Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

GEOTHERMAL RESOURCES OF THE CZECH REPUBLIC – GENERAL OVERVIEW

Vlastimil Myslil, Michal Stibitz

GEOMEDIA Ltd., Spolecna 35, 182 00 Praha 8, Czech Republic

1. Introduction

Numerous studies concerning geothermal potential in both regional and local scales have been performed during the past 30 years in the Czech Republic. The presented paper provides a brief inventory of the known geothermal resources of the Czech Republic. The resources are available either directly in the tectonic structures of the crystalline of the Bohemian Massif or in sedimentary basins covering the Massif which represent secondary accumulations of geothermal heat originating in the deep structures of the Bohemian Massif.

2. General Geology and Geothermics

The territory of the Czech Republic consists of two different geological structures: the Bohemian Massif and a part of Carpathian system. Both main structures have different conditions for the geothermal heat flow. The Bohemian Massif represents an old consolidated basement which is formed by Proterozoic and Paleozoic crystalline rocks. These basement rocks are overlain by several sedimentary basins of Paleozoic, Cretaceous and Neogene age. The West Carpathian unit is in general younger and is represented by the nappe structure of alpine type.

The basement of Bohemian Massif is tectonically affected by Variscan, Hercynian and Alpinian orogenetic activities, which caused the block faulting as well as folded chains by various types of movements. Number of sedimentary basins have developed on the hard-rock basement, such as:

- *Barrandian* (Precambrian clastics and shells up to Silurian shells and Devonian carbonates), tectonically affected to the total depth of about 1000m.
- Permocarboniferous platform terrestrial sediments (*Pilsen - Rakovník Basin*, *Kladno Basin*, *Zacler Basin* and *Upper Silesian Basin*), which include clastics on the bottom and then alternate fine sandstones, shells with coal beds. The total thickness of sedimentary formations vary from 300m to 400m in the first two basins up to 1500 - 2000m in *Zacler* and *Upper Silesian basins*.
- Czech Cretaceous basin in the north of Bohemian Massif is represented by Cenomanian fine sandstones and clay, Turonian marls and sandstones and Senonian fine sandstones and clay. The total thickness of sediments reaches a maximum of 600m. Two small depressions in the southern part of Bohemian Massif at the *Budweis* and *Wittingau basins* are tectonically limited. The total thickness is 400m near *Budweis*. The *Wittingau basin* is shallow with a maximum of only 150m.
- Of the many Tertiary basins the more promising ones are: *Falkenau-Karlsbad Tertiary basin*, *Chomutov -Brüx- Teplice Tertiary basin* and Foredeep on the contact of the Bohemian Massif and West Carpatians which is followed by Vienna basin. Falkenau-Karlsbad as well as Chomutov-Brüx-Teplice basins reach a maximum depth of 250 m. They are formed by clastics on the base and in further sequence by clay and tuffitic clay which include tertiary coal beds. The upper part is represented by clayey shales. Locally there exist Permian and Creatceous sediments preseved in tectonically sunken blocks. The basement is formed mostly by metamorphic rocks and partly by granite.
- The *Carpathian Foredeep* is divided into three parts with various thickness of sedimentary formations from a few hundred metres up to more than 6000 m. The depth increases to the southwest to the Vienna Basin.The botom of the Tertiary sedimentary formation by Devonian carbonates and granitic rocks.

3. Geothermal Characteristics

3. 1. Temperatures

Data related to geothermal potential are primarily the temperature measurements in various depths in bore holes. These data were collected from 498 measured bore holes on the whole territory of the Czech Republic.

The southern part of the Bohemian Massif is cold with respect to the heat flow. Most of Bohemian Massif shows the heat of low-enthalpy. More promising are only:

- Foreland fault of Erzgebirge,
- the axial and western part of the Bohemian Cretaceous Basin and
- West Carpathian Foredeep from the Vienna Basin up to the Ostrava region in North Moravia.

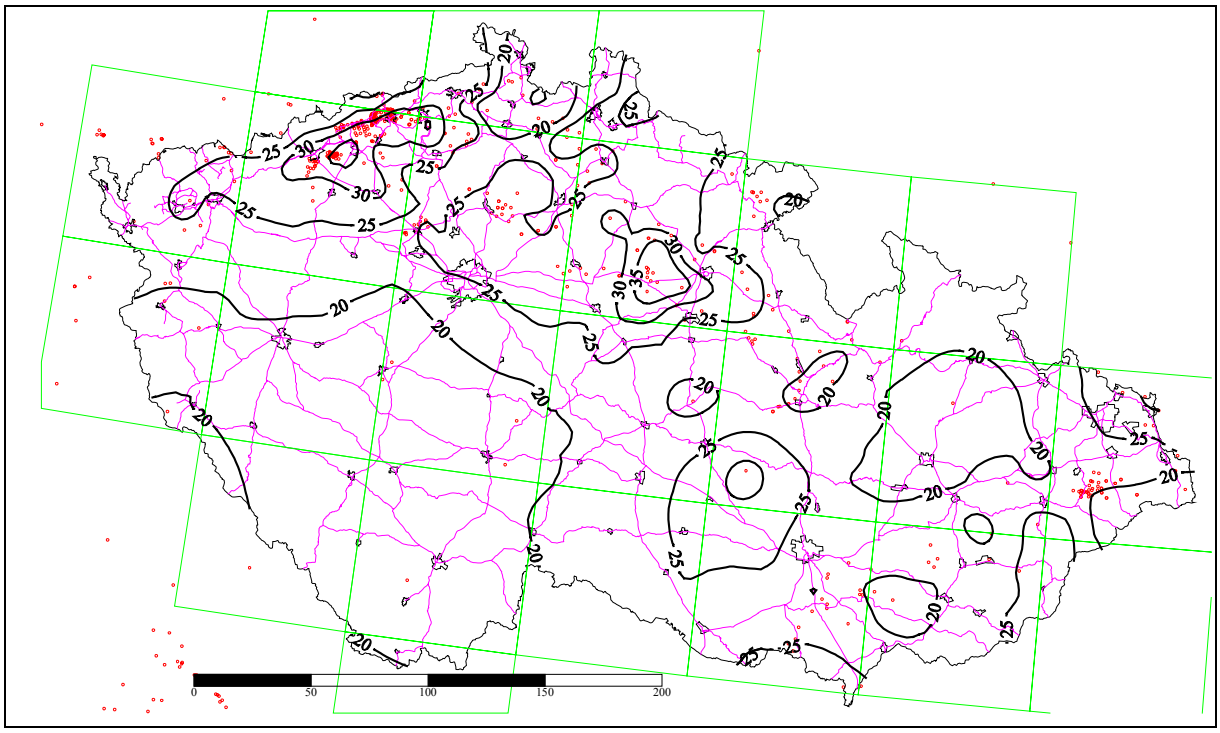

Fig. 1: Geothermal resources of the Czech Republic - Isotherms at the depth of 500 m b.s. [C]

Local anomalies of warm and hot waters in the Czech Republic have been used as spas for a long time. The warmest spring with the temperature 72°C in Karlsbad has been used for many hundreds of years. The other springs have a lower temperature : Teplice Spa 42°C, Jáchymov 32°C, Janske Lazne 32°C, Velké Losiny Spa 34°C, Darkov Spa 28°C.

3.2. Heat Flow

The heat flow on the territory of Czech Republic was measured on more then 200 points. These values were in same cases confronted with the geological position and the form of heat flow isolines was modified following the borderlines of geological structures.

The heat flow map indicates mostly lower value on the south part of the Bohemian Massif (below 50 mWm^{-2}) in Moldanubikum, where the thickness of Earth's crust reaches to more than 42 km. The north part of the Bohemian Massif from the line W - E approximately following Cheb - Praha - Ostrava shows the thickness of the crust of only 32 km.

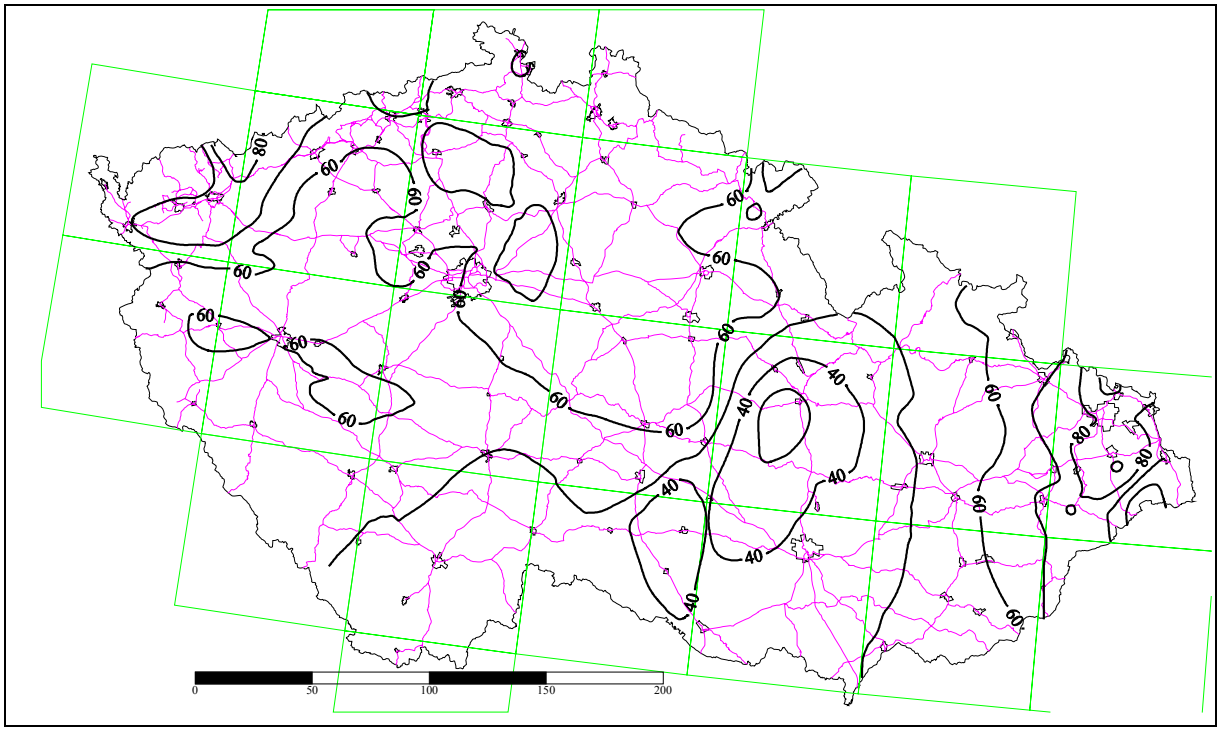

Fig. 2: Geothermal resources of the Czech Republic - Isolines of heat flux [mW/m^2]

The most promising areas of the Bohemian Cretaceous Basin are in its axial part where the average heat flow exceeds 70 mWm^{-2}, tertiary basins in the foreland of Erzgebirge shows heat flow of more than 100 mWm^{-2} and the Foredeep on the border of the Bohemian Massif and West Carpathians reaches the value of heat flow up to 90 mWm^{-2}. There are some anomalies out of these regions, which show also higher value of heat flow. These places are on the junctions of regional fault systems that enable an easier and faster ascent of geothermal heat. The most promising zones are on the junctions of NS and WE faults. The NS faults show also the highest seismicity in south-western part of the Erzgebirge region.

4. Geothermal Potential of the Czech Part of Bohemian Massif

The average value of heat flow in the Bohemian Massif is about 60 mWm^{-2}. Zones with higher heat flow in the Bohemian Massif where geothermal energy is being used or where it would be possible to use it, are the following:

I. Sub-Erzgebirge Region - Egrensian rift
   - *A. Aussig-Teplice-Duchcov Region*
   - *B. Duchcov-Brüx-Chomutov Region*
   - *C. Chomutov - Kadan Region*
   - *D. Falkenau and Cheb Basins*

II. Bohemian Cretaceous Basin

III. Upper-Silesian Basin

IV. Jeseníky Mountains - Silesikum
V. Moravian-Silesian Devonian
VI. Krkonoše (Giant Mountains or Riesengebirge)

Special case are the tectonic structures in crystalline of the Bohemian Massif accompanied by high heat flow and subsequently by warm and hot water occurrence have been used as spas since very long time. The tectonics in the underlying rock of the sedimentary formations functioning either as a thermal isolator or thermal accumulator is of crucial importance for the use of geothermal energy.

5. Geothermal Installations

Geothermal heat of the low-enthalpy is used for domestic and swimming pool heating, and for some small industry. For the use of heat pumps more than 1,000 localities were assessed. Actually about 300 heat pumps were installed with a total of 2 MW of heat energy.

- The small scale private installations are typically used for heating of family houses (output less than 20 kW), hotels, accommodation facilities, swimming pools and small businesses (20 to 100 kW) as well as 3 water treatment plants using heat pumps with output more than 100 kW each.
- A heat pump with 1 MW output has been installed at the Prokop Mine of the Pribram ore mining district in the framework of these research activities. The warm water is pumped from the Prokop shaft (28 °C), the heat pump works with the heat gradient of 10 K and water flux of 10 l.s-1. The heat pump increases the water temperature which was then suitable for heating of the mine facilities as well as of the adjacent administrative buildings.

Further project possibilities have been investigated:

- Feasibility study has shown a potential of heat pump installations of 15 MW in the town of Breclav for district heating.
- In the region of Aussig the thermal water from the Cretaceous aquifer is used for the industry (soap factories) and for the heating of open swimming pool in Strekov.
- Two sites (Mušov and Písek by Jablunkov) were preliminarly studied and prepared for the project of utilization for thermal spas, heating, swimming pool and glass-houses.
- Potential of geothermal energy utilization as a source for geothermal power plant is under investigation in the region of Doupovske vrchy and Bozi Dar close to the Czech-German border.

Ad table 1:

- Research project for geothermal electric power plant in preparation
- project closure in 2001, should serve as project proposal for international funding

Relevant parts of the table 4: Czech Republic - distributed sources and heat pump installations:

Ground or water temp. (°C)	Typical Heat Pump Rating or Capacity (kW)	Number of Units	Type
8	25	30	W
12	20	350	V
9	20	10	H

Tab. 7: Allocations of professional personnel to geothermal activities:

Year	***Professional Person-Years of Effort***					
	1	***2***	***3***	***4***	***5***	***6***
1995	3	0	3	0	0	6
1996	3	0	4	0	0	8
1997	3	0	6	0	0	10
1998	4	0	6	0	0	18
1999	5	0	7	0	0	20
Total	***18***	***0***	***26***	***0***	***0***	***62***

Ad table 8 - only R&D including surface exploration & exploration drilling is relevant:
1985 - 1989 mill. US$ 0.2
1990 - 1994 mill. US$ 0.5
1995 - 1999 mill. US$ 0.3