Geomagnetic anomalies in the Czech Republic
(Summary)

The first comprehensive pattern of the geomagnetic field of the Czech Republic was obtained by the airborne geophysical mapping on a scale of 1 : 200 000 (with a 2-km distance between the parallel flight-lines) realized at the end of the 1950s. All the magnetic structures exceeding the amplitude of 50 nT and the length of 2 km were mapped. The results of this airborne mapping were published in a set of maps on scales of 1 : 200 000, 1 : 500 000 and 1 : 1 000 000 in the 1960s. The realistic contour interval of these maps is 50 nT.

More detailed knowledge concerning the geomagnetic field of the Czech part of the Bohemian Massif was acquired by the detailed airborne survey on the scale of 1 : 25 000 (with a 250-m distance between the flight-lines) using the flux-gate magnetometer carried-out in the years 1960–1970. Some selected parts of the Bohemian Massif were even re-flown by proton magnetics with simultaneous application of the airborne gamma-ray spectrometry in the 1980s. The results of these detailed airborne magnetic surveys were the foundations of the new Geomagnetic map of the Czech Republic, scale 1 : 500 000, which was compiled with the contribution of the Grant Agency of the Czech Republic (Šalanský 1995). The magnetic data of the Carpathian part of the Czech Republic were obtained from the ground regional magnetic survey carried out mostly during the 1970s. The results of the latest geomagnetic surveys mentioned above were consequently checked on the ground of and interpreted regarding to the local geology.

The aim of this paper is to summarize the anomalies typical of individual geological regions and to acquaint the reader with the structural, petrologic and/or metallogenetic features of the magnetic anomalies developed in these regions. For this purpose the territory of the Czech Republic is divided into 20 regions shown in Fig. 1. At the end of the text comment of each region the scheme of the magnetic pattern and some graphs showing the magnetic data obtained in the places of the airborne anomalies by the ground magnetic measurements are added.

Before the interpretation of magnetic anomalies pertaining to each of the 20 regions, some criteria of their classification were mentioned and discussed, such as:

1. Quality of the anomalous source, characterizing two main groups – (a) natural/geological sources and (b) artificial/anthropogenous sources.
2. Depth of the sources.
3. Magnitude of the wavelengths (sizes of anomalies).
4. Shape of anomalies.
5. Direction of the axes of anomalies and the orientation of their sources.
6. Complexity of the anomalous field and its sources.
7. Distribution of anomalies on the map.
8. Amplitudes of anomalies.
9. Course of magnetization.
10. Different geological causes of magnetic anomalies.
11. Level of geological knowledge of the source.
12. Relation of magnetic anomalies to the contents of actual geological maps.
13. Relation of magnetic anomalies to the other geophysical fields/parameters.
14. Prospective significance of magnetic anomalies towards raw material resources.

In the 20 demarcated partial regions the following magnetic features can be summarized:

Region 1. The crystalline complexes of the Český les Mts.
In general, the region represents the positive regional field caused by the huge amount of magnetized paragneisses. The anomalies of the expressive amplitudes are concentrated in the northern part of the region. Besides the stratigraphic reasons some hydrothermal processes are supposed to contribute to the origin of magnetic minerals. Local anomalies of smaller sizes are produced by diorite, amphibolite and serpentinite bodies.

Region 2. The Moldanubicum of the Šumava Mts. – western part
The regional magnetic field which creates the magnetic low reaching up to –50 nT is substantially caused by granite bodies. The large amount of small- to medium-sized anomalies are situated within the Moldanubian metamorphic rocks. Monotonous magnetic field is developed in the Sušice variegated group with substantial contingent of marbles. A lot of anomalies is bound to amphibolites, lime silicate rocks and paragneisses. Anomalies of the highest amplitudes are evoked by garnet amphibolites and scarns (near the villages of Běšiny and Nýrsko). The expressive magnetic anomalies are also developed upon hornstone bodies in the Kasejovice "islet" of metamorphites in the NE part of the region 2.

Region 3. The Moldanubicum of South Bohemia and of the Šumava Mts. – eastern part
The regional field is mostly oscillating around zero. The expressive positive anomalies are concentrated in the areas built by granulite complexes in which amphibolite and serpentinite bodies are predominantly responsible for the origin of these high anomalies. Frequent anomalies can also be found in the paragneiss formation where, above all, intercalated rocks (amphibolite and erlane), and partly the paragneisses themselves are sources of the anomalies. Among generally non-magnetic granite plutons occurring in the region 3 the granodiorite of the Freistadt type raises magnetic anomalies.

Region 4. The Central Bohemian Pluton
The large negative regional field developed in the major part of the Pluton and, on the contrary, generally positive field of the metamorphic "islets" situated in the Pluton area is sharply broken in the belt of the so-called Central Bohe-

mian magnetic anomaly which involves the NW part of the Pluton, the Mirovice "islet" and the metavolcanics of the Jílové zone. The anomalies of very high amplitudes reaching up to 2000 nT (as measured in the airplane) can be found in this Central Bohemian magnetic anomaly (Central Bohemian Scar). Many plutonic as well as volcanic and metamorphic processes contributed to the origin of this remarkable anomalous belt, the sources of which are located at various depths.

The South Bohemian Moldanubian complexes demonstrate a mild magnetic field with anomalies of relatively low amplitudes. The variegated group of the Moldanubian complex distributed in the surroundings of the town of Týn nad Vltavou embraces several local anomalies caused by graphitic gneiss with pyrrhotine.

Among many types of granite rocks of the Central Bohemian Pluton mostly magnetically indifferent the following exceptions should be mentioned: (1) several parts of the granodiorite of the Sázava type and (2) the so-called marginal type of granite with frequent intermediate to basic bodies occurring namely in the Příbram district. Among metamorphic "islets" lying in the Pluton area the Mirovice islet, the Sedlčany-Krásná Hora islet, and the Jílové zone are the most impressive magnetic objects.

Region 5. The Moldanubicum – Bohemian part and the Moldanubian Pluton

The Moldanubian Pluton evokes the negative regional field (up to –100 nT) in almost the whole Bohemian part of the Pluton. The magnetic field of its mantle predominantly composed of paragneisses is also rather monotonous. The magnetic exceptions within the monotonous mantle are caused by stratiform amphibolite bodies producing narrow elongated anomalies for the most part not exceeding 100 nT. More variegated magnetic field belongs to the Chýnov Group of micaschists. Relatively large anomalous magnetic structure found in the W of the Pluton (near the town of Humpolec) pertain to cordierite gneiss rich in magnetite and embracing many erlan, amphibolite and scarn bodies. Along the Blanice Furrow there are strongly magnetized serpentinites. The sole exception among the non-magnetic granite rocks of the Moldanubian Pluton was found in the southernmost part of the Czech territory, i.e. near the Czech and Austrian frontier between the small towns of Nová Bystřice and Slavonice, where an expressive circle-shaped anomaly produced by the source at a depth of several hundred metres was found within the Pluton.

Region 6. The Kutná Hora unit, the Moldanubicum – northern part, the Central Bohemian Pluton – north-eastern part, the metamorphic "islets", the Železné hory unit – north-western part

The region 6 is a place of conjunction of several geological units. The negative regional field prevails in its northern part where the Paleozoic and Proterozoic complexes are submerged under sediments of the Cretaceous Basin. Several elongated anomalies are developed there as an effect of buried metamorphosed basic volcanic and sedimentary complexes. High amplitude anomalies (up to 1000 nT) of smaller sizes pertain to the serpentinite bodies involved in the Kutná Hora unit.

The smaller of the metamorphic "islets" of the Central Bohemian Pluton, i.e. those of Tehov and Voděrady-Zvánovice, with their volcanic and sedimentary formations and with metamorphosed basic rocks, evoke rather high anomalies (up to 600 nT) in the southern part of the region 6. In the northern part of the Central Bohemian Pluton there are expressive magnetic responses caused by the gabbro bodies situated predominantly within the granodiorite of the Sázava type.

Rather monotonous magnetic field of the northern margin of the Moldanubicum is only slightly diversified with several small anomalies that are probably provoked by hydrothermal alterations in mylonite zones. The source of striking anomaly situated near the town of Zruč nad Sázavou was not successfully proved even by a 600-m deep borehole. (Only several thin layers of paragneiss with pyrrhotite were found in it.)

Region 7. The Bohemian Cretaceous Basin – south-eastern part, the Svratka crystalline complex, the Poličká crystalline complex, the Moldanubicum – north-eastern part

In general, the negative regional field prevails in the Region 7. The most expressive positive anomalies of this region are: (1) the Železné hory magnetic structure, (2) the Česká Třebová magnetic structure, (3) the Svitavy magnetic structure, and (4) the Vysoké Mýto magnetic structure. The second, third and fourth ones have their sources completely covered with non-magnetic Cretaceous sediments. In the SW corner of this region there is the striking and complicated anomaly caused by the mafic and ultramafic rocks of the Ransko basic to ultrabasic body.

The most impressive part of the variegated Železné hory magnetic structure is its SE margin where the arc-shaped anomaly exceeding 2000 nT is developed. Basic, intermediate and even acid (granodiorite) rocks of the Železné hory pluton are mostly responsible for this remarkable anomaly. Besides these intrusive rocks the Proterozoic metasediments with pyrrhotite are essential contribution to the origin of the anomalous magnetic field of the area. Their anomalous response can be distinctly followed in the southern part of the Cretaceous Basin area, too, where these rocks participate in its basement rock complexes.

The metamorphosed rocks of the Svratka and Poličká crystalline complexes produce generally monotonous magnetic field which is only locally diversified by small anomalies evoked by petty serpentinite and scarn bodies. The Letovice crystalline complex, on the contrary, shows variegated magnetic field with several elongated anomalies mostly caused by basic metavolcanics.

Three remarkable magnetic anomalies are developed in the SE corner of the Cretaceous Basin area, namely the Vysoké Mýto, Česká Třebová, and Svitavy anomalies. Their sources pertain to the basement complexes of the Basin. The boreholes drilled in the area of the Svitavy anomaly proved mafic to ultramafic rocks in the role of the anomalous source.

Region 8. The Moldanubicum of western Moravia

The western part of the Moravian branch of the Moldanubicum between the Moldanubian Pluton and the Třebíč (syenite) pluton demonstrates, in general, slightly variegated negative field. The eastern part of the Moravian Moldanubicum displays, on the contrary, large positive regional field reaching the level of 100 to 150 nT. The highest magnetic anomalies are caused by many basic to ultrabasic near-surface bodies occurring there but the generally high level of the field is produced by a deeper-seated part of the basement with expressive magnetic properties. (ŠALANSKÝ 1989 speaks about so-called astenokon, GNOJEK and HEINZ 1993 explain it as a response to the independent Proterozoic Brunovistulicum, unit consolidated by Cadomian orogeny. This unit is supposed to be found below the outcropping Moldanubicum.)

The Třebíč pluton itself is non-magnetic. Significant anomalies caused by serpentinite and amphibolite bodies and high-amplitude and short-wave anomalies raised by scarns are situated in the outer rim of the Pluton, i.e. in the Moldanubian crystalline complexes. The outcropping part of the Dyje pluton does not evoke variegated magnetic field. Among generally monotonous southernmost part of the Moravicum only the Luková Group, composed of altered volcanic rocks, produces the striking anomalies exceeding 1000 nT.

Region 9. The Brno Pluton, the Moravicum – northern part, the Boskovice Furrow, the Lower Carboniferous of the Drahanská vrchovina Highlands – south-western part

Three main types of the regional magnetic field can be found in this region: (1) positive field being a continuation of the West-Moravian regional positive anomaly mentioned in the previous paragraph, (2) variegated field of the outcropping part of the Brno Pluton, and (3) negative field extended in the Drahanská vrchovina Highlands area.

The positive West-Moravian regional anomaly is, in addition, diversified by distinct anomalies caused by serpentinites and allied rocks pertaining to the Náměšť granulite complex. The Brno Pluton comprises many types of distinctly magnetic rocks not only among intermediate and basic to ultrabasic rocks situated mostly in its central suture but also among granodiorites. In the northern (the Svratka) part of the Moravicum both magnetically monotonous and anomalous groups can be found. The Bíteš Group can be regarded as a typical monotonous member of the Moravicum while the Olešnice Group and the phylite hem bordering the Svratka "granites" involve some sources of magnetic anomalies. The Lower Carboniferous sedimentary rocks (Culm facies) building the Drahanská vrchovina Highlands do not embrace any magnetic components.

Region 10. The Krušné hory Mts. – western part, the Doupovské hory Mts.

The regional positive magnetic field of the western part of the Krušné hory Mts. reaches up to 100 nT. This high level of the magnetic field also remains in the Karlovy Vary pluton area, the granites of which were proved non-magnetic. This fact means that a deep-seated lower-crust source ought to be responsible for this positive regional field. Volcanic rocks of the Doupovské hory Mts. evoke very complicated magnetic field.

The crystalline rocks of the Krušné hory Mts. unit are rather poor in sources of expressive magnetic anomalies. Only the Jáchymov Group of mica-schists with some magnetic metabasites and pyroxenites is a certain exception. Most of the scattered local anomalies pertain to isolated bodies of neovolcanics and – in the surroundings of the frontier town of Vejprty – also to several Fe-scarn bodies. Larger anomalies are developed in the Mariánské Lázně mafic complex; the most expressive among them is caused by the serpentinite body near the village of Prameny.

The magnetic structure of the Doupovské hory Mts. reveals that besides the central circle-shaped volcanic structure there are many linear and elongated effusions taking place in this volcanic area. The horizons of volcanic rocks are the cause of the stratiform and belt-shaped magnetic anomalies in the Cheb crystalline complex partially covered with the Tertiary non-magnetic sediments of the Cheb Basin. Mostly monotonous magnetic field of the Dyleň and Horní Slavkov crystalline complexes are locally variegated by isolated chimney bodies of neovolcanics.

Relatively large and high-amplitude anomaly situated in the border-line between the Karlovy Vary pluton and the Teplá crystalline complex was proved by a drill hole to be produced by strongly magnetized amphibolites to scarns.

Region 11. The Krušné hory Mts. – eastern part, the České středohoří Mts. – western part, the Most Basin

The whole area of the České středohoří Mts. built by the Tertiary volcanic rocks displays distinctly increased regional field reaching up to 200 nT. The central part of the Most Basin shows, on the contrary, the lowest part of this regional field with the values varying from 50 to 80 nT. From this relative magnetic low developed in the Basin the regional field grows up to both the Krušné hory Mts. (to the W) and to the České středohoří Mts. (to the E).

Though many volcanic centres are covered with non-magnetic Neogene sediments, they evoke distinct anomalies, mostly isometric, with the amplitudes of several hundreds of nT. The anomalies of both normal and reverse magnetic polarization and of various forms and sizes are developed in this volcanic region. Besides the circle-shaped magnetic volcanic bodies some linear effusions elongated in the NW-SE direction are also frequently present.

The eastern part of the Krušné hory Mts. built by non-magnetic orthogneiss provokes a monotonous field. The only exception diversifying this quiet field is a linear magnetic structure in the W-E direction running through the mica-schists dome near the village of Hora Sv. Kateřiny. All the other local anomalies variegating the mentioned monotonous field are produced by isolated neovolcanic bodies.

Region 12. The Teplá unit, the Domažlice unit, the Barrandian Proterozoic – western part

The regional magnetic field of this area systematically grows to the west reaching the highest values in the Slavkovský les Mts. and Krušné hory Mts. Considerably

long and belt-shaped magnetic anomalies are typical of this region. A lot of anomalies superimposed on the regional field are caused by pyrrhotite accessory in the rocks. The origin of the pyrrhotite is combined with the chemical interaction of basaltic lava with sea water during Proterozoic submarine effusions. That is why the paleovolcanic belts situated in the Proterozoic complexes produce the most expressive magnetic anomalies of this region.

The most distinct element of this region is the so-called Přeštice magnetic structure with the anomalous values reaching up to 1000 nT. This magnetic structure follows the main "spilite stripe" of the West-Bohemian Proterozoic area. The next elongated magnetic structures of the same direction are situated in the Domažlice and Teplá crystalline units. Another isolated anomalies found in the Teplá unit are evoked by the chimney-form neovolcanic bodies.

The Proterozoic complexes embrace several granite and basic intrusions. In general, the granite bodies cause magnetic depressions. The typical ring structure is provoked by altered and magnetite enriched granites of the Čistá granite massif. An implication of the circle-shaped magnetic structure can also be seen in the Štěnovice granite massif. The distinct magnetic low is developed in the Klatovy granite apophysis, the northern rim of which towards the Barrandian Proterozoic complex is, on the contrary, underlined by the distinct magnetic high raised by the effects of the contact metamorphism. Basic intrusions of the Poběžovice massif provoke only a scanty ellipsis-shaped magnetic structure. Striking small-sized anomalies developed in the surroundings of the massif are bound to erlans having the pyrrhotite admixture.

Region 13. The Barrandian

Low to medium positive values of the regional field prevail in the western part, the negative regional field is developed in the eastern (Prague) part of the region. The pattern of the regional field seems to be influenced by a displacement of huge crust blocks along the NW-SE regional faults. This phenomenon is apparently manifested in the area surrounding the small town of Rožmitál pod Třemšínem.

The dominated anomaly disclosed in the Rožmitál pod Třemšínem area is evoked by thick Cambrian tuff layers with high content of magnetite. Medium amplitude anomalies caused by the Cambrian volcanic rocks can also be found in the NE part of the Brdy Highlands. A variegated magnetic pattern is developed in the SE part of the Barrandian Proterozoic where the various volcanic and sedimentary rocks with pyrrhotite often altered in contact with the intrusions of the Central Bohemian Pluton are the sources of magnetic anomalies. The NW part of the Barrandian Upper Proterozoic is, on the contrary, quite monotonous. But further to the NE, i.e. in the area buried in the Cretaceous, Permian and Carboniferous non-magnetic mantle rocks, remarkable magnetic anomalies pertaining probably to volcano-plutonic bodies situated within the Proterozoic basement were found.

Predominantly acid non-magnetic volcanic rocks of the Křivoklát-Rokycany Cambrian complex evoke a magnetic depression on the background of which small magnetic anomalies caused by andesites arise.

Silurian, partly also Ordovician volcanic (diabase) rocks are the only sources of the slight to medium magnetic anomalies in the Prague Basin. Several covered volcanic bodies of this kind were disclosed by airborne survey.

Region 14. The České středohoří Mts. – eastern part, the Lusatian unit, the Bohemian Cretaceous Basin – north-western part

The substantial part of the České středohoří area manifests the positive regional field slightly exceeding 100 nT. The lower level of the regional field situated in the northern part of the region is complicated by numerous local anomalies appertaining to isolated surface and/or near-surface volcanic bodies. The regional magnetic high – probably bound with deep resources of magma from which the České středohoří area arose – is a background on which several expressive magnetic anomalies (magnetic structures) of large sizes are superimposed.

The large Břvany magnetic structure occurring near the town of Louny – in the region 11 (Fig. 25), and the Kravaře magnetic structure (No. 7 in Fig. 31) are interpreted as effects of basic intrusions. The Dřevčice (No. 5) magnetic structure was verified by a drill hole which disclosed a magnetic granodiorite. The Pavlovice magnetic structure (No. 6) occurring near Maršovice Hill outcrop of the basement can be bound to the metamorphic rocks and the circle-shaped part of it is comprehended as an effect of a small intrusive body. The expressive elongated anomalies (structures) – the Sychrov (No. 12), Valtínov (No. 11) and Hamr (No. 4) ones - are interpreted as a response to the Early Paleozoic belts of volcanic rocks. Sources of this kind, i.e. strongly magnetized intermediate to basic volcanics situated within the phyllite complex, were proved by a drill hole verifying the Hamr anomalous structure exceeding 1000 nT. Similar rocks of the crystalline basement are supposed to be the sources of the Mšeno and Borky magnetic structures found in the S of the region 14.

The anomalous area near the village of Chrastava (to the NW of the town of Liberec) is the main magnetic phenomenon of the Ještěd part of the Krkonoše-Jizera crystalline unit. Volcanic and sedimentary Upper Proterozoic formations influenced by hydrothermal alterations are the sources of this anomalous area. The granite massif of the Lusatian unit is, generally, non-magnetic. Narrow and in the W-E direction elongated anomalies within the Lusatian Pluton are produced by lamprophyric dike rocks.

Region 15. The Bohemian Cretaceous Basin – central part, the Krkonoše Piedmont Basin – south-western part

It is almost the negative regional field of the Cretaceous Basin from which the positive field in the southern rim arises. The latter is caused by the Železné hory unit. Several large mostly isometric anomalies stand out from the negative field in the east of the town of Mladá Boleslav. They are considered to be a response of intrusive bodies situated within the basement complexes covered with Cretaceous, Permian and Carboniferous non-magnetic sediments. This interpretation follows from the result of the borehole drilled near the village of Chotělice (the Chotělice

No. 1 anomaly), where intensively magnetized syenodiorites to syenogabbros were found. The origin of another distinct anomaly disclosed near the small town of Městec Králové (No. 2), which is elongated in the WNW-ESE direction, has not been cleared up, hitherto.

Rather contrast magnetic pattern is developed in the Krkonoše Piedmont Basin, where lots of smaller (shorter-wave) anomalies are distributed. They are mostly provoked by many andesite (melaphyre) sills both outcropping and buried. The lengths of the sills are proportional to the lengths of anomalies. The most expressive anomalies of this kind follow the Lužice fault system. Some of these narrow and elongated anomalies were found even in the NE margin of the Basin, which means that some andesite sills are also distributed along the Lužice fault within the basement as covered with non-magnetic Cretaceous sediments.

Many isolated anomalies, mostly small-sized but intensive, arising in the Cretaceous Basin – particularly in the Jičín District – are evoked by neovolcanics. The most distinct neovolcanic centres were disclosed by the airborne magnetics around Kozákov Hill near the town of Semily.

Region 16. The Krkonoše-Jizera unit, the Krkonoše Piedmont Basin

The regional magnetic field of this region is, generally, negative. The lowest values occur in the Krkonoše-Jizera Granite Pluton. The inner rim of the Jizera part of the Pluton displays a remarkable horse shoe-shaped positive anomaly. An extent and high-amplitude anomaly is also developed in the crystalline area of the Jizerské hory Mts. near the town of Tanvald. This anomalous effect seems to be continued to the eastern part of the Krkonoše Mts. as the so-called Modrý důl magnetic structure. The Albeřice magnetic structure is a dominant magnetic object in the eastern part of the Krkonoše Mts. Both the mentioned anomalies are provoked by the belts of metavolcanic complexes pertaining to the Early Paleozoic.

The main anomalous zone, called the Raspenava magnetic structure, follows the magnetized layers in the phyllite to the mica-schist formation. Local small-sized anomalies are mostly produced by isolated penetrations of neovolcanics; the only exception among them is the local Raspenava anomaly evoked by a small scarn body.

Region 17. The Bohemian Cretaceous Basin – eastern part, the Intra-Sudetic Basin, the Orlické hory crystalline complex – northern part

From the negative regional field only sporadic positive anomalies arise. The most expressive of them are the Hostinné, Jaroměř, and Hradec Králové magnetic anomalous structures. The amplitudes of these anomalies do not exceed 100 nT. The Hostinné elongated magnetic anomaly (magnetic structure) is evoked by the Early Paleozoic zone of volcanites situated below the Late Paleozoic formations. The sources of the Jaroměř and Hradec Králové magnetic structures are completely covered with the Cretaceous and probably also Permian sediments. They are interpreted as a response to the bodies involved in basement crystalline complexes. The source of the Jaroměř anomaly is supposed to be at a depth of 70–330 m; volcanic and sedimentary Late Paleozoic rocks are estimated to represent the anomalous source bodies. The Hradec Králové anomalous structure was checked by a drill hole, tuffaceous shales with anomalous magnetic susceptibility where found at a depth of 530 m.

Relatively smaller anomalies disclose various volcanic rocks inside the Intra-Sudetic Basin. But the outcropping andesites in the Vraní hory Mts. arising in the NE margin of the Basin provoke high magnetic anomalies reaching up to 1000 nT. Another remarkable, almost isometric, anomaly pertaining to a completely covered deep-seated source was found near the town of Broumov in the Intra-Sudetic Basin (NE Bohemia). Quite a large intrusive body situated below the thick Permian sedimentary and volcanic formation is expected there at a depth exceeding 1000 m.

The Orlice-Kłodzko unit is, generally, monotonous. Rather rare low-amplitude anomalies were identified only in the variegated Stronie Group. The monotonous magnetic pattern was also stated in the Zábřeh and Nové Město nad Metují Groups in the Orlické hory Mts.

Several small-sized and also low-amplitude anomalies found in the eastern part of the Cretaceous Basin have not been proved from a geological point of view up to now. They are interpreted – in the most cases – as small intrusive bodies or as volcanic formations pertaining to certain Proterozoic and/or Late Paleozoic basement complexes.

Region 18. The Orlice-Sněžník unit – eastern part, the Silesicum – northern part

The region 18 is the area in which two high-order geological units, i.e. the Lugicum in the W and the Silesicum in the E, keep in touch. Each of these units manifests quite different regional fields – the magnetic field and that of gravity. While both the fields of the Lugicum are negative, those of the Silesicum are generally positive. Only the Keprník dome structure – being just on their touch line – demonstrates the negative field though it belongs to the Silesic unit. The positive anomaly occupying almost the whole Hrubý Jeseník region continues further to the E, i.e. to the Nízký Jeseník area and to the Polish territory. The source of this regional anomaly is estimated to be at a depth of about 10 km and is supposed to pertain to the Brunovistulicum basement consolidated by the Cadomian orogeny.

The Orlice-Sněžník unit has, generally, a monotonous magnetic pattern, only slightly variegated by quite rare low and small-sized anomalies evoked by intercalated rocks of the Stronie Group. A more variegated field is developed in the Staré Město Group, where amphibolites and serpentinites cause distinct magnetic anomalies. The Velké Vrbno Group embraces relatively a small amount of anomalies evoked by amphibolites, schistose rocks with pyrrhotite and, exceptionally, by scarns. The Branná Group is, generally, free of magnetic anomalies. The only exception is a distinct negative anomaly near the village of Horní Lipová.

The Keprník dome structure embraces, in the main, non-magnetic orthogneiss with only rare magnetically active metamorphosed basic rocks and erlans occurring in the marginal part of the dome.

The Desná dome structure has a variegated magnetic

pattern caused, first of all, by amphibolites. Some stratiform iron ores evoking striking anomalies were even found in this geological structure. The Rejvíz and Devonian Vrbno Groups embrace the biggest amount of small- to medium-sized outstanding anomalies produced by strongly magnetized amphibolites and poor iron ores (in the Rejvíz Group) and by Devonian slightly metamorphosed basic volcanics and green schists (in the Vrbno Group). Similar expressive anomalies are developed in both basic intrusive bodies – the Jeseník and Sobotín ones. Anomalies of the very high amplitudes were found especially in the Jeseník body.

In the Nízký Jeseník area built by non-magnetic Culm facies there is a positive but monotonous magnetic field produced probably by the deep-seated Cadomian Brunovistulicum complex. This monotonous field is variegated only locally by mostly outcropping Devonian rocks of the Šternberk-Horní Benešov belt-shaped Group (structure) embracing basic volcanic rocks and several small iron ore deposits. The Pleistocene basaltic effusions occurring in several localities in the Bruntál District distinctly diversify the monotonous positive magnetic field of the Nízký Jeseník area, too.

Region 19. The Silesicum – southern part, the Zábřeh unit, the Moravo-Silesian Paleozoic, the Hornomoravský Vale

Several geological units are included in the region 19. This fact results in its complicated magnetic pattern and in quite different features of its partial areas. The anomalies of the highest amplitudes can be seen near the Bušín fault, where the expressive magnetic belts produced by amphibolites and serpentinites of the Staré Město Group are cut. Another elongated anomalies but of different direction are developed in the crystalline rocks of the Zábřeh Group, the west continuation of which is covered under non-magnetic Cretaceous sediments. The Šumperk granodiorite body provokes fairly well developed ring structure.

The magnetic responses of both the above mentioned Devonian belts of volcanic and sedimentary rocks, i.e. the belts of the Vrbno and the Šternberk-Horní Benešov Groups can be followed by magnetic anomalies in the upper part of the Hornomoravský Vale as covered with non-magnetic Neogene sediments filling the depression. Several small magnetite iron ore deposits connected with these Devonian volcanics – some of them partly outcropping, other completely buried under Neogene strata – were disclosed there. In the lower (southern) part of the Vale, i.e. in the SW surroundings of the town of Olomouc, there are also distinct magnetic anomalies elongated in the NNW-SSE direction provoked by mostly covered Proterozoic crystalline rocks pertaining to the Brunovistulicum basement unit.

The Lower Carboniferous Culm facies strata of the Drahanská vrchovina Highlands are conspicuous by shortage of magnetic anomalies. Sporadic small anomalies found there pertain to the remnants of Devonian volcanic rocks. The small relics of crystalline rocks occurring in three small tectonic islets in the Culm facies of the Highlands are also free of distinct magnetic anomalies.

Region 20. The Carpathian part of the Czech Republic (and the easternmost corner of the Nízký Jeseník Culm facies)

Predominant part of the region 20 manifests the positive regional magnetic field. The only areas with the negative field are developed (1) in the northern piedmont of the Moravskoslezské Beskydy Mts. and (2) on the NW slopes of the Bílé Karpaty Mts. near the frontier between the Czech and Slovak Republics. The predominant positive field of this region is also concentrated in two areas: (1) the smaller Silesian magnetic high and (2) the large South Moravian-Beskydy Mts. positive territory. The Silesian magnetic high represents the eastern continuation of the positive regional field (mentioned in the regions 18 and 19) covering the substantial parts of the Hrubý and Nízký Jeseník Mts. It fills only the narrow near-frontier area of the region 20 between the towns of Opava and Karviná. The South Moravian-Beskydy magnetic high (vast magnetic elevation) continuously follows up with the positive parts of the South Moravian regions 8 and 9 thus creating the largest (230 km long and 40 to 80 km wide) positive magnetic area in the Czech territory.

Seven expressive partial magnetic anomalies can be distinguished in the South Moravian-Beskydy elevation. From WSW to ENE they are: Břeclav, Slavkov, Ždánice, Chřiby, Kroměříž, Haná, Hostýnské vrchy, and Beskydy partial anomalies. The sizes of most of them are in tens of kilometres. Each of them exceeds at least 100 nT, most of them exceed several hundreds nT.

The anomalies of the smallest sizes caused by source-bodies in relatively shallow depths and partly even outcropping are those which occur in the Hornomoravský Vale (signed as ha-anomalies in the Fig. 45) distinctly influenced by the Haná fault system. They are mostly produced by granite to diorite (exceptionally basic) bodies followed by metamorphic mantle rocks. The group of medium-sized anomalies is completed by the Slavkov (sl), Ždánice (zd), and top part of the Hostýnské vrchy anomaly (ho). Regarding the results of drill holes realized in these anomalies their sources predominantly pertain to intermediate and basic rocks building the basement intrusive bodies situated at a depth of 1–3 km.

The largest anomalies situated in the SW half of the discussed region, i.e. the Břeclav (bv), Chřiby (ch), and Kroměříž (km) ones, are – according to the results of boreholes – predominantly produced by acid (granites to granodiorites) rocks of completely buried plutonic basement bodies. A belt-shaped body of basic rocks is supposed to fill a suture running from the Brno area to the S and SE within the Břeclav anomaly which, together with the Kroměříž, Chřiby, Slavkov and Ždánice anomalies, represent the magnetic responses to the so-called South Moravian Pluton. Several tens of the boreholes and results of the seismic survey proved the depth of the Pluton lying below the Carpathian foredeep, below the Vienna Basin and below the West Carpathian Flysch nappes, at a depth of about 1 km in the foredeep area to 7–8 km below the Outer Carpathian nappes in the SE region part of the Czech Republic.

Predominant source rocks disclosed by drill holes in the areas of the Hostýnské vrchy anomaly (ho) and Beskydy

Mts. anomaly (bes) are metamorphic rocks – mostly paragneisses. Besides the above mentioned basic intrusive rocks encompassed by metamorphites of the Hostýnské vrchy anomaly some intrusive "core" inside the paragneisses and migmatites largely evoking the Beskydy anomaly is also assumed. Two boreholes prove these intrusive rocks in the easternmost corner of the Czech Republic.

Extensive studies of magnetic properties of rock patterns taken from the cores of the great amount of drill holes proved that neither the Neogene sediments of the Carpathian foredeep nor the Cretaceous or Paleogene sequences of the Outer Carpathian Flysch nappes are able to produce large anomalies in the south and east of Moravia. Further, it is clear that the structural elements of the present magnetic anomalies, such as the orientation of their axis, the direction of their gradients, etc., do not correspond with the structural features of the foredeep and/or of the Flysch nappes at all. And, finally, the wave-lengths of the anomalies are mostly so long that they insinuate very deep sources.

Therefore, almost all the magnetic anomalies extending in the S, SE and E of Moravia were found to be caused by the basement metamorphic and intrusive complexes pertaining to the Proterozoic Brunovistulicum unit consolidated by the Cadomian tectogenesis. This unit is considered to be a constituent part of the North European Platform (the Baltic Shield). The Brunovistulicum unit, producing large positive fields, both magnetic and of gravity, is supposed to lie below the Moldanubian complexes SW of Moravia, as well. The substantial part of the large positive anomaly developed in North Moravia near the border on Poland seems to be caused by the Cadomian Brunovistulicum unit, too.

Only two relatively small groups of short-wave anomalies were found in this large region 20. Both pertain to volcanic rocks. The larger group situated in the northern piedmont of the Beskydy Mts. within the Silesian nappe is produced by Mesozoic volcanic rocks of the teschenite formation. The smaller group of short-wave magnetic anomalies is located on the NW slope of the Bílé Karpaty Mts. (SE margin of Moravia). It is produced by Tertiary small andesite and basaltic bodies within the Bílé Karpaty Flysch and partly also in the Bystrica Flysch nappes.

Translated by I. Gnojek