

# **Geothermal energy for the benefit of inhabitants of Beius town, County Bihor-Romania.**

**-Olah Stefan-**

## **Introduction**

TRANSGEX Oradea is mainly specialized in geological surveys, explorations and exploitation of geothermal water resources, proven by deep well drillings in the Western Fields of Romania, starting with mid 60's.

In 2000 the TRANSGEX has become a private owned company, the main investor being Dafora Services Medias. The main activities developed by the company are geological research and surveys and mapping, drilling activities and the production and distribution of geothermal energy and sanitary hot water.

After the Mining Law 61/1998 became effective, the company has taken the legal steps and obtained a portfolio of licenses as follow:

- 4 concession licenses for exploitation of geothermal waters in Oradea, Sacuieni, Marghita and Bors
- 12 concession licenses for exploration

From a geographical point of view, Beius perimeter is situated in the middle part of the Beius basin, the northern part of the Apuseni Mountains, at a relative altitude of +180 up to 200 meters. The basin is surrounded by the Bihor Mountains at E and SE, and by Codru Moma Mountains at W and SW, with peak heights between 1000 and 1800 meters.

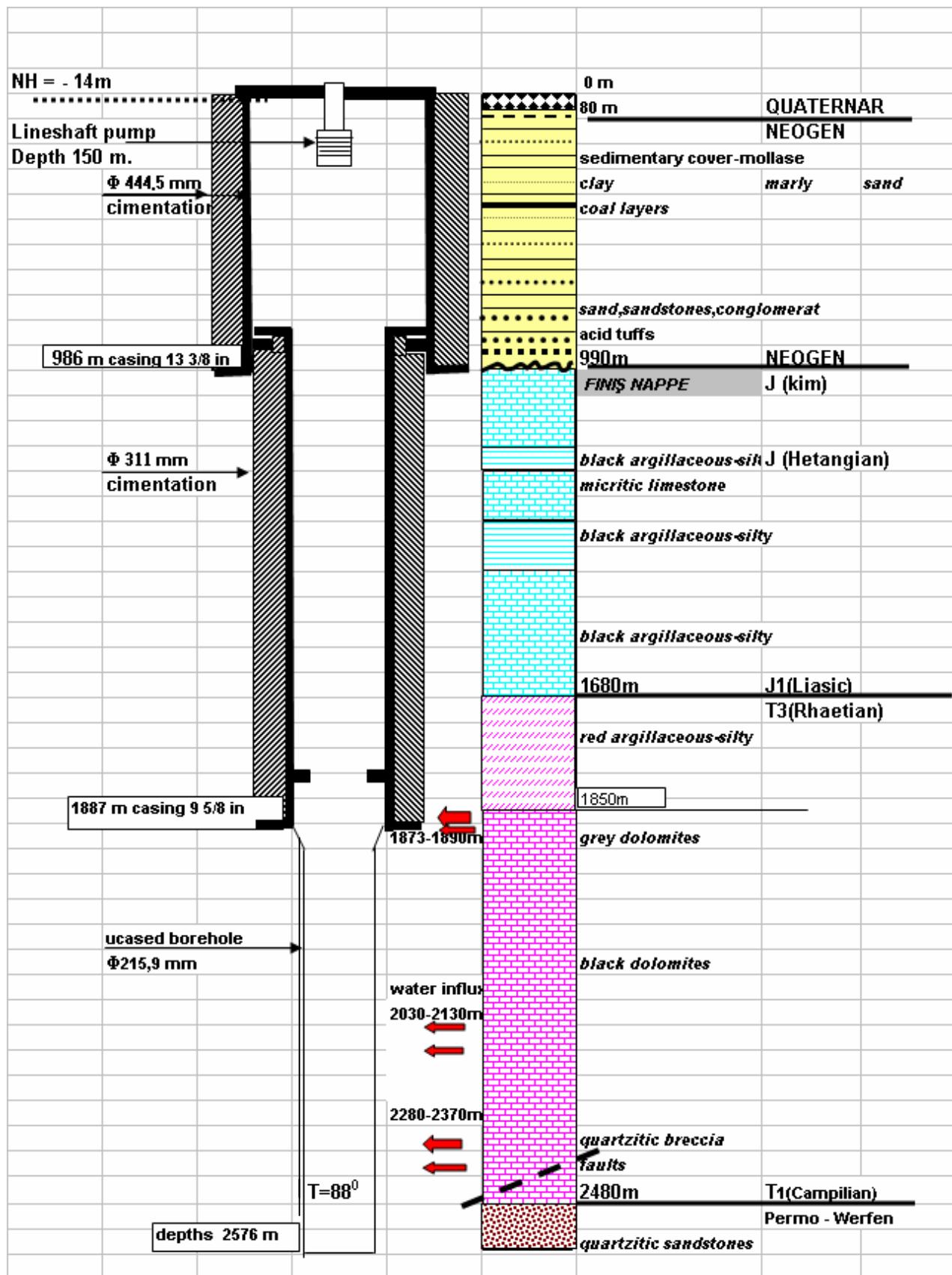
The greatest success of our company has been the discovery (to present) of the geothermal reservoir at Beius in 1996. The 2576-meter deep geothermal well shows us the complicated layer structure of the Beius basin. The reservoir is located in Middle Triassic limestone and dolomites, at 1887-2450 m depths. The great pumping flow rate and the 84°C temperature of the water opened the perspectives of using the geothermal energy.

## **I. The geological and hidrogeological characteristics of Beius geothermal reservoir**

Transgex Company upon its own geological projects, with state subventions from 1995- to 1996 finished the 2576-m deep geothermal well. At the construction of the well we paid attention to the characteristically geological structure of the zone:

- 0-988 m Neogen – closed with an 13 3/8 inch steel casing
- 988-1887 m Jurassic (carbonate rocks) – closed with an 9 5/8 inch steel casing
- 1887-2576 m Middle Triassic (fractured limestone and dolomites) –uncased borehole

## FH 3001 H BEIUS.The construction of the well, characteristically geological structure



## **I. a.The geological characteristics of Beius geothermal reservoir**

The Beius Basin lies between the above-mentioned massifs, interrupting the cropping out of the structures is composed of a base of mesozoic carbon rocks and permian rocks, structured as fallen blocks and rising blocks covered by sediments formations (pliocen , and miocen age), is formed by marlstones- shales, sands, microconglomerates, volcanic rocks and coal layers.

The Codru Nappe System lies south of the Bihor Autochthon, being developed especially in the Codru-Moma Mts and the Bihor Mts.

Bihor Autochthon ,unit the northernmost and lowermost visible one of the Apuseni Mts. Tectonic edifice,crops out in a large tectonic halfwindow,bordered to est de Finis Nappe and the south-west by the Codru nappes.

The bassement are one nappe-system structure and formed in Messozoic, lather modified by normal faults activated in Neozoic.

The Codru Nappe System lies south of the Bihor Autochton, being developed especially in the Codru-Moma Mts and the Bihor Mts.

**-Permian** is formed by conglomerates and sandstones interbedded by volcanics rock.

**-Triassic** belongs to The Codru Nappe System and begin with sandstone overlaid by dolomites and dolomitic limestone. The main geothermal aquifers are situated in fissured dolomites.

**-Jurassic** belongs to The Codru Nappe System and is formed by micritic limestone, marly limestone and shale and marly claystone.

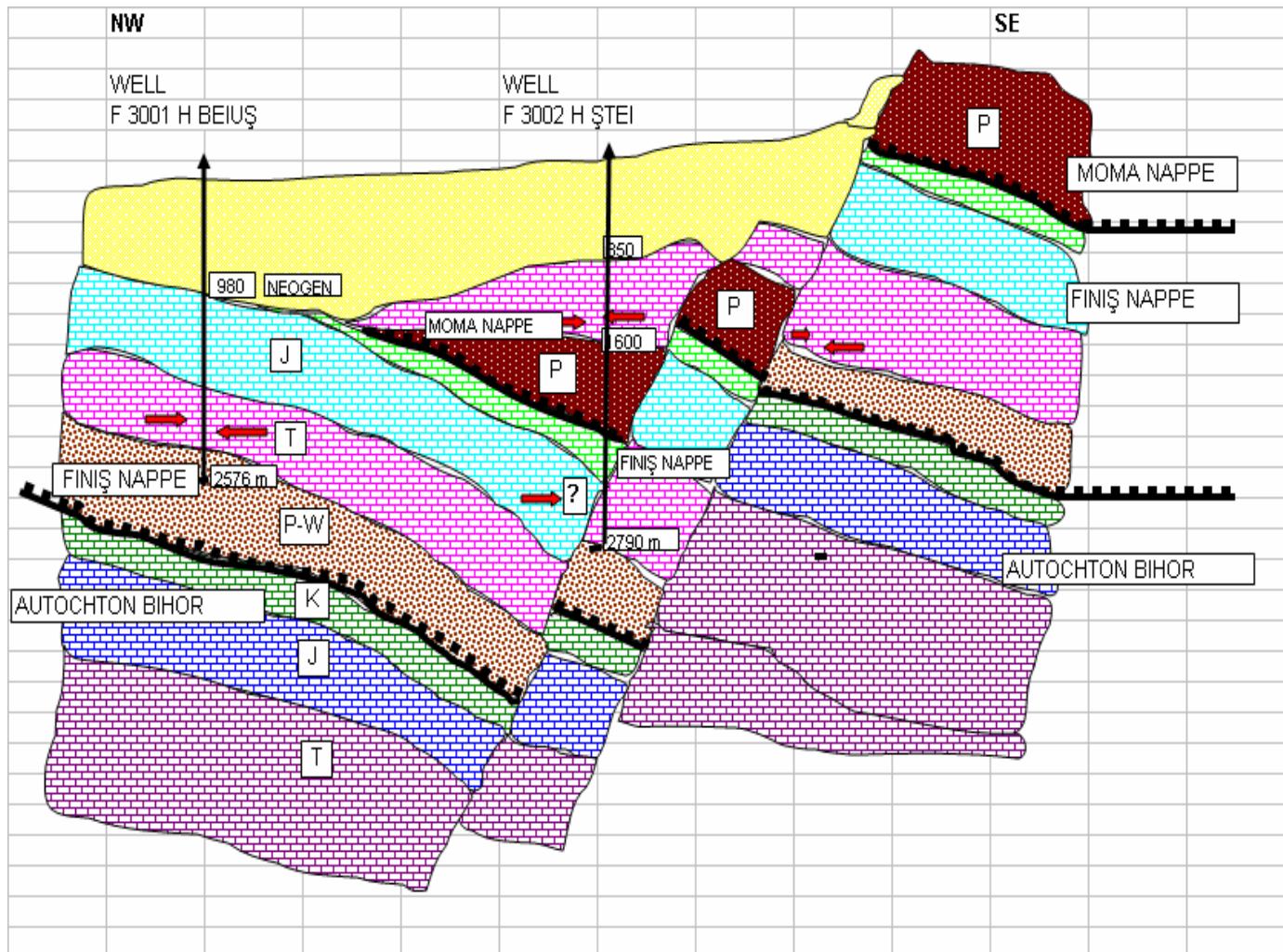
**-Cretaceous** Is weakly represented inside the Codru formations and is formed by Clay and Sandstones

**-Neogen** formations

Is formed by molasse formation, and belongs to the pliocene and miocene and is formed by marlstones, clay, sands, sandstone weakly cemented conglomerates volcanic rocks interbedded by coal layers.

**-Quaternary** outcrops on seminifivative area inside Beius basin and is formed by very poorly sorted sands with grain size from medium grained to very coarse and pebbles size.

## CORELATION OF THE AUTOCHTON BIHOR AND THE UNITS OF THE CODRU NAPPE



CROSS SECTION ALONG THE WELL-3001 BEIUS BETWEEN THE WELL 3002- STEI

Designer  
MIRCEA NOVAC

## **I.b.The result of the hidrogeological researches supported by the INCO-COPERNICUS Program**

The financial support from EC (INCO-COPERNICUS) was used to buy the equipment (deep Well Lines haft Pump Assembly, control and metering outfit ,pump house and electrical mains)and for engineering and scientific work.

### **I.b.a.Conceptual model**

The Triassic aquifer geothermal system has a large span, practically on the entire surface of Beius basin. Edge areas constitute the alimentation system, water circulating on a system of cracks and flows.

The aquifer is under pressure with negative water levels (-18,48 meters at 3001 H Beius) or artesian flow (30002 H Stei), depending of the position of the tectonic blocks where the well is located.

The flow areas were determined using deep well measurements on the following intervals: 2370 m to 2280 m, 2130 m to 2030 m and 1890 m to 1873 m.

### **I.b.c .Assessment of the potential of geothermal reservoir**

The main phases of reservoir assessment were:

- 1.Ghatering of data collected during the pumping test
- 2.Analysis of production characteristic of the well
3. Models used to predict the water level changes in well, for different future production scenarios
- 4.Analysis of chemical data, white emphasis on estimating the potential for scaling and corrosion, future chemical changes and possible reservoir cooling.

### **I.b.d. The production test (during the period from April and September 1999)**

A down-hole pump was installed at a depth of 149 m, for the purpose of testing the well and geothermal reservoir

The hydro-geological parameters were determined on the basis of the efficiency tests and deep well measurements. The following data emerged:

- coefficient of transmissivity  $T=132,46$  cubic meter/meter/day
- filtering coefficient  $K=0,64$  meter/day
- average static pressure  $P_s=196,73$  atmospheres
- flow capacity  $kh=47$  darcy/meter
- specific drawdown  $S/Q=1256.5$  m/m<sup>3</sup>/s
- hydrodynamic efficiency of the well 3001 H  $E=77,5\%$
- deep well temperature at 2460 meters is 88 Celsius degrees and the temperature at the well head is 84 Celsius degrees

### **I.b.e. The quality characteristics of the geothermal water**

Chemical characteristics:

- water type: sulfurous sodium bicarbonate
- low mineral contents 0,4-0,9 gram/liter
- total hardness 12,73 G
- bicarbonates 256 mg/l

From a chemical point of view, the geothermal water of the well 3001 H is similar to the geothermal waters of Baile Felix – 1 Mai, except a higher increase of Ca 2+ and Mg 2+ ions.

### **I.b.f.Hydrodynamic modeling and evaluating Beius reservoir**

The test results were evaluated by VAG Iceland and completed by simulation by GEOTHRMIE-NEUBRANDENBURG Germany.

Variation graphics were drawn for the determinant parameters as follows:

- flow rate as a function of time
- dynamic level as a function of time
- dynamic level as a function of flow rate

The reservoir evaluation main issue was estimating the long-term potential of the well, and elaborating a model for the reservoir.

### **I.b.g. Assessment of the heat resources of geothermal reservoir using one well**

The long-term production potential of well H-3001 is estimated to be 60 l/s for pump depth 150 m and 90 l/s for pump depth 250 m.

$$W=Q_e (T_e - T_r) \delta C \text{ [ Gcal/h ]}$$

$$Q_e = 147,6 \text{ m}^3/\text{h} \text{ (pumping rate)}$$

$$T_e = 84 \text{ }^{\circ}\text{C} \text{ (well temperature)}$$

$$T_r = 40 \text{ (reference temperature)}$$

$$\delta = 970,4 \text{ kgf/m}^3 \text{ density geothermal water}$$

$$C = 982,2 * 10^{-9} \text{ Gcal/h specific heat}$$

$$W = 6,189 \text{ Gcal/h} = 148,5576 \text{ Gcal/day} = 54223,52 \text{ Gcal/year}$$

## **II.Systems for exploitation and use of geothermal waters**

The exploitation of geothermal waters from Beius perimeter is achieved by pumping the water from the main well to four substations equipped with heat exchangers. Each substation has two heat exchangers, one for sanitary hot water and another one for heating agent.

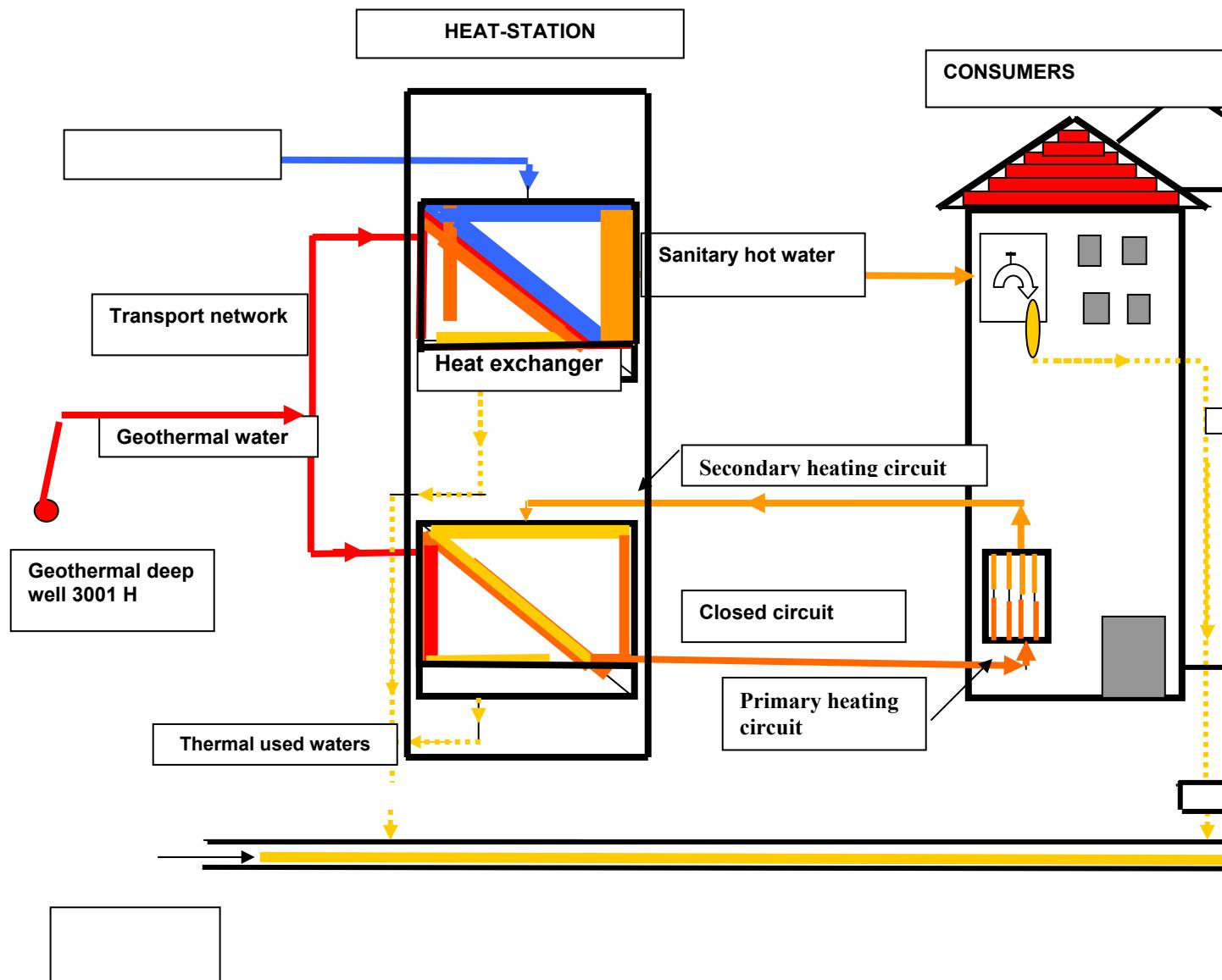
The sanitary hot water system is composed by a cool water network, that flows through the heat exchanger accumulating heat from the geothermal water and is pumped afterwards to the final consumers. The used hot water is directed to a cleaning station and a sewerage system.

The heating circuit is a closed one, closed at one end in the heat exchanger from the substation and at the other end in the radiators of the final users.

The cooled geothermal water exiting the heat exchangers is sent to the sewer network.

### III.Measuring the energy production

The quantity of geothermal water delivered to the consumers is metered and according to the flow it is possible to calculate the thermal energy quantity, measured in Gcal. According to these figures, the company pays the mining authority a royalty tax for the state budget.



**TECHNOLOGICAL SCHEME FOR THE USE OF GEOTHERMAL ENERGY  
EXTRACTED FROM 3001H WELL BEIUS**

### IV.Reserve assurance degree

During experimental exploitation of the well 3001H Beius we have not encountered decreases of water temperature from the well or other parameter changes for flows between 10 and 40 liters/second. As a consequence, the realimentation rate is sufficient to cover exploitation flows

with the installed pumping system, regarding the heat reserves according to the evaluation documentation.

Currently we are continuing the research process for geothermal waters in Beius basin, area Beius-Delani where we are drilling 3003 H Beius well, in order to achieve further data regarding the potential of the thermal aquifer and adequate pumping equipments. After we have completed 3003 H Beius we will be able to develop the exploitation in Beius area, according to future technical studies.

#### **V. The degree of use for the exploitation capacities**

The maximum capacity for the pumping equipment from well 3001 H Beius is 50 l/s, equivalent to 7,72 Gcal/hour or 5558 Gcal/month.

The whole need of energy for Beius town in a month is 8000 Gcal for a month, but currently we are still working to develop the network in order to connect all main potential users.

We are estimating that in 2004 we will deliver an average of 5000 Gcal/month, equaling our maximum exploitation capacities. This will lead to a use degree of 100%.

#### **VI. The geothermal energy using for the district heating in Beius**

The submersible pump has produced a flow of water equivalent to 65.000 MWt in the last year. The feasibility study proved the opportunity of investment. After this, Transgex Company invested in construction of a 3.5-km long thermal insulated distribution pipeline (the main network); in concession and retechnologising three old substations. In the 2001-2002 wintertime the City Hall, the hospital, offices, schools, and other public and commercial buildings were heated with geothermal energy. Also from geothermal energy benefited 1000 from the 1430 apartments existing in Beius.

In May 2002 we started to drill the second well in the heart of the town. The government financed this work, on a research project basis of over 1 million Euro. The new well together with the old one would assure the necessary thermal energy consumption for the whole town.

#### **VII. Concrete investment plans in the next future**

The value of the mentioned investment in Beius has grown to 350.000 Euro. The development is continuing with the drill of a drinking water well, with the rehabilitation of the secondary network for 84 apartments, realisation of flow metering system and new principal network. The value of the new investment is estimated to 550.000 Euro.

The current price paid by the population of Beius for Gcal is 10 Euro. There are still in Beius some power stations that produce energy using wood and oil, operated by companies and institutions, and in their case, the price at which they produce a Gcal exceeds 75 Euro.

