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Heat Flow Map of the Bohemian Massif

Vladimír Čermák

Geophysical Institute, Czechoslovak Academy of Sciences,
141 31 Praha, Boční II/1a, Czechoslovakia

Abstract. The heat flow pattern of the Bohemian Massif is presented by the compilation of 47 heat flow values. The isolines of the geothermal activity were constructed using also data in the neighbouring countries. A clear relationship between heat flow and the tectonic structure can be observed, higher geothermal activity corresponds to the zones of the weakened earth's crust coinciding with two major deep faulted zones bordering the most rigid central part of the whole massif.

Key words: Geothermics – Heat flow – Bohemian Massif.

The Bohemian (Czech) Massif is an approx. lozenge-shape consolidated segment of the Variscides (part of Meso-Europe) situated in Central Europe. Tectonically the Bohemian Massif represents a platform-type block, genetically and structurally complicated, emerging in a form of a horst from the surrounding area. In the south and south-east the massif submerges below the Neogene foredeep of the Alpine-Carpathian Neoidic belt, in the west it is limited by a number of faults separating it from the Mesozoic of the Bavarian plate and in the north and north-east it is bordered by Permian and Triassic sediments of the Palaeozoic platform (North-German – Polish Lowland).

Already the first geothermal measurements in the Bohemian Massif revealed the characteristic heat flow pattern (Čermák, 1968). At present there are 47 heat flow determinations in the Czechoslovak part of the massif (Čermák, 1976); additional information was obtained from geothermal measurements in or close to the marginal parts on the territories of the Federal Republic of Germany (Haenel, 1971), Austria (Haenel and Zoth, 1973), German Democratic Republic (Hurtig and Schlosser, 1975) and Poland (Majorowicz, 1973). Extensive heat flow investigation revealed the heat flow field along the Carpathian Frontal Foredeep (Čermák, 1975b), the contact zone between the Bohemian Massif and the Western Carpathians.

The mean heat flow in the Bohemian Massif is 67.9 mWm^{-2} (i.e. 1.62 μcal/

Table 1. Heat flow in the Bohemian Massif

Region	Number of data	Mean heat flow		Standard deviation	Standard error
		μcal/cm²s	mWm^{-2}	mWm^{-2}	mWm^{-2}
Intramontane stable block	14	1.40	58.6	6.5	1.7
Cretaceous Table	20	1.70	71.4	12.8	2.9
Area of intensive Variscan tectogenesis	10	1.76	73.8	11.5	3.6
Total	44	1.62	67.9	12.4	1.9

cm^2s), when 3 anomalous values from the hydrothermally disturbed area of Teplice (Čermák, 1967) were excluded. More statistics of the mean heat flow values within the Bohemian Massif can be found in Table 1.

Figure 1 shows the heat flow map of the Bohemian Massif. The lowest heat flow was observed in southern and central parts, i.e. in areas where the crustal thickness reaches its maximum value of about 40 km (Beránek and Dudek, 1972). The characteristic heat flow value in the so-called stable intramontane block, which forms the nucleus and the most rigid part of the whole massif (Zoubek and Malkovský, 1974), is 50–60 mWm^{-2}. Generally the heat flow is increasing in all directions as the crustal thickness is decreasing. To the north-west and to the north-east the central part is bounded by two zones of the relatively weakened crust (32–34 km), which separate the stable intramontane block from the area of intensive Variscan tectogenesis. Both these zones, called rift structures by Kopecký (1972), are typical with increased geothermal activity.

In the Labe rift zone or in the Bohemian Cretaceous Table in the north-eastern Bohemia the highest heat flow values group into a belt which roughly coincides with the axis of the whole sedimentation basin (Čermák et al., 1968). This zone is believed to represent an old tectonic suture in the frontal area of the Caledonian range and it has been steadily subsiding relatively to the adjacent regions since the Late Palaeozoic.

The geothermal activity in the north-western part of the Bohemian Massif is also higher and is probably connected with higher content of radioactive matter in the basement rocks of the Krušné Hory Mts. The igneous rocks forming the roots of the mountains and some Late Variscan granitic plutons belong to the most radioactive rocks of the Bohemian Massif (Matolín, 1970). There are no direct data on the heat flow inside the Krušné Hory graben (Ohře rift zone), however, in view of the deep structure the situation here is similar to, that beneath the Cretaceous Table and the increased geothermal activity may be expected here. The increased supply of heat from below this zone can be further related to intensive Tertiary volcanism, thermal springs and discharges of CO_2 along both these zones (Kodým, 1960; Kačura et al., 1969).

While the characteristic temperatures at the Mohorovičić discontinuity beneath the most stable parts of the Bohemian Massif are 500–550 °C at the

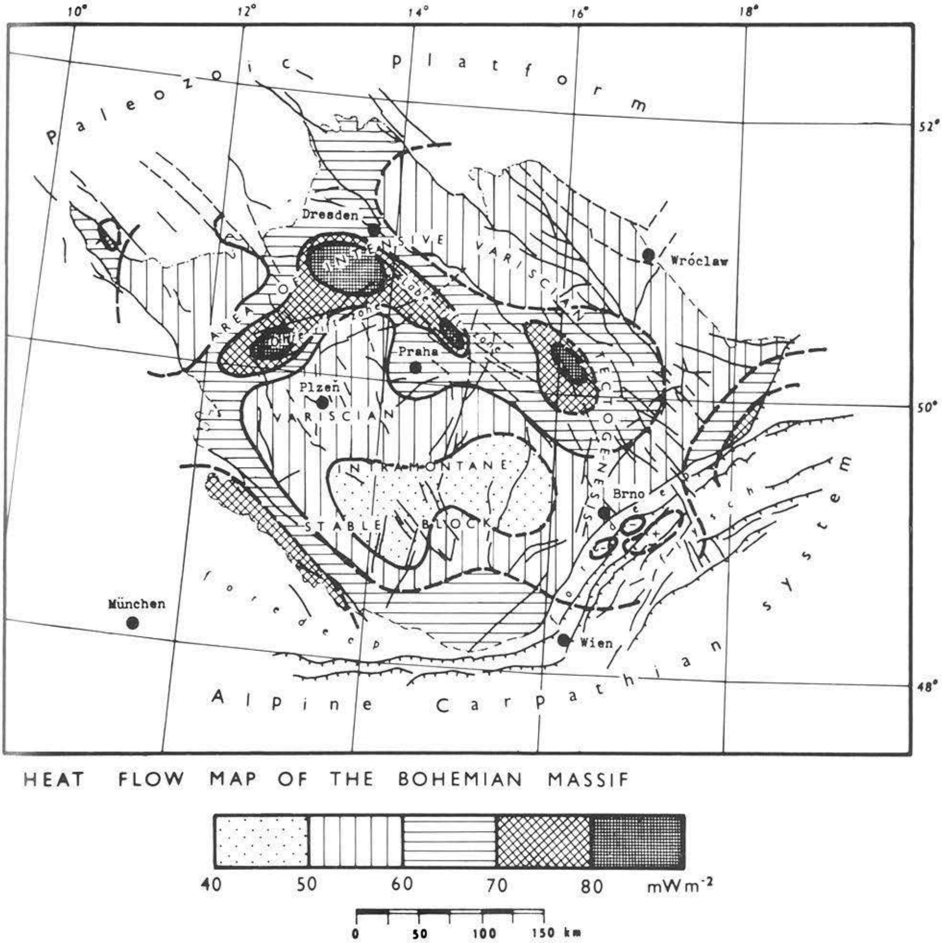

Fig. 1. Heat flow map of the Bohemian Massif

depth of about 40 km, and the Moho-temperature slightly increases towards the north up to 550–600 °C beneath the Assyntian region; the Moho-temperatures can reach 600 °C and more at the depth of 32 km below the Krušné Hory Mts. and the Cretaceous Table (Čermák, 1975a). The upper mantle heat flow contribution may also rise from 20–25 mWm^{-2} in the centre of the stable intramontane block to 25–30 mWm^{-2} beneath the Cretaceous Table. The degree of tectonic rejuvenation of the Bohemian Massif since the Palaeozoic (especially during the Alpine-Carpathian orogeny) may thus be accompanied by the thinning of the earth's crust together with the increase of energy influx from the depth, and the increase of crustal and subcrustal temperatures.

The proposed heat flow pattern may help in preliminary recognition of probable areas of geothermal resources. It is quite clear that the most of the territory of the Bohemian Massif will never be of any practical meaning in the utilization of geothermal energy, however, there are some prospects to find exploitable sources along both disturbed contact zones between the stable block and the crooked arc of the area of intensive Variscan tectogenesis. At the present level of exploration, the most promising is the thermal spring area near Děčín (Jetel, 1975), i.e. approx. at the cross point of both rift zones. Near to this area the highest heat flow values by Teplice (Čermák, 1967) were recorded, as well. Other potentially prospective locations can be found close to high heat flow anomalies (over 80 mWm^{-2}) (see Fig. 1) between Karlovy Vary and Doupovské Hory Mts. to the south-west along the Ohře rift zone, and/or close to Mělník to the south-east in the Labe rift zone, resp. The most eastern high heat flow anomaly (at approx. 50° N, 16° E) is not quite clear yet.

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