PROSPECT OF GEOTHERMAL ENERGY RESOURCES USE IN THE EAST SLOVAK BASIN AREA

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Abstract: In the East Slovak Basin there were delineated 16 hydrogeothermal structures in Neogene, volcanic and clastic sedimentary rocks or in Mesozoic carbonate underlier. The most prospective of them are Ďurkov in Mesozoic carbonate underlier and Beša-Čičarovce in a buried stratovolcano. Besides that there is a possibility of dry rocks heat utilization from crystaline rocks complex of deeper underlier.

Key words: East Slovak Basin, geothermal energy, heat flow

Introduction

East Slovak Basin is from geographic-geological viewpoint situated in a dividing area between the West and East Carpathians. This basin represents western part of a higher order regional unit so called Trans-Carpathian Depression, eastern part of which is situated in Ukrainian territory. (Fig. 1).

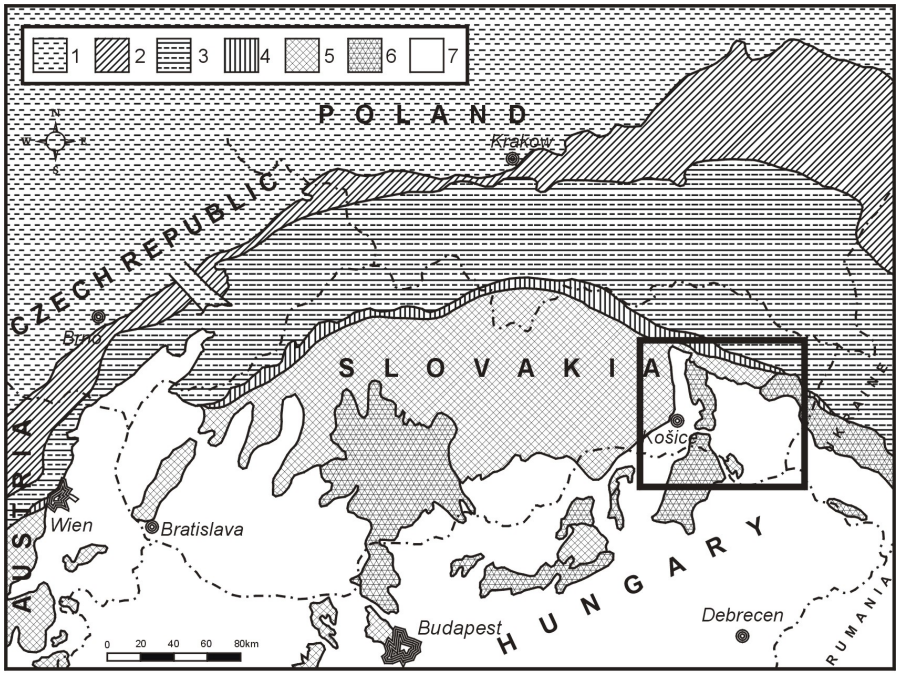

Fig.1. Position of studied area within the West Carpathians
1 - European Platform, 2 - West Carpathians and Alpine Foredeep, 3 - Alpine - Carpathian Flysch Belt, 4 - Pieniny Klippen Belt, 5 - Inner Alpine - West Carpathian Units, 6 - Late Cainozoic Volcanic Rocks, 7 - Neogene Basins

From genetic viewpoint this area represents longitudinal intramount depression filled by Neogene sediments and volcanics. This basin morphologically represents north-eastern promontory of Pannonian Basins System.

During more than 50 years of systematic oil-geological exploration a quantity of knowledge was gathered here, as on geological structure and hydrocarbon fields as on thermal setting and geothermal waters. It is a case of nearly 20 000 analyzed water samples and temperature measurements in the depth span from surface up to 4200 m what enables us to distinguish in this region several prospective geothermal areas. Geothermal energy resources can be gained either from aquifers or by utilization of hot dry rocks.

Geological setting and hydrogeological conditions

Geothermal water is bound to three types of rock environment:

- Mesosoic carbonate rocks with secondary void and fracture porosity in the undrelier of Neogene sedimentary filling
- Sands and sadstones with primary porosity in Neogene sedimentary filling
- Fractured andesites and volcanoclastics of buried Sarmatian stratovolcanoes.

Hot dry rocks energy can be gained from Young-Palaeozoic low-metamorphosed clastic rocks and Old-Palaeozoic crystalline complexes of Neogene sedimentary filling underlier.

Evaluation of the East Slovak Basin thermal setting is based on measurements of stabilized temperatures in 45 deep wells. Thermal field in 1000 m depth below the surface is a relatively stable. In marginal parts of the basin temperatures fluctuate about 50 °C and in central part about 60 °C. Temperatures on pre-Neogene underlier surface fluctuate in a very wide span, depending on depth of burial, from 25 °C in marginal parts up to more than 325 °C in central parts of the basin.

Knowledge of thermal properties of rocks has an extraordinary significance primarily for strucures recovered by re-injection system because of their need for the modelling of geothermal water recovery and its re-injection regarding to the optimization of withdrawal – re-injection systems life. Heat capacity of geothermal water reservoir rocks, i.e. Neogene sands and sandstones, has a mean value of 1091.2 ± 46.2 J/kg.K, Sarmathian volcanics 1175.0 ± 111.3 J/kg.K and Mesozoic carbonates 811.4 ± 14.5 J/kg.K. Earth's heat flow density in the East Slovak Basin was established on 30 wells and fluctuates in span of 82.1 – 121.6 mW/m^2.

Mineralization of geothermal waters in the East Slovak Basin depends the same on depth of their burial and position. Water in shallow horizons (approximately to 1500 m) and on basin margin is low to medium mineralized up to 10 g/l. In deeper parts of the basin there are very highly mineralized brines with a total mineralization frequently above 100 g/l.

Hydrogeothermal structure Ďurkov

Hydrogeothermal structure Ďurkov was proven by 3 wells in western part of the East Slovak Basin. It is possible to gain from depth between 2200 to 3200 m by one well free flow of water in quantity of 60 -170 l/sec with a well head temperature approximately of 130 °C and mineralization of 30 g/l here. It is a case of closed structure requiring withdrawal – re-injection system.

This very good result impulsed a judgement of geothermal energy resources utilization possibilities in the whole East Slovak Basin. Based on processing of quantity of data 14 prospective areas of interesting amount of geothermal water occurence and 7 geothermic regions suitable to use hot dry rocks with a reservoir temperature of 130° and 180 °C were set in the East Slovak Basin (Fig. 2).

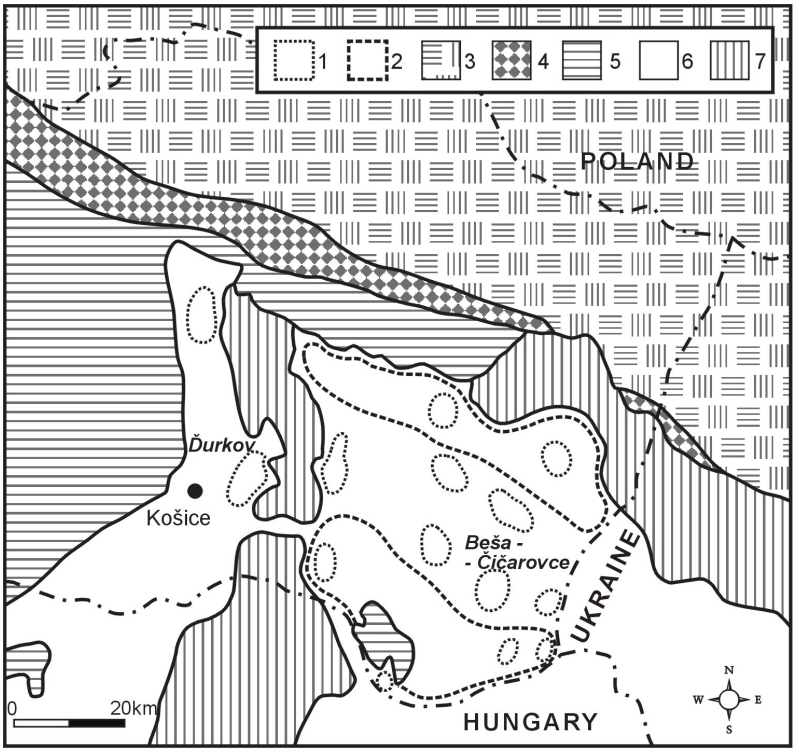

Fig.2. Geothermal energy prospective areas in the East Slovak Basin
1 - Geothermal waters, 2 - Hot dry rocks, 3 - Alpine - Carpathian Flysch Belt,
4 - Pieniny Klippen Belt, 5 - Inner West Carpathians, 6 - Neogene Basins,
7 - Neovolcanics

Hydrogeothermal structure Beša-Čičarovce

Another delineated hydrogeothermal structure of buried Sarmatian stratovolcano Beša-Čičarovce has an approximate acreage of 86.5 km^2. Surface of the stratovolcano is situated in depth from 350 to 2000 m with an ascertained maximum thickness of 3000 m. Heat flow density is approximately 120 mW/m^2. Temperature on stratovolcano surface, depending on its burial depth, fluctuates in span of 30° to 120 °C. Geothermal water inflow with reservoir rocks temperature of 135 °C can be expected from depth approximately of 2500 m. Porosity fluctuates in interval from 7.3 to 24.6 %. Cumulative thickness of reservoir rocks based on loging of oil and gas wells is about 300 m.

Hydrogeothermal structure Beša-Čičarovce has an accumulated prospective thermal-energy potential of 288.75 x 10^6 GJ of geothermal energy. For its use there is required a withdrawal – re-injection system. Life of 40 yers can by assured for withdrawal – re-injection wells using suitable areal distribution and optimal way of recovery of these wells. Prospective thermal-energy potential of geothermal energy resources of this structure then represents 228.9 MW.

Present effectiveness of operated geothermal resources utilization in Slovakia, conditioned above all by technical and economic possibilities, represents 48.5 %. Regarding this effectiveness prospective thermal-energy potential of Beša-Čičarovce then represents 111.0 MW.

Conclusions

These large resources of geothermal energy in the East Slovak Basin would not be unnoticed. It can be believed they will attract interest of potential investors and will be profitable not only for those investors but also for the whole area.

References:

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