 57	*36.5*
8	Frakulla 27	36
9	Frakulla *33*	33
10	Semani 1	35
11	Ardenica 12	*32*
12	Gorisht 6	38
13	Gorisht 103	33
14	Gorisht 120	32

Abandoned deep oil wells can he used as "vertical earth heat probes". From a preliminary evaluation it is concluded that in wells of 2000m depth, where the gradient is ahout 18mK/m, it is possible to pump cold water from the suriace and to receive from the depth water wilh a temperature about 10°Cgreater, which can he used for agricultural purposes during the winters. The German experience is very exiting for us to work with in this direction (Hoffman F. et al, 1993).

5. CONCLUSIONS.

1. In Albania there are geothermal energy sources that can be used.

2. Geothermal energy sources are natural thermal water springs and deep wells with a temperature up to 60°C. Deep abandoned oil wells can he used as "vertical earth heat probes".

3. The evaluation of Albania's geothermal energy must be done as soon as possible in the framework of a separate project.

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TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

	Geothermal		Fossil Fuels		Hydro		Nuclear		Total	
	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr
In operation in January 1995	---	---	160	590	1427	5260	---	---	1587	6687
Under construction in January 1995	---	---	---	---	---	---	---	---	---	---
Funds committed, but not yet under construction in January 1995										
Total projected use by 2000	8	68							2484	10467

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TABLE 5. GEOTHERMAL HEAT PUMPS

[1] Thermal energy used (TJ/yr)
= Annual average geothermal water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

Locality	Heat Source °C	COP - Factor	Heat Pump Rating MW, (Output)	Thermal Energy Used in Heating Mode[1] TJ/yr
ISHEM	60			
KOZAN-ELBASAN	7			
LIXHA-ELBASAN	58			
BUBULLIME	48			
GALIGAT	47			
MARINZE	40			
PESHKOPI	25- 43			
BALLSH	38			
KRANE	34			
LANGARICE	26- 31			
SHUPAL	29.5			
SARANDAPORO	26.7			
Total				

TABLE 6. INFORMATION ABOUT GEOTHERMAL LOCALITIES

[1] Main type of reservoir rock

[2] Total dissolved solids (TDS) in water before flashing. Put v for vapor dominated

[3] N = Identified geothermal locality, but no assessment information available
R = Regional assessment
P = Pre-feasability studies
F = Feasability studies (Reservoir evaluation and Engineering studies)
U = Commercial utilization

Locality	Location To Nearest 0.5 Degree		Reservoir		Status[3] in January 1995	Reservoir Temp. (°C)	
	Latitude	Longitude	Rock[1]	Dissolved Solids[2] mg/kg		Estimated	Measured
ISHEM	41°30'	19°41'	Limestone		N		60
KOZAN-EL	41°08'	20°02'	Limestone		N		57
LLIXHA-EL	41°20'	20°05'	Dis.tecton.	403	P		58
BUBULLIME	40°48'	19°39'	Limestone		N		48
GALIGAT	40°56'	20°10'	Limestone		N		47
MARINZE	40°43'	19°56'	Sandstone		N		40
PESHKOPI	41°40'	20°28'	Dis.tecton.	49	N		25- 4
BALLSH	40°35'	19°44'	Limestone		N		38
KRANE	39°54'	20°05'	Limestone		N		34
LANGARICE	40°14'	20°26'	Dis.tecton.	4	N		26-11
SHUPAL	41°26'	19°56'	Flysch		N		29.
SARANDAPORO	40°06'	20°40'	Dis.tecton.	7	N		26.
Total							

TABLE 9. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with a University degree)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industry

Year	Professional Man Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
1990			1			
1991			1			
1992			5			
1993			6			
1994			6			

TABLE 10. TOTAL INVESTMENTS IN GEOTHERMAL IS (1994)US$

Period	Research & Development Incl. Surf. Exp. & Exp. Drilling	Field Development Incl. Prod. Drilling & Surf. Equipment	Utilization		Funding Type	
	Million US$	Million US$	Direct Million US$	Electrical Million US$	Private %	Public %
1975 - 1984	--	--	--	--	--	--
1985 - 1994	15000+	--	--	--	--	100

+ Expended for geothermal studies in compilation of the " Atlas of geothermal maps of Albania ".