STUDY ON THE GEOTHERMAL ENERGY ON ROMANIAN TERRITORY

Natalia-Silvia Asimopolos*, Laurentiu Asimopolos

Geological Institute of Romania, Caransebes Street, 1, Bucharest, 012271, Romania

ABSTRACT

Geothermal energy is an unconventional renewable energy source with enormous potential for exploitation, of which only a very small part is currently used today. Worldwide, countries with a high geothermal potential are Iceland, New Zealand and in Europe there are Hungary, Romania and Serbia. In these countries, as well as in many others, there are geological conditions that allow to geothermal phenomena to manifest on the surface of the Earth. The limited exploitation of this energy resource is still limited by existing technologies and by the high cost of deep-water equipment.
For a good image of the Romania's geothermal potential, we present, in our paper, the temperature map at 3000 m deep and the geothermal flow map on the surface. These maps made with the Surfer program, based on the data presented on geophysical portal on the WEB page of the Geological Institute of Romania.

***Keywords**: environment, geothermal, renewable energy, geophysical data, geothermal flow.*

1. INTRODUCTION

Geothermal energy is considered to be the Earth's most important energy resource for the future, given the estimate that the temperature in the centre of the Earth is equal to the temperature at the surface of the Sun. The problem lies in finding the most suitable technologies for exploitation both in areas with geothermal phenomena on surface and in the areas with these manifestation in underground (Veliciu, 1998).

The main geothermal systems discovered on the Romanian territory are found in porous permeable formations, such as sandstones interbedded with clay and shales or carbonate formations of Triassic age in the basement of the Pannonian Basin and Aptian age in the Moesian Platform.

Geothermal reservoir Oradea is located in the Triassic limestone and dolomites at the depths between 2200 m to 3200 m on an area of about 75 Km^2 with a total flow rate of 140 L/s geothermal water with temperatures at the head of 70-105 degrees Celsius. Recharge area is in the Northern edge of the Padurea Craiului Mountains and the Borod Basin. Although there is a significant recharge of the geothermal system, the exploitation with a total flow rate of 300 L/s generates pressure draw down in the system (Cohut, 1998).

**Corresponding author: Natalia Asimopolos, E-mail: natalia.asimopolos@igr.ro*

The Bors geothermal reservoir is a tectonic closed aquifer with a surface area of 12km^2, situated at about 6 km north-west to Oradea with geological framework is completely different from the Oradea geothermal reservoir, although the reservoirs in the same fissured carbonate formations.

In relation to geothermal resources and, especially, to their exploitation for geothermal energy utilization, sustainability means the ability of the production system applied to sustain the production level over long times. Sustainable production of geothermal energy therefore secures the longevity of the resource, at a lower production level (Rybach, 2003).

2. CHARACTERISTICS OF GEOTHERMALISM IN ROMANIA AND GEOLOGICAL CONNECTIONS

Thermal methods consist of measuring thermal gradient and satellite, which can be used to determine the Earth's surface temperature and thermal inertia of surficial materials, of thermal infrared radiation emitted at the Earth's surface.

Thermal gradient measuring, with a knowledge of the thermal conductivity provides a measure of heat flow. Conditions that may increase or decrease and heat flow are influenced by hydrologic, topographic factors and anomalous thermal conductivity.

Also, oxidation of sulphide bodies in-place or on waste deposits, if sufficiently rapid, can generate thermal anomalies, which can provide a measure of the amount of metal being released to the environment.

The geothermal gradient on the territory of Romania, the increase of the temperature with the depth, has an average value of 2.5-3°C/100 m, which corresponds to a temperature of 100°C at 3000 m deep. There are many areas where the value of the geothermal gradient differs considerably from this average. For example, in areas where the rock plate suffered rapid dips and the basin was filled with sediment "very young "from a geological point of view, the geothermal gradient may be less than 1°C/100 m. On the other hand, in other geothermal areas the gradient exceeds much this average.

These areas are true underground thermal reservoirs of potentially high geothermal energy which under certain favourable conditions can be exploited to serve heating installations and domestic hot water systems.

The geothermal prospecting for the entire territory of Romania, carried out by temperature measurements allowed the development of geothermal maps, highlighting the temperature distribution at different depths.

We made maps from figures 1-4, using the Surfer software, based on the data presented on geophysical portal on the WEB page of the Geological Institute of Romania.

These maps indicate temperature of 3000 m depth (Fig. 1), geothermal flow (Fig. 2), Bouguer anomaly, after filtering and smoothing of gravity data (Fig. 3) and Free Air anomaly, after filtering of gravity data with 2D Fourier analyses, on the Romanian territory.

By overlaying this geophysical information, corroborated with other geological, geophysical, geodetic, laboratory and drilling data, conclusions can be drawn regarding the geothermal systems on the territory of Romania.

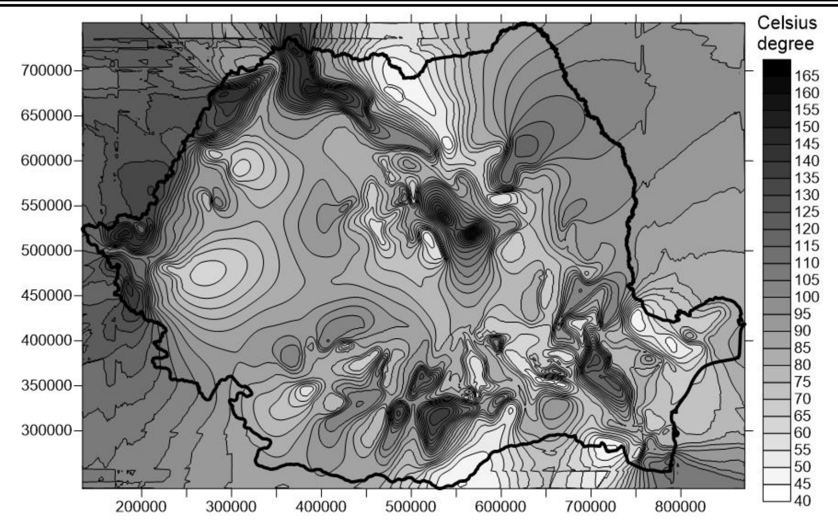

Figure 1. Temperature of 3000 m depth on the Romanian territory, after data from the geophysical portal of Geological Institute of Romania

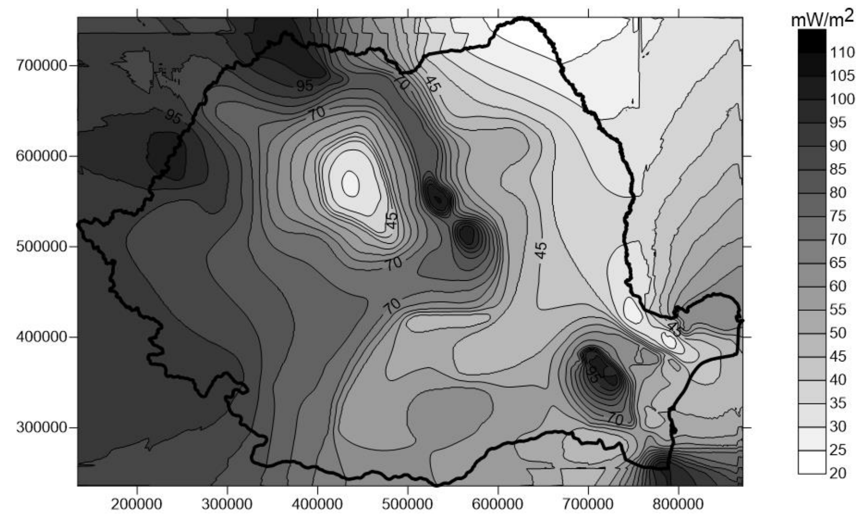

Figure 2. Geothermal flow on the Romanian territory, after data from the geophysical portal of Geological Institute of Romania

Geophysical data obtained through various methods and geophysical modelling provide generalized and non-unique solutions to the geometry of underground geological relations as well as to the physical characteristics of different formations.

The non-uniqueness of these models (solutions to the direct problem) arises from the impossibility of knowing the boundary conditions between different strata, which together with the propagation equations of the different fields (depending on the geophysical method used for the investigation of the basement) form the systems that offer the solutions of the model.

Gravity measurements define anomalous density within the Earth. Ground-based gravimeters are used to precisely measure variations in the gravity field at different points. Gravity anomalies are computed by subtracting a regional field from the measured field, which result in gravitational anomalies that correlate with source body density variations. Positive gravity anomalies are associated with shallow high-density bodies, whereas gravity lows are associated with shallow low-density bodies.

Physical parameter measured in gravity method is total attraction of Earth's gravity field (the vertical attraction of anomalous masses) for calculating the rock density contrast. In gravity are important other parameter such as gradient of gravity, analytical continuation of gravity field, filtering's and smoothing of gravity data.

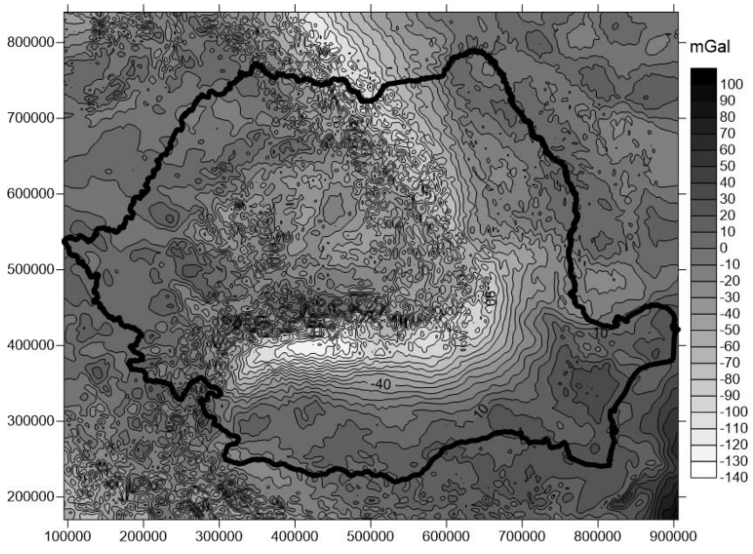

Figure 3. Bouguer anomaly, after filtering and smoothing of gravity data, on the Romanian territory (data from the geophysical portal of Geological Institute of Romania)

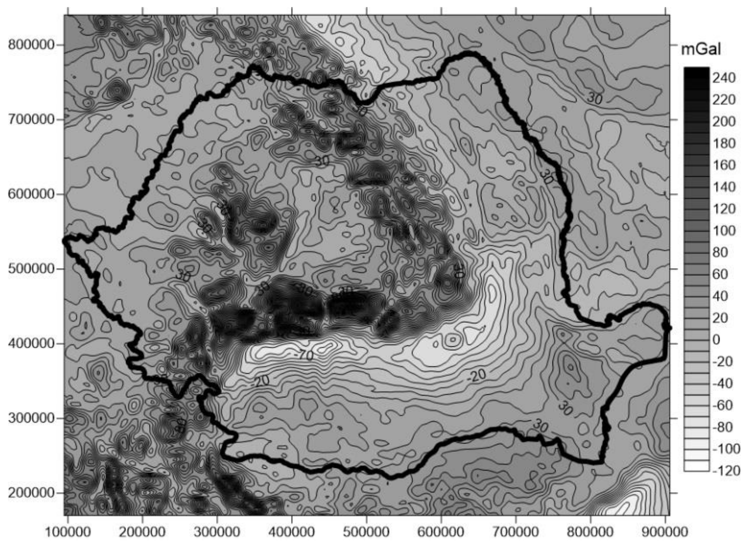

Figure 4. Free Air anomaly, after filtering of gravity data with 2D Fourier analyses, on the Romanian territory (data from the geophysical portal of Geological Institute of Romania)

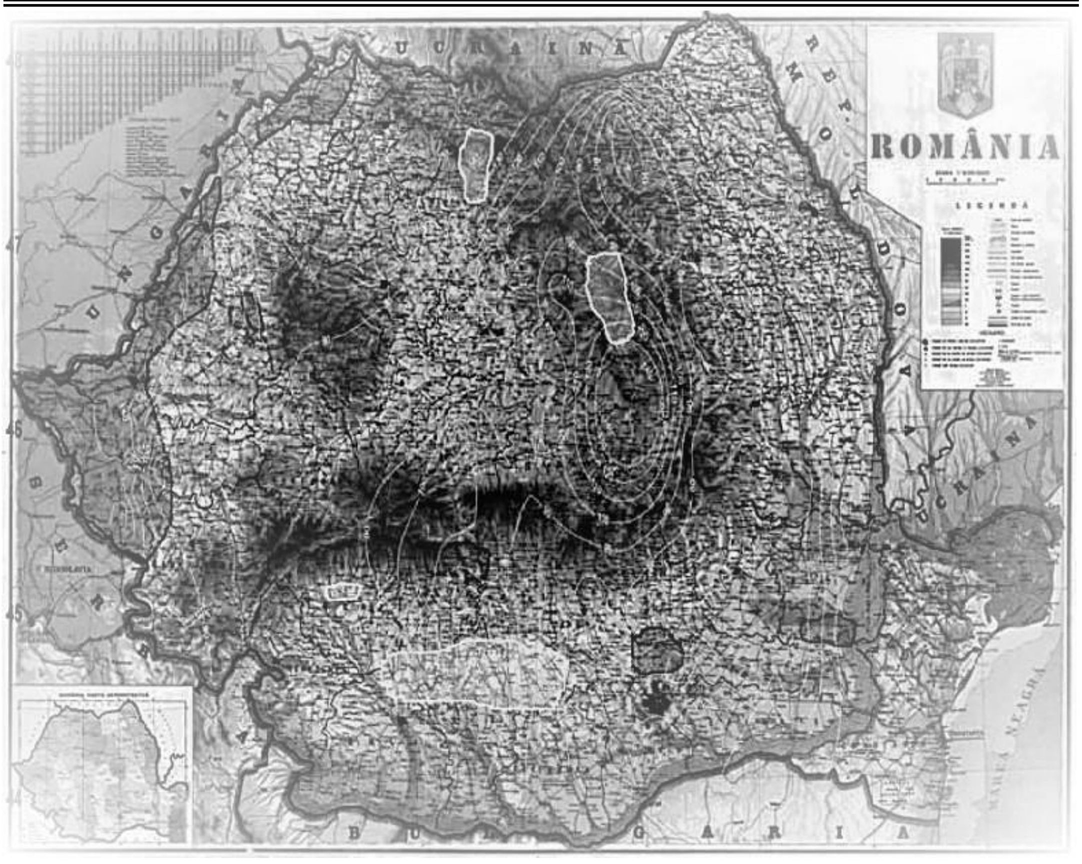

Figure 5. Geothermal map on the Romanian territory (after IGR, 2006)

The map from fig. 5 indicate (the areas delimited by dark polygons) that geothermal resources concentrate the 60 to 120°C (for the exploitation of geothermal water for the production of thermal energy) and possible areas for exploiting geothermal energy in order to generate electric power (the areas delimited by light polygons).

3. CONCLUSION

The knowledge about geological-geophysical-structural data, rock’s and hydrogeological’s features is essential to characterize the geothermal resources.

The main geothermal resources in the country are found in porous and permeable sandstones and siltstones (such as in the western plains), or in the fractured carbonate formations (such as at Oradea and Bors from the western part of the country).

On the territory of Romania, more than 200 drillings for hydrocarbons met at depths between 800 and 3500 m of geothermal resources.

The use of extracted geothermal energy is used in the proportion of 37% for heating, 30% for agriculture (greenhouses), 23% for industrial processes and 7% for other purposes.

Geothermal waters represent an inexhaustible and non-polluting energy resource, of great importance, which will have to be used in the future and for the production of electricity.

Acknowledgments**:** This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI – UEFISCDI, project Nr.16PCCDI/2018: “Institutional capacities and services for research, monitoring and forecasting of risks in extra-atmospheric space”, within PNCDIII.

REFERENCES

Cohut I., 1998, *Utilisations of Geothermal resources in Romania*, Romanian Journal of Geophysics, vol. Special Issue, pp. 17-24

Rybach L., 2003, *Geothermal energy: sustainability and the environment* Geothermics, **32**(4-6): 463-470

Veliciu S., 1998, *Dezvoltari recente in exploatarea geofizica a resurselor geotermale in Romania*, Romanian Journal of Geophysics, vol. Special Issue, pp. 11-16