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Paleovolcanic reconstruction of the Neogene Vepor stratovolcano (Central Slovakia), part I

VLASTIMIL KONEČNÝ[1], PATRIK KONEČNÝ[1], PETER KUBEŠ[1] and ZOLTÁN PÉCSKAY[2]

[1]State Geological Institute of Dionýz Štúr, Mlynská dolina 1, Bratislava, Slovak Republic
[2]Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI), Debrecen, Hungary

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Abstract

During Neogene, due to the subduction of the oceanic crust of the Tertiary basin, situated on the outer (northern) side of Carpathians, several volcanic fields of the calc-alkaline andesite volcanism developed on the inner side of the Carpathian orogenic belt. In the territory of Slovakia there are two main areas of Neogene volcanism: The Central Slovakian Neogene Volcanic Field and the Eastern Slovakian Neogene Volcanic Field. East of the Central Slovakian Neogene Volcanic Field in the area of the western Veporic unit built-up dominantly by the Hercynian age crystalline rocks there are numerous scattered relics of volcanic rocks (pyroclastics, epiclastic volcanic rocks, lava flows) and intrusive-extrusive bodies, which are exposed on the surface after the denudation of the primary volcanic structures. Presented contribution is focused on paleovolcanic reconstruction of the original volcanic structure of the supposed Vepor stratovolcano.

Applying the detail geological mapping and geomagnetic profiling, the central subvolcanic diorite intrusive complex, exposed on the surface north of the Tisovec town, was analysed. In the lower level of the Rimava river valley, the diorite intrusive bodies broke through the Hercynian granodiorite–granite in the form of intrusive stocks. In the higher level of the eastern slope bellow the Magnetový vrch Hill, the diorite apophyses-sills penetrate into the Mesozoic carbonate rocks in several levels. Due to metasomatic processes, the belts of magnetite skarns have developed at the contact of diorite sills and carbonatic rocks.

During subsequent intrusive phase several laccolith bodies of andesite to diorite porphyry have been emplaced in the central volcanic zone at the north-western side of the subvolcanic diorite complex. Younger intrusive phase in the central volcanic zone represents dykes and dyke swarms mostly of ENE–WSW orientation, penetrating through the subvolcanic diorite complex. Composition of dykes varies from pyroxene diorite porphyry, pyroxene amphibole diorite porphyry to pyroxene andesite. Dyke system overpasses the dimension of subvolcanic diorite complex.

In the final stage of intrusive activity a system of basalts to basaltic andesite dyke swarms in south-western side of the central volcanic zone has developed. Dyke system is interpreted to be a feeding system to parasitic volcano on the western slope of the Vepor andesite stratovolcano.

In the proximal volcanic zone numerous scattered intrusive and extrusive bodies, exposed on the surface, were investigated: different forms as extrusive domes, laccoliths, stocks and necks of variable composition (from andesite to dacite and rhyodacite and from andesite porphyry to diorite porphyry).

In a greater distance northward of central volcanic zone in the area built of Mesozoic carbonates (Silicicum nappe) a new Stožka volcano of small dimension was defined. Volcano consists of relics of pyroclastic cone (agglutinated lapilli tuff with scoria and volcanic bombs) and central lava neck.

In the western sector of the stratovolcano, the relics of several paleovalleys with volcaniclastic fillings were identified. Paleovalleys with radial orientation to central volcanic zone are gradually deepening to the west. The most extensive paleovalley filling represents the Hájna hora Hill to SE of the Brezno town. Detail lithological study of this paleovalley filling has brought an important information about the evolution of volcanic activity. At the base of the paleovalley filling at its western edge, the products of amphibole biotite rhyodacite volcanism like pyroclastic flows and ash-pumice tuff are deposited. Rhyodacite volcanism preceded volcanic activity of the Vepor andesite stratovolcano. Early stage of andesite volcanism dominantly of explosive type represents deposition of ash-pumice tuffs and epiclastic volcanic sandstones in lower part of the paleovalley filling. During next volcanic activity the eruptions of pyroclastic block and ash flows of amphibole pyroxene andesite were dominant. In more advanced stages the lava effusions occurred as it is documented by the lava flow in the uppermost part of the palleovalley filling of the Klenovský Vepor Hill.

Relics of volcaniclastic rocks continue to south as fillings of paleovalleys on the southern slopes of the Slovenské rudohorie Mts. The volcanosedimentary complexes of the Pokoradza Formation at the northern edge of the Rimavská kotlina Basin represent deltaic and lake sediments exposed in the present relief on the Pokoradzská tabuľa Plateau and the Blžská tabuľa Plateau.

Key words: andesite stratovolcano, intrusive complex, epiclastic and pyroclastic volcanic rocks, extrusive domes, diorite stock, diorite sill, dyke, laccolith, andesite and diorite porphyries

Introduction

The findings of sporadic occurrences of diorite and andesite bodies, as well as the remnants of volcaniclastic rocks in the north-western part of the Slovenské rudohorie Mts. – the area of crystalline massif of Veporicum, have inspired numerous geologists, engaged in this area, to opinion that a Neogene volcanic field developed in this territory is similar to that located westward in the middle Slovakia, resp. it represented its eastward continuation. This presumption was supported also by the presence of relatively extended remnants of the volcanosedimentary rocks at the northern margins of the Lučenská kotlina Basin, which in recent relief represent areas of plateaus – the Pokoradzská tabuľa and Blžská tabuľa plateaus. Due to their relatively long distance from the eastern margin of the Central Slovakia Neogene volcanic field, it is not acceptable to consider them as produts of Javorie and Poľana stratovolcanoes, located at the eastern part of the Central Slovakian Volcanic Field. According to some authors of geological maps (Kuthan et al., 1963), the advanced level of denudation with removal of primary surface structures and the exposing of subsurface intrusions have pointed to their older i.e. Lower Badenian to Middle Badenian age. On the contrary, the andesite volcanoes of Badenian to Sarmathian age in the central Slovakia have relatively lower level of denudation. The Badenian age of relics of intrusive and volcaniclastic rocks was accepted in the past, despite the fact that paleobotanic studies of flora in basal sediments evidenced their younger, Sarmatian age.

After the mapping by the employees of the Department of Neogene Volcanites of the Geological Institute of Dionýz Štúr Bratislava led by prof. M. Kuthan, resulted in the General geological map of Slovakia at a scale 1 : 200 000 (Kuthan et al., 1963), the relics of the intrusive and volcanic rocks, scattered in the relatively wide area in the NW part of the Slovenské rudohorie Mts., have not been later systematically investigated. Works of research teams from the 1970s to 1990s were focused on actual problems in the region of Central Slovakian Neogene Volcanic Field, i.e. volcanic mountains of the Štiavnica Mts., Kremnica Mts., Javorie Mts. and Poľana Mts. and their metallogenesis. Only episodical attention was devoted to the occurrences of volcanic and intrusive rocks of supposed Neogene age in the area of the crystalline massif of the Veporic unit in the NW part of the Slovenské rudohorie Mts. It was only in relation to the preparation of geological maps from this area at a scale 1 : 50 000, eventually in the more detail scales in the case of prospect works for mineral ore deposits (deposit of magnetite skarns in the area of the Magnetový vrch Hill north of the Tisovec town). During assembling of geological maps by individual authors, there was a disagreement among criteria used for evaluation of volcanic and intrusive rocks, their forms and petrologic content, as well as for the definition of basic units, facies, complexes and formations. Many authors have explained position of eruptive centers, resp. source regions of volcanic rocks, while presented ideas were not supported by the results of detailed field and laboratory investigation and remained only at the level of hypotheses.

The above stated ambiguity in the interpretation of former results as well as differences in the level of processing and evaluation of data from volcanic and intrusive bodies have initiated the approval and realization of the partial thematic geological task T 07/08 "Paleovolcanic reconstruction of the Vepor stratovolcano" in the frame of the project "Update of the geological setting of problematic areas of the Slovak Republic" at a scale 1 : 50 000 (principal leader of the project RNDr L. Hraško, PhD.).

The main aim of the project was to carry out systematic mapping of the relics of Neogene volcanism in the NW part of the Slovenské rudohorie Mts. in the region of crystalline massif of Veporic unit, to analyse forms and structures of intrusive bodies, their mineralogical-petrographic composition, as well as to define the facies of volcanoclastic rocks and their position in the context of volcanic structure, and finally based on obtained knowledge, to carry out paleovolcanic reconstruction of the primary volcanic structure.

The first phase of this investigation task took place in 2008–2011. The area of supposed central volcanic zone, encompassing the Magnetový vrch Hill intrusive complex was mapped at a scale 1 : 2 000, and the scattered relics of intrusive and volcanic rocks including volcaniclastic rocks in the paleovalleys of more external zones were mapped at a scale 1 : 10 000.

The investigation during this initial period has depicted the contours of spatial extent of the Vepor stratovolcano, but simultaneously highlighted the need of detail lithological-facial analysis of the volcanosedimentary complex on the southern slopes of the Slovenské rudohorie Mts. and in the northern part of the Rimavská kotlina Basin, being designated as the Pokoradza Beds. A new partial thematic report was adopted within the main project with the title T 02/11 "Geological profiling and structure of Neogene volcanism in the northern part of Rimavská kotlina Basin (Pokoradza Formation)". The field investigation and mapping of volcanosedimentary rocks, resp. its remnants in the northern part of the territory at a scale 1 : 10 000 during 2011–2012 have proved their genetic relations to the Vepor stratovolcano, being a source of volcanic material. In its lithological profile, the volcanosedimentary complex of the Pokoradza Formation, present on steep slopes of the Pokoradzská tabuľa and Blžská tabuľa plateaus, provides a unique record of volcanic events and their succession. Obtained knowledge has by principal way contributed to learning and understanding of the volcanic processes and to reconstruction of the Vepor stratovolcano, as well.

With regard to extent of obtained material during two research periods it was adopted a decision to publish it in two parts, Part I and Part II.

Part I (this issue) includes analytical data on scattered relics of volcanic and intrusive rocks in the NW part of the Slovenské rudohorie Mts. Geomagnetic methods were used in research of shallow intrusive and deeper subvolcanic bodies in the area of central and proximal volcanic zones. First part includes knowledge on paleovalley fillings west of the central volcanic zone formed by facies of volcaniclastic rocks and relic of scoria volcano with lava neck northward of the central zone.

Part II contains the findings of the study of volcaniclastic complexes in the fillings of paleovalleys on the southern slopes of the Slovenské rudohorie Mts. Paleovalleys represented communication paths along which a volcanoclastic material from southern slopes of the Vepor stratovolcano was transported to the sedimentary basin where it was deposited in the form of thick volcanosedimentary complex designed as Pokoradza Formation.The lithological profile of the volcanosedimentary complex of the Pokoradza Formation, accessible on step slopes of the Pokoradzská tabuľa and Blžská tabuľa plateaus expresses an unique record of volcanic events and their time sequence. The nature of primary volcanic structure, time evolution of volcanic activity and the evolution of stratovolcano in relation to evolution of south-located sedimentary basin are discussed in part "Paleovolcanic reconstruction of the Vepor stratovolcano". Discussion is also focused on volcanic processes involved in building of volcanic structure, time evolution of volcanic activity and evolution of stratovolcano in relation to development of the sedimentary basin located south.

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Neogene volcanism in the territory of Slovakia

During Neogene, the Carpathians formed continental margins or island arc including parts of older continental crust. The arc migrated to NE and to E due to subduction of oceanic and suboceanic crust of the Flysch basin and gradually collided from the west to east with margins of the European Platform. Retreat of the arc into area of the Flysch basin was compensated by formation of intra-arc and back-arc extensional basins. Lithosphere extensions in the area of Pannonian basin and at its northern margins were accompanied during Neogene by an ascent of dacite--rhyolite and andesite magmas of the calc-alkaline type and later by basaltic magmas of alkali-basalt type. Volcanic activity started in Lower Miocene with eruptions of a great volume of dacite-rhyolite ash-pumice tuffs deposited in the Pannonian and Transylvanian basins covering an area of about 125 000 km^2 (Fig. 1). Explosive activity was later accompanied with formation of the rhyodacite-rhyolite extrusive domes. According to Salters et al. (1998), the magma was generated by anatexis of the crustal material due to overheating of asthenosphere by diapiric ascent in extensional regime and supposed underplating by magma from the mantle sources (Póka, 1988). Formation of the crustal magma reservoirs is essential for the initial stages of the back-arc extension of relatively thick continental crust.

Continuing acid volcanic activity in the Middle and Upper Miocene (Badenian, Sarmatian and Pliocene) was accompanied by the andesite and basalto-andesite volcanism and several volcanic fields were formed on the inner side of the Carpathian orogenic belt (Fig. 1). In the territory of Slovakia, three main volcanic areas developed during the Neogene period: 1 – Central Slovakian Volcanic Field, and 2 – Eastern Slovakian Volcanic Field with the Slanské vrchy Mts. and the Vihorlat Mts., as well as 3 – Southern Slovakian Basalt Volcanic Field (Fig. 2).

1 – The basalt-andesite and andesite volcanism of the arc type in the Eastern Slovakian Neogene Volcanic Field is represented by andesite stratovolcanoes of smaller to medium size with minor occurrence of differentiated rocks and subvolcanic intrusions. A characteristic feature is the aligment of stratovolcanoes of the Slanské vrchy Mts. and the Vihorlat Mts. subpararel to Carpathian arc or orientation of the subduction zone. The Slanské vrchy Mts. and the Vihorlat Mts. in the Eastern Slovakia form a volcanic chain that continues into western Ukraine and on the territory of Northern and Eastern Romania with total length of about 500 km.

2 – Andesite volcanism in the Central Slovakian Neogene Volcanic Field, indirectly related to the subduction of the oceanic basement of the Krosno flysch zone, was controlled by processes of diapiric ascent of the mantle in extensional regime of the back-arc area (Lexa and Konečný, 1974, 1979a, 1998; Póka, 1998; Lexa et al., 1993, 1995; Konečný et al., 2002). Volcanism of Andean type developed in the area of continental blocks of the Central Western Carpathians over the Hercynian crust, which underwent metamorphic and granitization processes with following Mesozoic and Paleogene sedimentation. The Central Slovakian Volcanic Field with an area of about 5 600 km^2 developed during the Middle and Late Miocene (Badenian, Sarmatian, Pannonian) in the period 16–9 Ma. Andesite stratovolcanoes of medium to great size are dominant structures, the extrusive domes and effusive complexes are in minority (Fig. 2; V. Konečný et al., 1995). Evolution of andesite statovolcanoes with differentiated andesite and dacite-rhyolite volcanic rocks accompanied formation of calderas (Štiavnica stratovolcano, Poľana stratovolcano), or volcanotectonic grabens (Kremnica graben, Javorie stratovolcano) and development of subvolcanic intrusive complexes (V. Konečný and Lexa, 1995). In the case of Štiavnica stratovolcano, the formation of caldera with large dimensions 18 x 22 km was followed with the renowed andesite volcanism and origin of smaller volcanoes situated within caldera and stratovolcanic slopes. Later rhyolite volcanism in the Upper Sarmatian is accompanied with uplifting of central block in caldera and formation of horst structure – the resurgent horst (Konečný, 1970, 1971). In the central and northern parts of volcanic area the volcanic products were deposited in terrestrial environment, while in the southern part of this area, the volcanic rocks were deposited in marine and brackish environments (volcanosedimentary complexes of the Krupinská planina Plain). In the southern part of the volcanic area, near the southern edge of the Krupinská planina Plain, the submarine extrusive volcanism of the Vinica Formation is represented by extrusive andesite domes and related volcaniclastic rocks. Submarine extrusive volcanism occurred also in the Kováčovské kopce Hills near southern state border with Hungary. In the southern and eastern parts of the Krupinská planina Plain two smaller pyroclastic volcanoes Čelovce and Lysec also developed.

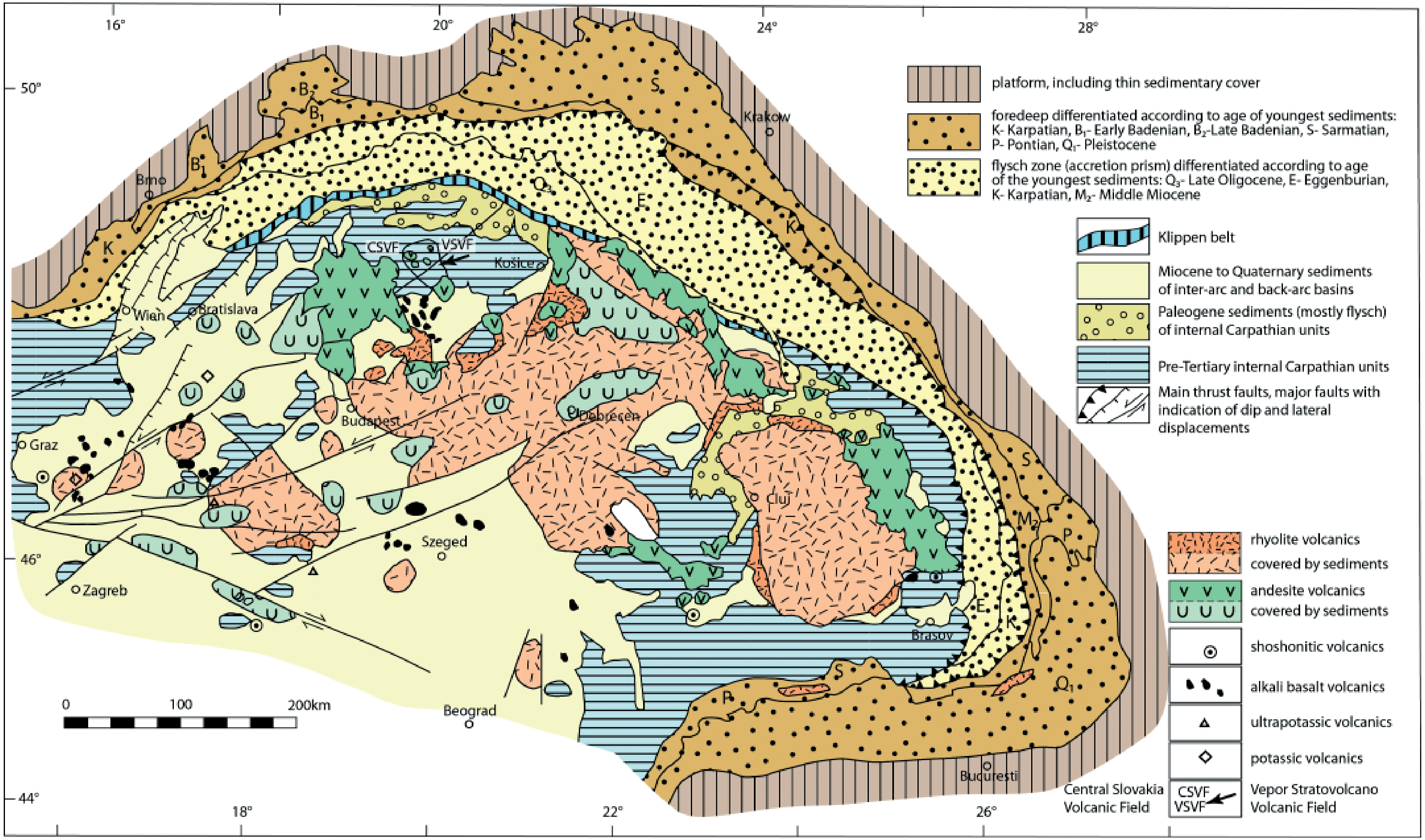


Fig. 1. Geotectonic setting of the Neogene volcanic field on the inner side of the Carpathian orogenic belt with position of the Central Slovakian Volcanic Field and Vepor Stratovolcano Volcanic Field (black arrow), after Lexa and Konečný (1998), modified.

Relics of volcanic and intrusive rocks, occurring further to east in the area of crystalline rocks of the Veporic Unit (Fig. 1), we consider as an eastern continuation of the Central Slovakian Volcanic Field. The main aim of this work is to analyse the primary volcanic forms and to make paleo-reconstruction of supposed Vepor stratovolcano.

3 – The Neogene-Quaternary alkali basalt and basanite volcanism following immediately the calc-alcaline andesite volcanism is related to diapiric ascent of asthenospheric mantle and indicates a continuing extension of the back-arc area. Volcanic products of the alkali basalt volcanism occupy an area of the southern Slovakia, continuing to Northern Hungary. Characteristic volcanic forms represent cinder cones often accompanied by lava flows, maars, tuff cones, diatremes and lava necks. In the Central Slovakian Neogene Volcanic Field there occur only scarse relics of lava flows, necks and one cinder cone (Putikov vŕšok Hill) with lava flow of Quaternary age (Fig. 2).

Review of the regional geological setting of the western part of the Slovenské rudohorie Mts. – the area of the Veporic unit

The Veporic unit or **Veporicum**, located east of the margin of Central Slovakian Neogene Volcanic Field in the western part of the Slovenské rudohorie Mts., represents an extensive massif built dominantly of granitoids and crystalline schists of Hercynian age with the remnants of Upper Paleozoic and Mesozoic rocks, as well as Paleogene and Lower Miocene sediments (Fig. 3). Westward this unit sinks beneath the volcanic rocks of Neogene age, building the Central Slovakian Neogene Volcanic Field and continues in their footwall towards south-west. Area of the western Veporicum in the north-western part of the Slovenské rudohorie Mts., which due to the occurrences of relics of the Neogene volcanism and intrusive bodies is subjected to our interest, has a complicated setting. It is a result of multistage Hercynian and Alpine tectonic processes. The Veporicum consists of crystalline basement rocks (Paleozoic to Proterozoic? in age), Upper Paleozoic, Mesozoic, Paleogene, Lower Miocene sediments and in smaller extent the intrusive bodies and volcanic rocks of Neogene volcanism.

The western part of the Slovenské rudohorie Mts. in the frame of the Veporic crystalline massif, more precisely the *middle unit* sensu Bezák et al. (1994), is built predominantly of the middle to higher-temperature metamorphosed complexes (paragneisses, orthogneisses, amphibolites and migmatites), being at the end of collision phase intruded by the S-type granitoids (hybrid granitoids) concordantly with the setting of metamorphosed cover. Middle unit is overthrust on the *lower unit*, being formed prevailingly of micaschist complexes. The final phases of Hercynian tectonic processes encompass significant

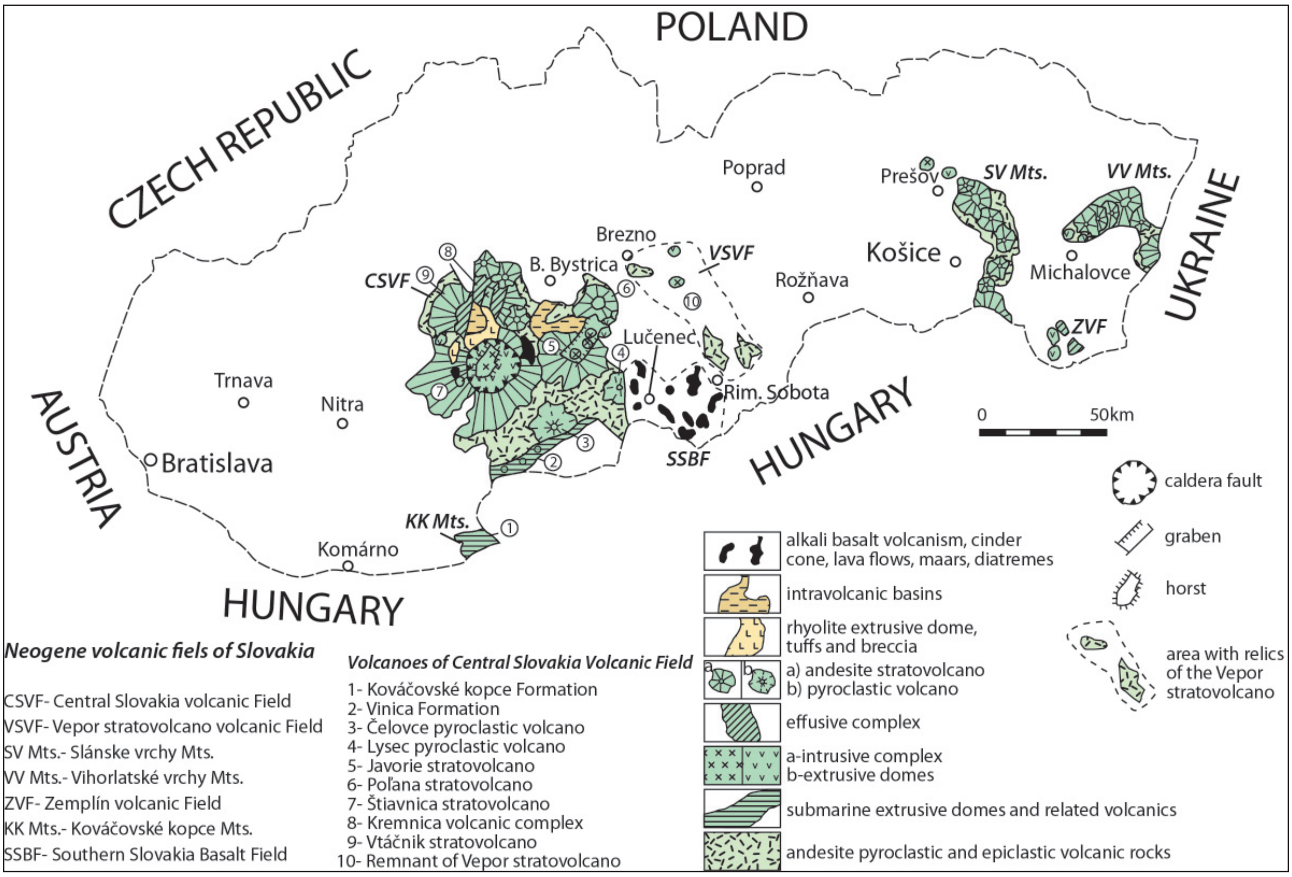


Fig. 2. Distribution of Neogene volcanic rocks in Slovakia.

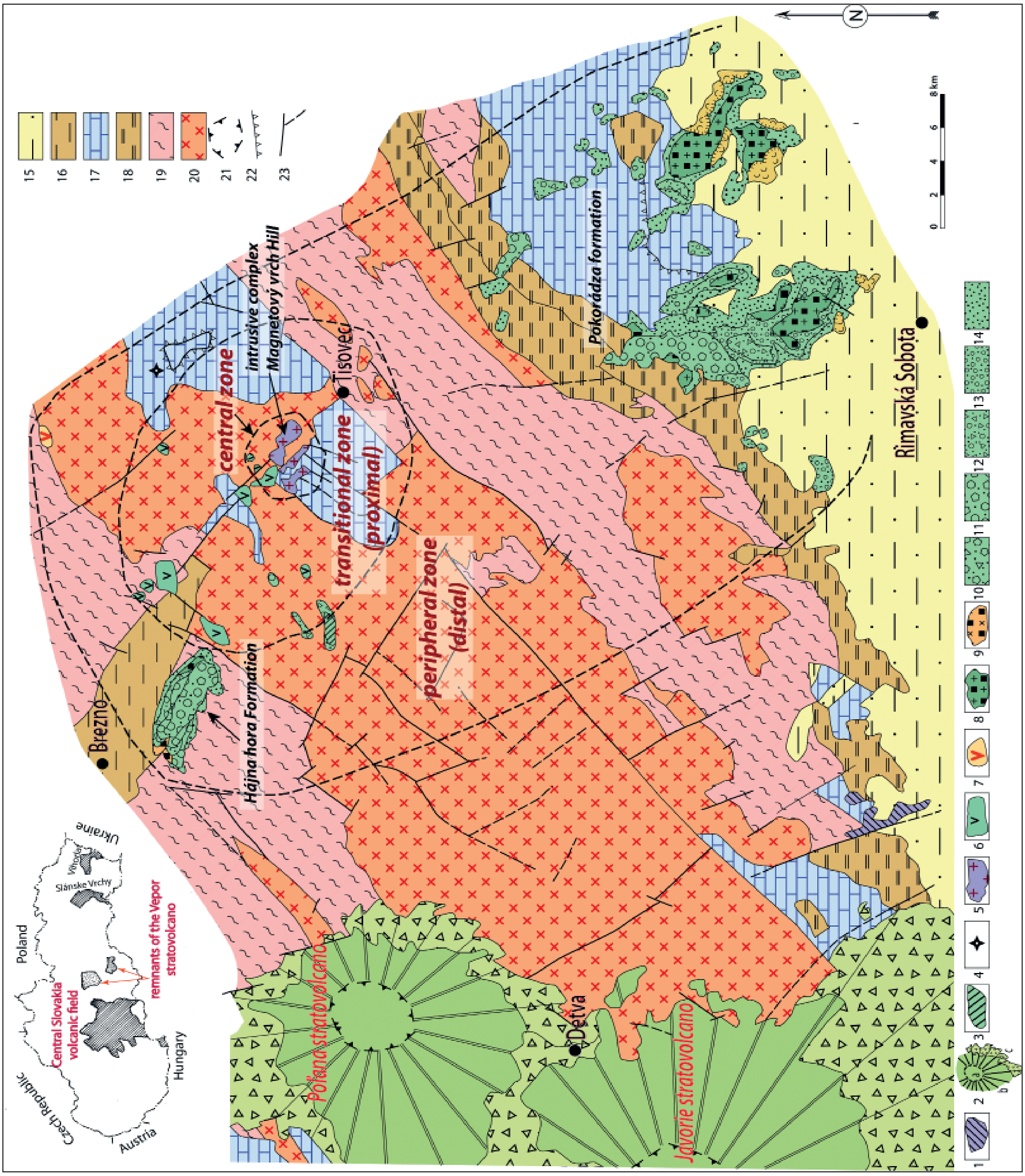


Fig. 3. The extent of the area with remnants of the Vepor stratovolcano. 1 – basalt lava flow (alkaline basaltic volcanism, Neogene – Quaternary); 2 – andesite stratovolcanoes (Ca-alkaline volcanism, Neogene), a – central zone, b – proximal zone, c – distal zone, d – fluvial and proluvial volcanosedimentary rocks, denudation remnants of the Vepor stratovolcano; 3 – pyroxene andesite lava flow; 4 – lava neck and scoria cone; 5 – diorite intrusive complex; 6 – intrusions and extrusions of pyroxene andesite and andesite porphyries; 7 – rhyodacite extrusion; 8 – pyroxene andesite block and ash pyroclastic flows; 9 – rhyodacite block and ash pyroclastic flows; 10 – coarse to blocky epiclastic volcanic breccia; 11 – coarse to blocky epiclastic volcanic breccia-conglomerate; 12 – medium to coarse epiclastic volcanic breccia-conglomerates; 13 – fine to medium volcanic conglomerates; 14 – epiclastic volcanic sandstones. Underlying rocks: 15 – Lower Miocene sediments (undivided); 16 – Paleogene sediments (undivided); 17 – Mesozoic complex (undivided); 18 – Permian and Carboniferous sediments; 19 – metamorphosed rocks (phyllites, schists and gneisses); 20 – granitoids; 21 – caldera fault; 22 – thrust line; 23 – fault.

transpression movements at lower grade metamorphic conditions, as well as the retrograde alterations of rocks and younger intrusions of I- and A-type granitoids.

The Alpine tectonic processes of the overthrust as well as transpression kinematics are superimposed on this Hercynian phase, changing former distribution of units and forming new arrangement in zones of NE–SW direction. In the northern part of the territory, orthogneisses and paragneisses prevail with evidences of the diaphtoresis in variable degree, and further, here are zones of crystalline schists with lower degree of metamorphic alteration and zones of phyllites. The A-type granitoid intrusions (the Hrončok type) are intruding through the shear zones.

Huge granitoid intrusions dominate in the middle part of the region, being formed by the S-type tonalites and granodiorites, concordantly penetrating the Hercynian metamorphic rocks along the foliation planes. Besides these intrusions, the middle zone is characterized by vigorous evolution of Neo-Hercynian granitoids of I-type with the age around 300 Ma, composed of tonalites and porphyric granitoids of the Sihla and Ipeľ types. The middle part of the region has the deepest erosive cut with uncovered large granitoid intrusions on the surface.

Southern part of the region is formed by complexes of higher parts of the Hercynian tectonic setting, represented by the hybrid complex and granitoids of Rimavica type with their metamorphic mantle. The metamorphic complexes of the lower Hercynian structural level crop out in transpression Alpine zones, being represented mainly by micaschists. Other lithologies found in the southern part of the region represent chlorite-muscovite, resp. quartz schists with variable content of graphitic component.

The Upper Paleozoic rocks in the area of western Veporicum consist of Upper Carboniferous metasandstones and shales – the *Slatvina Formation* and Permian metaarkoses and metaconglomerates – *Rimava Formation*. The *Foederata Series* rocks of Permo-Triassic age are represented by metaquartzites, shales, dolomites and crystalline limestones. In the south-eastern part of the territory, the nappes of Gemericum and Silicicum were overthrust on the Veporic crystalline rocks and its cover during the paleo-Alpine tectonic phase.

Gemericum is represented with the *Ochtiná Group* of Lower Carboniferous age, built of metasandstones, phyllites, as well as interbeds of magnesites and sediments with the higher content of carbon component. The Muráň nappe of **Silicicum** is located in the eastern part of the territory in the area of the Muránska planina plateau and at the Tisovec town. Silicicum represents the nappe of more extended carbonate platform separated from the footwall by the horizon of clayey and evaporitic sediments of Scythian age.

Paleogene sediments as a post nappe unit fill the Brezno Basin (east of Brezno town) in the northwestern part of the region. Sediments consist of conglomerates, clays and sandstones with interbeds of manganese ore. Into the post-nappe younger units there belong also Oligocene-Miocene sediments in the area of the Rimavská kotlina and Lučenská kotlina Basins extending to southern slopes of the Slovenské rudohorie Mts.

Westward of the given area the volcanic areal of Central Slovakian Neogene Volcanic Field has developed during the Late Neogene (Badenian-Sarmatian). Its recent eastern margin, partially modified by the erosion, is limited by the eastern edge of the Javorie and Poľana stratovolcanoes (Fig. 3). Relics of intrusive and volcanic rocks in the area of western Veporicum (east of the Javorie and Poľana stratovolcanoes), clearly demonstrate that former Central Slovakian Neogene Field has continued eastward and its products covered an essential part of the western territory of the Slovenské rudohorie Mts., including northern part of the Lučenská kotlina and Rimavská kotlina Basins.

The aim of our contribution is the reconstruction of the former volcanic field in the area of the western part of Veporic Unit in the western part of Slovenské rudohorie Mts. and consequently answering the questions what was the original extent of this volcanic areal, which volcanic forms and structures in the period of its evolution were created and which volcanic processes took place here.

Geographical and geomorphological characteristics of the area with the occurrence of Neogene volcanism in the region of the Veporské vrchy Hills.

Denudation relics of the Neogene volcanism are scattered in the wide area which includes region of the Veporské vrchy Mts. in the western part of the Slovenské rudohorie Mts., the Muránska planina Plain and the northern part of Horehronské podolie alley. Relics of the volcaniclastic rocks continue towards the southern slopes of the Slovenské rudohorie Mts. into the area of Stolické vrchy Hills, Revúcka vrchovina Highland up to the southern margins of the Rimavská kotlina Basin, where the relics of more extended volcanosedimentary complex form the Pokoradzská tabuľa Plateau and the Blžská tabuľa Plateau (Fig. 4).

As a discussion about the relics of volcanic and intrusive rock in this first part of our work is concentrated on the northern part of region where they crop out, information about the morphologic and geographic characteristics will be limited to the northern part of the Slovenské rudohorie Mts. (Veporské vrchy Hills, Muránska planina Plain and Horehronské podolie valley).

Western part of the Slovenské rudohorie Mts. – Veporské vrchy Mts.

A territory in the NW part of the Veporské vrchy Hills, where the relics of intrusive and volcanic rocks of Neogene age occur, is situated in the area east of the Brezno town and extends eastward to the Závadka nad Hronom village (Fig. 4). Northern boundary of the area is represented by the valley of the Hron river, southern boundary is represented with the mountain range of the Klenovský Vepor Hill with the elevation point (e.p.) 1338 – Rozsypok e.p. 1128 – valley of the Rimava river (north of the Tisovec town). Eastern margin of the area is represented by a relic of the smaller pyroclastic volcano Stožka (Kľak) with the central lava neck.

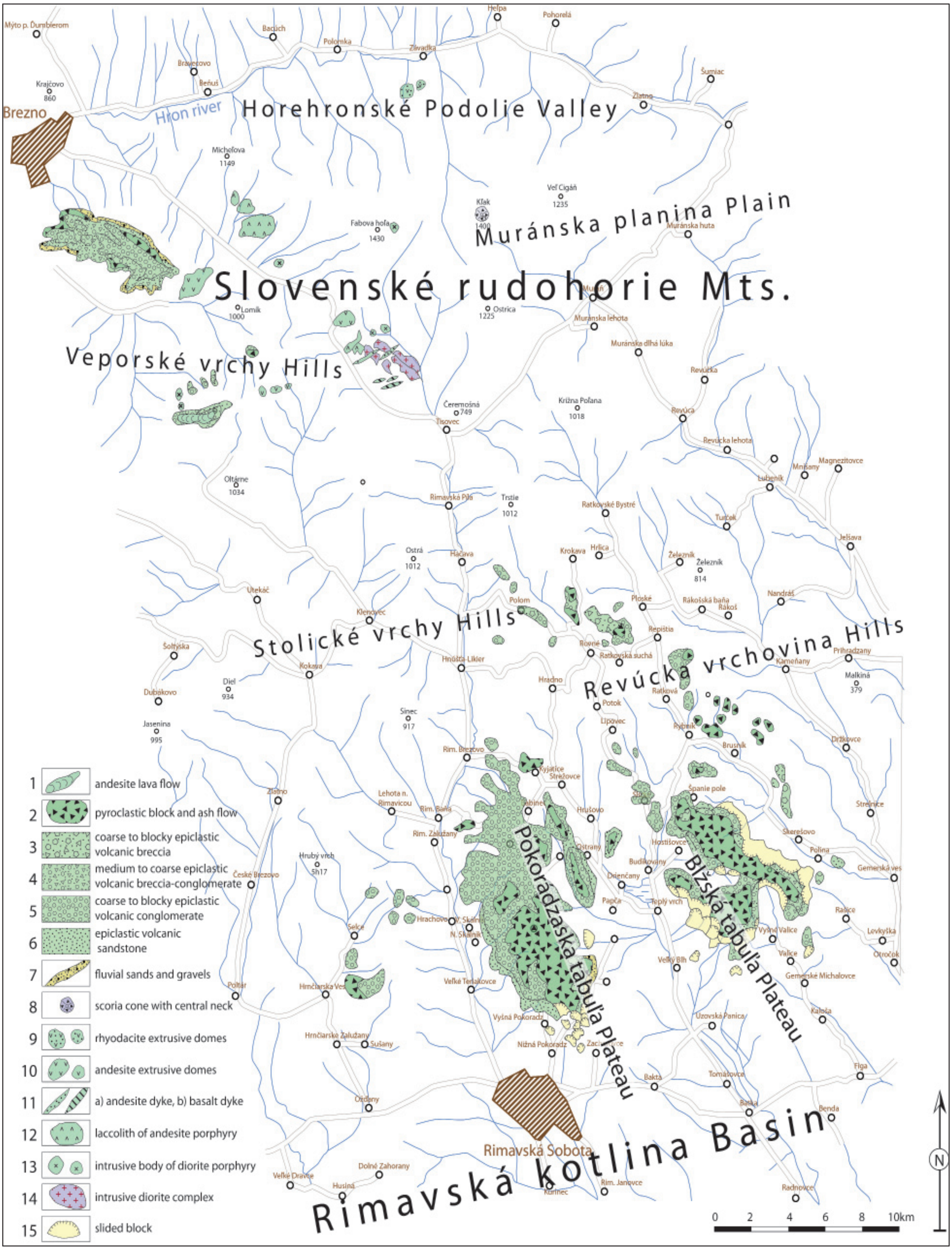


Fig. 4. Scheme of the area with relics of volcanic and intrusive rocks of the Vepor stratovolcano.

The majority of the area has a highland character. The highest position above the sea level reaches the mountain range of the Klenovský Vepor Hill 1338 m a.s.l. in the southern part of the area built in its apical part by the andesite lava flow. Other peaks in this territory are represented by Lomík, altitude 1000, Pomývačný grúň, altitude 1002, and Rozsypok, e.p. 1128. Area of the Hájna hora Hill (east of the Brezno town and north of the Čierny Balog village) built by a complex of volcaniclastic rocks represents a mountain range trending NW–SE with flat top and steep slopes. Area of the flat top of the Hájna hora Hill gradually lowers from 973 m a.s.l. at eastern margin to 850 m a.s.l. at the western edge. Mountain relief of the Veporské vrchy Hills. gradually decreases northward with transition to Breznianska kotlina Basin, where the present relief reaches the lowest level around 550 m a.s.l. Northern slopes of the Veporské vrchy Mts. are divided by the deep valleys and drained by the streams trending to the north to the Hron river. The Pomývač stream, Čierny potok stream and Šaling stream represent the largest of them. The stream network, springing east of Michalová – Pohronská Polhora village, flows into the Rohožná river, flowing westward through the NW–SE trending valley (north of the Hájna hora Hill), where it flows at the Brezno town into the Hron river. The southern slopes of the mountain ranges of the Klenovský Vepor and Rozsypok are furrowed with deep valleys and streams are flowing southward into the Veporský potok stream, which flows south into the Rimava river. The Rimava river, with tributaries springing north under the Kučelah massif (north of the Magnetový vrch Hill), is heading to the south to the Rimavská Sobota town in the valley of N–S trend.

In the eastern part of the area, the mountain relief reaches the highest altitude in the Fabová hoľa peak – 1439 m a.s.l. and in the Stožka (Kľak) peak – 1049 m a.s.l., which top is built of remnants of smaller pyroclastic Stožka volcano with the lava neck. Mountain relief sloping north is drained by the streams trending north and flowing into the Hron river.

On the geomorphological evolution of the territory, the older tectonic processes of uplifting character participated particularly, being active already during the development of the volcanic area and with greater intensity in the later periods. Due to the enormous uplift, the primary stratovolcanic structure was removed by denudation with exceptions of more external areas where the relics of the original paleovalley fillings have remained in the form of volcaniclastic rocks (Hájna hora Hill), or the filling was preserved from erosion due to its coverage by the lava flow (Klenovský Vepor Hill). In the assumed central volcanic zone, the denudation cut reached subvolcanic level and exposed the subvolcanic intrusive complex (area of the Magnetový vrch Hill, north of the Tisovec town).

Settlement in the form of towns and villages is concentrated mainly in the valleys of larger watercourses; it is mainly in the Brezno town at the confluence of the Hron river and the Rohožník stream at the NW margin of the area, joined villages Michalová – Pohronská Polhora, further along the Hron river, as well as the villages of Bacúch, Polomka and Závadka nad Hronom. Another area of settlement in the SE part of the territory along the Rimava river represents the Tisovec town, which in the past was known by smeltery, producing iron, by the supply of raw materials from magnetite skarn deposits coming from a nearby mineral deposit of Magnetový vrch Hill. Only scattered settlements are in the mountainous parts of the area. Agricultural areas are used at low parts of the relief along the Hron river and Rohožná stream in the northern part of the territory and partly the Rimava river in the SE part of the territory. At higher levels the middle mountain relief pastures predominate, steeper hillsides are forested.

History of researches

The attention of researchers dealing with issues of Neogene volcanism in previous periods largely focused to the area of Neogene volcanism of the Central Slovakia, and in particular to the volcanic mountain range, which already provided ore wealth since the Middle Ages and became famous by the mining of precious and polymetallic ores (Banská Štiavnica and Kremnica towns). However, volcanic rocks occurring sporadically eastwards from the Central Slovakian Neogene Volcanic Field in the environment, built dominantly of the crystalline rocks of Hercynian age with rare remnants of Mesozoic rocks on its surface, did not escape their attention.

The presence of volcanic rocks in the western Veporicum was noticed in the general geological map of the Austro-Hungarian monarchy (Geol. Ubersichtskarte der O´´-II Monarchie 1867–1871), where at a scale of 1 : 56 000 among others there is also shown the andesite body in the area of the peak of Klenovský Vepor Hill that Hauer identified as trachyte-andesite (D. Štur Jb. d. k. k. Geol. R. A. 1858 IX). Dr. Luka Marič from Univerzity of Zagreb in the Klenovský Vepor mountain ridge and further to east in the Rozsypok ridge has conducted mineralogical and petrographic studies of pyroxene andesite lava flow, publishing his results in the work "Andezitska erupcia u Veporu" (Věst. St. geol. Úst. Čs. Republ., 1931, Issue VII, No. 6, Praha).

In the period after the Second World War in the context of the works on the compilation of a general geological map 1 : 200 000 by the workers from the Geological Institute D. Štúr led by prof. M. Kuthan in the crystalline rocks of the western Veporicum there was recorded in the geological map a larger number of andesitic bodies in the form of veins, intrusions and relics of pyroclastic rocks, including lava flow on the top of the Klenovský Vepor Hill. After adopted scheme of division of andesite volcanism products from the first that time of Badenian to Sarmatian age into eruptive phases (from to third andesite phase), the occurrences of volcanic and intrusive rocks in the Veporic unit were integrated into the second andesite phase (Kuthan et al., 1963).

Increased demand for iron ore for the ironworks in the Tisovec town required further exploration work of magnetite skarn ore deposit in the region of the Magnetový vrch Hill north of the Tisovec town. After making drilling and mining works (Bacsó, 1964; Bacsó and Valko, 1969) an information about the actual skarn ore deposit, the volcanic rocks and intrusions,as well as mineralization processes (Bacsó, l. c.) was obtained. The author distinguishes between two stages of ore mineralization in relation to three stages of development of andesite and diorite bodies. The rise of the skarn-making solutions of the mineralization period No. 1, causing the origin of zonal skarnization in the rocks during first period (I) was linked with the development of the Tisovec diorite complex. To the following second stage (II) there were included bodies of biotite-amphibole and biotite-hyperstene andesites, as well as other varieties of amphibole andesites and pyroxene andesites. Post magmatic solutions of mineralization stage No. 2 were linked with this phase. Into the third stage (III), the clinopyroxene-garnet andesites and biotite-garnet andesites with no associated mineralization were included. The survey resulted in the preparation of a specialized geological map that displayed geological relations in the mineral deposit Magnetový vrch Hill and surrounding areas (Bacsó and Valko, 1969). The results achieved in this period meant significant progress in the research of ore mineralization around the Magnetový vrch Hill and contribution to geological structure and position of intrusive bodies in this area.

The next research stage in this area, linked to the geological mapping, was completed by assembling of Geological map of the Slovenské rudohorie Mts. and the Low Tatras at a scale 1 : 50 000 (Klinec, 1976). The relics of Neogene volcanism are included into this map. Although the size and forms of volcanic and intrusive bodies and their petrographic composition were significantly schematized, the map at a scale of 1 : 50 000 represented at that time new contribution to the knowledge of volcanic intrusions and bodies in this area.

Relics of the volcanosedimentary complex on the northern margin of the Rimavská kotlina Basin were mapped by V. Konečný and J. Lexa (1982), who after typical locality near the Vyšná Pokoradz village entitled it as the Pokoradzské súvrstvie (formation), where they distinguished facies of epiclastic and pyroclastic rocks represented mainly by the pyroclastic flows. Mapping results were included in the Geological map of the Rimavská kotlina Basin and adjacent part of the Slovenské rudohorie Mts. at a scale 1 : 50 000 (Elečko et al., 1985) and explanations to the geological map (Vass et al., 1986) and in detail commented in the monograph Geology of the Rimavská kotlina Basin (Lexa in Vass, Elečko et al., 1989a).

Two different opinions, occurring in the previous stages of the research, were expressed in stratigraphic position of the Pokoradza Formation. Kuthan et al. (1963) in the context of preparation of the general Geological map of volcanic rocks at a scale 1 : 200 000 included the remnants of volcanic and intrusive rocks into the 2nd andesite phase, corresponding to Badenian age (Tortonian in that time), despite the biostratigraphic data by Němejc (1960, 1967), indicating the presence of Sarmatian flora in the basal sediments of corresponding beds near the Nižný Skálnik village. Later, the Sarmatian age of flora in the basal beds of volcanosedimentary complex near localities of Nižný and Vyšný Skálnik was demonstrated also by Sitár and Dianiška (1979). The results 16.4 $\pm$ 0.6 Ma and 16.2 $\pm$ 0.2 Ma (Repčok, 1981) by K/Ar radiometric dating of the pebble conglomerate horizon and a fragment of pyroclastic flow pointed to Baden age.

In 1982 V. Konečný and J. Lexa mapped volcanic and intrusive rocks of Neogene age in the western Veporicum at a scale of 1 : 25 000, including volcanosedimentary complex of the Hájna hora Hill (east of the Brezno town). The mapping results were included into the manuscript of geological map-sheet Pohronská Polhora at a scale of 1 : 25 000 (Ivanička et al., 1986) and commented in the explanatory notes to this map. Volcanosedimentary complex of the Hájna hora Hill. has been identified as a filling of paleovalley directed from presumed center (Magnetový vrch Hill) to the NW. Volcanosedimentary complex V. Konečný and J. Lexa divided into individual facies of epiclastic and pyroclastic rocks. Area of the mountain ridge Klenovský Vepor (e. p. 1338.2) south of the Hájna hora Hill. was identified as a filling of the paleovalley oriented to WWS with the lava flows on the top of the ridge. Other relics of the original filling of paleovalley, directed to the west, were identified on the northern slope of the Klenovský Vepor Hill. Geological mapping in the wider area of the village Michalová revealed the presence of intrusive bodies. Their structure and petrographic composition was described by V. Konečný and J. Lexa in Ivanička et al. (1986). The knowledge about the relics of volcanic and intrusive rocks was later incorporated into the geological maps of the Slovenské rudohorie Mts. – Western part at a scale 1 : 50 000 (Bezák et al., 1999).

In the monograph Metallogenesis of Neovolcanites in Slovakia (in Slovak, Burian et al., 1985) authors indicate the relics of volcanic and intrusive rocks in the Western Veporicum as "volcanoplutonic complex of the Veporské vrchy Hills." and subdivide them into formation and complexes. The Tisovec intrusive complex comprises bodies of the Tisovec diorite and quartz diorite, as well as further dacite veins, present at the contact of diorite with limestone. Intrusive complex authors considered as the central zone. Diorite bodies are reported as a second center at the Kľak elevation (three isometric bodies). Intrusive forms and lava flows of biotite-amphibole and biotite-hyperstene andesite authors include into the Vepor Formation, which extends in the large area at the margin of the Tisovec central zone. As the youngest there are considered the garnet andesite intrusions, appearing in the form of veins and stumps in the central volcanic zone and on the edges of diorite bodies. Location of those bodies is assumed to follow concentric and radial fractures around the central zone. The Hájna hora Formation west of the Michalová village, formed by tuffitic rocks and tuffs is regarded as a relic of the upper structure. Into the formation of the Železnícke predhorie foothills the authors include the explosive products, agglomerates, tuffs and lava sheets north of the Rimavská Sobota town. According to authors, this formation represents a peripheral part of the Tisovec volcano-plutonic complex. Part of monographic work is a geological scheme of the area Tisovec-Magnetový vrch Hill, constructed on the basis of previous works by Bacsó (1969) and Klinec (1976). Burian et al. (1985) defined the contours of ore bodies and types of mineralization, accepting the concept of two mineralization stages, being proposed by Bacsó (1964), Bacsó and Valko (1969). In addition to the proposed division of groups of volcanic and intrusive rocks, the work does not include more detailed characteristics of volcanic and intrusive bodies (information on their nature, spatial parameters and composition is scarce).

During studies of the geological and tectonic structure of the Tisovec karst and its surroundings Vojtko (1999, 2000) carried out study of Tisovec intrusive complex in the area of Magnetový vrch Hill and its surroundings. A geological map Tisovecký karst massif and Kučelah was compiled with geological profile and explanatory notes (Vojtko, l.c.). In the part dealing with the structure of relics of intrusive and volcanic rocks in the brief explanations to geological map, author in principle accepts division of volcanic rocks to particular formations proposed by Burian et al. (1985) and this division extends for several other formations. Within the Tisovec intrusive complex a nine separate diorite bodies of irregular form are specified with dimensions up to 2500 x 500 m. Author describes penetrations of pyroxene andesites in the Vepor Formation, which are older then diorite bodies. The newly defined Pacherka Formation contains a group of dyke bodies of basaltic andesites to basalts in the SE part of Tisovec intrusive complex, which represent the final stage of volcanic activity. The Magnetový vrch Formation is formed by the amphibole-pyroxene andesite bodies, penetrating the diorite intrusions, and occupies an area of about 4000 x 1500 m, trending NW–SE. The Strieborný vrch Formation (NW of the Magnetový vrch Hill) is formed by the garnet-pyroxene andesites ($\pm$ biotite), considered as the oldest member of the succession. For subvolcanic intrusive rocks a Lower Badenian age is expected. The contribution of this work is based mainly on the finding of a group of dyke bodies of the basalt-andesite to basaltic composition, involved in the Pacherka Formation. Volcanoplutonic complex north of Tisovec was named as the Tisovec stratovolcano.

In the summary article on the structure and development of the Central Slovakian Neogene Volcanic Areal (V. Konečný et al., 2001), the denudation relics of volcanic and intrusive rocks in the Western Veporicum and the northern edge of the Rimavská kotlina Basin, including the southern slopes of the Slovenské rudohorie Mts., are considered to be a product of the Vepor stratovolcano. The area of the central volcanic zone of the Vepor stratovolcano, located in the space of the Magnetový vrch Hill (north of Tisovec), contains the dispersed intrusive-extrusive bodies externally to the Magnetový vrch Hill, which are incorporated into transition (proximal) volcanic zone. More distal relics, represented mainly by the volcaniclastic and volcanosedimentary rocks west of the central zone, represent the denudation remnants of the original fillings of paleovalleys (Hájna hora Mts. east of the Brezno town, Klenovský Vepor Mts. with the lava flow on the top of the mountain ridge, etc.). They are located within the area of crossing from the transitional (proximal) to peripheral (distal) volcanic zone. Relics of the volcaniclastic rocks on the southern slopes of the Slovenské rudohorie Mts. and the northern edge of the Rimavská kotlina Basin are located in the southern peripheral volcanic zone.

The proposed concept of distribution of denudation relics of volcanic and intrusive rocks within volcanic zones by Konečný et al. (2001) represented a starting point for projects “Paleovolcanic reconstruction of the Vepor stratovolcano” and “Geological Profiling and structure of products of the Neogene volcanism in the northern part of the Rimavská kotlina Basin (Pokoradza Formation)”. During research on both projects and geological mapping in the western Veporic unit within 2008–2012 V. Konečný and P. Konečný studied the relics of volcanic and intrusive bodies at a scale of 1 : 10 000. Wider area of subvolcanic intrusive complex Magnetový vrch Hill was mapped at a scale of 1 : 2 000 and later transformed into the geological map at a scale of 1: 5 000.

Relics of the volcanosedimentary rocks on the southern slopes of the Slovenské rudohorie Mts. and at the northern edge of the Rimavská kotlina Basin (Pokoradza Formation) were mapped at a scale of 1 : 10 000 (26 sheets of topographic maps). Works resulted in the preparation of geological-lithofacial maps at the same scale. The geological-lithofacial maps contained also the lithological-geological profiles (37 profiles), trending E–W across the sedimentary basin of the Pokoradza Formation and visualizing the lithological succession in the vertical dimension. The knowledge, gained through the field research and petrological studies of volcanic and intrusive rocks, represent the basis for the paleovolcanological reconstruction of the Vepor stratovolcano.

Distribution of relics of Neogene volcanism in the NW part of the Veporic unit

In the Veporic unit, built predominantly of the crystalline rocks, there was previously identified a greater number of relics of volcanic intrusive rocks, which, as already mentioned, indicate the existence of a volcanic field in this area during the Neogene time. Despite the differences in opinion on the nature of relics of intrusive and volcanic rocks, it is clear that after the origin of volcanic field, there has occurred an enormous uplift of extensive regional block in this area, which determined the intense erosion and denudation of primary volcanic structure, or if appropriate, more volcanic structures. Volcanic structure at the surface with supposed volcanic cone was due to deep erosive cut completely removed and denudation processes have exposed the subsurface levels with intrusive and intrusive-extrusive bodies. Only remnants of paleovalleys filling west of supposed stratovolcanic cone have been preserved with a volcaniclastic material that was transported from the stratovolcanic slope to larger distances away from the stratovolcano.

Model of stratovolcanic zonal structure

It has occurred as appropriate in assessing of the position of relics of volcanic and intrusive rocks in the western Veporic tectonic unit within the expected primary stratovolcanic structure, to apply the model of its zonal division. The principle of this model is the division of the facies of volcanic rocks, based on their spatial relationship to the position of eruptive centers (i.e., the source region of volcanic materials), to: 1 – *facies of the central volcanic zone* (the area of the crater and the top part of the cone, including feeding systems and intravolcanic to subvolcanic intrusions), 2 – *volcanic facies in the transitional volcanic zone*, which participate in building of the slopes of stratovolcanic cone, 3 – *facies of peripheral volcanic zone* extended at the base of the cone with the transition to proluvial plane. This model was in our literature designed to solve structure of pyroclastic volcanoes on the southern edge of the Krupinská planina Plateau, in the case of Čelovský and Lysecký volcanoes (V. Konečný, 1969) and published in the Geological Map of Ipeľská kotlina Basin and the southern part of the Krupinská planina Plateau at a scale 1 : 50 000 (V. Konečný et al., 1979). This concept of division of volcanic facies within volcanic zones was later also applied to volcanoes of stratovolcanic type during the compilation of regional geological maps of the volcanic mountains of the Central and Eastern Slovakia at a scale 1 : 50 000.

Similar division was applied in the English professional literature: 1 – central volcanic zone, 2 – proximal volcanic zone (near volcanic zone), 3 – distal volcanic zone (remote volcanic zone). Reported division in the summary work Encyclopedia of Volcanoes (2000) is based on the associations of volcanic rocks: 1 – crater association, 2 – association of stratovolcanic cone, 3 – association at the slopes of stratovolcanic cone (ring plain).

The division to the form of associations of volcanic rocks is appropriate for stratovolcanic structures with a relatively high degree of conservation (resp. with low degree of denudation), i.e. the current recent volcanoes. The intensively eroded stratovolcanoes (most Neogene stratovolcanoes of the Central and Eastern Slovakia), due to their advanced destruction, cannot be longer identified by the crater facies associations and when there are uncovered intrusive complexes and bodies of feeding systems in their subvolcanic level, it is preferable to apply the scheme with the definition of the central volcanic zone, which includes feeding systems or intravolcanic and subvolcanic intrusions. For these reasons the assessment of positions of relics of Neogene volcanic rocks and intrusive rocks in the Slovenské rudohorie Mts. seems to be a more appropriate model for the division into central, intermediate (transitional) and peripheral volcanic zones (Fig. 5). With respect to further discussion on the position of relics of volcanic and intrusive rocks in the crystalline massif of Veporic unit in the NW part of the Slovenské rudohorie Mts. it is advisable to list short characteristics of facies in the volcanic zones.

Central Volcanic Zone (central zone) includes volcanic rocks facies in the crater area, i.e. crater breccia, bodies of feeding systems (volcanic necks, diatremes, dykes) or breccias of extrusive domes filling the crater area. The central volcanic zone also includes apical parts of stratovolcanic or pyroclastic cone. The central volcanic zone is considered as the main source area of volcanic materials transported to the surface of the volcano at multiple outputs of magma to the surface. In the central volcanic zone in the case of partial denudation of volcanic structure, the feeding bodies (dykes, necks) or alternatively intrusive bodies of intravolcanic position (stocks, sills, laccoliths) are exposed. After complete removal of surface volcanic structure there are exposed subvolcanic intrusive complexes or subvolcanic plutons. In our case this situation, as will be shown further, corresponds to intrusive complex of the Magnetový vrch Hill.

Transitional volcanic zone consists of pyroclastic facies and epiclastic volcanic rocks and lava flows that build stratovolcanic cone. Facies of transitional volcanic zone correspond to facies in proximal zone, alternatively to associations of the stratovolcanic cone. More dimensional stratovolcanoes have usually in the place of stratovolcanic slope located smaller satellite volcanoes (resp. parasitic volcanoes), as well as numerous domatic extrusions. A good example in the Central Slovakian Neogene Volcanic complex is the Štiavnica stratovolcano. Bodies of sills, laccoliths and stock intrusions are placed in the lower levels of stratovolcanic slope, or even at the base of stratovolcanic structure. Due to removal of surface volcanic structures by erosion, these bodies are at the level of denudation cut exposed at the surface, alternatively the feeding systems for surface parasitic volcanoes, situated in stratovolcanic slope, are exposed. This situation corresponds to the position of the majority of scattered intrusive-extrusive bodies, located externally of the intrusive complex of the Magnetový vrch Hill.

Peripheral volcanic zone covers an area at the foot of the stratovolcano with the transition to proluvial plane (plain ring), in which predominantly redeposited facies of volcaniclastic material in the form of epiclastic volcanic breccias, conglomerates and sandstones are deposited. The peripheral volcanic zone corresponds to the distal volcanic zone, respectively to association at the foot of the stratovolcanic cone. Peripheral volcanic zone is episodically reached by the gravitational clastic flows of lahar type and hyperconcentrated flows, mud flows, stream flows, etc. During volcanic activity the peripheral areas of volcanic zones are also covered by falls of volcanic ash from the volcanic cloud, as well as by the products of flushes of ash from areas of stratovolcanic slope. The space of peripheral volcanic zones is often hit by the block and ash pyroclastic flows and to shorter distances there progress also the lava flows.

When comparing with this model the denudation remains of volcanoclastic rocks west of the central zone, which represent the original filling of paleovallyes, it would correspond to the zone of transition from stratovolcanic slope to the peripheral volcanic zone (filling of the Klenovský Vepor paleovalley with the lava flow at the top, paleovalley Za Kýčerou north of the Klenovský Vepor Hill). The complex of the Hájna hora Hill represents a filling of the paleovalley that after transition from the stratovolcanic slope continued westward to the area of peripheral volcanic zone, or to the more distal parts.

Denudation relics of volcaniclastic rocks on the southern slopes of the Slovenské rudohorie Mts. in the form of paleovalleys filling represent almost classic example of the transition from the stratovolcanic slope to the proluvial plane at the foot of the volcano. Paleovalleys southward run into the sedimentation basin in the peripheral area (distal zone) of volcanic zone at the southern foot of the Vepor stratovolcano, where a deposition of volcanosedimentary rocks representing the Pokoradza Formation took place.

Distribution of relics of volcanic and intrusive rocks of the Vepor stratovolcano in the context of model of volcanic zones – a review

Denudation relics of volcanic and intrusive rocks in the NW part of the Veporic unit (western part of the Slovenské rudohorie Mts.) are scattered over an area about 24 x 16 km^2 (Fig. 6,7). The initial extent of the volcanic area covered by the volcanic activity products of the Vepor stratovolcano in the Neogene period was much larger. It is necessary to count the continuation of the peripheral volcanic zone further westward and the primary volcanic structure in the east and north directions, as well as the range of the peripheral zone southward (volcanosedimentary complexes at the northern margin of the Rimavská kotlina Basin). From this idea there has resulted that the stratovolcano products of covered prevailing part of the massif of the Veporic tectonic unit (including the southern

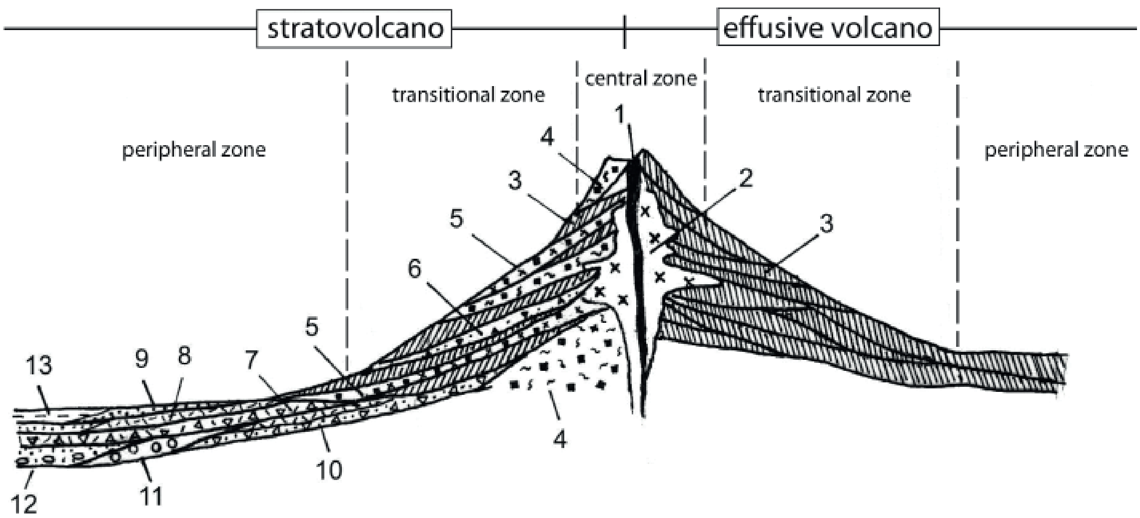


Fig. 5. Scheme of zoned stratovolcanic structure (V. Konečný and J. Lexa, 1995). 1 – lava neck; 2 – central intrusive complex; 3 – lava flow; 4 – volcanic breccia, agglutinate; 5 – chaotic breccia of pyroclastic flow; 6 – reworked pyroclastic rocks; 7 – lahar breccia; 8 – tuff, lapilli tuff, pumice ash tuff; 9 – epiclastic volcanic sandstone; 10 – epiclastic volcanic breccia; 11 – coarse epiclastic volcanic conglomerates; 12 – fine epiclastic volcanic conglomerates and sandstones; 13 – epiclastic volcanic siltstones.

slopes of the Slovenské rudohorie Mts.) and in the south direction they substantially exceeded the current extent of recent denudation relics (the Pokoradzská tabuľa and Blžská tabuľa plateaus) in the northern part of the Rimavská kotlina and Lučenská kotlina basins.

Area of the central volcanic zone

The deep denudation cut in the central volcanic zone has exposed *subvolcanic intrusive complex Magnetový vrch Hill* (1), located about 5 km NW of the town of Tisovec (Fig. 6). Intrusive complex is uncovered on the slopes of the Rimava river valley and on the top of the Magnetový vrch Hill (e.p. 964.3). Intrusive complex, exposed in the lower levels of the slopes of the Rimava valley, is represented by the stock-like diorite intrusion with transition towards the west at a higher level in several apophyses intruding the Mesozoic rocks. Diorite complex is cut by the younger dyke swarms of andesite and diorite porphyry of various compositions trending ENE–WSW to E–W.

Dyke swarm of basaltic andesites to basalts (2) is exposed south-west of the Magnetový vrch Hill and on the slopes of the Pacherka ridge (e.p. 960).

A group of intrusive bodies of andesite porphyry intrusions and quartz-diorite porphyry with signs of autometamorphic alterations is located north-west of the Magnetový vrch Hill. The first smaller intrusive body (3) on the western slope of the Magnetový vrch Hill is elliptical in shape and trending NW–SE. Next intrusive body (4), roughly isometric in shape, occupies hill with the flat top (missing elevation point) and its western slope. West of that body in the area with the elevation 757 m a.s.l. and on its western slope, the intrusive body (5) is located, roughly elliptical in shape and oriented in the NNE–SSW direction. Another intrusive body (6) of elliptical shape trending N–S, situated north of previous body, is exposed on the ridge with e.p. 795. In its southern part it follows the body exposed on the southern slope of the side Nemcova valley and continues to SW to the lower level of the main valley with the Furmanec brook.

Two diorite porphyry bodies are exposed north of the Magnetový vrch Hill at the level of present denudation cut. Larger body (7), roughly elliptical in shape with dimensions of 170 x 130 m, is exposed on the western slope of the Spuzlová valley, branching from the main valley of the river Rimava northward. Smaller body of diorite porphyry (8), nearly isometric in shape, is uncovered in erosional cut of the side valleys with estuary to the main valley of the Rimava river.

Area of transitional (proximal) volcanic zone

Extrusive-intrusive andesite porphyry bodies and andesites are scattered within this zone at a distance of 8-10 km from the central volcanic zone.

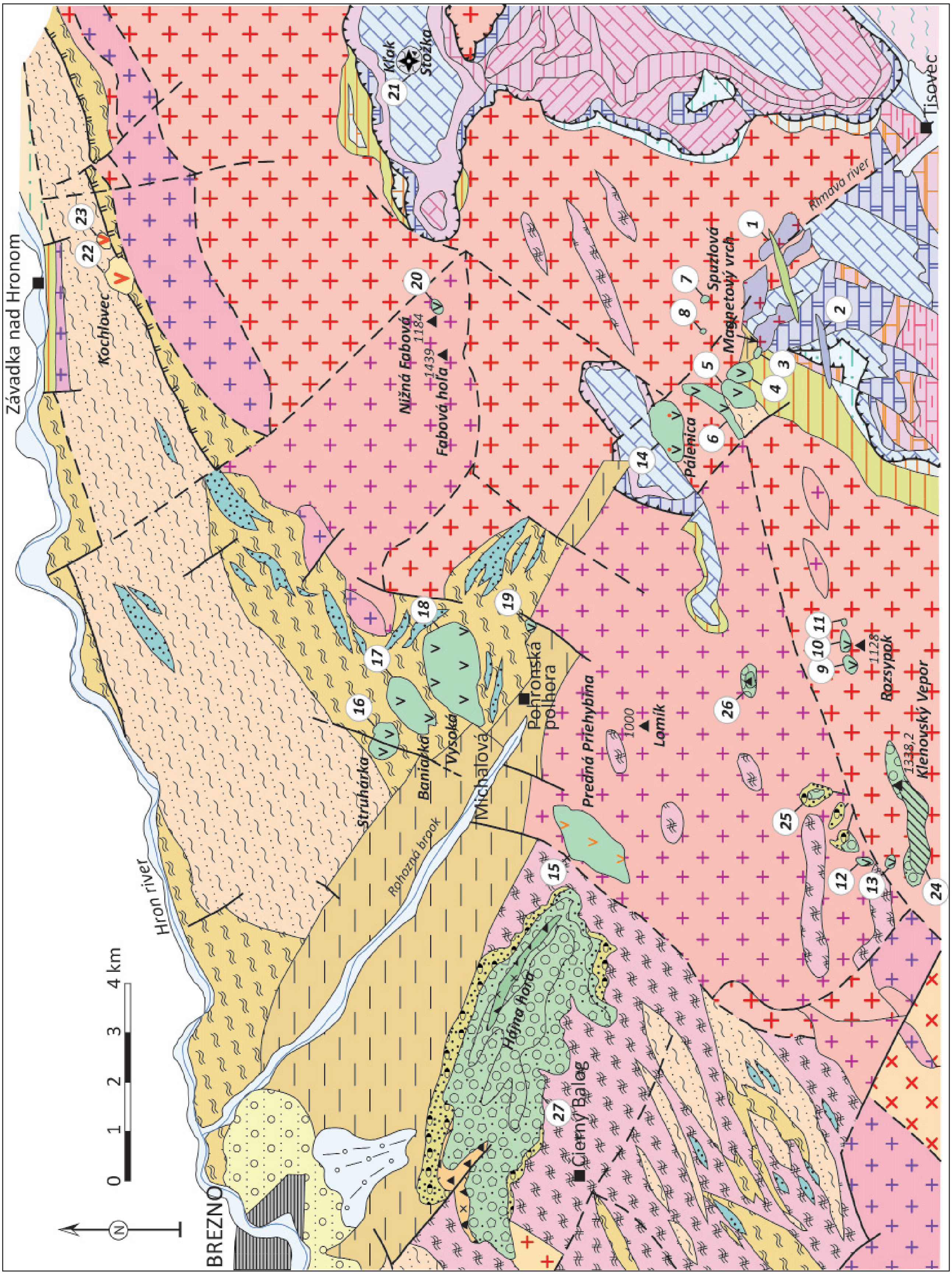
Three bodies of amphibole andesite and pyroxene andesite occur in the southwestern sector in the proximal volcanic zone on the northern slope of the Rozsypok mountain ridge (e.p. 1128). The elliptical body (9) on the mountain range under the Rozsypok elevation point with dimensions 200 x 150 m is trending NW–SE. Closer to central volcanic zone, in the ridge with an elevation point 1073, the next elliptical body (10) is located with dimensions of 250 x 150 m, being oriented ENE–WSW. In the lower level of that ridge (995 m a.s.l.) an andesite neck (11) occurs, having dimensions of approximately 100 x 150 m with the ENE–WSW orientation. Those bodies follow the direction of WSW–ENE trending tectonic line with radial orientation concerning the central volcanic zone. In continuation of this line to the southwest in a distance of about 10 km from the central volcanic zone, there are located two small intrusive-extrusive bodies on the NW slope of the Klenovský Vepor Mts. The bodies crop out in the Molčanov grúň ridge beneath the e.p 1222.6. The body of the amphibole pyroxene andesite (12) is located in the lower level of the range 950–1000 m a.s.l., having dimensions 350 x 200 m and orientation in the NNW–SSE direction. In the higher level of the Molčanov grúň ridge, based on block debris, another body of smaller size (13) was found.

Several intrusive-extrusive bodies are present in the northern sector of the transitional volcanic zone. Complex of extrusive bodies of amphibole andesite with garnet (14) is located closer to central volcanic zone on the slopes of the Pálenica valley and in the area of the ridge with e.p. 869 east above the Čertová dolina valley with the Furmanec brook. The longer axis of the body is trending E–W. The next intrusive-extrusive complex of Predná Priehybina (15) SW of Michalová – Pohronská Polhora villages is located in a greater distance. The complex irregular in shape, which includes a larger number of intrusive-extrusive bodies of quartz amphibole biotite dacite, is oriented with longer dimension in the NE–SW direction and is about 2000 m long.

North of the Michalová – Pohronská Polhora villages on the western slopes, the geological mapping and geomagnetic profiling have revealed three bodies formed of the autometamorphic amphibole pyroxene andesite porphyry. A more distant body Strúhanka (16), north of the Michalová village is roughly elliptical in shape, having a longer dimension oriented in the E–W direction. Closer is located the Baniarka body (17), roughly elliptical in shape with dimensions of 1000 x 650 m and with longer dimension trending NE–SW. The most extensive Vysoká body (18) occurs on the ridge Vysoká (e.p. 926 and 884). The body irregular to elliptical in shape with dimensions of 2200 x 1000 m is oriented NE–SW. East of Pohronská Polhora at the foot of the Gracihôrka ridge there is located smaller intrusive body of autometamorphosed andesite porphyry (19) with dimensions of about 300 x 200 m. The body is exposed in smaller abandoned quarry.

Sporadic bodies are recorded in the north-eastern sector. Body of amphibole andesite porphyry (20) on the ridge with e.p. 1184 Nižná Fabová (east of the Fabová hora Hill with e.p. 1484) is roughly elliptical in shape with dimensions of 200 x 100 m and oriented in the E–W direction. Further to the east from Fabová hoľa Hill in the area with elevation 1049 Stožka (Kľak) there occurs on the surface of Wetterstein limestones the denudation relic of the smaller pyroclastic cone with lava neck (21).

Further to north, closer to the Hron river valley at a distance of about 13 km from the central volcanic zone



Závadka nad Hronom
Kochlovec
Kľak
Stožka
Tisovec
Rimava river
Spazlová
Magnetový vrch
Nižná Fabová
Fabová hoľa
1439
1184
Pálenica
Rozsypok
1128
Klenovský Vepor
1338,2
Lomík
1000
Predná Priehybina
Pohronská polhora
Struhárka
Vysoká
Michalová
Rohozná brook
Hron river
Hájna hora
Čierny Balog
BREZNO
N
0 1 2 3 4 km
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

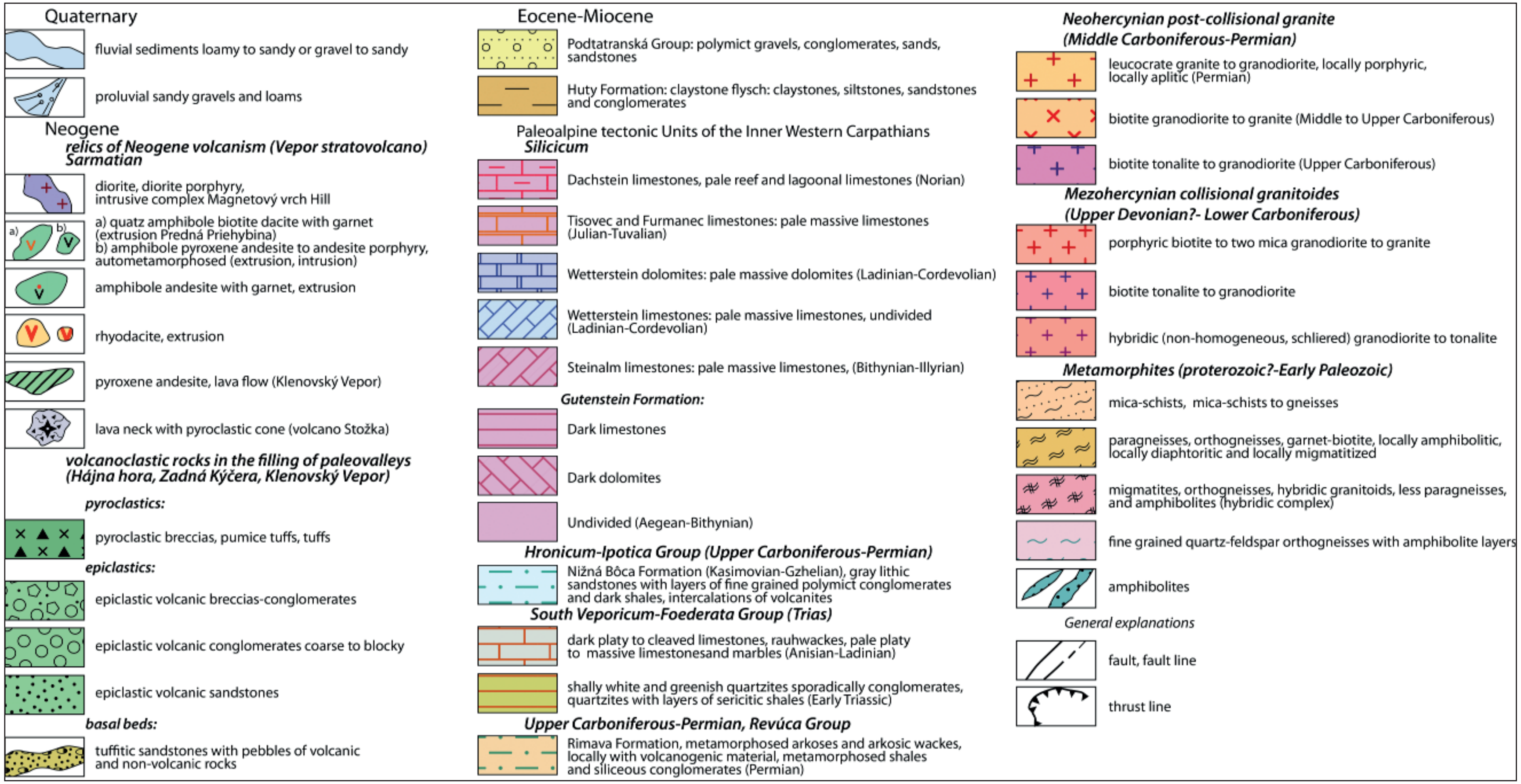


Fig. 6. Scheme of geological setting of the western Veporic unit with situation of relics of the Neogene volcanism.

there extends rhyodacite extrusive body (22) at the place Kochlovec (south of the village Závadka nad Hronom). A body roughly elliptical in shape with dimensions of 110 x 700 m is trending NE–SW. Smaller satellite body (23) of the same composition is in its eastern margin. Evolution of the Stožka pyroclastic volcano and the Kochlovec rhyodacite body, as well as its smaller satellite may take place externally out of the reach by the products of the Vepor stratovolcano.

Area of peripheral (distal) volcanic zone

The original filling of paleovalleys remained in the form of volcaniclastic rocks in the western sector of the stratovolcano in the transitional zone from volcanic slope to the peripheral area of volcanic zone. Remnants of these fillings of paleovalleys from the north to south are:

24 – The filling of the Klenovský Vepor Hill paleovalley forms morphologically distinct mountain range with a maximum height of 1338.2 m oriented in the direction WSW–ENE at a distance from the central volcanic zone about 8 km. The bed of fluvial sediments (gravel, sand) is at the base, above them there follows the epiclastic volcanic conglomerates and breccia-conglomerates, as well as the lava flow at the top, tilting to the west.

25 – The Zadná Kýčera paleovalley is on the northern slope of the mountain range of Klenovský Vepor Hill. It is trending SW–NE, representing the denudation relics of volcaniclastic rocks in the area of the peaks and ranges of Zadná Kýčera, Záruby and Kuričiarka. Filling of the paleovalley at a distance of about 9 km SSW of the central zone consists mostly of epiclastic volcanic rocks (conglomerates, breccias and sandstones).

26 – The filling of the Zvadie paleovalley (south of the Chlípavica village about 7 km west of the central zone) encompasses, except the epiclastic volcanic rocks, the chaotic breccia pyroclastic flow at a higher level.

27 – Volcaniclastic complex of the Hájna hora Hill, east of the Brezno town and north of the Balog village forms a mountain massif with the flat top in the altitude around 970 m a.s.l., trending NW–SE. The westward flat peak gradually declines to a level of 650 m a.s.l. The volcanosedimentary complex restricted from the north and south by the steep slopes, is formed mostly by the facies of epiclastic and volcanic rocks (breccias, conglomerates and sandstones), less frequent there are the pyroclastic type facies.

The most extensive remnants of deposits within the peripheral zone of the Vepor stratovolcano represent relics of volcanosedimentary and volcaniclastic rocks on the southern slopes of the Slovenské rudohorie Mts. and at the northern edge of the Rimavská kotlina Basin, being identified as the Pokoradzské súvrstvie (strata) and later redefined as the Pokoradza Formation. This formation includes a larger number of relics of fillings of the original paleovalleys oriented from the southern slopes of the Vepor stratovolcano to the south and terminated in the sedimentary environment of the Pokoradza volcanosedimentary Formation. The denudation relics of the fillings of the original paleovalleys are in the present relief dissected and form mostly apical areas of highland ridges generally oriented to the south. Original paleovalleys represented communication paths, allowing transport of the volcaniclastic material southward to the sedimentary basin. The deposits of sedimentary filling of the Pokoradza Formation, formed by the volcaniclastic material of epiclastic, as well as pyroclastic type (epiclastic volcanic breccias, conglomerates, sandstones, lahar bodies, pyroclastic flows and reworked pyroclastic deposits) build in present relief isolated uplands in the form of the Pokoradzská tabuľa and Blžská tabuľa plateaous, being separated by the deep cuts of the valley with the Blh river and further divided by cuts of side valleys. The Pokoradza Formation represents an almost classic example of the facial complex of volcaniclastic rocks in the transitional zone from stratovolcanic slope to the area of proluvial plane with delta sedimentation in the southern foothills of the Vepor stratovolcano. The geology and lithology of the Pokoradza Formation are described and discussed in the second part of this work, published in the following paper – part II.

Pre-volcanic basement rocks

In the period immediately prior to the volcanic activity the territory was already well peneplenized and substantial part of the Mesozoic complexes in the western part Veporic Unit were removed. An advanced stage of peneplenization is indicated by the presence of Paleogene sediments preserved in the sinked position in graben structure of Breznianska kotlina Basin, being limited by faults of SZ–SE direction. Newly found relic of Paleogene sediments maintained near the summit of Magnetový vrch Hill (Vojtko, 2000) represents continuation of that graben structure to the SE. Paleogene sediments clearly represent only small remnants of the original extension of the sedimentation basin.

Remnants of Mesozoic rocks that make up the current relief of Tisovec karst (SW area of the Magnetový vrch Hill), Kučelah massif (north of the top of Magnetový vrch Hill) and the edges of Muránska planina Plain at the eastern margin of the territory, had probably formed continuous massif before the start of volcanic activity. Different situation is in the western part of the area, where remnants of Mesozoic rocks are missing. Paleovalleys in the western part of the area with relics of filling in the form of volcaniclastic rocks are cut into crystalline rocks, which confirm the assumption that the complexes of Mesozoic rocks in this area were removed before the beginning of volcanic activity.

Mesozoic complex in the area of the central volcanic zone (wider area of Magnetový vrch Hill with outcrops of subvolcanic intrusive complex) is in sinked position within partial graben structure limited by faults of NE–SW direction.

South of the central volcanic zone in a relatively wide area with Vepor crystalline rocks, the relics of volcanic rocks are missing (they were apparently removed by the denudation). First appearance of relics of paleovalleys with filling of volcaniclastic material are on the surface of crystalline rocks found on the southern slopes of the Slovenské rudohorie Mts. north of the village Polomka at a distance of about 12 km to the south of the central zone. These continue in the form of rare relics southwards, overlying crystalline rocks and Mesozoic rocks of the Silicicum nappe. Volcanosedimentary rocks of the Pokoradza Formation on the northern edge of the Lučenská kotlina Basin and Rimavská kotlina Basin, forming the highlands of Pokoradzská tabuľa and Blžská tabuľa plateaues are deposited on the Oligo-Miocene sediments that form filling of sedimentary basins.

Rock complexes of the Veporic unit
(transitional and peripheral volcanic zones)

Zone of low metamorphosed rocks south of the Brezno town is trending NE–SW and is included into the North Veporic unit (Bezák et al., 2008). This zone consists of chlorite-muscovite schists, chloritic schists and albite phyllites containing garnet. Locally present smaller bodies of garnet-biotite-plagioclase paragneisses are trending NE–SW. The rocks probably represent the low grade Early Paleozoic volcanosedimentary formation with predominance of metasediments, which was metamorphosed by progressive Hercynian metamorphism in the chlorite-sericite subfacies (Korikovskij and Miko, 1992).

The pre-volcanic basement of the larger relic of volcanosedimentary rocks of the Hájna hora Hill in the western part of the territory forms so called *hybrid complex* in which the predominant types of rocks are migmatite, orthogneisses, sheared hybrid granites, less frequent are gneisses and amphibolites with frequent signs of retrograde metamorphism. Less common there are in the hybrid complex bodies of gneisses injected by granodiorites (Bezák et al., 1999). These are characterized by parallel banded texture with local ptygmatitic textures. Enclaves of the fine-grained biotite paragneisses in the hybrid complexes are common, with narrow zones of garnet-paragneisses trending NE–SW and zones of diaftorites of mica schist character. The hybrid complex represents medium to highly metamorphosed complex where appropriate conditions for migmatization have occurred and concurrently represented environment for granitoid intrusions. West from the Čierny Balog village a complex body of leucocratic at some places porphyric granite of Hrončok type is wedging into the rock complex.

At the eastern margin of the hybrid complex there is a tectonic contact with areally extensive body of biotite granodiorite to tonalite, resp. hybrid complex forms highly metamorphic gneiss-migmatite mantle of this body. A characteristic feature of the granodiorite body is represented by the parallel sheared texture formed by the smudges of biotite and frequent occurrences of the gneissic enclaves with the transition to banded migmatites. In the granodiorite body there locally occur the granodiorite porphyry bodies with white phenocrysts of K-feldspar (Vepor type), sporadically diorite bodies (Lomík body) and the remnants of metamorphosed mantle. More extensive denudation relic of Neogene intrusive-extrusive complex Veľká Priehybina is present in the western part of that granodiorite body.

Denudation relics of volcaniclastic rocks are present at its SW margin, which are part of fillings of paleovalley Zadná Kýčera (northern slopes of the Klenovský Vepor Mts.) and further west two intrusive bodies of amphibole pyroxene andesite (12, 13) are present on the ridge Molčanov grúň.

East of biotite granodiorite body to tonalite there follows a wide zone built of porphyric two mica granodiorite (Vepor type). The large white to grey K-feldspar phenocrysts, often rotated and cataclased, represent its characteristic sign. Plagioclase is subhedral, intensively altered, biotite is baueritized, muscovite forms large phenocrysts and quartz, feldspar and plagioclase are in the interstitial spaces. Granite to granodiorite of Vepor type is characterized by significant deformation and recrystallization.

On the surface of the Vepor type granodiorite intrusion a denudation relic of filling of former paleovalley is preserved in the form of mountain range of the Klenovský Vepor Hill with lava flow at the top. More to the east a relics of amphibole andesite extrusive bodies (9, 10) are present below the peak with e.p. 1128 Rozsypok including smaller andesite neck (11). In the continuation to the NE in the area of granodiorite intrusion there is more extensive intrusive-extrusive body Pálenica (14). A subvolcanic intrusive complex Magnetový vrch Hill (1) and basalt dyke swarm (2) are situated more to the south and several bodies of autometamorphosed quartz amphibole andesite porphyries (3, 4, 5 and 6) are located north of it at Nemcová (e.p. 795 and 757).

At the northern edge of extrusive body Pálenica (14), an extensive remnants of Mesozoic rocks in the form of Kučelah massif with e.p. 1141 occur, formed at the basal parts of Triassic carbonate sandstones to shales of Torňa unit (Vojtko, 2000) and higher by the Silica-Muráň nappe of Wetterstein limestones with dolomites.

Northward after discontinuation of granitic intrusions of Vepor type by transversal fault system of NW–SE direction, there follows a paragneiss complex (biotite, garnet-biotite, locally amphibole), partially diaftoritized. Amphibolite bodies are often present within the paragneiss complex. The complex is wedged between paragneiss zone and the prevailingly diaftoritized mica schists (which terminates it from the west) and granitic intrusion of Vepor type, which restricts it from the east.

Few bodies occur in the area of the paragneiss complex north of Pohronská Polhora – Michalová villages: clinopyroxene amphibole andesite porphyry Vysoká (18), Baniarka (17) and body Strúhanka (16). East of Pohronská Polhora – Michalová villages in contact of tectonic zones limiting the block of biotite paragneiss from the block of hybrid granodiorites to tonalites there is smaller intrusive body of andesite autometamorphosed porphyry Gracihôrka (19) NW of Zbojská.

At the northern edge of the area (south of the village Závadka nad Hronom), near tectonic line trending NE–SW, separating zone of the mica schists and mica to biotite to two mica granodiorites to granites and more to the north, there is extrusive body of rhyodacite Kochlovec (22, e.p. 825) and smaller rhyodacite body (23) at its eastern margin. Intrusive body on the eastern slope of the Fabová hoľa Hill under the e.p. 1184 Nižná Fabová (20) is located in an environment of hybrid granodiorite to tonalite complex. In the northern part of the territory east of Fabová hoľa Hill on the surface of the Wetterstein Middle Triassic limestones at the e.p. 1049 Stožka (Kľak), there is a relic of smaller pyroclastic volcano, represented by the scoria cone with lava neck (21).

Area of Magnetový vrch Hill (central volcanic zone)

The environment, in which the intrusive complex of Magnetový vrch Hill was emplaced, consists of Hercynian crystalline rocks, Paleozoic rocks, Mesozoic carbonates and Paleogene sediments. During the field works in the wider area of Magnetový vrch Hill a geological map was compiled at a scale 1 : 5 000 (V. Konečný and P. Konečný, 2010). Neogene diorite intrusion of stock type, trending NW–SE in the lower level penetrates through the crystalline rocks and westward it passes into the huge apophyses (sills), penetrating at several levels into the Mesozoic carbonate complex. At the NW margin the intrusive complex is in contact with the Permo-Triassic rocks and at northern side with newly identified Paleogene sediments.

The crystalline rocks are represented by porphyric biotite to two mica granodiorite to granite of Vepor type, characterized by the distinct K-feldspars of white to grey colour large 2–3 cm. Granodiorite-granite rock is significantly deformed, cataclased, recrystallized with parallel texture. Granodiorite crops out on both sides of the slopes of the Rimava river valley. In the zone of immediate contact, the diorite intrusion, penetrating into the granodiorite and enclosing its fragments in diorite mass, was observed.

Except for granodiorite, the crystalline rocks are represented by the mica schist-gneisses to mica schists, which crop out west of the intrusive complex Magnetový vrch Hill on the western slope of the ridge under the e.p. 757 above the Furmanec brook valley. The rock has parallel texture with distinctive "eyes", consisting of plagioclase large from 0.5 to 1 cm. The texture is parallel oriented. The rock is dark green, muscovite and biotite are on the planes of schistosity. Jointing is parallel to irregular and platy. Age of metamorphic rocks is assumed to be Early Paleozoic or Proterozoic (?).

Higher parts of the Veporic tectonic unit in this territory are built of the rocks of Foederata Group of Permo-Triassic age. The rocks of this series are on the western slope of the Magnetový vrch Hill in the ridge Vicianová, continuing to the Furmanec brook valley. The lower part consists of a series of detrital *Lúžna Formation* of Permian-Triassic age; the upper part of a sequence is represented by the *dolomites and dolomitic limestones* of Triassic age.

The Lúžna Formation, extending to low levels of the slopes, consists of the light grey to greenish quartzite sandstones, which are often deformed and metamorphosed with developed foliation and lineation. In addition to quartzite sandstone, arkoses are also present. In the higher levels of the sequence there are common beds of the fine-grained to silty, grey-green banded shales to phyllites containing the interbeds of the fine- to middle-grained sandstones. Muscovite and chlorite occur on bedding planes. At higher levels of the slope Viciánová under the e.p. 787, there occurs a bed of small metaconglomerates, containing interbeds of middle to coarse arkosic sandstones. Quartz grains and pebbles of fine conglomerates, large 1–2 cm, are deformed, lineated, boudinaged, the jointing is platy-shaped. Layers of microconglomerates and arkose sandstones of Permian age were assigned by Vojtko (2000) with the Rimava Formation.

Dolomites and dolomitic limestones of Triassic age SE of the top of the Magnetový vrch Hill on the southern slope of the valley side Bánova occur in a narrow strip south of tectonic line trending NE–SW, separating them from the Lúžna Formation of metamorphosed quartzite sandstones. Dolomite and dolomitic limestones are light grey, occasional impregnations of limonite are brown and speckled, often cellular and cavernous (rauchwackes) and strongly scarsted. Vojtko (2000) the carbonate rocks in the narrow strip affiliates to the Tuhár Succession as a higher member of the Foederata Group. The intensive crushing was observed along tectonic zones of NW–SE direction with the origin of tectonic breccia at the contact of limestones and dolomites with metamorphosed sandstones and microconglomerats. Breccia consists of angular fragments of carbonates, metasandstones and brown detrital matrix. Blocks of siliceous shales along the tectonic zones are uplifted and strongly tectonized.

Rocks of the Foederata Group represent autochthonous or paraautochtonous sedimentary mantle of the Hercynian basement, which was together with the basement rocks epimetamorphosed and intensively deformed during the Alpine metamorphic event.

Higher tectonic units in this area are represented by Hronicum Unit with Nižná Boca Formation (upper Carboniferous-Permian, Ipoltica Group). The rocks of this group crop out on the western slope of Magnetový vrch Hill south of Bánovo side valley to valley of the Furmanec stream. Beds are formed of grey to dark grey sandstones, often containing interbeds of the fine conglomerates, dark schists and volcanics. Dark green to grey slates are slightly shally, flakes of muscovite are at the jointing surfaces. The above beds Vojtko (2000) includes into Gemeric tectonic unit represented by the Ochtiná Formation (Dobšiná Group). Through this formation a swarm of basaltic andesites penetrates.

The Hronicum unit is along the thrust line of NE–SW direction thrust over dolomites and dolomitic limestones of the Foederata Group. Over the Hronicum Unit from the east there is thrusted over the higher tectonic unit – the Silicicum unit.

Silicicum unit is represented in this area by the Muráň nappe. The basal parts of the Muráň nappe are formed of Wetterstein limestones (Ladinian), the higher parts by the Wetterstein dolomites (Ladinian-Cordevolian). Wetterstein limestones are light grey, massive, with frequent dolomitic interbeds and lenses. Except for a narrow zone south of the Bánova valley, the limestones are to a greater extent present in the middle level of eastern slope of Magnetový vrch Hill. Close to contact with a diorite bodies, the limestones are recrystallized and marmorized (grains reach up to 1 cm) and immediately upon contact skarnized - altered into magnetite skarns. Upward the Wetterstein limestones pass to Wetterstein dolomite.

The Wetternstein dolomites are light grey, massive and layered. Layering is highlighted by alternating light and darker laminas. In lower levels of dolomite complex the interbeds to layers of limestones are common. Wetterstein dolomites build apical part of the ridge of N–S direction continuing southward from the Magnetový vrch Hill (e.p. 980, 931, and 959.6 Pacherka). The thickness of dolomite complex southward gradually increases (from 50–75 m in the northern part up to 250 m and more in the southern part).

South of the top of Magnetový vrch Hill on the western slope of the range with e.p. 959.6 Pacherka and the Bánova valley there occurs a dyke swarm of basaltic andesites to basalts (less frequent are dykes of amphibole andesite porphyries to andesites). The dyke swarm trending ENE–WSW breaks through a zone of dolomites of Foederata Group, through the Nižná Boca Formation of the Hronicum Unit, as well as through the Wetterstein limestones and dolomites of the Silicicum nappe. After crossing the ridge, sporadic dykes appear on the eastern slope of the Pacherka ridge.

Paleogene sediments

On the northern slope of the Magnetový vrch Hill a denudation relic of silt-clay sediments of grey-green (locally grey-black) colours is present, having massive texture with signs of bedding. The thickness of the sediments is about 50–60 m, they are inclined 5–10 degrees to SW. The disintegration of sediments is irregular, shally-like. Near the contact with intrusive complex the sediments are significantly consolidated and partially silicified. From the north and from the SE side, the sediments are tectonically limited by faults, near SW edge they are in contact with extrusive body of autometamorphosed biotite-amphibole quartz diorite porphyry. In earlier interpretations the sediments were considered to be Carboniferous, corresponding to the Gemeric unit (Bacsó, 1964; Bacsó and Valko, 1969). Based on the new findings of the Globigerina associations these sediments are considered to be of Paleogene age (Vojtko, 2000).

Coarse to blocky conglomerates of undetermined age crop out at the southern range (east of e.p. 757 NW from the Magnetový vrch Hill) at the contact of metasediments of Foederata Group and body of autometamorphosed biotite amphibole andesite porphyry in the cut of forest roads at 785 m a.s.l. Material of coarse to blocky conglomerates form pebbles 5–10 cm in size to blocks with dimensions up to 30–40 cm of siliceous shales and siliceous sandstones. The matrix is light grey and sandy. The conglomerate bed, dipping by ca 35 degrees to the east, is evidently deposited above the Foederata Group. It is confirmed by the composition of clastic material. Age of that position is not clearly defined yet; its determination is subject of further research.

Methods of investigation

A method of lithofacial analysis was applied during survey of volcaniclastic and volcanosedimentary rocks. The lowest mappable units represent ***facies*** of volcanic or volcaniclastic rocks (e.g. lava flow, conglomerate bed, epiclastic volcanic sandstone bed, lahar breccia body, etc.). A body or facies of sufficient thickness or dimensions, which allows drawing it into geological map is understood as mappable unit. Facies of volcaniclastic or volcanosedimentary rock corresponds to a “member” according code of Hedberg (1976).

A higher order unit is the ***formation*** which includes a set or group of base units, i.e. facies of volcanic or volcanosedimentary rocks. Formation is a basic lithostratigraphic unit defined by its stratigraphic position, spatial extension (i.e. thickness and areal extension), lithological and petrographical content.

Applying these criteria, facies of volcaniclastic and volcanosedimentary rocks forming the denudation relics in the southern slopes of the Slovenské rudohorie Mts. (relics of paleovalleys fillings) and in Pokoradzská tabuľa and Blžská tabuľa Plateaus (remnants of sedimentary basin) at the northern margin of the Lučenská kotlina Basin were defined as Pokoradza Formation.

In the case of single, smaller and scattered denudation relics of volcaniclastic or volcanic rocks or intrusive rocks, when there is insufficient information on the spatial distribution (i.e., thickness and areal extent), or on stratigraphic position, a less strictly defined term as the ***complex*** was applied (e.g. diorite porphyry intrusive complex, volcanosedimentary complex of Hájna hora Hill, etc.) with supplied more detailed characteristic.

In previous works the groups or individual volcanic and intrusive bodies on the basis of their different petrographic composition were often named as “formation” without sufficient information on their form, composition, age relationship, as well as the spatial parameters (Burian et al., 1985; Vojtko, 2000). In present works such not clearly defined formations are not accepted.

To obtain a sufficient base of essential data for paleovolcanic reconstruction it was necessary to conduct a mapping of these relics in detailed scales. Mapping of intrusive complex Magnetový vrch Hill in the central volcanic zone for its complexity and relatively small area extension required to conduct field research in topographic map at a scale 1 : 2 000 with consequent transformation into a geological map at a scale 1 : 5 000. To determine more precisely the structures of intrusive complex the method of geomagnetic profiling was used. Scattered relics of intrusive-extrusive bodies externally from the intrusive complex Magnetový vrch Hill in the area of transitional volcanic zone were mapped at a scale 1: 10 000 and similarly their dimensions were better specified using geomagnetic profiling methods. Parallel with the mapping, there were conducted studies of the structure of intrusive-extrusive bodies and parameters of their presence in the environment of surrounding rocks to determine their form types. The method of lithofacial analysis has been applied in studying the relics of volcaniclastic rocks in the paleovalleys filling. In addition to geological maps of lithofacial volcanosedimentary complex Hájna hora Hill at a scale 1 : 10 000 there was constructed a larger number of lithological profiles documenting the structure of this paleovalley in the vertical profile. Similarly, the relics of volcaniclastic rocks of the Pokoradza Formation on the southern slopes of the Slovenské rudohorie Mts. were mapped at a scale 1 : 10 000 (24 map sheets) and supported by geological and lithological profiles in the direction E–W (38 profiles). Documented natural outcrops and places with an assessed debris material were recorded on documentation sheets, and in the case of natural or artificial rock outcrops descriptions were accompanied by drawings and photographs. Position of documented objects was recorded with GPS coordinates. On the basis of this data a geological-lithofacial map of Pokoradza Formation in the region of the Pokoradzská tabuľa and Blžská tabuľa plateaus was compiled which is a part of the following paper (part II).

During mapping, the rock samples were collected for the purpose of petrographic study using an optical microscope. Whole rock and trace element analyses were done and used for petrological study.

On the basis of international cooperation with the laboratory ATOMKI, Debrecen (Dr Z. Pécskay) a radiometric dating of a series of rock samples (10 pc) was done in order to determine the timing of the intrusive and volcanic activity of the Vepor stratovolcano. Geomagnetic methods were conducted by P. Kubeš from the State Geological Institute of Dionýz Štúr, Bratislava, Slovakia.

Asymmetric character of original volcanic structure

Relics of Neogene volcanism in the western part of the Slovenské rudohorie Mts. are scattered over a relatively large area covering about 2100 km^2. Relics of volcanosedimentary rocks in the direction to the west pass from the central volcanic zone (intrusive complex Magnetový vrch) to a distance of about 18 km (western edge of the denudation relic of volcanosedimentary complex Hájna hora Hill). Relics of volcanic rocks in the direction to N and NW are in the distance about 13 km (rhyodacitic body Kochlovec). The southward relics of volcano-sedimentary rocks extend much far from the central volcanic zone about 36 km up to the southern edge of the Pokoradzská tabuľa and Blžská tabuľa plateaus. It should be added that the original extension of volcanosedimentary rocks was much larger and continued particularly in the case of Pokoradza Formation further to the south to larger distances (some isolated outcrops of volcaniclastic rocks were found 13 km to SW from southern edge of the Blžská tabuľa Plateau in the vicinity of Šafárikovo town). The original areal extent has been considerably modified and shortened by subsequent denudation. The current extent of relics of Neogene volcanics from the NW margin of the distal zone to its SW margin exceeds 54 km. The mentioned facts demonstrate an impressive extent of the original structure of the Vepor stratovolcano, being surrounded at the foot in proluvial plane by the deposits of volcaniclastic and volcanosedimentary rocks that passed southwards into the sedimentation areas of the delta and lake environment. The areal extent of supposed Vepor stratovolcano is comparable or exceeds the surface dimensions of products of stratovolcanoes Javorie and Poľana together (Fig. 3).

Shorter extent of volcaniclastic deposits in the peripheral volcanic zone is expected to N and NE. It points out that extrusive rhyodacitic dome-like bodies (Kochlovec area south of the Závadka nad Hronom village) at a distance of about 13 km to NE from the central volcanic zone have developed on the surface of crystalline rocks, and similarlly, development of small pyroclastic volcano Stožka at a distance of about 7.5 km from central zone took place also on the surface of Mesozoic rocks. It follows from the foregoing that the original volcanic structure was characterized by asymmetric extending with maximum extent of deposition of volcaniclastic rocks in the direction to the S, SW and SE, less to W and primarily shorter distance in the direction to N and NE. Information on the distribution of volcanic rocks of the primary volcanic structure eastward from the central zone is missing, these rocks were probably removed by denudation.

Estimated asymmetric character of the original volcanic structure was probably conditioned by gradually increasing paleorelief of the pre-volcanic basement to the north and its descends in direction to the south, as shown by a significant shortening of the transitional and peripheral zone of volcanic zone to the north direction and much large extent of volcaniclastics in the southern peripheral volcanic zone. Another role in the development of asymmetric volcano could be played by the block movement associated with uplifting movements of the northern part of the Slovenské rudohorie Mts. and the recent sinks in its southern part (rotation of the regional block).

The first part (I) of this work deals with the structure and lithology of volcanic and intrusive bodies extending in the western part of the Slovenské rudohorie Mts., which will be discussed in the following order: a) the central volcanic zone, b) transitional volcanic zone (proximal zone), c) peripheral volcanic zone (distal zone). Relics of volcaniclastic rocks on the southern slopes of the Slovenské rudohorie Mts. and Pokoradzská tabuľa and Blžská tabuľa Plateaus will be content of the second (II) part of our work.

Central volcanic zone – intrusive subvolcanic complex

In the central volcanic zone of the andesite stratovolcano, the intrusive bodies of several intrusive forms and various petrographic composition are exposed on the surface by the deep denudation (Apps. 1 and 3; see numbering as follows):

1. Central intrusive complex of Magnetový vrch Hill in the central volcanic zone is represented by diorite intrusion of a stock-like type with transitions to the apophyses, penetrating westward into the Mesozoic carbonate rocks. Younger dyke swarms of andesite to diorite porphyries is trending ENE–WSW and penetrating through the body of diorite intrusions, representing a younger phase of intrusive activity.

2. The dyke bodies of younger basaltic andesites, continuing from the area of the proximal (transitional) volcanic zone on the western slope of the Pacherka ridge (e.p. 959.6). They pass into space of central volcanic zone. Dyke swarm of basaltic andesites oriented in the E–W to ENE–WSW is considered to be a part of the feeding system of supposed smaller parasitic (satellitic) volcano, situated at a higher level on the western slope of the original volcanic cone at the SW margin of the central volcanic zone.

3. – 6. Shallow intrusive bodies, located at the NW margin of the Magnetový vrch Hill, having composition of autometamorphosed amphibole diorite porphyry – Nemcová complex, ongoing from the NW edge of the Magnetový vrch Hill to the transitional volcanic zone (slopes of the Nemcová valley and the ridge with the e.p. 795).

7. – 8. In the space of the central volcanic zone also two stock bodies of amphibole diorite porphyry are included, located north from the Magnetový vrch Hill: body in the Spuzlová valley (6) and smaller body on the slope of the valley of Rimava stream (7). Position of these bodies north of the margin of diorite intrusion is near to border of central and transitional volcanic zones.

The central volcanic zone is a major source area of volcanic material, being involved in the construction of volcanic cone where its features include multiple, repeated outputs of magmatic masses through the feeding systems. The presence of bodies of the original feeding system in its deeper levels indicates abundant xenoliths included in the diorite body. The xenoliths come from the destruction of the older feeding system due to the emplacement of diorite intrusion.

A defined area of the central volcanic zone comprising the above mentioned volcanic intrusive complexes is shown in attached scheme (App. 1). It is roughly elliptical in shape with dimensions ca 3.5 x 2.5 km, having longer dimension oriented NW–SE.

Intrusive complex Magnetový vrch Hill

Intrusive complex is exposed by the deep denudation cut at lower levels of both slopes of the Rimava river valley and in the area of Magnetový vrch Hill, e.p. 964.8, about 2.5 km northwest of Tisovec town (Apps. 1 and 3). Intrusive complex extends over the area of about 5.25 square kilometers (at the length of about 2.5 km and a width of about 1.2 km), being oriented by longer dimension in a NW–SE directon.

Detailed mapping at a scale 1 : 2 000 using a GPS system for documenting locations of outcrops and debris material was used for compilation of geological map of a wider area of Magnetový vrch Hill at a scale 1 : 5 000. Results of detailed mapping revealed the complex nature of diorite intrusion. The fact that in margins the diorite porphyric intrusion manifests locally porphyric character with transitions to diorite, has initiated the previous authors to the designation of the rock as "andesite" (Bacsó, 1964; Bacsó and Valko, 1969), or "subvolcanic andesite" (Vojtko, 2000). In the case that the bodies of andesite composition have a higher degree of crystallinity of the groundmass, which occurs in subvolcanic level instead of the term andesite a name "andesite porphyry" is used, being supplemented by the data on the shape of the body (laccolith, sill, dyke, etc.).

In this work, based on the results of detailed geological mapping, there is accepted a concept of multistage evolution of diorite pluton intrusion in the form of stock body, passing into apophyses intruding westward at several levels into Mesozoic carbonate rocks. Intrusive complex Magnetový vrch Hill comprises remnants of broken older feeding system (preserved in the form of xenoliths), being followed by multistage diorite intrusion (subvolcanic pluton) and younger dyke system of pyroxene and amphibole andesite and diorite porphyry, intruding through the diorite intrusion in the form dyke swarms.

Rock types in the Magnetový vrch Hill intrusive complex

The development of the central intrusive complex Magnetový vrch Hill took place during seven intrusive phases. Succession of intrusive phases has been compiled on the basis of relations between the intrusive forms (e.g. penetration or intrusion of younger dykes through existing older intrusive members, contact effects of intrusive forms) and also by enclosing fragments and blocks of older intrusive phases in the form of xenoliths in the younger intrusions or dykes. Also at the same time the degree of hydrothermal or contact alteration in xenoliths was estimated, e.g. some hydrothermally altered or skarnized xenoliths are included in the younger intrusion members which were not affected by the alterations. Study of xenoliths contributed to estimation of timing of skarnization process within the succession of intrusive phases.

The succession of individual types of intrusive rocks according to intrusive phases is presented in Tab. 1.

Structure of diorite pluton

Diorite intrusion has complicated structure and for clarity it was devided to smaller units marked by the letters A-F. In the lower levels of the slopes of the Rimava valley the intrusion has steep vertical shape and intrudes the surrounding crystalline rocks in the form corresponding to the stock intrusion (segments A_1, A_2 and B_1, B_2). Westward at higher levels of the slope below the elevation point Magnetový vrch Hill, the intrusion passes into apophyses that in the form of sills or more complicated laccoliths intrude into the Mesozoic rocks (segments C and H).

A – diorite stock intrusion

Diorite intrusion (segments A_1, A_2 and B_1, B_2) with a distinct orientation in the direction NW–SE, being exposed by the deep erosive cut of the Rimava river valleys on both adjacent slopes from the sea level of 480 m to 670 m, is divided by the Hercynian granite into two parts.

Diorite intrusion in segment A_1 on the eastern slope of the Rimava valley with a length of about 850 meters in the northern part of the eastern slope of the Rimava valley is penetrated by the dyke swarm of andesite to diorite porphyry (dyke of H2, S2 type). In the outcrop above 645 m a.s.l. a contact of dyke cutting through the diorite is exposed. Columnar jointing is oriented perpendicular to the body of diorite (Fig. 7). At the outer edges of the diorite intrusion in the contact with the Hercynian granite the zones of crushing are locally present (this is also documented by abundant xenoliths of Hercynian granite included in diorite block debrie at the outer edge of the intrusion). At the northern edge of the A_1 segment of the slopes of the Rimava valley and at the foot of the slope there was observed the diorite breaking through Hercynian granite in the form of short apophyses.

The dominant part of the intrusive body consists of inhomogeneous fine-grained diorite porphyry (DiPN) of 3. intrusive phase. Smaller areas (domains) in the body form medium-grained diorite (Di1) and fine-grained diorite (Di2). Medium-grained diorite is grey-black with irregular blocks and blocky jointing (Fig. 8). In the case of fine-grained inhomogeneous diorite porphyry (DiPN) there can be macroscopically observed inhomogeneities in the form of variable grain size and distribution of phenocrysts, locally with signs of fragmentation. A break in continuity of diorite intrusion is observed near the northern edge of the segment A_1. Interruption is caused by the deeper cut in the side valley at the outer edge of the intrusion by which outer wall of Vepor granodiorite was uncovered.

In the area of intrusive complex there was conducted a series of geomagnetic profiles aimed to refining the areal dimensions of intrusion bodies, particularly the outer boundary from the surrounding geological environment,

Tab. 1
Types of intrusive rocks of the central intrusive complex Magnetový vrch Hill. The rocks are ordered after succession of intrusive phases

Symbol	Rock (intrusive phase)
	7. intrusive phase – dykes of basalt and basaltic andesites
B	Microcrystalline basalt to basaltic andesite
	6. intrusive phase – dykes of andesite porphyries with needles of amphibole and clinopyroxene basaltic andesite
PxM	Fine-grained dark amphibole clinopyroxene andesite porphyry, Magnet type
DiPJ	Fine-grained clinopyroxene basaltic andesite, slightly altered, slightly biotitized
I3	Medium-grained garnet amphibole andesite porphyry with short needles of amphibole
I2	Scares porphyric fine-grained to vitritic amphibole andesite porphyry with rare big needle amphibole
I1	Medium-grained amphibole andesite porphyry with long needles of amphibole
	5. intrusive phase – extrusion of quartz diorite porphyry in the apical part of the Magnetový vrch hill
KDP	Autometasomatically altered medium-grained biotite amphibole quartz diorite porphyry
	4. intrusive phase – dykes of andesite porphyry
J	Fine-grained pyroxene diorite porphyry, very intensively altered, chloritized, silicified and carbonatized
S2	Medium-grained clinopyroxene diorite porphyry with frequent pyroxene, medium altered
S1	Medium-grained clinopyroxene diorite porphyry with subordinate pyroxene, medium altered, endoskarnized
H2	Coarse-grained clinopyroxene diorite porphyry, medium altered and endoskarnized
H1	Leucocrate coarse-grained clinopyroxene diorite porphyry, partially altered, actinolitized
	3. intrusive phase – (dioritic) – unhomogeneous diorite porphyries fine- to medium-grained and diorites
DiPN	Fine-grained inhomogeneous clinopyroxene diorite porphyry, biotitized
DiPNh	Medium- to coarse-grained unhomogeneous two-pyroxene diorite porphyry, biotitized, actinolitized
Di2	Fine-grained clinopyroxene diorite, diopsidized
Di1	Medium-grained clinopyroxene diorite, actinolitozed
	2. intrusive phase – (doritic) – younger stage: altered fine- to medium-grained diorite porphyries
DPv	Very intensively altered endoskarnized inhomogeneous diorite porphyry, partially bleached
Dv2	Very intensively altered endoskarnized inhomogeneous diorite to porphyry
DiP	Altered medium-grained clinopyroxene diorite porphyry, partially bleached, columnar pyroxene is loosing habitus
DiDaj	Partially altered, biotitized medium- to coarse-grained clinopyroxene diorite porphyry
DiJM	Altered partially bleached fine-grained diorite, pyritized, chloritized, sericitized, Magnet type
	2. intrusive phase – (dioritic) – older stage: coarse-grained diorite porphyries
VSt	Bleached coarse-grained clinopyroxene diorite to porphyry with rare big phenocrysts of clinopyroxene
VSt2	Partially altered two-pyroxene porphyric diorite
St	Weakly altered coarse-grained two-pyroxene porphyry
	1. intrusive phase – before emplacement of diorite: amphibole andesite porphyry to diorite porphyry
DiPM	Altered sparse porphyric andesite porphyry with big amphibole, pyritized, Magnet type
PSt	Altered coarse-grained amphibole clinopyroxene porphyric diorite, columnar pyroxene looses habitus
PSt2	Skarnized intensively altered amphibole porphyric diorite
GpM	Medium-grained garnet amphibole andesite porphyry, altered, endoskarnized

as well as to identify the probable type of intrusive forms (App. 3). Two geomagnetic profiles were realized in the segment A_1, the profile PF-6 (Fig. 9a) oriented NW–SE, which passes through the central part and the profile PF-7 (Fig. 9b), extending to the outer edge of the intrusive body.

Geomagnetic profile PF-6 (Fig. 9a) with a length of 980 m extending from NW to SE on the eastern slope of the Rimava valley at the level of 600–620 m a.s.l., starts at the NW edge of the area of Hercynian granodiorite-granite by low delta T value around 48 400. Increased delta T value to 49 000 corresponds probably to a dyke or dykes penetrating Hercynian granite. The prevailing part of the profile PF-6 runs in the diorite intrusion. Delta T values reach 49 000 and more, the maximum values 49 400 and 49 600 in the form of two peaks probably correspond to two dyke bodies. Abrupt drop in delta T values to an average of 48 400 in the distance of 800 m is in accordance with the transition from intrusion into Hercynian granodiorite-granite.

Geomagnetic profile PF-7 (Fig. 9b) with a length of 1 250 m at a higher level of the slope above the Rimava valley runs from SE to NW. Profile starts at the SE at a level 600 m above sea level in an environment of Hercynian granite (delta T values below 48 400), then it passes into environment of diorite intrusions (delta T over 48 800). High delta T values reaching 49 600 correspond likely

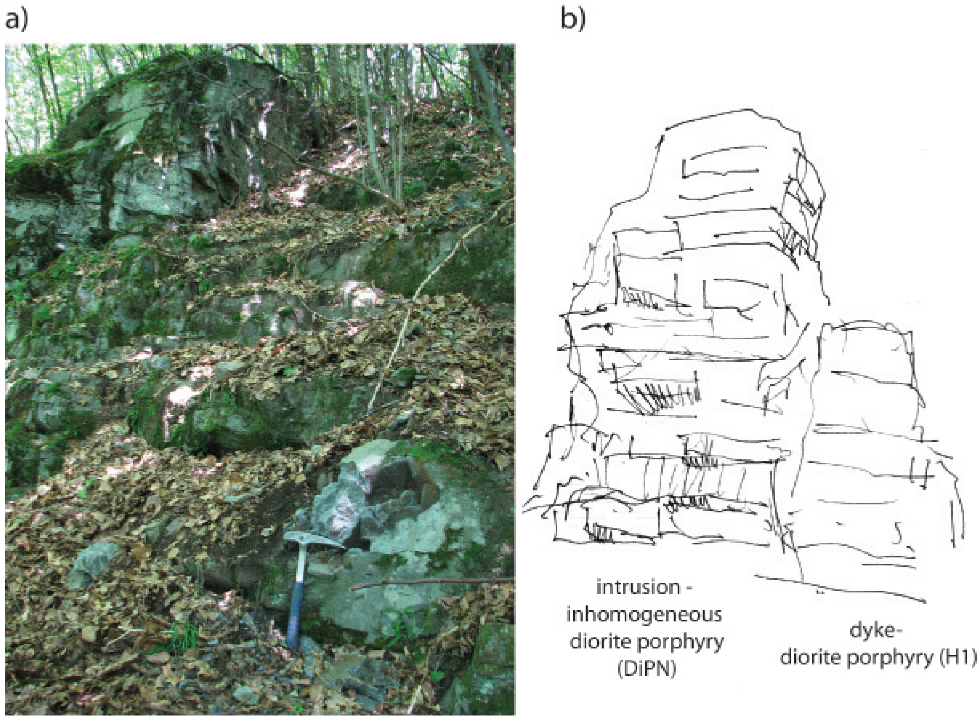


Fig. 7. Penetration of dyke of diorite porphyry (H1) through diorite porphyry (DiPN). Dyke is at a place of the hammer (in photo). Other rock steps on the left side belong to inhomogeneous diorite porphyry.

Fig. 8. Regular blocky jointing of inhomogeneous diorite porphyry (DiPN) at the northern edge of the A_1 segment (a, b). Block jointing of medium-grained diorite (Di1) in the northern part of the segment A_1 (c, d).

to the presence of younger dyke bodies penetrating the diorite intrusion and Hercynian granite. A further decrease in values below 48 600 up to 48 400 in the continuation of the profile to NW indicates the presence of Hercynian granite. In further course of the profile to the NW the values increased to 48 800 delta T correspond to a diorite intrusion environment, two peaks of delta T 49 000 and 49 500 indicate the presence of dyke bodies.

Segment A_2 in oposite side on the western slope of the Rimava valley is shorter and its length is about 650 m (App. 3). Like in the A_1 segment the diorite body is formed by inhomogeneous diorite porphyry (DiPN) from 3. intrusive phase. In southern part near the intrusive contact with the surrounding Hercynian granodiorite and granite a relic of older 2. intrusive phase was preserved in the form of medium-grained diorite porphyry (DIP). Intensity of autometamorphic alterations locally increases and the diorite porphyry of type DIP has an inhomogeneous character with manifestations of endoskarnization. At the southern edge of the body, the diorite magma in the form of short injections intrudes into the Hercynian granodiorite to granite. Through the diorite intrusion in the A_2 segment there penetrates a dyke of diorite porphyry and another diorite porphyry dyke extends into the diorite body in the northern part of the A_2 segment.

Diorite intrusion described in A_1 and A_2 segments represents one stock intrusive body. Different southern boundary and of unequal length of A_1 and A_2 segments indicate their separation by fault zone with a shorter horizontal displacement.

Two bodies of diorite intrusion separated by Hercynian granite – segments B_1, B_2 were identified by geological mapping on the NE slope of the Magnetový vrch Hill in the continuation of the Rimava river valley.

Segment B_1 (App. 3) representing northern diorite body situated at a higher level of the slope of the Rimava valley below Magnetový vrch Hill is from the northern side at contact with Hercynian granite limited by fault zone of ENE–WSW direction, followed by a dyke of coarse-grained clinopyroxene diorite porphyry (type H_1). In the northern part of the body in a rock outcrops a fine-grained heterogeneous and brecciated diorite porphyry (DiPN) dominates and corresponds to the 3. intrusive phase, while its inhomogeneity and brecciated nature increases with proximity to northern intrusive contact with the Hercynian granodiorite-granite. South of fine-grained heterogeneous diorite porphyry type DiPN, there appears inhomogeneous coarse-grained diorite porphyry (type DiPNh) and partly altered, medium grained to coarse porphyric diorite porphyry (DiDaj) included into the second intrusive phase. The diorite intrusion at higher levels in the eastern slope

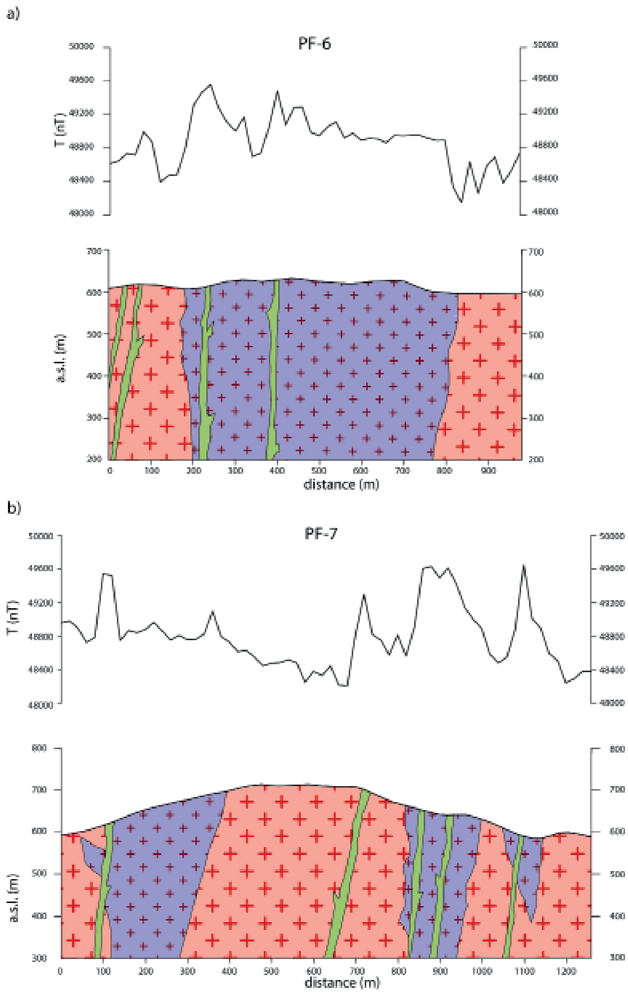


Fig. 9. Geomagnetic profiles through the diorite body on the eastern slope of the Rimava valley. a) profile PF-6 in the middle part of the body; b) profile PF-7 in the northern side of the body.

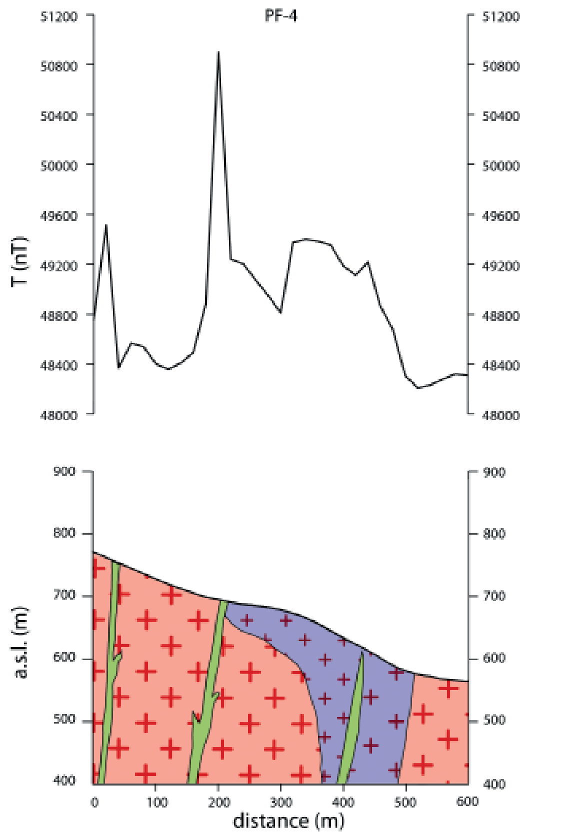


Fig. 10. Geomagnetic profile PF-4 in the NW edge of the intrusive complex of segment B_1.

of the intrusive body passes into subhorizontal intrusion (sill). Sill penetrates along the boundary of Hercynian granodiorite-granite and overlying complex of the Mesozoic carbonates. The diorite intrusion is cut by younger dykes of diorite porphyry of type S_1 and S_2 oriented in the EEN–WWS direction.

Geomagnetic profile PF-4 (Fig. 10) through the diorite body in segment B_1 with the course W–E and NE begins in the west at a higher level in the hillside in the environment of Hercynian granite with the value of delta T about 48 400. Narrow next following peak with delta T 49 550 corresponds to the position of dyke penetrating through Hercynian granodiorite-granite. At a distance of 200–480 meters geomagnetic profile passes through the diorite intrusion, the maximum delta T is above 49 200. Strong narrow peak with a maximum value of about delta T 50 800 corresponds to the position of a dyke at the western edge of diorite intrusion. Geomagnetic profile and the shape of the body are compatible with the stock intrusion having steep contact with the Hercynian granodiorite-granite at the eastern side, while in western part is indicated a transition into sill.

Segment B_2 (App. 3) is a southward placed diorite body that is present at a lower level of slope of the Rimava valley below top of the Magnetový vrch Hill and continues to the bottom level of the valley with a small river Rimava. Eastern edge of the intrusive body is amputated by a fault zone of NW–SE direction extending at the axis of the Rimava valley. Intrusion of the stock-type is formed by the fine-grained diorite porphyry (DiPN). At a southern edge of the intrusive body it is possible to observe the penetrations of diorite magma through surrounding Hercynian granodiorite-granite at a level of about 610 m a.s.l. Diorite intrusion is in this part strongly inhomogeneous (parts of coarse-grained diorite are included in fine-grained diorite mass, while the edges are blurred, indicating their partial melting). Coarser-grained diorite penetrates into the Hercynian granodiorite-diorite and encloses its fragments in the form of xenoliths. Diorite dykes intrude through diorite body at northern edge and in the southern part the pyroxene diorite porphyry (S_1 type) and a dyke of amphibole pyroxene diorite porphyry (type PxM). Diorite body in B_2 segment corresponds to the stock type intrusion.

B – Diorite sills (segments C to H)

On the eastern slope of the Magnetový vrch Hill with e.p. 964.8, several diorite bodies of subhorizontal intrusions – sills with greater areal extensions were identified by geological mapping. These bodies, being interpreted as huge apophyses of diorite intrusion, penetrate along margins of Hercynian granite and overlying Mesozoic carbonates and also in higher position through Mesozoic complex in several levels. Emplacement of sills is associated with skarnization processes leading to origin of magnetite skarns. Totally, there was devided 5 etages of subhorizontal intrusions – sills in various altitudes (a.s.l.), the segments C to H.

I – Lower level, segment C

On the eastern slope of the Magnetový vrch Hill at a higher altitude (a.s.l.) above the stock of diorite intrusion in the segment B_1 an extensive diorite sill is situated and designated as a segment C (App. 3). The sill body is placed at the contact of Hercynian granite and overlying Mesozoic carbonate complex. The lower edge of the sill is at the level of 690–700 m a.s.l., the upper edge of the sill intrusion in contact with Mesozoic complex is uneven with irregular course. A predominant part of the intrusive body consists of inhomogeneous fine-grained diorite porphyry (DiPN), included in the 3. diorite intrusive phase (after skarn). Within this larger body there were identified domains of a different character, formed by coarse-grained two pyroxene diorite porphyry, partially altered (VStz), which represents relics of the 2. diorite intrusive phase (older stage). Bodies of this type are present especially in the southern part of the C segment (three bodies) and occasionally at the northern edge (one body). Other relics of the 2. diorite intrusive phase (younger stage) are bodies of very intensively altered endoskarnized, inhomogeneous diorite porphyry (DPV) and fine-grained diorite to diorite porphyry (Dv2), which are located at a higher altitude at the western edge of the horizontal sill intrusion. A skarn zone is developed at the edge of diorite body of type DPV in contact with Mesozoic carbonates.

A dyke swarm of medium- to coarse-grained pyroxene diorite porphyries (type S_2, H_2) of 4. intrusive phase and amphibole andesite porphyries (type I_2, I_3) of 6. intrusive phase penetrate through the sill intrusion in the segment C. Dyke bodies are within dyke swarm oriented in the NE–SW, EEN–WWS to E–W direction.

Geomagnetic profile PF-2 (Fig. 11a) at the sea level 790–800 m with a length of 400 m, which runs from south to north in the segment C (App. 3) confirms the presence of diorite intrusions (delta T over 40 200), with a peak value of about 50 000, corresponding to penetration of younger dyke body. Local decrease of delta T in the southern part of the profile and discontinuous nature is likely to represent the Mesozoic rocks under and above the sill, as well as its changes in thickness.

Geomagnetic profile PF-5 (Fig. 11b) with a length of 690 m (App. 3) runs at the southern edge of the sill intrusion in segment C on the eastern ridge under the Magnetový vrch Hill from 790 m a.s.l. to the Rimava valley, where it ends at the level of 550 m a.s.l. In the initial part of the profile the delta T values around 49 200 indicate the presence of intrusion, possibly with a common effect of dykes (discontinuous character of the curve). The transition to the environment of Hercynian granodiorite-granite responds to a drop in delta T values under 48 800 with monotonous course.

I – Lower level, segment D

On the eastern slope of the ridge Pacherka-Magnetový vrch Hill south of segment C (App. 3) and above the A_2 segment 570–605 m a.s.l. in the block debris from broken outcrop, there was revealed the presence of diorite intrusion. This intrusion of horizontal type is located at the boundary of Hercynian granodiorite-granite and overlying Mesozoic complex. Frequent blocks of skarnized limestones and abandoned mines and heaps are higher above the intrusion. A predominant portion of the intrusive body is formed by altered medium-grained diorite porphyry (type DIP) of 2. intrusive phase, younger stage. To a lesser areal extent there is at the lower edge of intrusion a relic of younger intrusion of fine-grained pyroxene diorite (Di2), included in the 3. intrusive phase, which penetrated into the environment of previous intrusive phase.

II – Middle level, segment E

Thicker body of diorite sill intrusion in the segment E emplaced in an environment of Mesozoic complex is located higher in the slope of the ridge Pacherka-Magnetový vrch Hill above the segment D (App. 3) of the lower zone in the 720–870 m a.s.l. It is from lower intrusion in the D segment separated by a belt of carbonate rocks with intensive skarnization. A predominant part of the body consists of altered clinopyroxene diorite porphyry (DIP), partially bleached, included in the 2. diorite intrusive phase. A zone of skarnization is at the upper outer edge in contact with the overlying Mesozoic carbonates which is extending more externally behind a zone of recrystallized carbonates. A smaller relic of altered coarse grained amphibole pyroxene porphyric diorite (PSt) is at the SE edge of the intrusion at its base, representing 1. diorite intrusive phase. At the bottom part of more extensive intrusion of DIP type there is located a body of the younger intrusion of inhomogeneous fine-grained clinopyroxene diorite porphyry (DiPN) often with symptoms of biotitization, included in the 3. diorite intrusive phase.

Geomagnetic profile PF-Ia (Fig. 12a) starts in the valley of the Rimava river in the level 550 m a.s.l. and continues higher on the range on the eastern slope of the Pacherka to level about 700 m a.s.l. (App. 3). Low delta T at the beginning of the profile below 48 200 corresponds to Hercynian granodiorite-granite. A zone of slight increase of delta T over 48 000 at a distance of about 250 m from the beginning of the profile indicates the northern edge of the diorite intrusion in the segment A_2. The continuation of the monotonous level of delta T of about 48 400 corresponds to Hercynian granodiorite-granite. Variable course of the curve in segment E with the values of around 48 400 and above indicates the presence of horizontal intrusion (sill) of small thickness (a few meters) bellow Mesozoic carbonates. Locally attained highs delta T can signal the presence of dyke bodies. At the southern edge of the diorite sill in contact with Mesozoic carbonates there was found a greater concentration of mining works and heap material.

Dyke swarm of various composition penetrates through the diorite sill, dykes represent coarse-grained clinopyroxene diorite porphyry (type H_2) of 4. intrusive phase and dykes of medium-grained amphibole andesite porphyry (type I_1) with long needle-like amphibole. Dykes are mainly oriented in the direction of EEN–WWS to E–W.

III – Upper middle level, segment F

At a higher level on the eastern slope under elevation points 930–931 Magnetový vrch-Pacherka, roughly from the level 720–730 m to the level 870–890 m a.s.l., in an environment of Mesozoic carbonate rocks a diorite body is located in the form of horizontal intrusion (sill) marked as F segment. The lower part of intrusion consists of intensively altered endoskarnized inhomogeneous diorite porphyry (type DPv), partially bleached, included in the 2. diorite intrusive phase (younger stage). Closer to the contact with the intrusion the limestones are on the eastern edge intensively skarnized and more externally recrystallized. At the eastern edge of intrusion there is a significant concentration of old abandoned mining works and heaps of waste material.

A body of altered medium-grained clinopyroxene partially bleached diorite porphyry (a type DIP), of 2.

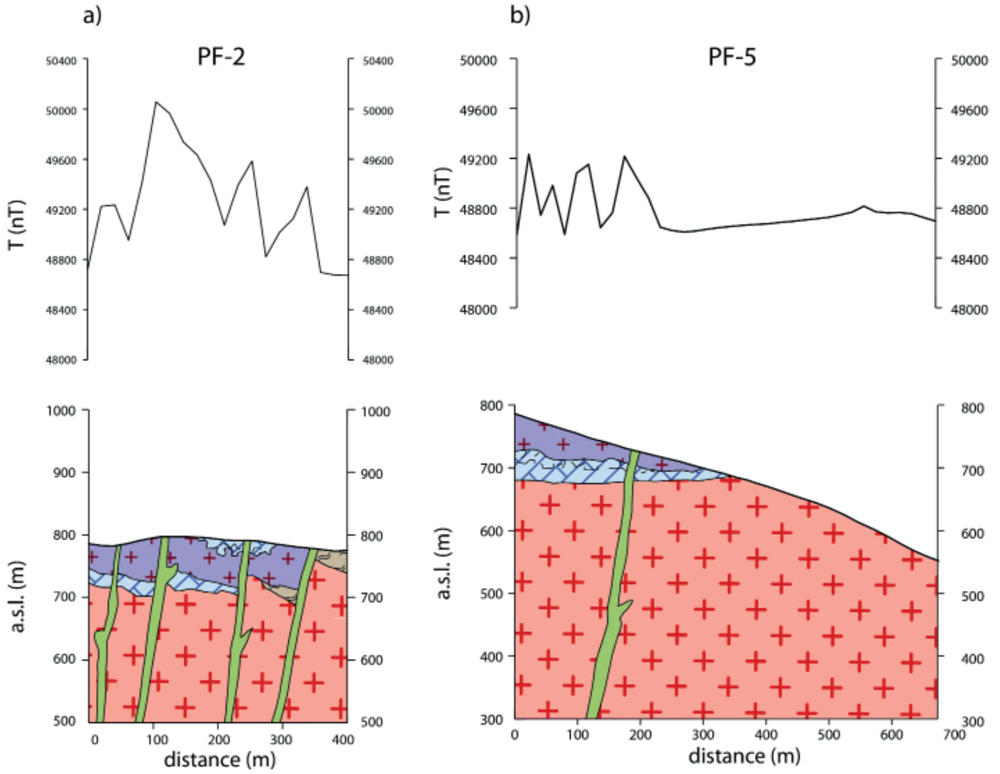


Fig. 11. Geomagnetic profiles in NW edge of the intrusive complex, segment C. a) geomagnetic profile PF-2; b) geomagnetic profile PF-5 at the southern edge of the segment C.

intrusive phase (younger stage) is present at a higher level in the bottom part of the intrusion of type DPv. A denudation relic of smaller extent above the intrusion consists of inhomogeneous fine-grained clinopyroxene diorite porphyry (type DiPN) assigned to the 3. diorite intrusive phase (post skarn). Smaller body is identified at SW edge of the F segment formed by intensively altered and skarnized amphibole porphyric diorite (PStz) of the 1. intrusive phase.

Through the horizontal sill intrusions the dyke swarms penetrate with orientation E–W. Dykes are formed by the medium-grained clinopyroxene diorite porphyry (a type S_1) of the 4. intrusive phase, further amphibole andesite porphyry (a type I_1) of the 6. intrusive phase and coarse- grained clinopyroxene diorite porphyry (H_2), which is moderately altered and endoskarnized.

Geomagnetic profile PF-Ia (Fig. 12a), which continues in segment F subhorizontally at the eastern edge of the sill intrusion shows a low delta T of about 48 100. These values can be interpreted as the influence of the Hercynian granodiorite-granite underlying carbonates. Locally increased delta T to 48 400 can be attributed to the presence of sills of small thickness or dyke body, or to the presence of debris material with blocks of intrusion rock.

Geomagnetic profile PF-Ib (Fig. 12b) begins in the environment of carbonates (App. 3) with corresponding low values of the delta T. Locally increased delta T, about 150 m from the beginning of the profile to a value 48 400 may indicate the presence of diorite intrusion, or dyke under the carbonates. The further course of the curve corresponds to the presence of granodiorite.

In the direction to the north the F segment continues

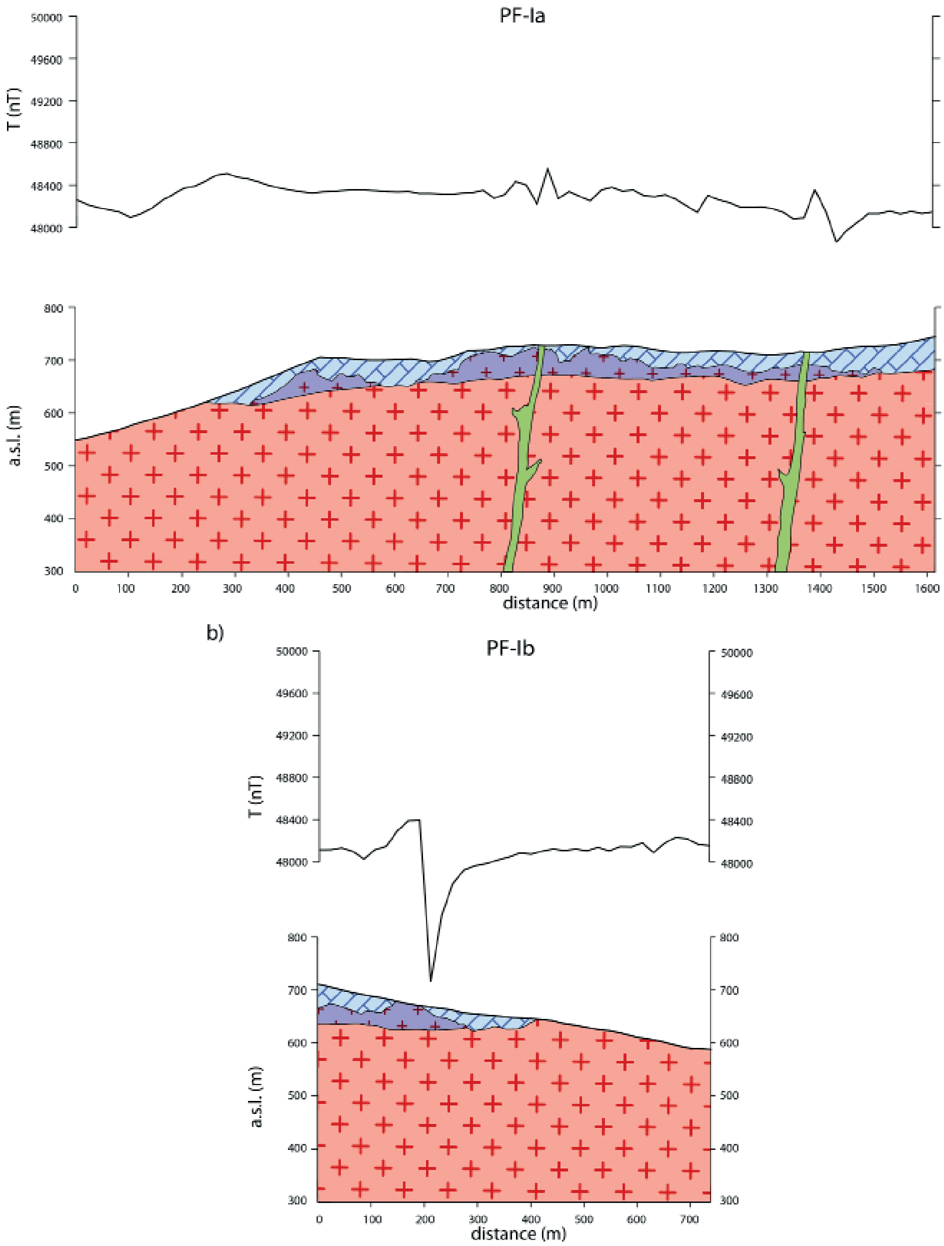


Fig. 12. Geomagnetic profile PF-Ia on the eastern slope of the Magnetový vrch Hill runs at the northern edge of the segment A through E segment and ends in segment F (a). Geomagnetic profile PF-Ib runs in the environment of carbonates and granodiorite (b).

to G segment of altered diorite porphyry body (DIP) and therefore, we describe it within the intrusive complex in segment G.

IV – Higher level – segment G

Intrusive complex in segment G of rather complicated structure is located to the north of the segment F at a higher altitude on the eastern slope of the ridge of the Magnetový vrch Hill (e.p. 964.8) from 850 to 920–930 m a.s.l. (App. 3). Intensively altered, endoskarnized, inhomogeneous diorite porphyry (a type DPv) partially bleached dominates near the upper contact with overlying Mesozoic carbonate rocks. South of this body at lower levels of the slope it continues to the altered medium-grained clinopyroxene diorite porphyry (a type DIP) without a clear boundary. Medium- to coarse- grained biotitized clinopyroxene diorite porphyry (a type DiDaj) is partially bleached, and also partially altered. The above types of diorite porphyries were included during the 2. diorite intrusive phase (younger stage). A major role in the skarnization process in the zone of contact with Mesozoic carbonates is attributed to them.

At NE margin of the intrusive complex in segment G in lower levels of eastern slope under Magnetový vrch Hill, there is exposed the fine-grained clinopyroxene diorite (diopsidized, type Di_2), it is included in the post skarn 3. diorite intrusive phase.

Younger dyke swarm penetrates through the diorite intrusive complex and is dominantly oriented in the E–W direction. It is represented by the dykes of 4. intrusive diorite porphyry phase of medium-grained diorite porphyry (types S_1, S_2), further by the medium altered and endoscarnized diorite porphyry (type H_2) and coarse-grained leucocratic clinopyroxene diorite porphyry (type H_1), partially altered and actinolitized.

Younger intrusive phase, 5. phase is represented by the dyke bodies of medium-grained garnet amphibole andesite porphyry (type I_3), sparse porphyric fine-grained to vitritic amphibole andesite porphyry (type I_2) and medium-grained amphibole andesite porphyry with needle-like amphibole (typ I_1).

Geomagnetic profile PF-1b (Fig. 13) with a length of 510 m (App. 3), trending SW–NE starts in the ridge south of e.p. 964.3 Magnetový vrch Hill in altitude 925 m and continues along the eastern ridge down for up to a level of 790 m a.s.l. Geomagnetic profile extending throughout the thickness of the intrusive complex confirmed its presence by achieving delta T value 49 000 and more. Individual peaks reaching a maximum value delta T 49 500–50 000 correspond to the dyke bodies which presence was evidenced by the geological mapping.

V – Upper level – segment H

Intrusive complex designated as a segment H (App. 3) is located in the top area of the range of Magnetový vrch Hill (e.p. 964.3), and in this area it has the highest altitude level. Intrusive complex in the apical part of the Magnetový vrch Hill is exposed by the denudation cut and does not have its Mesozoic cover, being removed by denudation. At the SE edge of intrusive complex of segment H it continues to a lower intrusive complex G (this is probably a laccolith form penetrating into the higher levels in the environment of Mesozoic rocks). At SE edge a Mesozoic carbonates extend at the base of the intrusion. At the northern edge the intrusion is in tectonic contact with Paleogene sediments. A contact of metamorphic rocks of the Foederata Group and rocks of the Silicicum nappe (contact area is covered with blocky debris) occurs in the form of tectonic zone on the western slope of the Magnetový vrch Hill. At the southern edge of the intrusive complex in its basement there are in short section exposed carbonate rocks of Silicicum nappe (Wetterstein dolomite). Intrusive complex in segment H is tilting to the northeast, its lower edge on the western slope is registered at the level of 870 m a.s.l., which allows estimation of its thickness around 90 to 100 meters. Several bodies within intrusive complex based on petrological study are distinguished.

Southern part of the intrusion of Magnetový vrch Hill forms inhomogeneous fine-grained diorite porphyry of the post skarn stage (type DiPN) of the 3. diorite intrusive phase. Altered partially bleached fine-grained diorite (a type DiJM) included in the 2. diorite intrusive phase (younger stage) was found on the northern slopes and at higher levels of the range of Magnetový vrch Hill.

Remnants of the structure from the 1. intrusive phase are recorded within the intrusive complex in the segment H. The body at the northern edge of the complex is formed by the scarse porphyric andesite porphyry with a large amphibole (type DiPM) included in the 1. intrusive phase (younger stage). Other body appears at the base of the complex on the eastern slope of the Magnetový vrch Hill,

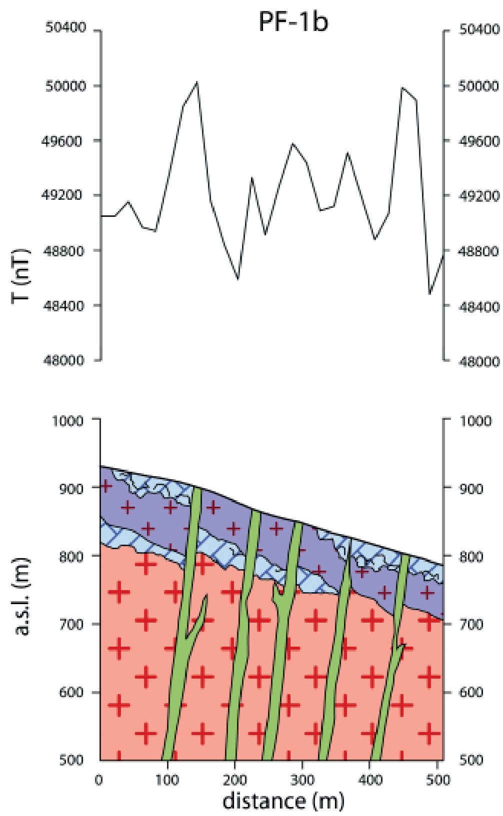


Fig. 13. Geomagnetic profile PF-1b in the segment G.

and it is comprised of medium-grained amphibole andesite porphyry with a garnet, endoskarnized (type GpM) included in the 1. intrusive phase.

Intrusive complex in the segment H is penetrated by younger dyke bodies of E–W to ENE–WSW direction. The northern edge of the intrusive complex follows a dyke of coarse porphyric diorite porphyry (type H_2) of ENE–WSW direction. On the western side the dyke ends by penetration of a younger body of quartz diorite porphyry (type KDP) cropping out at the NW range below summit of the Magnetový vrch Hill. Smaller isolated penetration of the body of quartz diorite porphyry of type KDP is registered also in the summit of the Magnetový vrch Hill. Younger bodies represent two other dykes. Longer dyke of amphibole andesite with needle-like amphibole (type I_1) penetrates through the intrusive rocks of the 1. and 2. phases, and also penetrates through the body of quartz diorite porphyry (KDP). A second shorter dyke of the fine-grained amphibole clinopyroxene andesite porphyry (type PxM) is found at NW slope of the ridge below the Magnetový vrch Hill.

Geomagnetic profile PF-1a (Fig. 14a) with a length of 900 m starts NW of the Magnetový vrch Hill in flat summit in the area of the rise up of intrusive body of amphibole quartz diorite porphyry (type KDP). The profile continues along its ridge to the NE, passes through the peak of the Magnetový vrch Hill and ends up in an environment of Mesozoic carbonates (App. 3). Increased delta T to 49 200 at the beginning of the profile corresponds to the presence of intrusive body of amphibole quartz diorite porphyry (type KDP). In the continuation of the profile to SE there follows a decrease in the values to around 48 600 delta T, corresponding to the presence of Hercynian granodiorite-granite (possibly with remnants of sediments of Mesozoic and Paleogene rocks in the overlying rocks). Local slight increase in delta T to 48 800 probably corresponds to the marginal part of penetration of intrusive body of type KDP. Further continuation of the profile to the SE to the area of apical part of the Magnetový vrch Hill indicates the increase in the delta T values over 49 000, which corresponds to the presence of a diorite intrusion, whereas the individual peaks in the form of peaks with values around 49 400 to 51 000 delta T are probably related to the presence of younger dyke bodies penetrating through the diorite intrusion. Drop of delta T values before the end of the profile to a level of 49 000 indicates the presence of the diorite intrusive body (sill) under the carbonate rocks of the lower thickness. In the end of the profile a sudden increase in delta T to 49 600 corresponds to the presence of dyke detected also by geological mapping.

Geomagnetic profile PF-3 (Fig. 14b) with a length of 950 m (App. 3) starts at the lower levels of the eastern slope of the Magnetový vrch Hill about 780 m a.s.l. and continues to the top of the Magnetový vrch Hill (e.p. 964.3), from where it is running down on the western slope to the level of 850 m a.s.l. At the beginning of the profile the delta T value over 48 800 indicates the presence of diorite porphyry sill intrusion within the segment C. The peaks with values of 49 200 and 49 400 correspond to younger dyke bodies penetrating through the sill. Continuation of the profile in a Mesozoic rocks reflects to a decrease of delta T under the 48 400. Following peak with value of about 49 600 corresponds to the course of dyke body at the edge of the intrusive complex H. The increase in delta T values over 48 800 in continuation of the profile indicates the presence of diorite intrusion in the H complex at the apical part of the Magnetový vrch Hill. The narrow peaks of geomagnetic curves with values of about 50 000 to 50 500 delta T correspond to penetration of younger dyke bodies through the diorite sill. Western edge of the sill in complex H on the western slope and the transition to the environment of carbonates and metamorphic rocks of Foederata serie is indicated by the drop of delta T values to around 48 500 at a distance of about 700 m from the beginning of the profile.

Dyke systems of andesite and diorite porphyries in the central volcanic zone

Numerous dykes and dyke swarms penetrating through the central subvolcanic diorite intrusive complex represent the younger phase of intrusive activity (App. 1). Rise up of dykes and dyke swarms is not limited to the scope of subvolcanic diorite complex, their spatial

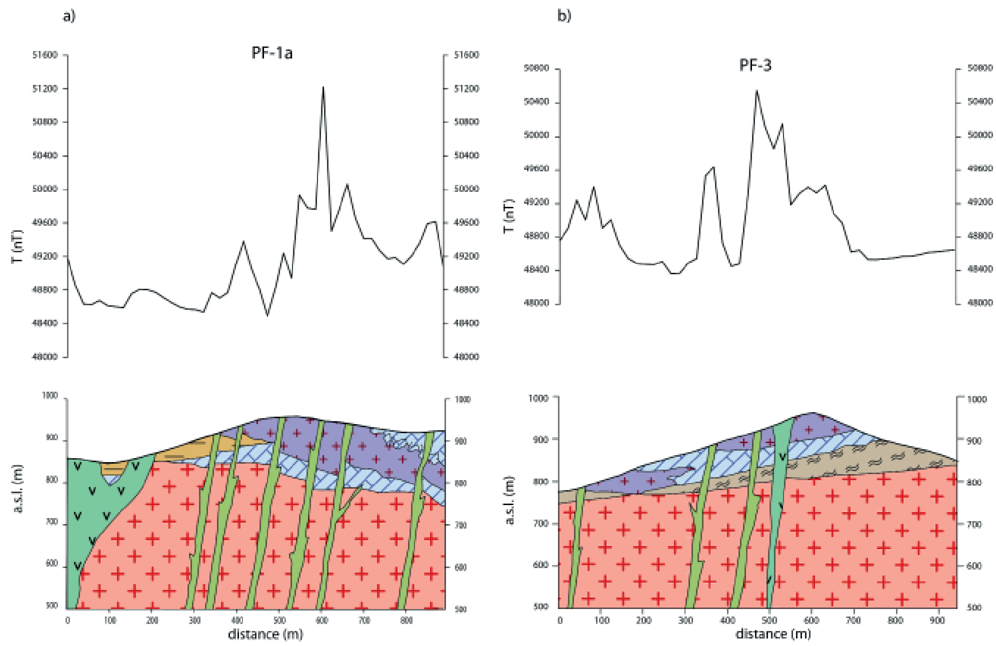


Fig. 14. Geomagnetic profile PF-1a in the segment H (a). Geomagnetic profile PF-3 in the segment H (b).

distribution extends into the surrounding rock environment, that in comparison with the dimensions of diorite complex indicates the expansion of magmatic reservoir in the period of younger stages of intrusive activity.

It is realistic to expect that the rise up of the dykes was terminated in subvolcanic levels before reaching the Earth´s surface. These are mainly diorite porphyry dykes with a higher degree of crystallinity of the groundmass. Part of dykes penetrated higher into the volcanic structure, or some of them could represent feeding channels for the surface effusion of lava flows and eruptions of pyroclastic material. They are particularly dykes with a lower degree of crystallinity of the groundmass or dykes with glassy development of the groundmass (dykes of amphibole andesites with vitrophyric to fine-grained development of the groundmass).

In spatial orientation of dyke systems the direction to ENE–WSW significantly predominates, locally the E–W direction is observed. A larger dyke accummulation is observed in the NW part of the diorite intrusive complex (dykes of diorite and andesite porphyries). In contrast, the dykes of basaltic andesites are concentrated mainly on the western slope of the e.p. 959.6 Pacherka outside of the central diorite subvolcanic complex where they are present in an environment of Mesozoic carbonate rocks). In the central diorite complex they are present only in sporadic cases (top of the Pacherka ridge and its eastern slope). Dykes of andesite and diorite porphyries, extending beyond the scope of subvolcanic diorite complex are exposed in the environment of Mesozoic carbonate rocks, metamorphic rocks of the Foederata Group and Paleogene sediments (northern and western slopes of Magnetový vrch Hill). Dykes, which occasionally continue eastward from the central subvolcanic intrusive complex, are exposed in surrounding crystalline rocks.

Dyke width varies from 0.5 m to 1 m even up to 20 m, length is similarly variable from several meters up to 600–800 m and occasionally up to 1 200 meters.

The following groups within dykes and dyke swarms based on the composition and their position there are identified:

1st group includes dykes of clinopyroxene diorite porphyries of variable grain size (fine-grained, medium- to coarse-grained) with various degrees of hydrothermal alteration and in some cases with signs of endoskarnization. The varieties of type J, S2, S1, H2, H1 are listed in Tab. 1 and more detail description is provided in App. 4. Dykes of the 1st group, according to the position in succession of intrusive rocks are assigned to the 4. intrusive phase. The dyke bodies of this group are documented in the outcrop present in the cut of the forest road on the Pred Striebornou ridge. Steep contact of diorite porphyry dyke with Wetterstein limestones is exposed in the outcrop of the length of about 10 m and height of 2 m. Coarse-grained diorite porphyry is grey-blue, slightly altered with blocky jointing. The limestones are in close contact zone skarnized.

2nd group consists of dykes of 1 – fine-grained dark amphibole clinopyroxene andesite porphyries (type Magnet, PxM), 2 – fine-grained clinopyroxene basaltic andesites

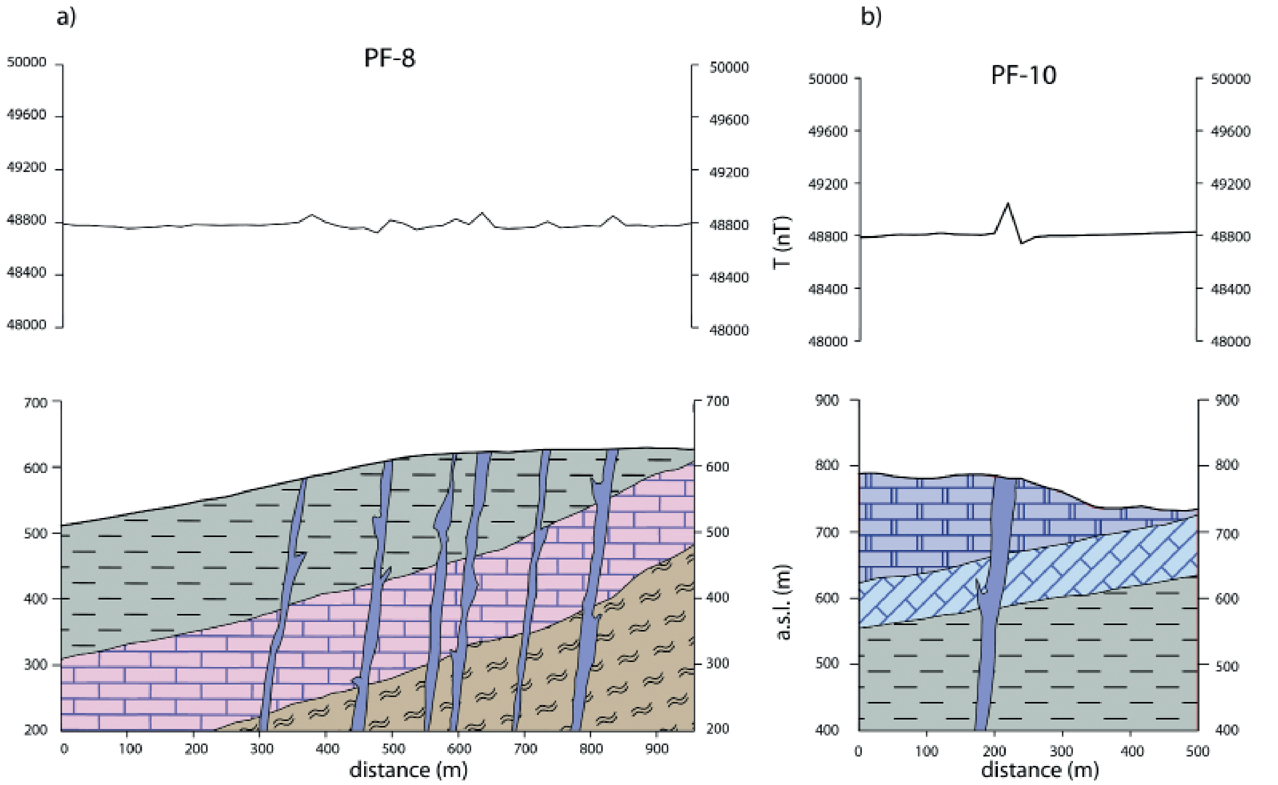


Fig. 15. Geomagnetic profiles in the Pacherka area, profile PF-8 directed through the dyke swarm of basaltic andesites (a), the profile PF-10 directed through the basaltic andesite dyke (b).

(DIP), 3 – medium-grained garnet amphibole andesite porphyries with a short needle-like amphibole (I_3), 4 – scarse porphyric fine-grained to glassy amphibole andesite porphyry with occasional large needle-like amphibole (I_2), medium-grained amphibole andesite porphyry with long needle-like amphibole up to 1–2 cm (I_1) (Tab. 1). Dykes of this group are included to the 6. intrusive phase.

Dyke system of basaltic andesites

Dykes of basaltic andesites (B) are located southwest of the central diorite intrusion on the western slope of the Pacherka ridge (e.p. 969.6), where is their main concentration and they continue eastward to the upper part of the ridge and on its eastern slope. Dykes of basaltic andesite represent the 7. intrusive phase. It is supposed that they are subvolcanic equivalents of surface parasitic volcano situated in higher level of the western slope the Vepor stratovolcano. Dyke bodies on the western slope of the ridge Pacherka in the area of maximum concentration above the valley Bánova are oriented mostly in the of E–W direction, their length is 150–350 m. In the ridge Pacherka the length of the dykes is about 400 m having prevailing directions of ENE–WSW, less common directions are EES-WWN (dyke in the northern part of the Pacherka ridge).

Geomagnetic profiles PF-8 and PF-10 aimed to verificaty the dyke bodies of basaltic andesites (Fig. 15).

Geomagnetic profile PF-8 (Fig. 15a) on the western slope with the e.p. 959.6 Pacherka with a length of 950 m and orientation N–S runs in the sediments of the Ipoltica Group (shales, claystones, and conglomerates) of Permo-Carboniferous age. Profile begins in the valley of Furmanec brook at altitude 510 m and continues on the slope to a higher level. Dyke bodies are indicated only by locally slightly elevated delta T values above 48 800, corresponding to the position of a small dyke body thick ca 1–2 meters.

Geomagnetic profile PF-10 (Fig. 15b), long 500 m, located on a higher level of the western slope of the Pacherka ridge in the environment of Wetterstein limestones, has verified the presence of basaltic dyke by increased delta T values to 49 000. It was subsequently identified in the forest roads cut and specified was its size.

Intrusive bodies of autometamorphosed pyroxene-amphibole andesite to diorite porphyry in the central volcanic zone

Complex of intrusive bodies of pyroxene-amphibole andesite porphyry to diorite porphyry occupies area NW of the Magnetový vrch Hill (bodies No. 3, 4, 5 and 6, App. 3).

3 – *Relativelly small body of andesite to diorite porphyry* elongated in shape of SE–NW direction and dimensions of about 250 x 100 m is exposed on the western slope of Magnetový vrch Hill. The intrusive body is in contact with Paleogene sediments at the northern margin and with Permian metamorphosed sediments (Foederata Group) along southern margins. Body of andesite to diorite porphyry intrudes through diorite complex of Magnetový vrch Hill in uppper part of the western slope of Magnetový vrch Hill. From that situation there appears the younger age of diorite porphyry body in relation to diorite complex of the Magnetový vrch Hill.

4 – *Extensive body of hydrothermally altered pyroxene quartz diorite porphyry* forms a small hill with flat top and its western slope west of Magnetový vrch Hill. Intrusive body of roughly isometric shape, dimensions ca 400 x 350 m is in contact with Hercynian granite along its NE side, with Paleogene sediments on E side and with metamorphosed Permian sediments of Foederata Group on the south. At western side the intrusive body is in contact with intrusive body No. 5. At southwestern side of intrusive body there is a belt of conglomerate sediments with rounded blocks of quartzitic sandstones derived from the Lužná Fm. Zone of brecciation is locally present along the margins of intrusive body. Top of flat hill is bearing scattered blocks of intrusive rocks. Mafic minerals represent the chlorite pseudomorphoses after pyroxene. Small pyroxene 1–2 mm prevails and less frequent is amphibole (dimensions 2–4 mm, rarely 1.5 cm-3 cm). Rock is desintegrated into irregular blocks and blocks with platy jointing. Intrusive rock during weathering obtains deep and light greenish colours often with brown spots. The rock is intensively chloritized, silicified and carbonatized.

As was mentioned earlier, the geomagnetic profile PF-1a (Fig. 14a) begins in intrusive body with 49 200 deltaT on flat hill. Next decrease to about 40 400 corresponds to occurrence of Permian metamorphosed sediments. The next increasing of delta T to 48 800 indicates the marginal part of smaller elongated intrusion of the diorite porphyry No. 3.

5 – *Intrusive body of autometamorphosed pyroxene andesite porphyry* with dimensions 650 x 450 m and with eliptical shape occupies area of hill with e.p. 757 and western slopes of Nemcová valley. At the northern side the intrusion is in contact with Hercynian granite, along western side with mica schists of Veporic unit and along the southern side with Permian metamorphosed sediments of the Lúžna Fm. Intrusion is exposed in small abandoned quarry near e.p. 757 and along forest road on the southern slope. The intrusive rock is medium porphyric with phenocrysts of plagioclase and smaller pyroxene. It desintegrates into platy blocks. All mafic minerals are replaced by chlorite and carbonate and in the groundmass the silicification was found.

To ascertain the extent of intrusive body covered with Quaternary deluvial sediments there were realized geomagnetic profiles: PF-15 on the eastern side and PF-24, 25 and 26 on western side of intrusive body (Fig. 16).

Profile PF-15 (Fig. 16a) begins in Hercynian granite with delta T values bellow 49 000. Transition to intrusion is indicated by their increase above 49 600 and to 49 800. In the case of profiles PF-25 (Fig. 16c) and PF-26 (Fig. 16d) a transition from mica schists into intrusion is accompanied with moderate increase of the delta T values, indicating smaller thickness of intrusive rocks near margins of intrusion. These facts point to laccolith type of intrusion at the western side. In contrast, a steep increase of delta T values to 49 900 in PF-24 (Fig. 16b) indicates a vertical contact with surrounding rocks (near feeding channel) at southern side of intrusive body.

6 – *The intrusive body of autometamorphosed andesite to diorite porphyry* of elliptical shape with dimensions 700 x 250 forms ridge with e.p. 795 with N–S orientation at the western part of intrusive complex. The intrusive body is penetrating through the Hercynian granite. Intrusive body continues without interruption in the western slope of Nemcová valley toward SW to the

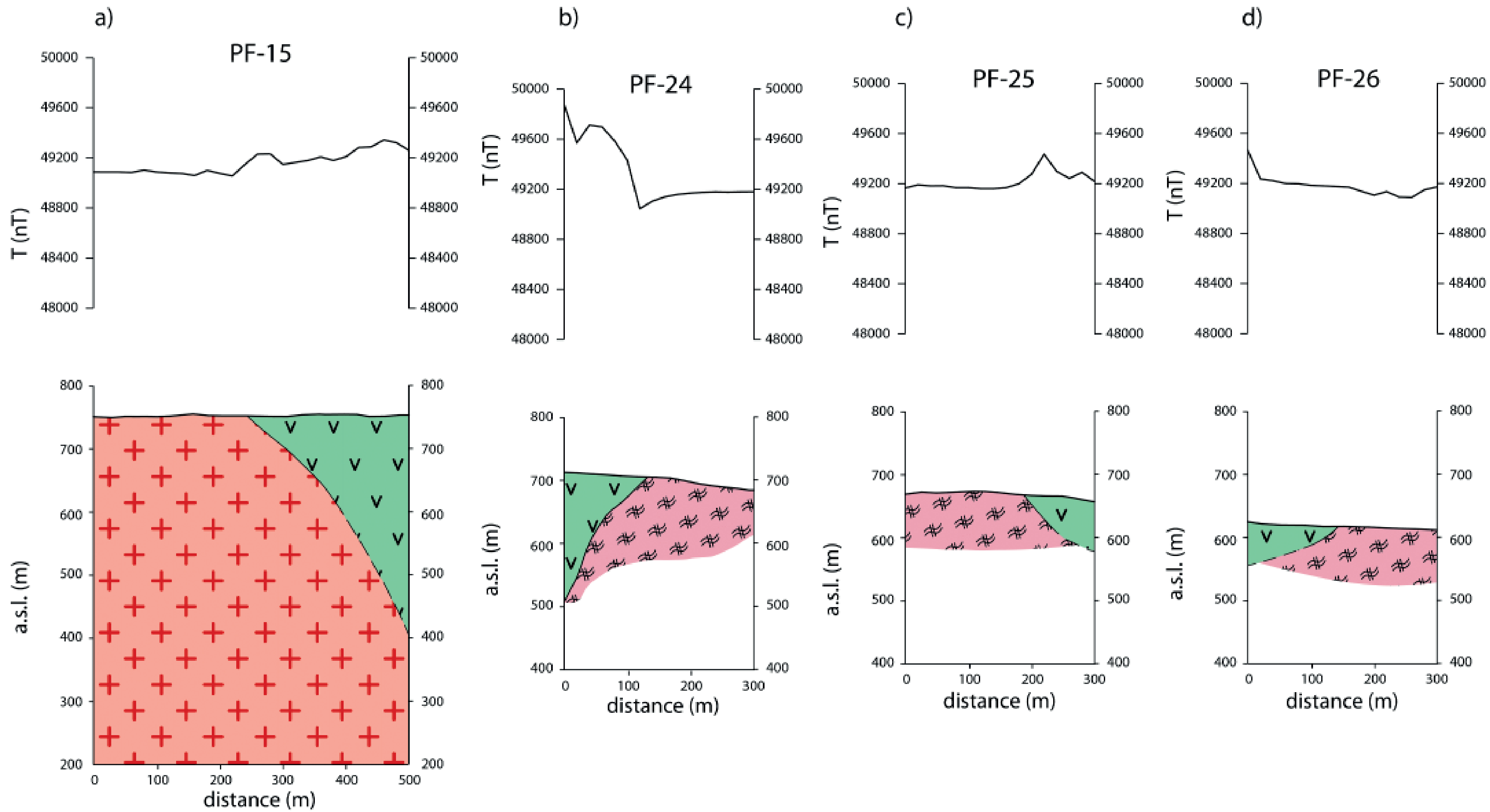


Fig. 16. Geomagnetic profiles in body of autometamorphosed andesite to diorite porphyry (No. 4), PF-15, PF-24, PF-25, PF-26 (a, b, c, d).

main valley with Furmanec brook. Intrusion is exposed in several outcrops on the ridge with e.p. 795. Intrusive rock is medium to coarse porphyric with phenocrysts of plagioclase, pyroxene, 1–2 mm and amphibole 2–4 mm, rarely amphibole xenocrysts reach up to 10 mm.

Geomagnetic profile PF-13 (Fig. 17a) crossing the ridge from the east to west begins in Hercynian granite with delta T values bellow 48 700. Transition from Hercynian granite into intrusive diorite body corresponds to their sudden increase up to 49 600. In further continuation of the profile in intrusive body, the delta T value gradually declines to ca 48 800 towards the contact with Hercynian granite.

Geomagnetic profile PF-14 (Fig. 17b) at the northern part of intrusive body is oriented N-S. Transition from Hercynian granite into intrusion corresponds to increasing of delta T values from 49 200 up to 49 800. That points also to steep contact of intrusion with Hercynian granite. This implies that intrusive body in the ridge with e.p. 795, exposed by erosion in subvolcanic level, corresponds to intrusion with vertical and-or subvertical form with the tendency of transition to laccolith form in the western side. Southern continuation of intrusion was not examined by geomagnetic methods. Orientation of intrusive bodies probably indicates their relation to fault system of N–SW direction.

Two intrusive bodies of andesite to diorite porphyry occur northward from the central diorite complex of the Magnetový vrch Hill. First body in locality Spuzlová No. 7 in the distance ca 800 from the central diorite complex and second body No. 8 on the slope of Strieborný potok brook valley at a distance of ca 900 m.

7 – *Intrusive body of diorite to diorite porphyry Spuzlová*, elliptical in shape with dimension of 120 x 170 m and orientation of NW–SE direction occurs on the western slope of Spuzlová valley bellow e.p. 986 (App. 1, 3). Intrusive body is exposed in a small abandoned quarry above the forest road in altitude 664 m. Intrusive rock is greenish, medium- to coarse-grained with transition to porphyric texture. Phenocrysts form plagioclase and amphibole up to 3 mm large, pyroxene is smaller. The rock is autometamorphosed with strong chloritization, silicification and local carbonatization. Intrusive rock disintegrates into irregular blocks.

Geomagnetic profile PF-11 (Fig. 18a) coursing N-S is long 400 m. Geomagnetic profile begins in the altitude 650 m in Hercynian granite with the delta T value ca 48 600. The transition to intrusive body is marked by the increase of the value up to 49 300–49 500. The second transition into Hercynian granite is accompanied with lowering of the value to level 48 800.

Geomagnetic profile PF-12 (Fig. 18b) of NW–SE orientation begins at 750 m a.s.l. in Hercynian granite with the delta T value above 48 800. With transition into intrusive body the value rapidly increases to 49 400 and after transition into Hercynian granite it declines again to 48 800. Intrusive body exposed in subvolcanic level corresponds to intrusive stock.

8 – *Intrusive body of diorite porphyry at locality Strieborný potok brook* (App. 3) of smaller size and isometric in shape with dimensions about 100 x 150 m was identified by the presence of fragments of intrusive rock in the debris on the slope of the side valley. Intrusive rock is fine to medium porphyric with phenocrysts of plagioclase, pyroxene 1–2 mm and amphibole to 3 mm. Weathering causes the light green colours of altered rock. Intrusive body was not examined by geomagnetic method.

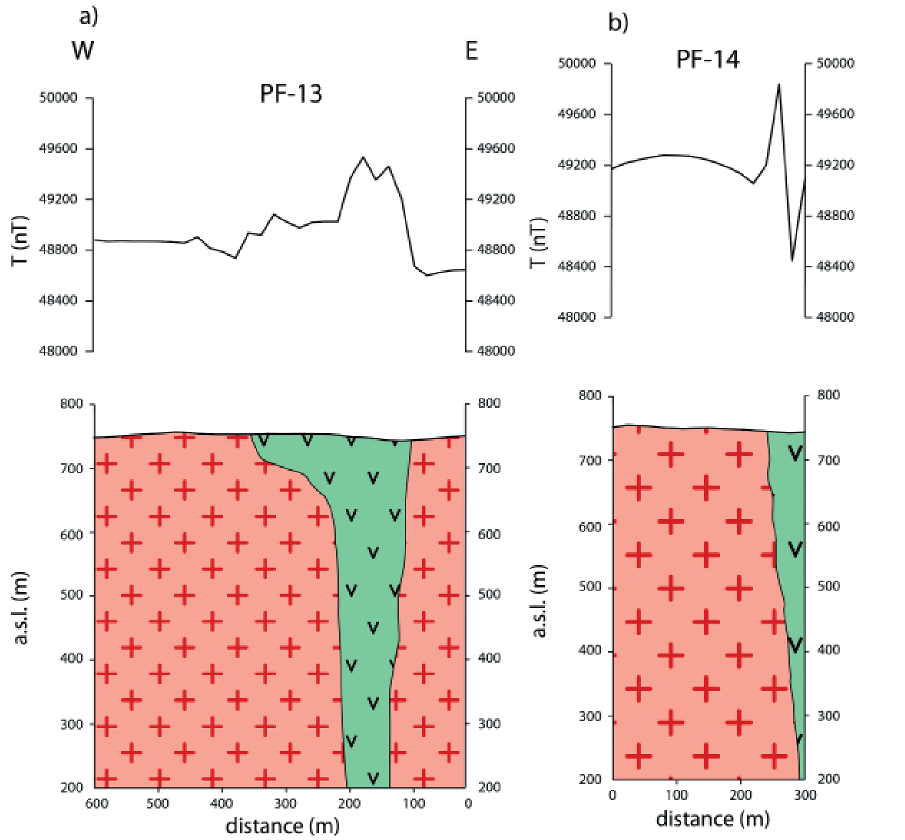


Fig. 17. Geomagnetic profiles PF-13 and PF-14 (a, b) crossing body of autometamorphosed andesite to diorite porphyry No. 6 in the ridge with e.p. 795.

Intrusive succession in central volcanic zone

On the base of space relations of intrusive bodies in the central volcanic zone, obtained during geological mapping and following petrological study, the general scheme of the intrusive succession was compiled (Fig. 19).

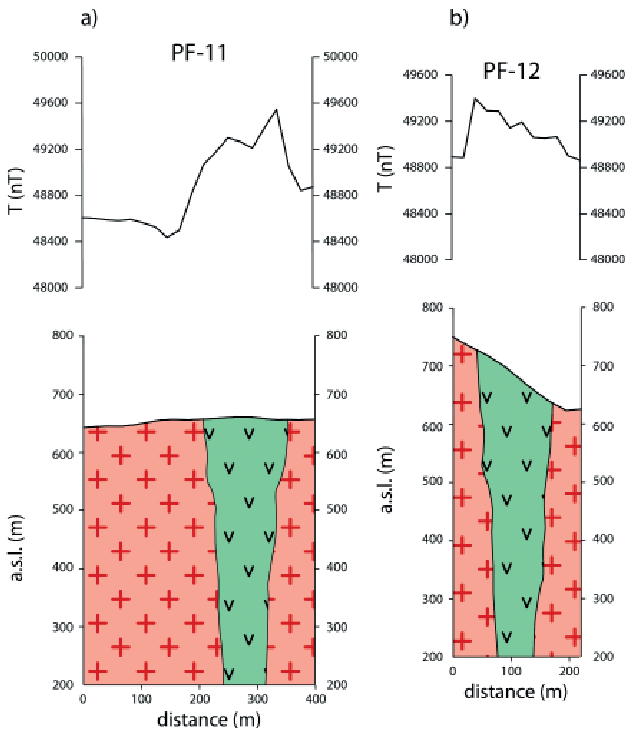


Fig. 18. Geomagnetic profiles through a body of diorite porphyry Spuzlová: profile PF-11 (a) and PF-12 (b).

The existence of bodies representing the feeding system to the volcano on the surface (before the emplacement of the central diorite intrusion) is proved by the frequent occurrence of xenoliths - the products of the destruction of former feeding system, being later included into the later central diorite intrusion.

Ascent and emplacement of the diorite intrusion in the subvolcanic level shows a multiphase evolution. Three main intrusive phases were distinguished (Tab. 1). In the structure of the subvolcanic diorite complex there were identified stock-like bodies penetrating through the Hercynian granodiorite-granite massif like a stock bodies (on both sides of the lower slopes of the Rimava valley). In higher level on western slope of the Rimava valley (below Magnetový vrch Hill) the apophyses of diorite bodies in the form of sills were intruding in five different levels into Mesozoic carbonate rocks. Intrusions of diorite sills caused the skarnization and recrystallization of surrounding carbonate rocks.

During following intrusive activity, several bodies of andesite to diorite porphyry were emplaced as laccoliths in the lower levels of volcanic structure at the NW side of subvolcanic diorite complex (NW slope of summit of Magnetový vrch Hill).

Dykes and dyke swarms dominantly of ENE–WSW orientation of various petrographic compositions (amphibole-pyroxene andesites to andesite porphyries) represent a younger phase of intrusive activity. It is assumed that some dykes, reaching the crater area, could represent a part of the feeding system for effusive and explosive activity of the volcano on the surfice.

Dykes and dyke swarms of basaltic andesites exposed by denudation on southwestern slopes bellow the Magnetový vrch Hill (western slopes of Pacherka) are interpreted as a youngest phase of intrusive activity,

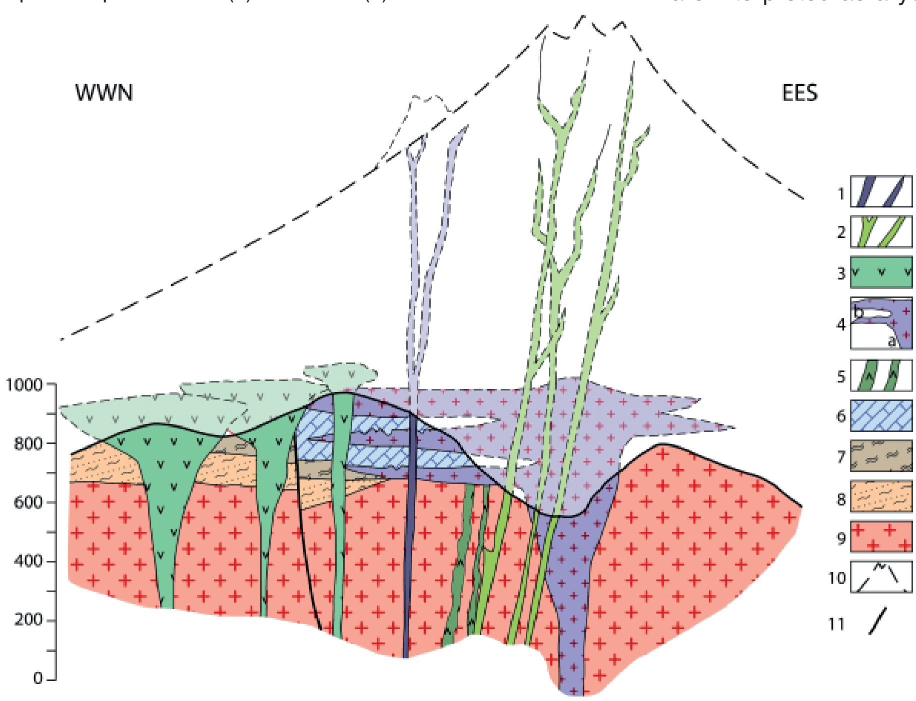


Fig. 19. Scheme of intrusive succession in the central zone of the Vepor stratovolcano. 1 – basalt dykes; 2 – andesite to diorite porphyry dykes; 3 – laccoliths of andesite to diorite porphyry; 4 – diorite intrusive complex, a – stock, b – sill; 5 – dykes of older feeding system; 6 – Mesozoic carbonate rocks (Triassic); 7 – metamorphosed claystones, sandstones and conglomerates, Foederata Group (Permian, Triassic); 8 – schists and gneisses of the Veporic tectonic unit (Paleozoic); 9 – Hercynian granite-granodiorite (Vepor type); 10 – paleoreconstruction of the stratovolcano; 11 – fault.

representing feeding system for parasitic volcano on SW slope of the stratovolcano. The position of intrusive bodies north of the central diorite intrusion (body Spuzlová No. 7 and body on the slope of the valley of the Rimava river No. 8) due to their isolation (surrounded by granite to granite of the Vepor type) in the intrusive scheme is uncertain. It is supposed that bodies most probably represent feeding system (necks) to the surficial parasitic volcano.

Scattered intrusive and extrusive bodies of rhyodacites, andesites and andesite to diorite porphyry in transitional volcanic zone

In a far distance of the central volcanic zone within an area of transitional (proximal) zone, the sporadic scattered intrusive bodies (laccoliths, sills, stocks) are exposed by erosion in the shallow subvolcanic level. Also bodies with signs of their ascent on the surfice (dome like extrusive bodies) were identified. Some bodies of intrusive complex continue from the area of the central volcanic zone to the area of transitional volcanic zone. This case is represented by few intrusive bodies of andesite to diorite porphyry situated NW of the Magnet intrusive complex, especially bodies Nos. 5 and 6. Another examples represent the dykes and dyke swarms of basaltic andesites, occuring in the area of central volcanic zone and continuing to SW partly to the area of transitional zone, where they probably represent feeding system of parasitic volcanoes on the slope of the Vepor andesite stratovolcano. Overlapping and extending of intrusive bodies between central and proximal volcanic zone means that the boundaries of zones cannot be understood as fixed limits, especially concerning the position of subvolcanic bodies and feeding systems like dyke swarms, etc.

SW sector of stratovolcano

In the SW sector of transitional volcanic zone (proximal zone), three andesite extrusive bodies are exposed on the northern slope of the Rozsypok ridge with e.p. 1128 m (Nos. 9-11; Fig. 20).

9 – *Extrusive body of amphibole andesite* is exposed on the ridge trending to NW bellow e.p. 1128 Rozsypok from the level 1025 a.s.l. to 1065 a.s.l. Extrusive body of eliptical shape with diameters 200 x 150 m forms a small hill with orientation to NWN. Andesite body is disintegrated into blocks. Andesite is fine to medium porphyric, with plagioclase (dimensions 1–2 mm) and amphibole (1–3 mm). Needles of amphibole are paralelly aranged. At marginal part, the andesite body is porous to strogly vesiculated. Lithophyses after escaping gasses are oriented along fluidality planes and they are parallel with the orientation of amphibole needles. Groundmass of andesite rock is glassy with microllites of plagioclase and amphibole. Andesite body is interpreted as an extrusive body (extrusive dome), exposed by erosion in its deeper level.

10 – *Extrusive body of pyroxene andesite with amphibole* is exposed on the ridge with e.p. 1088 and north of Rozsypok ridge with e.p 1128. Andesite body elliptic in shape with dimensions 250 x 50 m forms in the relief a conspicious ridge with NE–SW orientation. Andesite body is exposed as a tower-like rocks with hight about 25–30 m, continuing from the level 1088 m a.s.l down to the level about 1050 m a.s.l. Andesite rock is dark grey, very fine porphyric with relatively rare phenocrysts of plagioclase (1–2 mm) and orthopyroxene (1–3 mm). Groundmass is glassy with microliths of plagioclase and pyroxene.

Columnar jointing with the fan-like orientation was observed in a higher level of the rock-tower (Fig. 21a, b), locally passing to the zone of autoclastic brecciation with angular fragments and blocks (Fig. 21c, d). Relics of crystalline rocks (Hercynian dynamometamorphosed granite) are preserved in the lower level of the rock wall at the edge of andesite body (Fig. 22a, b). These relics of granitic rocks originally formed the wall of the feeding channel used for ascending of andesitic magma to the surface (Fig. 22c). Granitic rocks are breaked and crushed into angular pieces, cemented with andesite magma. In a lower level of the rock-tower there is a transition from autoclastic brecciation into the massive andesite with blocky jointing. Structural features of andesite body correspond to extrusive volcanic form of dome type (Fig. 22c), which is now exposed by denudation in its lower subsurface level. This is well documented by remnants of crystalline rocks from the walls of the feeding channel preserved on the outer edge of the andesite body. Fan-like orientation of columnar jointing in the upper part of andesite body points to enlarging of the space in the upper part of the feeding channel before ascending of viscous magma to the surface.

11 – *Pyroxene andesite body (neck)* is exposed on ridge bellow e.p. 1088 at the level 1025 m a.s.l. Body of elliptical shape with diameters 100 x 150 m and orientation E–W corresponds to neck. Fan like orientation of columnar jointing (Fig. 23a) developed during cooling of andesite

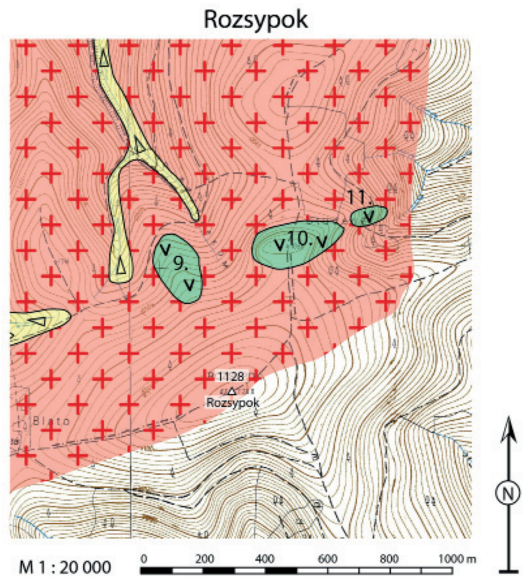


Fig. 20. Extrusive bodies of amphibole pyroxene andesite and pyroxene andesite on the northern slope of the ridge with e.p. 1128 Rozsypok, bodies No. 9, 10 and 11.

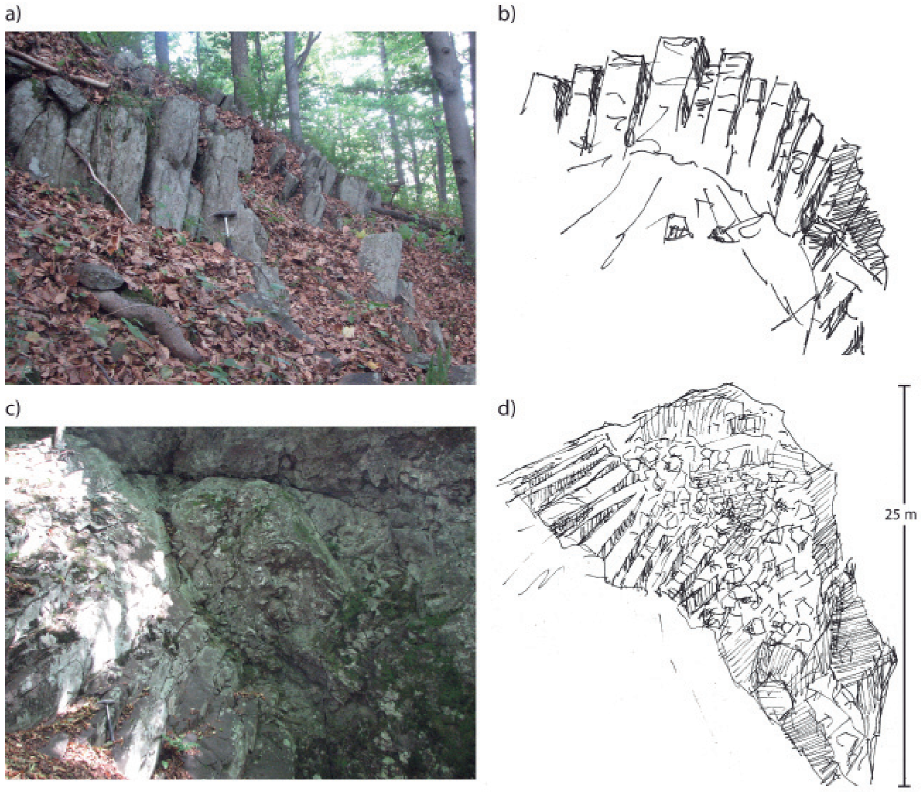


Fig. 21. Rock cliff with height about 25–30 m is exposed on NE ridge with e.p. 1088 bellow Rozsypok 1128 e.p. Columnar jointing with fan-like orientation (a, b) pass gradually in upper part into the zone of autoclastic brecciation with chaotic blocky breccia (c, d).

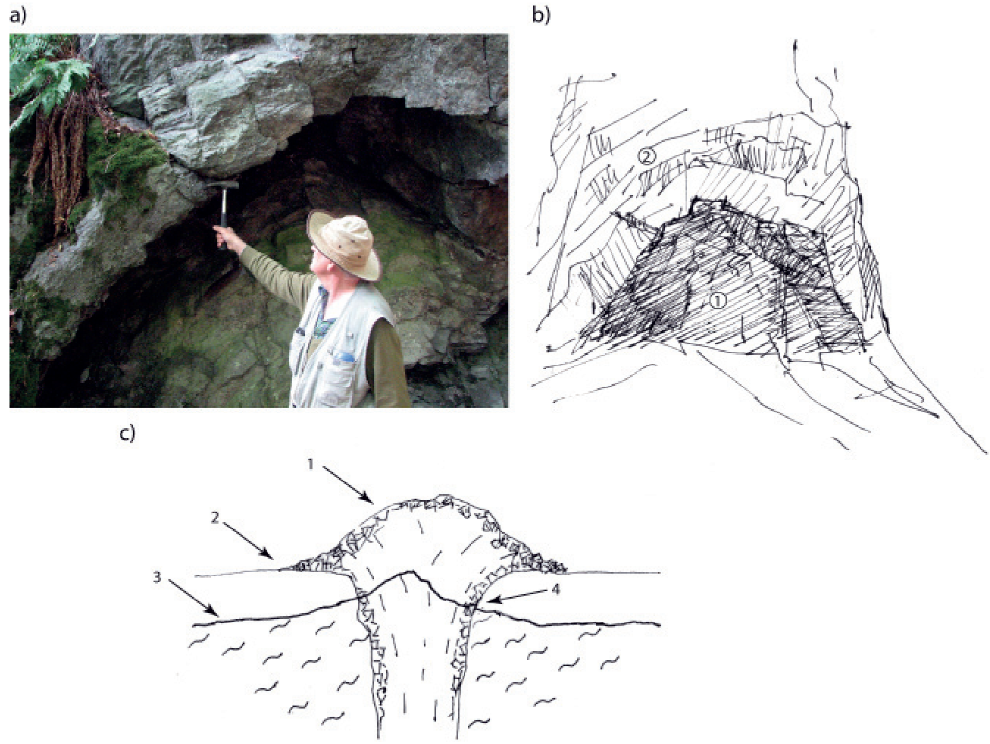


Fig. 22. Rock cliff on the ridge with e.p. 1088 (NE of Rozsypok with e.p. 1128). Relic of crystalline rock (Hercynian granite with the signs of metamorphic overprint), coming from the wall of the feeding channel is preserved in the lower part of the cliff at the edge of andesite body. Relic of crystalline rock (above hammer, photo a) is intruded by andesite magma (a). The crystalline rock (scheme b) is broken down and crushed into angular fragments, which are again cemented with andesitic magma. Inner part (1) represents brecciated andesite and outer part (2) the relics of crystalline rock (b). Scheme (c) shows paleoreconstruction of original volcanic form on the surface and position of discussed outcrop: 1 – dome-like extrusive body with brecciated cover; 2 – level of paleorelief; 3 – level of present relief; 4 – position of outcrop at the edge of andesite body at its contact with surrounding crystalline rocks.

magma points probably to enlarging of the space in the higher level of feeding channel (Fig. 23b). Andesite is dark grey, fine porphyric phenocrysts of plagioclase have dimensions 1–2 mm and scare pyroxene 2–3 mm. Groundmass is fine crystalline with plagioclase and orthopyroxene.

Position of three andesite bodies on the NE slope of the Rozsypok ridge indicates their relation to the fault system of NE–SW direction, which is radial to position of the central volcanic zone.

Another two bodies are exposed on the northern slope of the Klenovský Vepor ridge and in farther distance from the central volcanic zone (Fig. 24).

12 – *Body of autometamorphosed amphibole pyroxene andesite* is exposed on the ridge of Molčanov grúň from 950 m a.s.l. up to 1005 m a.s.l. on the northern slope of the Klenovský Vepor ridge. Andesite body of eliptical shape with diameters 200 x 300 m and orientation from N to S is exposed in a small abandoned quarry. Andesite of dark grey to greenesh colour is fine to medium porphyric with phenocrysts of plagioclase, pyroxene (1–2 mm) and amphibole (2–3 mm). Andesite disintegrates into the form of irregular blocks.

13 – *Body of amphibole-pyroxene andesite* in higher position on the ridge of Molčanov grúň on the northern slope of the Klenovský Vepor ridge was identified from scattered fragments and blocks at the level 1023 m a.s.l. Dimensions of body from scattered fragments and blocks is supposed to be about 75 x 50 m. Andesite rock of the dark grey colour is medium to coarse porphyric with plagioclase, pyroxene (1–2 mm) and amphibole (3–4 mm). Andesite body was broken into irregular blocks.

NW sector of the stratovolcano

14 – *Extrusive body Pálenica of amphibole andesite with garnet* (Fig. 25) occurs about 2 km to NW of central intrusive complex of Magnetový vrch Hill. Relativelly great extent of extrusive body and/or complex of extrusive bodies with irregular to roughly elliptic shape and diameters 1 050 x 750 m occupies area of the summit with e.p. 869 (east of the Čertova dolina valley) and both slopes of Pálenica valley. Extrusive body is in contact with Hercynian granite at its southern and eastern edge and with Mesozoic rocks of the Kučelah massif along the northern edge (Suchá valley).

Inner structure of the extrusive complex can be observed in walls of abandoned quarry at bottom of the western slope near Furmanec brook (Fig. 26a, b). Andesite body exposed in the right side of the quarry walls shows fan-like fluidality planes passing from the subhorizontal orientation to steeper one in central part of the quarry. Younger andesite body (with steep subvertical fluidality planes) penetrates through the older extrusive body on the left side of the quarry walls (Fig. 26a, b). Andesite rock is coarse porhyric with phenocrysts of plagioclase (1–2 mm) and amphibole (3–4 mm). Rare garnet grains reach from 8 to 10 mm in size. Rock disintegrates into blocks and plates, using the primary fluidality planes. The rock is autometamorphosed, amphibole is opacitized, groundmass is strongly silicified and K-metasomatized (secondary K-feldspar).

Geomagnetic profile PF-V (Fig. 27), long 1 150 m of orientation W–E begins in the Hercynian granite east of the extrusive complex of the delta T value bellow 48 000. With transition into extrusive complex the values gradually increase and maximum about 49 600 is reached in the summit with 860 e.p. Average values of delta T about 49 200 continue after moderate declain and in the western part of geomagnetic profile the value of delta T rise again to 49 600. Near western edge of extrusive complex a gradual decrease of delta T values was observed. Transition of geomagnetic profile into Mesozoic rock is indicated with the decline of delta T to 48 500.

Inner structure of the extrusive complex on the base of geomagnetic profile is evidently heterogeneous, composed probably of numerous extrusive bodies with several zones of brecciation. Zone of autoclastic brecciation was also observed at the northern edge of extrusive complex.

15 – *Predná Priehybina intrusive-extrusive complex of quartz amphibole biotite dacite* occupies area with the hill Predná Priehybina 868 e.p. and western slopes of Chmeluška, SW of Michalová village in distance of about

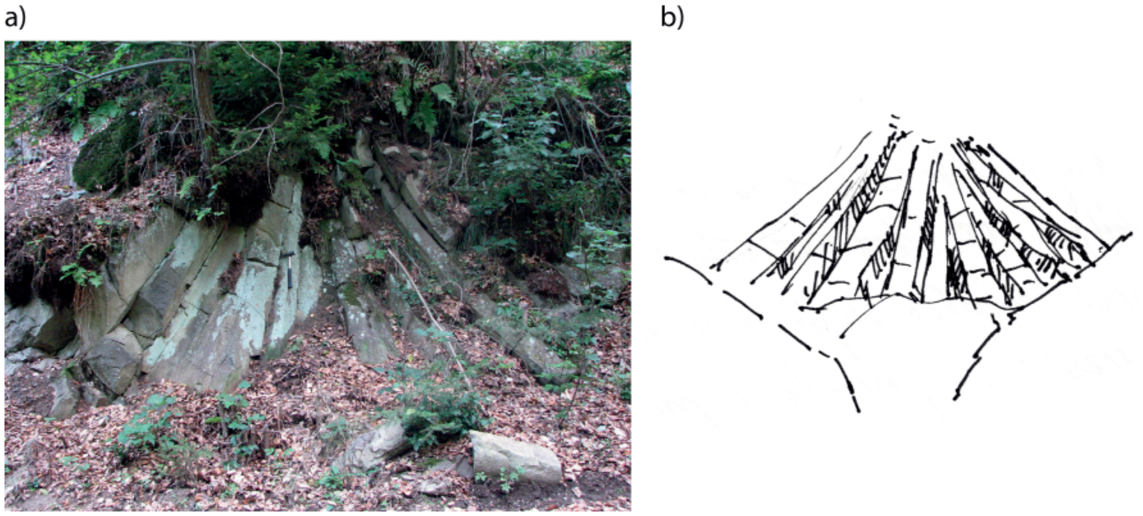


Fig. 23. Neck of pyroxene andesite is exposed on the ridge bellow e.p. 1088 at level 1025 m a.s.l. along forest road. Columnar jointing with fan-like orientation (photo a) points on enlarging of space in higher level of feeding channel (scheme b).

10 km to NW from the central intrusive complex Magnetový vrch Hill (Fig. 28). Relativelly extensive complex irregular in shape with dimensions 1 250 x 800 m is trending NE–SW. Intrusive-extrusive rocks in this complex are variably altered - the chloritization, local argillization and silicification are present. Due to alterations, the dacite is coarse porphyric, dark grey and blue-greenish. During weathering the rock obtains light green colours often with brown limonitic spots. Phenocrysts consist of plagioclase (2–4 mm), amphibole (3–4 mm), biotite (3–5 mm) and garnet (3–5 mm). Amphibole is completely opacitized and replaced by chlorite and Fe-oxides. Biotite and garnet are fresh and untouched by alterations. Groundmass is microlithic with plagioclase, quartz and mafic minerals. It is altered, chloritized and silicified.

Transition from massive andesite to zone of autoclastic brecciation was observed at the eastern edge of intrusive-extrusive complex along forest road (Fig. 29). Autoclastic breccia consists dominantly of angular fragments and blocks cemented with detritic matrix. Near the edge of this complex, the autoclastic breccia passes into epiclastic volcanic breccia, alternating with interbeds of epiclastic volcanic sandstones.

Geomagnetic profiles PF-IIa, PF-IIb and PF-IV were realized for detection of extent and inner structure of the intrusive-extrusive complex (Fig. 30).

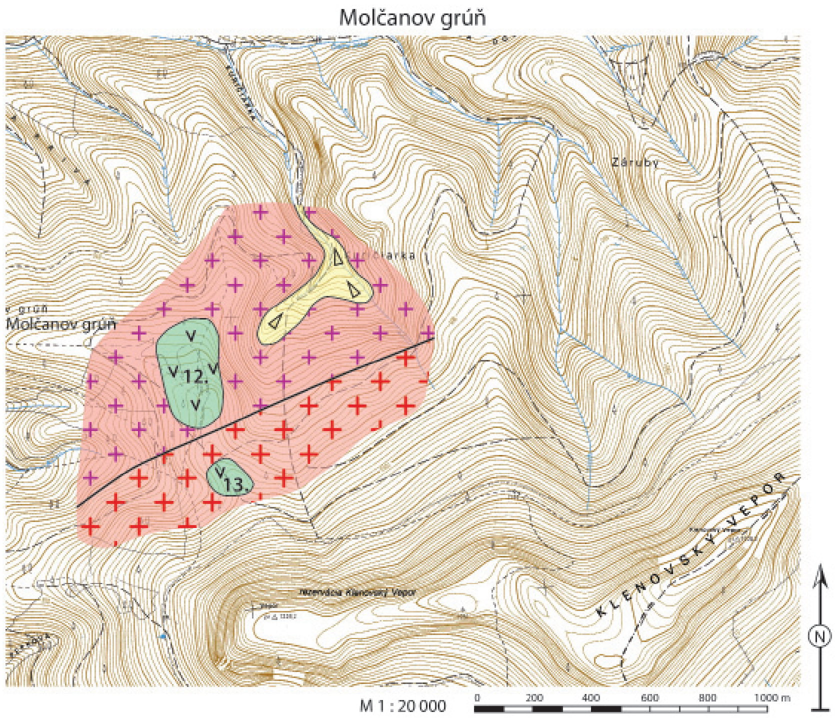


Fig. 24. Bodies of amphibole pyroxene andesite (Nos. 12 and 13) on the ridge of Molčanov grúň on N slope of Klenovský Vepor ridge.

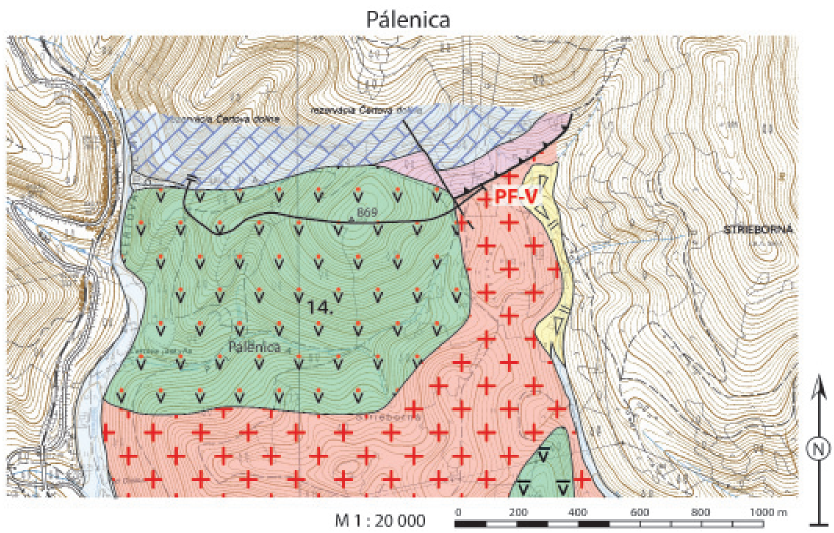


Fig. 25. Extrusive complex Pálenica (No. 14) of hypersthene-amphibole andesite with garnet with location of geomagnetic profile PF-V.

Geomagnetic profile PF-IIa (Fig. 30a), long 1 650 m, begins north of the intrusive-extrusive complex in Hercynian granite with delta T value ca 48 800. Transition into intrusive-extrusive complex is indicated with increasing value to 49 200. Following decline above 48 800 is probably caused by more intensive alteration of intrusive-extrusive rock. In the central part of the complex the delta T values raise again to 49 200. The second transition in Hercynian granite at the end of profile is marked with decline of delta T values to 48 900. Geomagnetic profile PF-IIa confirms the heterogeneous character of inner structure of the complex. Relativelly low values of delta T correspond probably to the higher degree of alterations of the intrusive-extrusive rocks.

Geomagnetic profile PF-IIb (Fig. 30c) with length 2 680 m begins in the central part of intrusive-extrusive complex and continues to its western edge. The course of geomagnetic curve is variable. Beside the delta T values from 49 000 to 49 440, there are recorded maximum values of 50 000 and 50 400 in the central part of the complex, as well as near its western edge. These maximum values probably correspond to younger low altered intrusions (resp. dykes), though they were not idenfied during mapping. Transition into Hercynian granite is accompanied with the decline of delta T to 48 800. Tectonic zone, identified during geological mapping as a zone of rock crushing at the contact of granitic rocks and crystalline sheets (Fig. 28), is indicated by the decline of delta T values to 48 400 (Fig. 30b). The following monotonous course of geomagnetic curve with values of delta T bellow 48 800 corresponds to crystalline sheets of Veporic unit (migmatites and orthogneisses). Local increasing of delta T to 43 910 corresponds to conglomerate bed with material of andesitic rocks. Increase of delta T values to 48 880 in further continuation of geomagnetic profile in the crystalline rocks can be

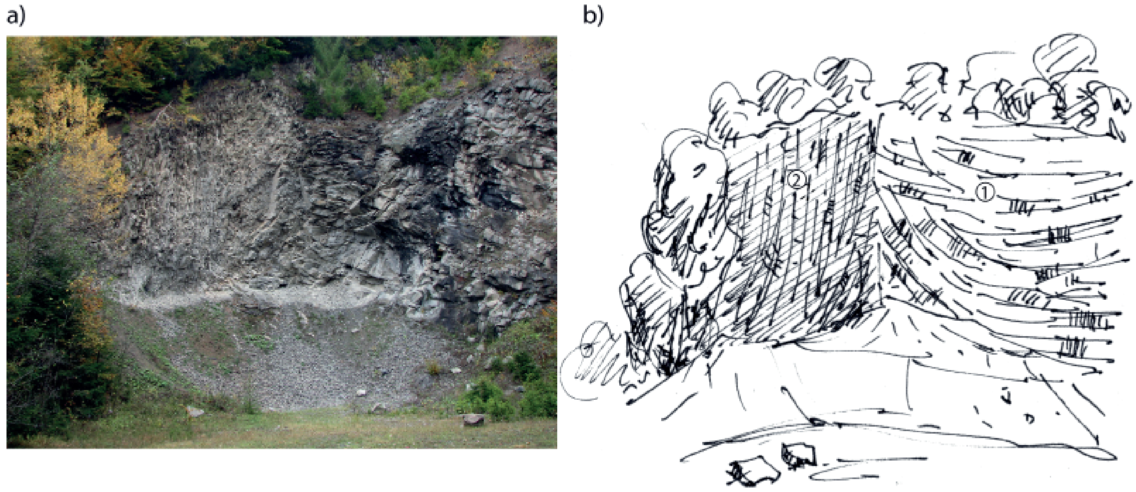


Fig. 26. Inner structure of extrusive complex Pálenica exposed in the quarry on western slope of the Pálenica valley. On the right side of the quarry wall there is andesite with fan-like structure of fluidality planes, photo (a) and scheme (b/1). In the left side of the quarry wall a steep inclination of fluidality plane indicates ascending (intrusion) of younger extrusive body, photo (a) and scheme (b/2).

Geomagnetic method was used for detection of the extent of extrusive complex (profile PF-V, Fig. 27).

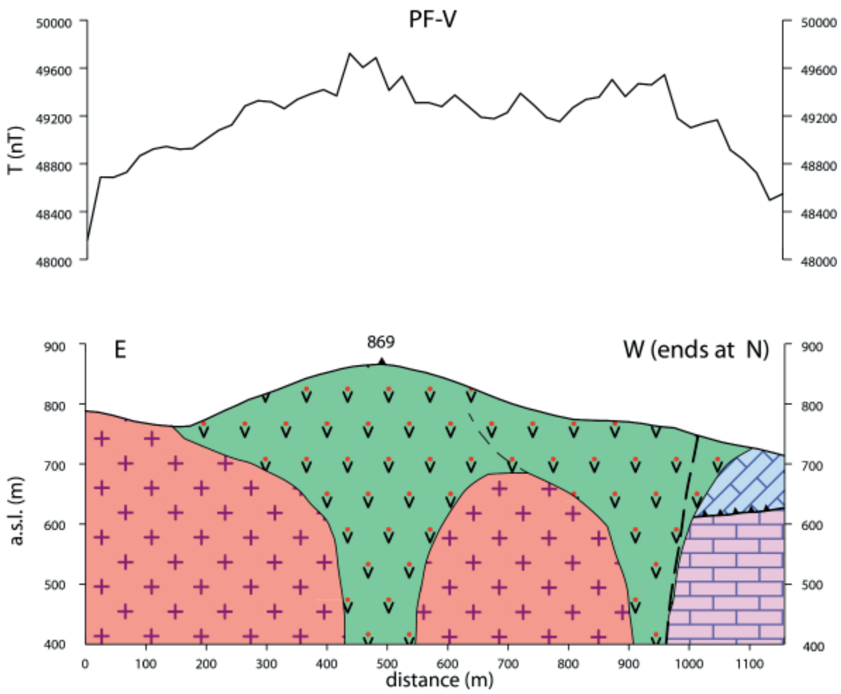


Fig. 27. Geomagnetic profile through the Pálenica body of hypersthene amphibole andesite with garnet: profile PF-V.

explained by presence of volcanic body in a form of a dyke (it was not identified during mapping).

Geomagnetic profile PF-IV (Fig. 30b), long 1 100 m, begins in the central part of intrusive-extrusive complex at the level 700 m a.s.l. and continues northward where it finishes in the Hercynian granite. The course of geomagnetic curve is variable with the values above 48 800. Increasing of delta T above 49 600 near to northern edge of intrusive complex can indicate a lower degree of hydrothermal alteration of rock and/or the presence of younger intrusive body. Transition into granitic rock corresponds to decline of delta T bellow 48 800.

Geomagnetic profiles PF-IIa, PF-IIb and PF-IV revealed heterogeneous structure of intrusive-extrusive complex Predná Priehybina which probably consists of a number of intrusive and extrusive bodies with variable degree of autometamorphic and local hydrothermal alterations. Zones of autoclastic brecciation at the eastern edge of the complex with transition into epiclastic deposits indicate the presence of extrusive bodies of the dome-like type. Bodies of andesite to diorite porphyry are deeply eroded up to subsurface levels.

Several bodies of autometamorphed amphibole pyroxene andesite porphyry are identified by geological mapping using geomagnetic methods north of Michalová-Pohronská Polhora villages (Fig. 31).

16 – *Strúhanka intrusive body of autometamorphosed amphibole-pyroxene andesite porphyry* occurs about 1 km north of the Michalová village. Intrusive body large 300 x 200 is situated within crystalline rocks of the Veporic unit (migmatitized and diaftorized paragneisses). Extent of body was identified in the field, covered with thick

Fig. 29. Scheme showing transition from massive andesite of extrusive body (1) into zone of autoclastic brecciation (2) and zone of epiclastic volcanic breccias (3) in outcrop along forest road at eastern edge of intrusive-extrusive complex. Epiclastic volcanic breccias alternate with epiclastic volcanic sandstones deposited with inclination about 10–20° to SE.

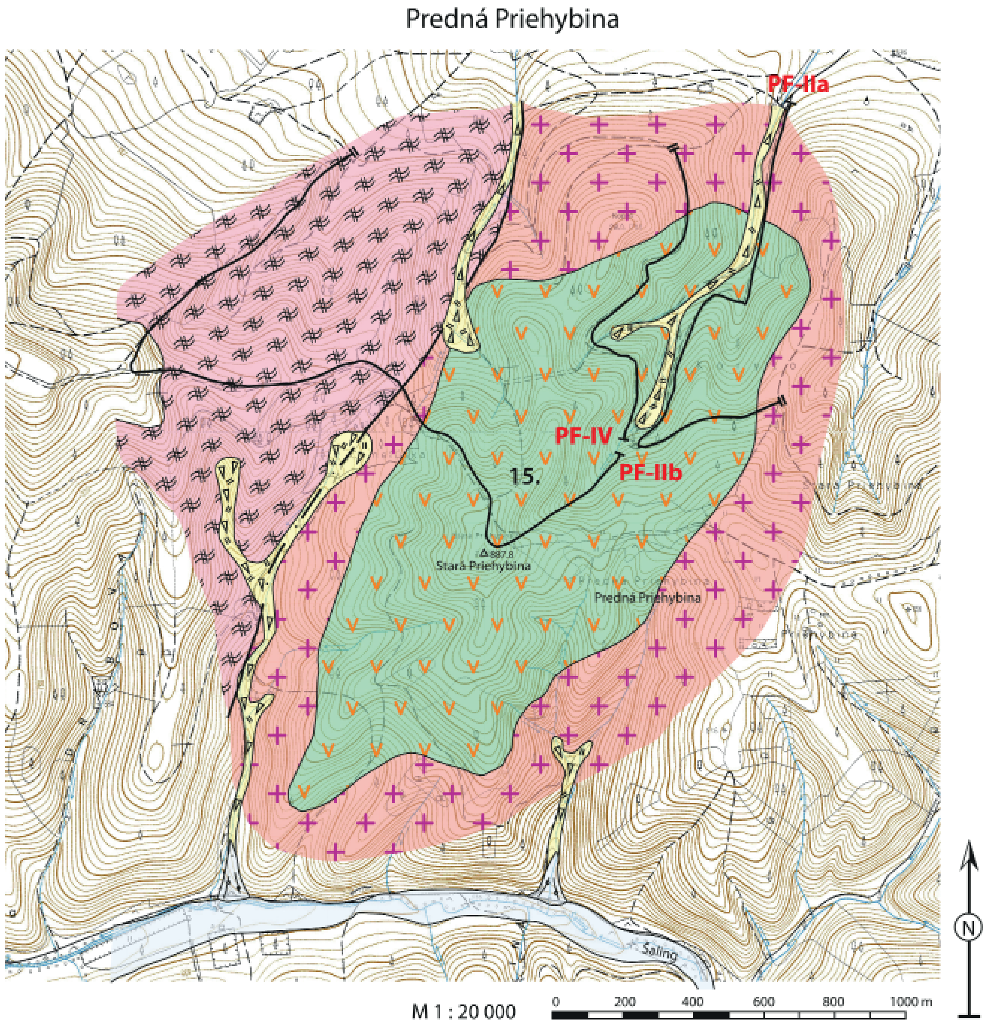


Fig. 28. Intrusive-extrusive complex Predná Priehybina with situation of geomagnetic profiles PF-IIa, PF-IIb and PF-IV.

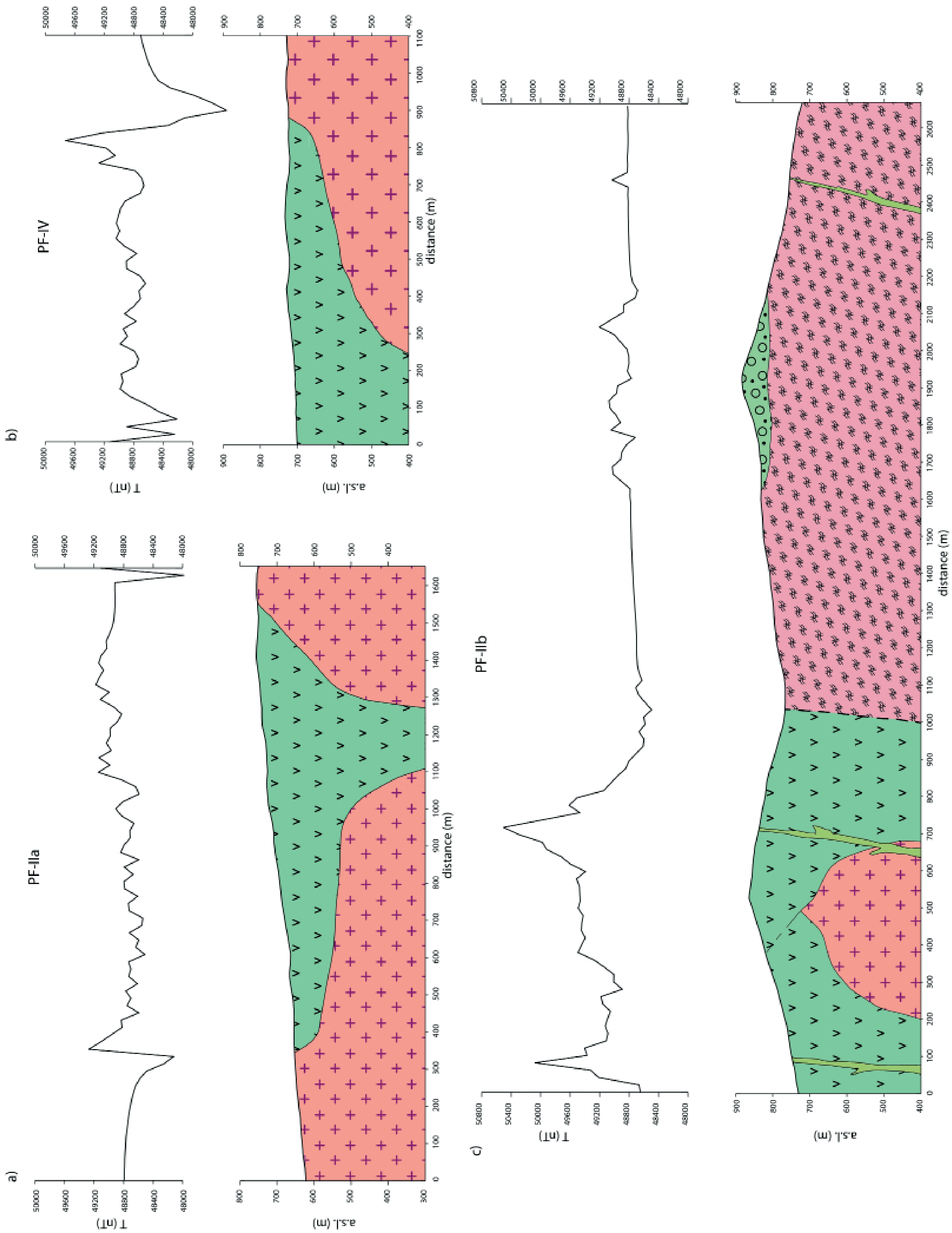


Fig. 30. Geomagnetic profiles PF-IIa, PF-IIb and PF-IV across the Predná Priehybina intrusive-extrusive complex.

Quaternary sediments, by mapping of rock fragments in the debris and also applying the geomagnetic method (profiles PF-16, PF-17). Rock is medium porphyric, greenish (autometamorphosed), with phenocrysts of plagioclase and pyroxene (1–2 mm) and amphibole (2–3 mm).

Geomagnetic profile PF-16 (Fig. 32a), long 650 m, begins within intrusive body near its eastern edge and continues northward. Presence of intrusive body is indicated only by moderate increasing of delta T values to 49 200. With transition into crystalline rock this value declines bellow 49 000.

Geomagnetic profile PF-17 (Fig. 32b) with length of 1 050 m begins north of intrusive body in crystalline rocks at altitude 760 a.s.l. and continues to south. Value of delta T in crystalline rock is about 49 000. Transition into the edge of intrusion is indicated with moderate increase of delta T above 49 200.

From the results of geomagnetic profiles there can be assumed the laccolith and/or sill-like morphology of the Strúhanka intrusive body.

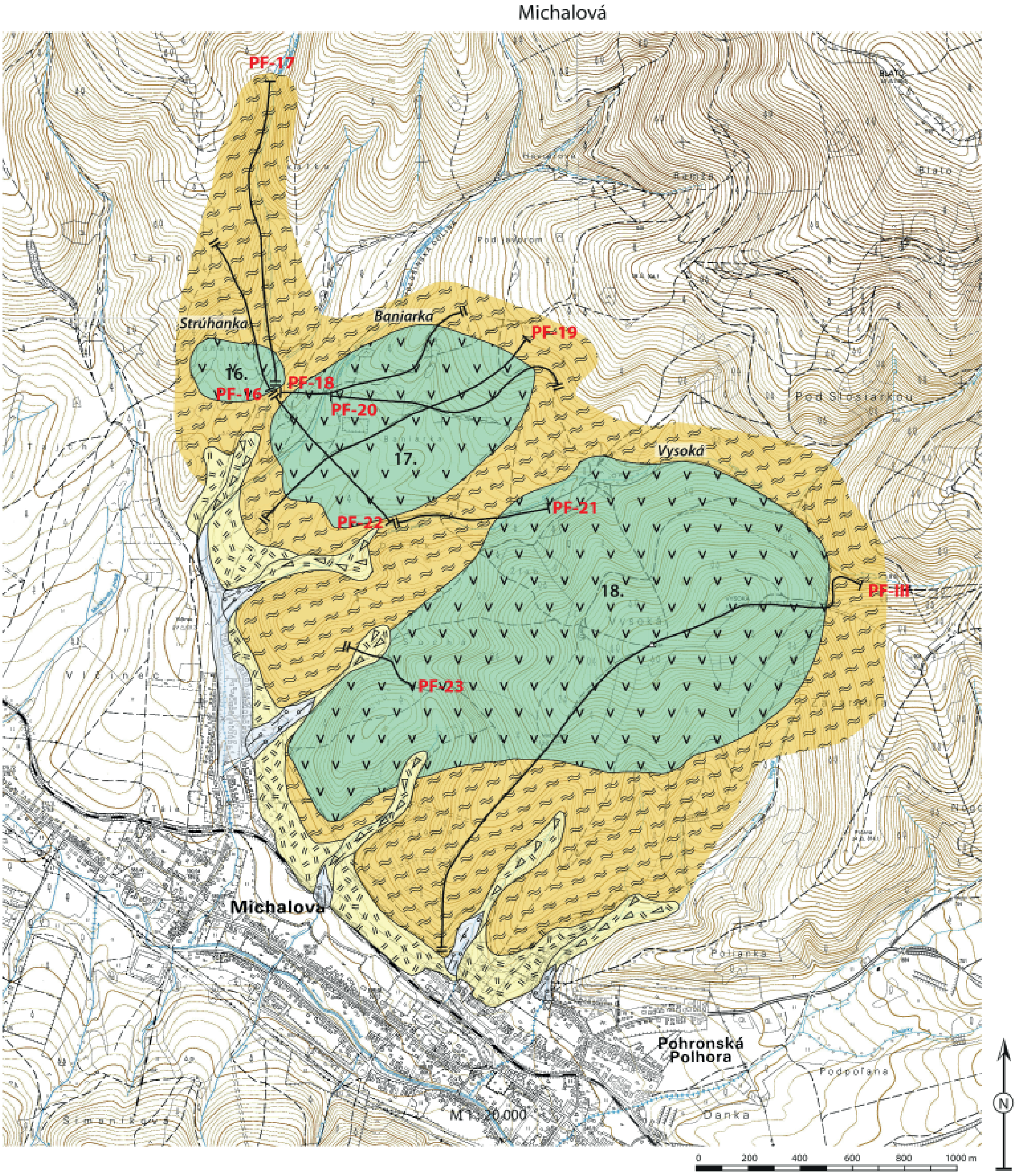


Fig. 31. Intrusive bodies of autometamorphosed amphibole pyroxene andesite porphyry, exposed north of the Michalová village: the Strúhanka body (16), Baniarka body (17) and Vysoká body (18) with location of geomagnetic profiles.

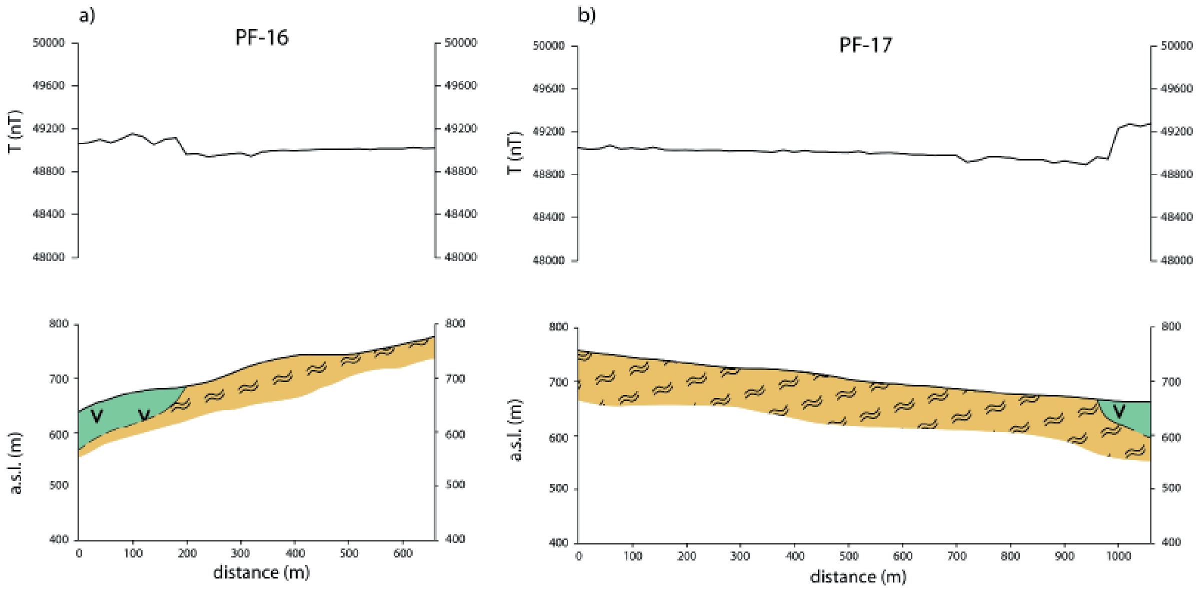


Fig. 32. Geomagnetic profiles PF-16 and PF-15 (a, b) investigating the Strúhanka intrusive body (16).

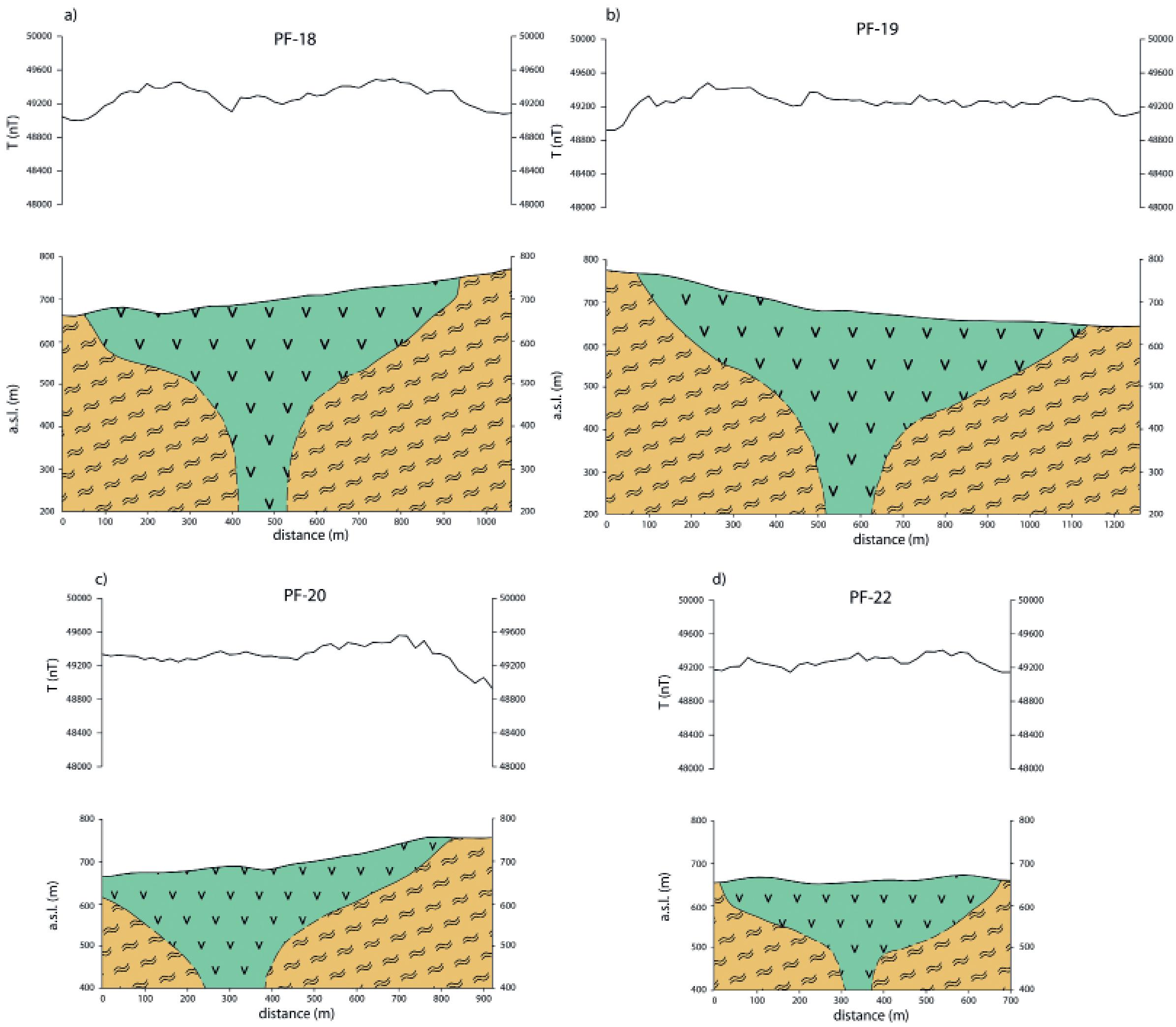


Fig. 33. Geomagnetic profiles PF-18, PF-19, PF-20 and PF-22 (a, b, c, d) investigating the Baniarka intrusive body (17).

17 – *Baniarka intrusive body of autometamorphosed amphibole-pyroxene andesite porphyry*. Intrusive body north of Michalová village on western slope of the Baniarka Hill is elliptical in shape with dimensions 1 050 x 650 m and orientation of NE–SW direction (Fig. 31). Both bodies Baniarka and Strúhanka are covered with thick Quaternary deposit. Extent of the body was determined by mapping of fragments in the rock debris and also with the use of geomagnetic profiles PF-18, PF-19, PF-20 and PF-22 (Fig. 33).

Intrusive body Baniarka is formed by medium porphyric amphibole pyroxene andesite porphyry with phenocrysts of plagioclase and pyroxene (1–2 mm), as well as amphibole (2–3 mm). Intrusive rock is altered, chloritized with greenish colour, during rock weathering changing to the light green colour.

Geomagnetic profile PF-18 (Fig. 33a) was realized in the north-western part of intrusive body trending NE–SW. Profile PF-18, having length 1 050 m, begins in crystalline rocks with the delta T value ca 49 000. Passing through the intrusive body the values vary between 49 200 and 49 500, but they decline again in crystalline rock to 49 100.

Geomagnetic profile PF-19 (Fig. 33b), long 1025 m, begins at altitude 780 m a.s.l. NE of intrusive body and continues to SW through the central part of intrusion. Profile PF-19 starts in crystalline rocks with the delta T value ca 48 900. During transition of profile in intrusive body the values increase to maximum value about 49 500. After transition to the area of crystalline rocks they decline to 49 100.

Geomagnetic profile PF-20 (Fig. 33c), long 920 m, is oriented across intrusive body from W to E and to NE. Profile PF-20 near the western edge of intrusive complex begins in altitude 670 m a.s.l. with delta T about 49 300. During transition through the intrusive complex the values vary between 49 300 to 49 600 and in crystalline rocks they decline to 48 900.

Geomagnetic profile 22 (Fig. 33d) with length 600 m is oriented across intrusive body in its southwestern part. This profile begins near the southern edge of intrusive complex with the delta T value 49 200. During transition through intrusive complex the values vary and reach the maximum of 49 400. At the end of geomagnetic profile the value of delta T decline bellow 49 200.

The results obtained from geomagnetic methods realized in the Baniarka intrusive body are pointing on laccolith and/or sill type as a most probable form of intrusive body. Moderate increasing of the values of delta T at the edges of intrusive body correponds to lower thickness of intrusive body at its margins. Intrusive body was probably emplaced in a relativelly shallov level bellow overlying rocks in a form of thin laccolith eventually like a sill.

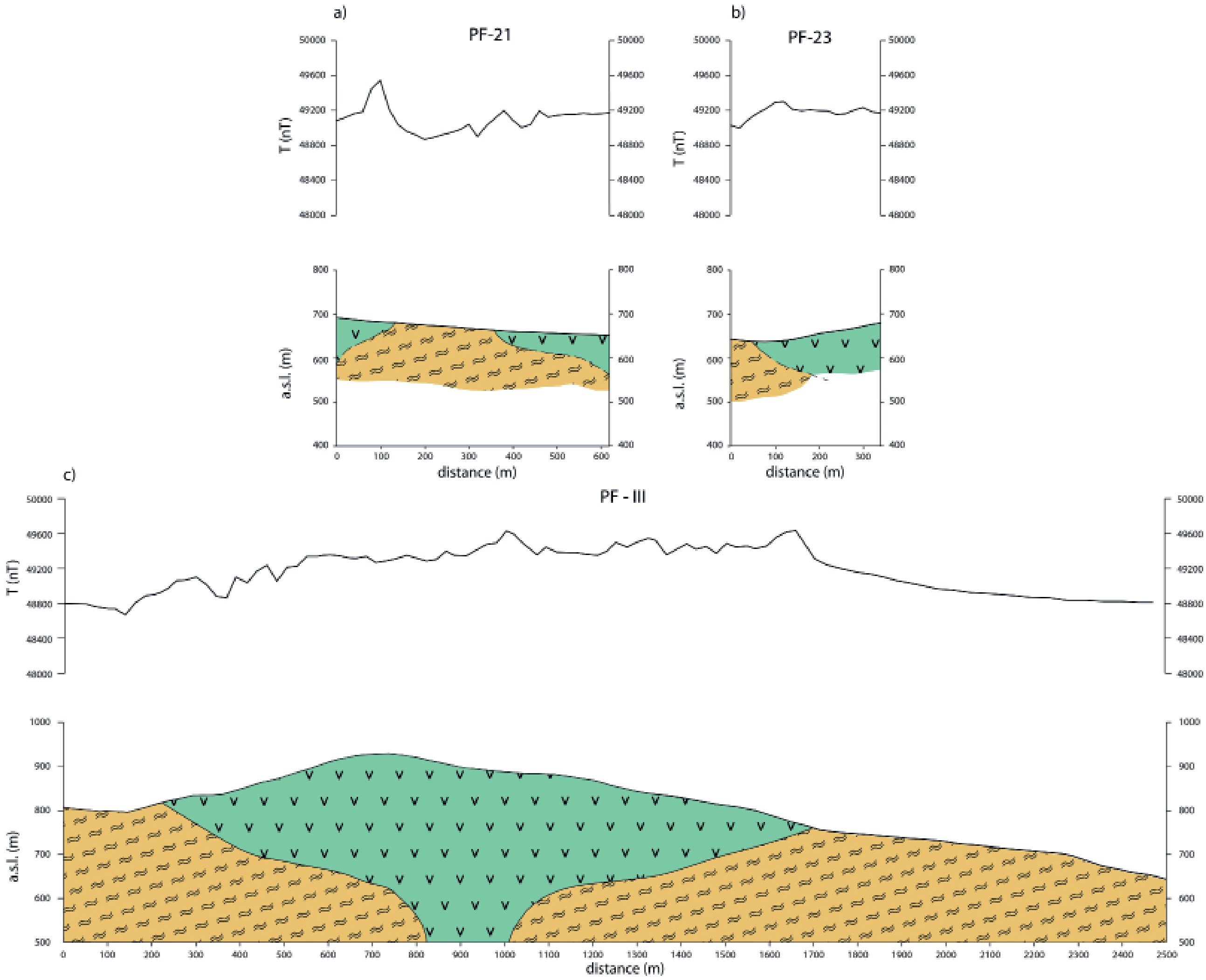


Fig. 34. Geomagnetic profiles PF-21, PF-23 and PF-III through the Vysoká intrusive-extrusive complex (18).

18 – *Vysoká intrusive-extrusive complex of pyroxene-amphibole andesite* forms the Vysoká Hill (e.p. 926) and ridge NE of the Michalová village (Fig. 31). Complex of elliptical shape with dimensions 2 200 x 1 000 m is elongated in NE–SW direction. Andesite rock is dark grey (locally of greenesh colour), coarse porphyric with phenocrysts of plagioclase (2–3 mm), pyroxene (1–2 mm) and amphibole (up to 5–6 mm). Andesite shows a signs of low autometamorphic alteration (chloritization, silicification). Geomagnetic profiles PF-21, PF-23 and PF-III (Fig. 34, b, c) were conducted for the detection of extent of this intrusive complex and its inner structure.

Geomagnetic profile PF-21 (Fig. 34a) at the northern edge of intrusive-extrusive complex with length 600 m begins at level 700 m a.s.l. in intrusive body. The presence of intrusive-extrusive body is indicated by the delta T value 49 600. This value in the course of profile with transition into crystalline rocks declines to 48 900. Transition to marginal parts of the Baniarka body is indicated again by moderate increasing of delta T to 49 200 at the end profile.

Geomagnetic profile PF-23 (Fig. 34b) with length 330 m at the northwestern side of intrusive-extrusive complex begins at altitude 650 m a.s.l. in crystalline rocks with delta T about 49 100. Transition in intrusive complex is marked with moderate increasing of delta T to 49 300.

Geomagnetic profile PF-III (Fig. 34c) with length 2 500 m begins at eastern edge of intrusive-extrusive complex in crystalline rocks with the delta T values ca 48 800. These values gradually increase and reach the maximum 49 600 on the summit area with e.p. 926. Variable values of delta T about 49 500 are reached in continuation of geomagnetic profile in extrusive body to SW. Maximum delta T values about 49 600 are reached near southern edge of extrusive body. They decline again to 48 800 after transition into surrounding crystalline rocks.

Geomagnetic record of the profile PF-III revealed inhomogeneous inner structure of the intrusive-extrusive complex that probably corresponds to presence of several intrusive-extrusive bodies, resp. the complex of extrusive domes which are exposed by denudation in their shallow subvolcanic level.

19 – *Gracihôrka intrusive body of amphibole-pyroxene andesite porphyry* (Fig. 35) on the southern slope of the ridge Gracihôrka east of Pohronska Polhora village is elliptical in shape with dimensions of about 300 x 200 m and elongation in W–E direction. Surrounding rocks are crystalline schists of Veporic unit. Intrusive body is exposed in a small abandoned quarry on the southern slope of the Gracihôrka ridge, long about 50 m. Andesite porphyry is autometamorphosed (chloritized), with dark grey to grey-green colour, the rock due weathering obtains light green colours. Rock is fine to medium porphyric with phenocrysts of plagioclase, pyroxene (1–2 mm) and amphibole (2–3 mm). Geomagnetic survey was not conducted.

NE sector of the stratovolcano

20 – *The Nižná Fabová intrusive body of amphibole-pyroxene andesite porphyry* (Fig. 36) is situated on the eastern slope of the ridge with 1148 e.p. (east of the Fabova hoľa e.p. 1438.8) at a distance about 6.5 km to the north from the central intrusive complex Magnetový vrch Hill. Intrusive body with dimensions 200 x 100 m is oriented W–E in direction of the ridge. Andesite porphyry is exposed in a small abandoned quarry. Intrusive rock, dark-grey in colour, is fine to medium porphyric with phenocrysts of plagioclase and pyroxene (0.1–1 mm) and needles of amphibole up to (3–4 mm). Geomagnetic methods were applied for the detection of intrusive body dimensions (Fig. 37a, b).

Geomagnetic profile PF-VIa (Fig. 37a) crosses the intrusive body from the east to north. Profile with length 1500 m begins at altitude 1050 m a.s.l. in crystalline rocks (hybrid complex of Hercynian granitic rocks) with delta T value above 48 800. With the transition through intrusive body, the values of delta T increase to 49 100.

Geomagnetic profile VIb (Fig. 37b), crossing intrusive body from NE to SW near its southern margins, begins at altitude 1100 m a.s.l. in crystalline rocks with delta T 48 000. During transition through intrusive body this value increased above 49 600. The second maximum with delta T 49 300 probably indicates the presence of small intrusive body like a dyke (that was not identified on the surfice).

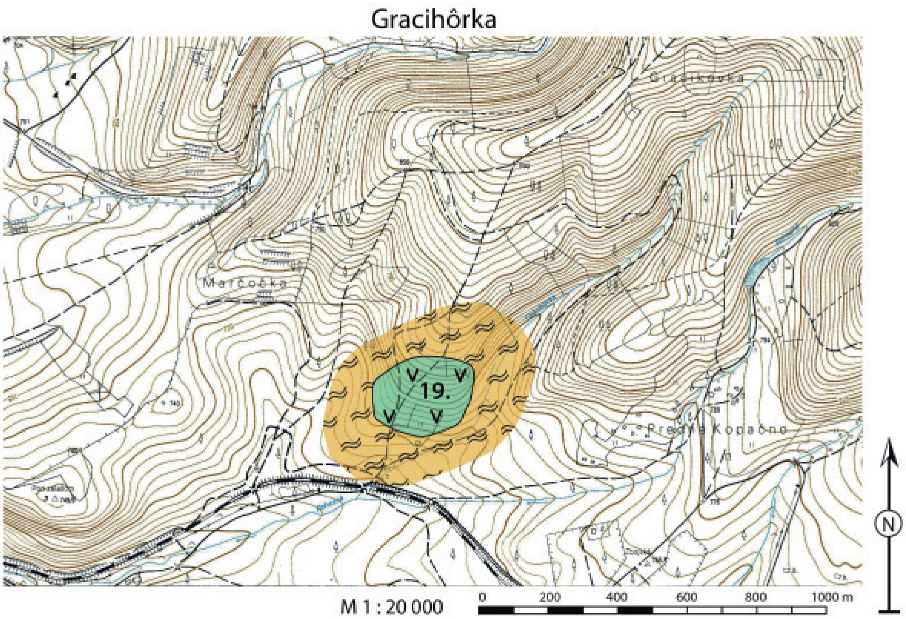


Fig. 35. Gracihôrka intrusive body of amphibole pyroxene andesite porphyry to east of the Pohronská Polhora village (19).

Geomagnetic survey and geological position points on body of probable feeding system (neck), exposed by denudation in a deeper subvolcanic level.

21 – *The Stožka pyroclastic volcano* with central neck is situated in the area of the Stožka (Kľak) summit (e.p. 1048) east of the Fabova hoľa (e.p. 1439) at a distance about 9 km to NE of the central intrusive complex Magnetový vrch Hill (Fig. 38). Stožka volcano represents a remnant of small pyroclastic cone with central lava neck, which developed on the surface of Triassic carbonate sediments. In small outcrop with the length about 5 m and height 3–4 m on the western slope of the hill with e.p. 1048, there is exposed a structure of pyroclastic cone (Fig. 39a, b). Lapilli and scoria are agglutinated with volcanic bombs and blocks (with diameter up to 30–50 cm), forming bed with inclination about 15° to west. Pyroclastic fragments and scoria are strongly vesiculated with brown and brown-red colours and locally intensively agglutinated. Pyroclastic material, bombs and fragments form the pyroxene andesite.

Scattered andesite blocks in the area of summit with e.p. 1048 are derived from disintegrated lava neck. Andesite is medium porphyric with phenocrysts of plagioclase (2–3 cm) and pyroxene (2–3 mm). For the detection of extent of pyroclastic cone and its inner structure there were applied geomagnetic profiles PF-IX and PF-X.

Geomagnetic profile PF-IX (Fig. 40a) with length 520 m begins to NW of e.p. 1049 in Mesozoic carbonate rocks with delta T from 48 400 to 48 800. Transition of profile into area of pyroclastic rocks is indicated with gradual increasing of delta T to 49 700. Rapid increasing of this value to maximum 50 800 is in crossing of the hill summit with e.p. 1048. Values then decline

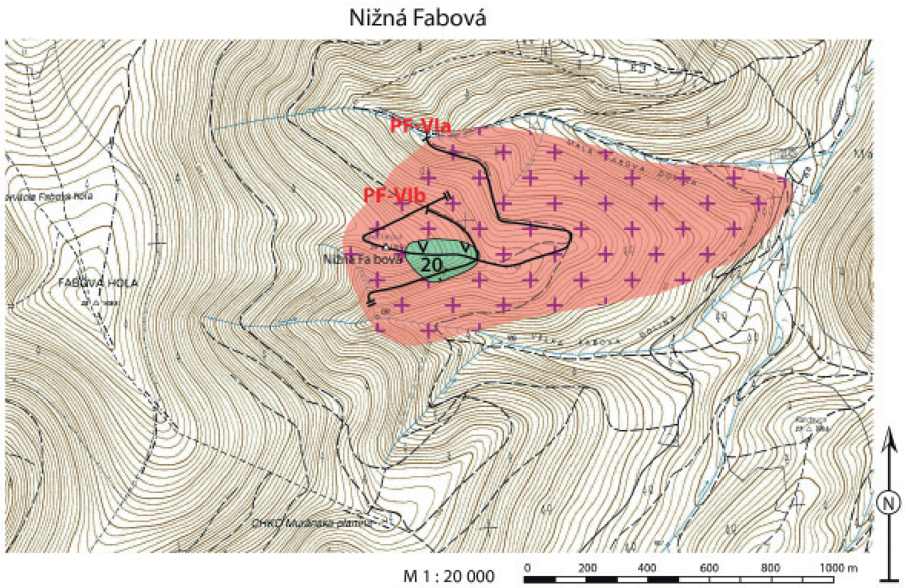


Fig. 36. Intrusive body Nižná Fabová of pyroxene amphibole andesite porhyry with location of geomagnetic profiles PF-VIa and PF-VIb.

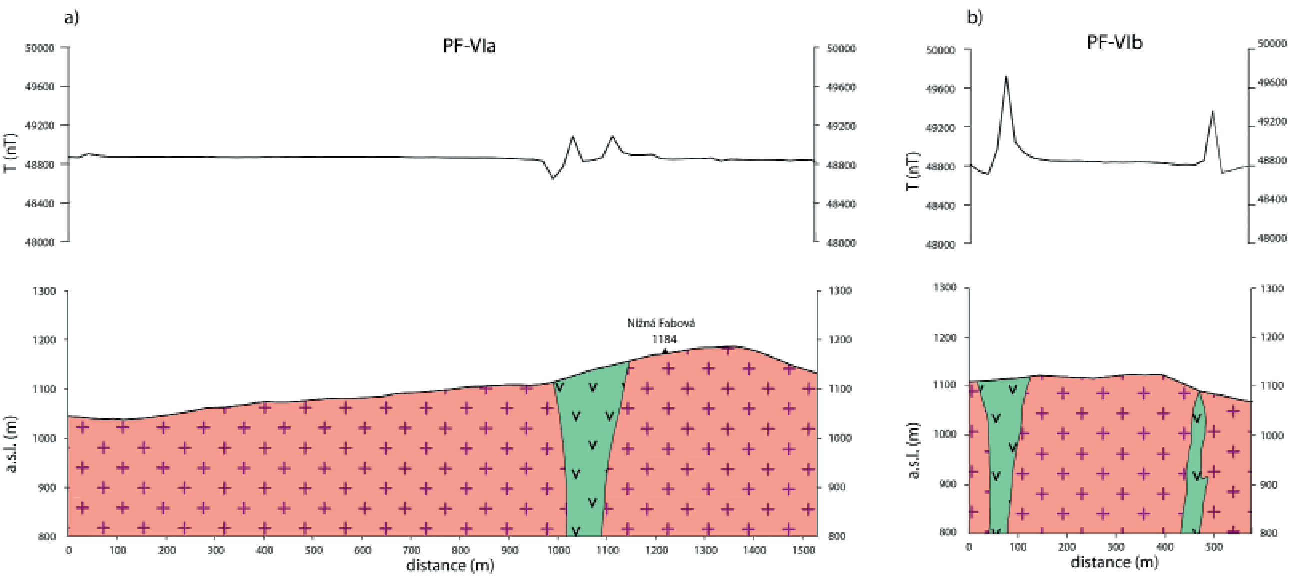


Fig. 37. Geomagnetic profiles PF-VIa and PF-VIb through the Nižná Fabová intrusive body (20).

to 48 900 in continuation of geomagnetic profile to SE, indicating relics of pyroclastic cone. Value 48 800 corresponds to transition into Mesozoic carbonates at the end of geomagnetic profile.

Geomagnetic profile PF-X (Fig. 40b) with length 400 m begins on the southern part of the hill with e.p. 1048 with a high value of delta T ca 51 200, corresponding to andesite lava neck. Profile continues to north and the decline of delta T bellow 50 000 probably indicates strongly agglutinated pyroclastic rock in the area of crater zone. Decline of the values to about 48 800 in continuation of profile to the north points to thinner relics of pyroclastic rocks. Geomagnetic profile finished in Mesozoic carbonates with values about 48 000.

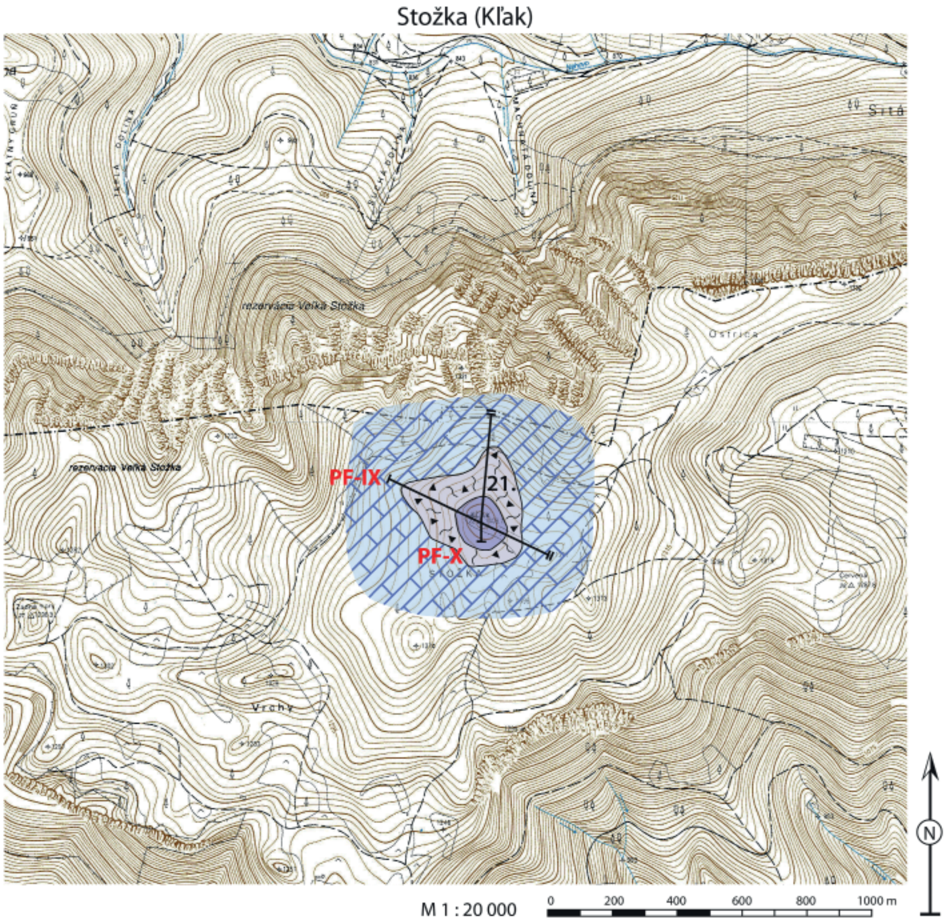


Fig. 38. Pyroclastic volcano Stožka (21) in summit area of e.p. 1048 Stožka (Kľak) east of Fabova hoľa, with location of geomagnetic profiles PF-X and PF-IX.

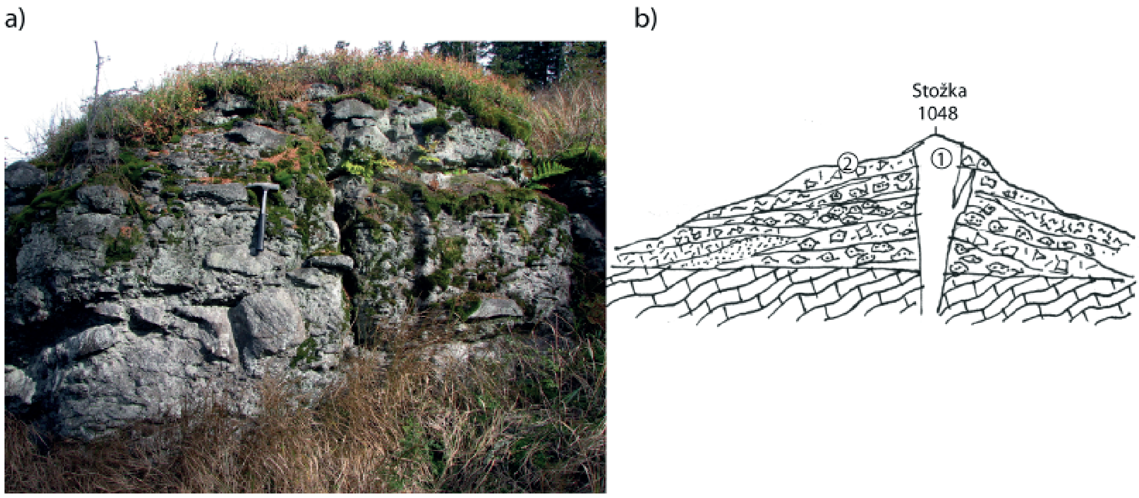


Fig. 39a, b. Pyroclastic volcano Stožka in the area of e.p. 1048. Relic of pyroclastic cone formed by layers of agglutinated scoria-lapilli tuffs and scorias alternated with layers of volcanic bombs and blocks (2). Penetration of lava neck (1) through the pyroclastic cone (2).

22 – *The Kochlovec extrusive body of rhyodacite* (Fig. 41) of elliptical shape, dimensions 1 000 x 700 m and course NE–SW occupies the Kochlovec Hill with e.p. 825 m south of the Závadka village. The Kochlovec rhyodacite body is distant about 13 km northward from the central intrusive complex Magnetový vrch Hill. Rhyodacite lava has ascended to the surface in tectonic zone separating two blocks (belt of the mica schists and gneisses at the northern side and paragneisses with granite body of Carboniferous age at the southern side). Rhyodacite is exposed in a small abandoned quarry long 50 m on the western side of Kochlovec Hill (Fig. 42a). Rhyodacite is light grey, locally light greenish, massive to porous. Frequent lithophyses after gasses have subvertical orientation, parallel with the fluidal texture. Phenocrysts belong to plagioclase (1 mm), and rare biotite (to 2 mm). Rhyodacite disintegrates into irregular blocks and platy fragments. Geomagnetic profile PF-VIII has detected the extent of rhyodacite body.

Geomagnetic profile VIII (Fig. 43) with length 1 300 m begins south of the rhyodacite body in altitude 890 m a.s.l. in crystalline rocks (hybrid complex) with delta T values bellow 48 900. With transition into ryodacite the values moderatelly increase, whereas the maximum 49 300 is reached in the central part of ryodacite body. The delta T values gradually decline in the northward continuation of the profile and the value 48 800 documents the transition into the crystalline basement.

On the base of geomagnetic profile PF-VIII and results of geological mapping, the rhyodacite body is interpreted as an extrusive dome-like body (Fig. 42b), recently being exposed in its deeper levels due to denudation.

23 – *Za Kýčerou extrusive body of rhyodacite*, located NE of Kochlovec, represents a roughly elliptical extrusive

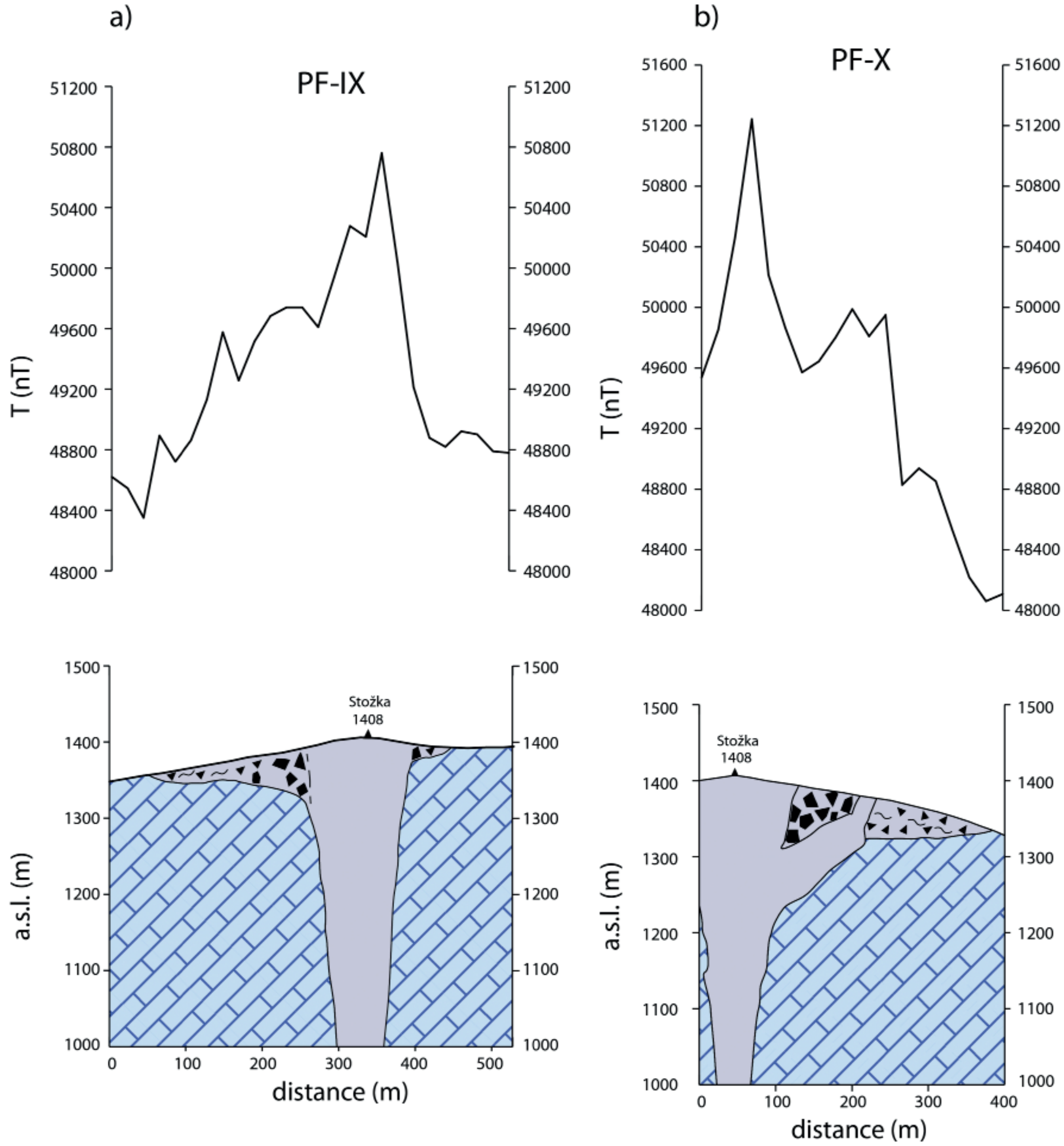


Fig. 40a, b. Geomagnetic profiles PF-IX and PF-X of the Stožka pyroclastic volcano (21).

body of smaller dimensions 300 x 200 m, trending NE–SW. It is exposed in rock cliff on the eastern side of the hill with e.p. 722. Central part of the rhyodacite body is situated in the tectonic zone, similarly as the Kochlovec body. Rhyodacite is light grey to white, porous, with phenocrysts of plagioclase (1 mm) and biotite (2–3 mm).

Fillings of paleovalleys on western slope of Vepor stratovolcano, structure and lithology

Relics of original fillings of paleovalleys were preserved after massive denudation of the volcanic structure of Vepor stratovolcano in more distal parts of peripheral volcanic zone. Paleovalleys served during volcanic activity for transport of volcaniclastic material from the western slopes of stratovolcano (transitional zone) into proluvial plain at the base of stratovolcano, where it was deposited and formed facies of the peripheral (distal) volcanic zone. Relics of original fillings of paleovalleys represent important material for the study of volcanic processes during volcanic activity and also for the paleovolcanic reconstruction of the evolutionary stages of the Vepor stratovolcano.

Only scarse relics of original fillings of paleovalleys can be found on the western side of stratovolcano in the area of transition from stratovolcano slope to peripheral (distal) volcanic zone. Relativelly larger amount of volcaniclastic rocks in the filling of paleovalleys is preserved south of stratovolcano on the southern slopes of the Slovenské

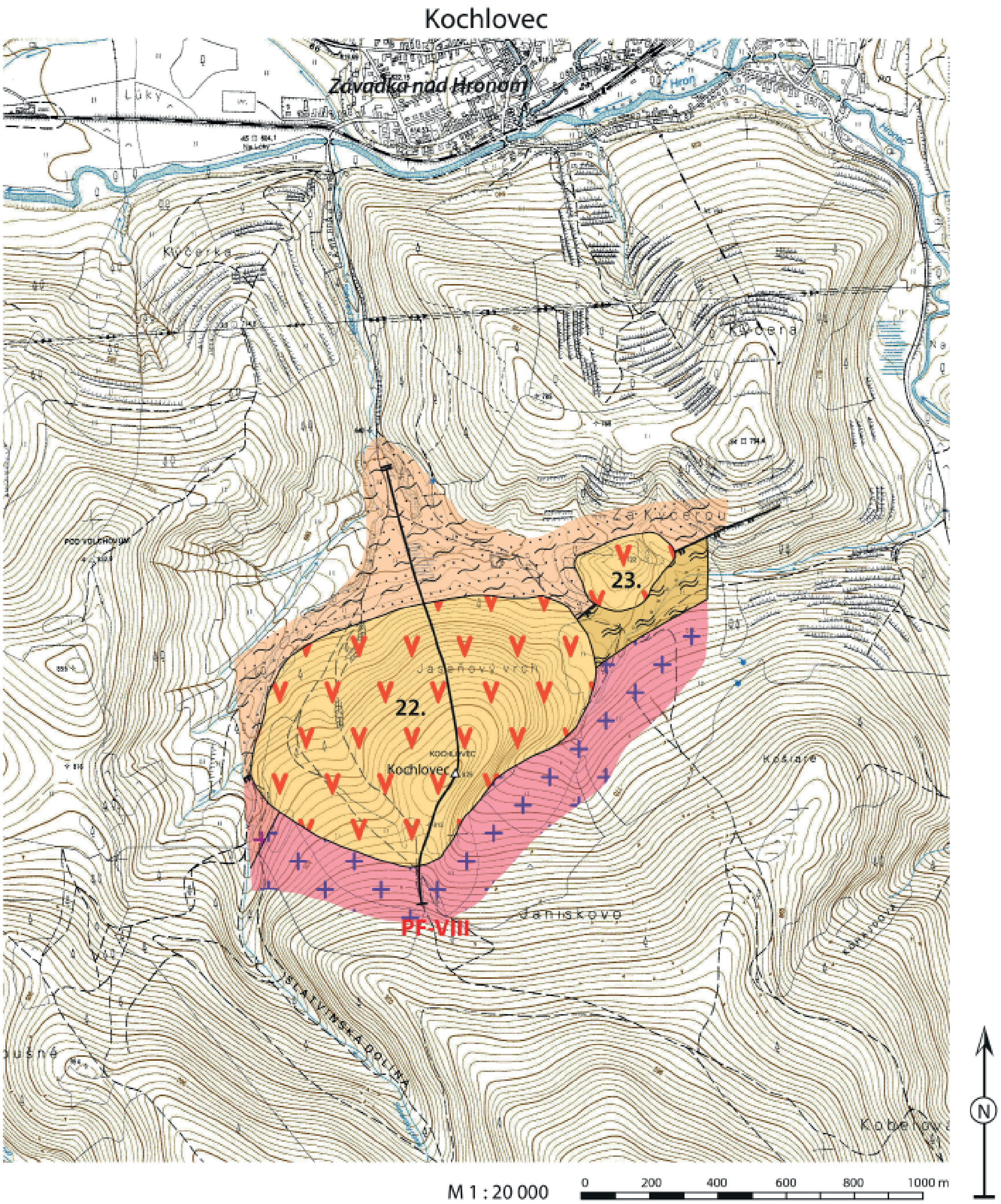


Fig. 41. Extrusive rhyodacite body Kochlovec (22) and rhyodacite body Za Kýčerou (23) south of the Závadka village with location of geomagnetic profile PF-VIII.

rudohorie Mts. Paleovalleys on the southern slope of stratovolcano communicated with the sedimentary basin, where the volcaniclastic material was deposited in a large scale at the northern margins of the Rimavská kotlina Basin, corresponding to the Pokoradza Formation. Original filling of paleovalleys is not preserved north of the central volcanic zone due to the deeper denudation cut.

Relics of four paleovalleys fillings were identified in the area of transition from the stratovolcanic slope to western part of peripheral volcanic zone (distal zone). Relics of filling of these

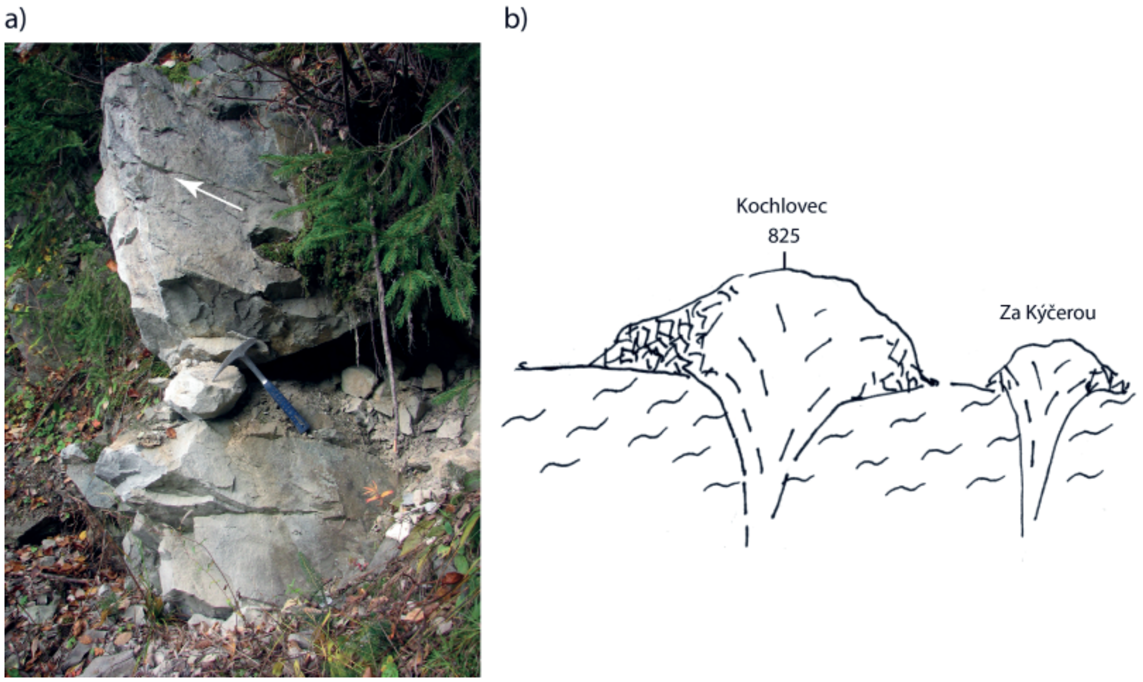


Fig. 42. Abandoned quarry in rhyodacite body Kochlovec (a). Rhyodacite rock is light grey, massive, locally porous with irregular blocky jointing. Fluidality planes (above hammer) are inclined about 25° to east. Supposed original form of extrusive body Kochlovec and body Za Kýčerou is shown in the scheme (b). Fan-like orientation of fluidality planes and belts of autoclastic brecciation suggest dome-like extrusive form.

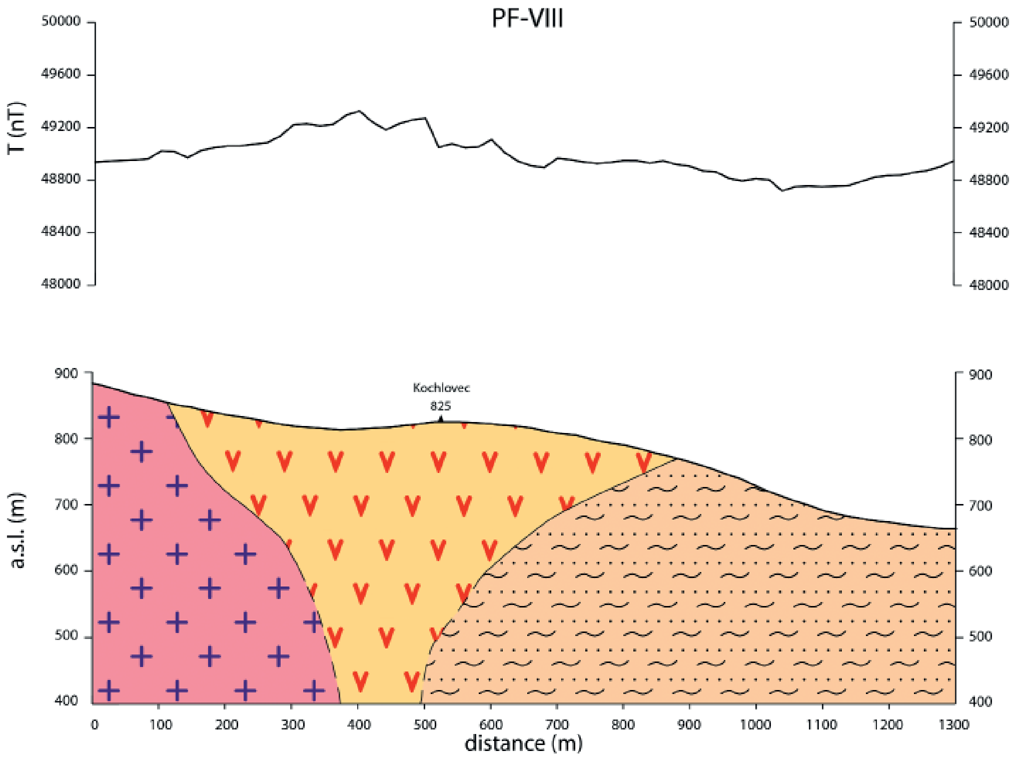


Fig. 43. Geomagnetic profile PF-VIII across rhyodacite body Kochlovec.

paleovalleys from south to north are as follows: 1 – Klenovský Vepor paleovalley, 2 – Zadná Kýčera paleovalley, 3 – Zvadie paleovalley, 4 – Hájna hora paleovalley.

The Klenovský Vepor and Zadná Kýčera paleovalleys (1, 2) directed to southwest, Zvadie paleovalley (3) probably to west and last paleovalley Hájna hora (4) with orientation to NW–SE is directed to northwest (Fig. 44). Paleovalleys are radially oriented with respect to the central volcanic zone. These represent probably only a part of original radial system of paleovaleys developed on the western stratovolcanic slope and continuing to distal parts of peripheral volcanic zone in the area of proluvial plain. The sediments of supposed proluvial plain at the western foot of stratovolcano were not preserved, being removed by erosion.

In the course of paleovalleys a gradual decline of their bottom was observed westward (paleovalleys 1, 2, 4). In the case of the Zvadie paleovalley (3), there is identified only one relic of volcaniclastic rocks on the summit of the hill with e.p. 947, so that the following continuation of paleovalley to the west cannot be evaluated. Fluvial sediments like gravels, sands and conglomerates with nonvolcanic and volcanic material deposited on the bottom of the paleovalleys filling prove that paleovalleys on the begining were used by ephemeral streams directing from the stratovolcanic slopes to west.

SW sector of the stratovolcano

24 – The Klenovský Vepor paleovalley

Relics of volcaniclastic rocks and lava flow on the top of the Klenovský Vepor ridge (e.p. 1338.2) represent the filling of the most southern situated paleovalley in the SW sector of stratovolcano. According to morphology of the lava flow building flat top of the ridge, there can be assumed that the orientation of paleovalley continuing from stratovolcanic slope to SW has changed orientation to WSW (Fig. 44). Filling of paleovalley consists of following facies:

The tuffitic sands and sandstones with pebbles of volcanic and nonvolcanic rocks with variable thickness (from several m up to 10–15 m) are exposed at the base of the filling at level 1125 m a.s.l. on the eastern side of the Klenovský Vepor ridge. Tuffitic sands, fine- to medium-grained, are incoherent and/or slightly compacted and well sorted. Coarse clastic material forms pebbles with diameter 5–10 cm and rare rounded blocks (up to 20 cm). Nonvolcanic material consists dominantly of pebbles of quartz, quartzites and crystalline rocks (granitoids and crystalline schists). Volcanic material belongs to several petrographic types: 1 – dark fine porphyric pyroxene andesite, 2 – fine to medium porphyric amphibole pyroxene andesite, 3 – coarse porphyric pyroxene-amphibole andesite with biotite, 4 – coarse porphyric amphibole-pyroxene andesite (rich in plagioclase of up to 3–4 mm in size). The presence of several petrographic types of andesites in the pebble material indicates that the erosive cut of paleovalley and its filling have occurred in advanced stages of the stratovolcano evolution, when on its structure has participated a wide spectrum of petrographic rock types of andesitic composition.

Medium to coarse epiclastic volcanic coglomerates, overlying the basal bed of tuffitic sands are exposed on the eastern side of the Klenovský Vepor mountain ridge at 1210 m a.s.l. On the western side of the mountain ridge, this bed of epiclastic volcanic conglomerates is in lower position in altitude 1066 m a.s.l. (lower about 145 m). This documents general deepening of the paleovalley to the west. Material of epiclastic volcanic conglomerates dominantly with size 10 to 20 cm (rare up to 30 cm) is well rounded and belongs to several petrographic types: 1 – strongly vesiculated fine porphyric pyroxene andesite of red colour (pyroclastic fragments), 2 – dark-black fine porphyric pyroxene andesite, 3 – medium to coarse porphyric amphibole pyroxene andesite.

The coarse to blocky epiclastic volcanic conglomerate in the higher position of paleovalley filling forms a distinct horizont on the northern slopes of mountain ridge in altitude 1086 m a.s.l. On the southern slopes this conglomerate bed is hidden under rock debris and its position cannot be exactly justified. A bed of coarse to blocky conglomerate with rounded blocks from 30 cm up to 80 cm consists dominantly of fine porphyric to aphanitic pyroxene andesite (often vesiculated). Matrix of conglomerate represents coarse-grained epiclastic volcanic sandstone.

Epiclastic volcanic breccia-conglomerates consist of angular, subangular and also rounded adesite blocks with dimensions 10–30 cm (rare up to 50 cm), sometimes with signs of sorting and coarse bedding. Matrix is coarse-grained and sandy. Facies of epiclastic breccia-conglomerate, present in a higher level of the paleovalley filling, is probably a product of debris flows (lahars), comming from stratovolcanic slope. During downward movement an angular material was mixed with rounded material of fluvial sediments previously deposited on the bottom of the paleovalley.

Breccia with pyroclastic material, overlying facies of the breccia-conglomerate, is exposed bellow the base of andesite lava flow at level 1250 m a.s.l. on eastern slope of the mountain ridge. Breccia consists dominantly of small pyroclastic fragments with dimension 2–5 cm with vesiculated structure; colour is dark grey to black and brown-red. Matrix is tuffaceous with higher content of pumices. Breccia with pyroclastic material was transported from the stratovolcanic slope probably during explosive volcanic activity as a debris flows and/or hyperconcentrated flow. Breccia is not exposed in the outcrop, it was identified only in blocks and fragments.

Lava flow of pyroxene andesite on the top of the Klenovský Vepor ridge (Fig. 45a, b) represents uppermost member of the original paleovalley filling. The base of lava flow at eastern mountain ridge is in level 1250 a.s.l., at western side of mountain ridge it is in the level 1100 a.s.l. These differences indicate a gradual deepening of the paleovalley bottom to the west with ca 150 m subsidence before inflow of the lava flow. Morphology of the andesite lava flow also indicates the change of orientation of original paleovalley from the southwestern direction more westward. The lava flow building top of the Klenovský Vepor mountain ridge is exposed in impressive rocky walls (Fig. 45). Thickness of the lava flow at eastern edge of the mountain ridge is about 90 m; westward its thickness

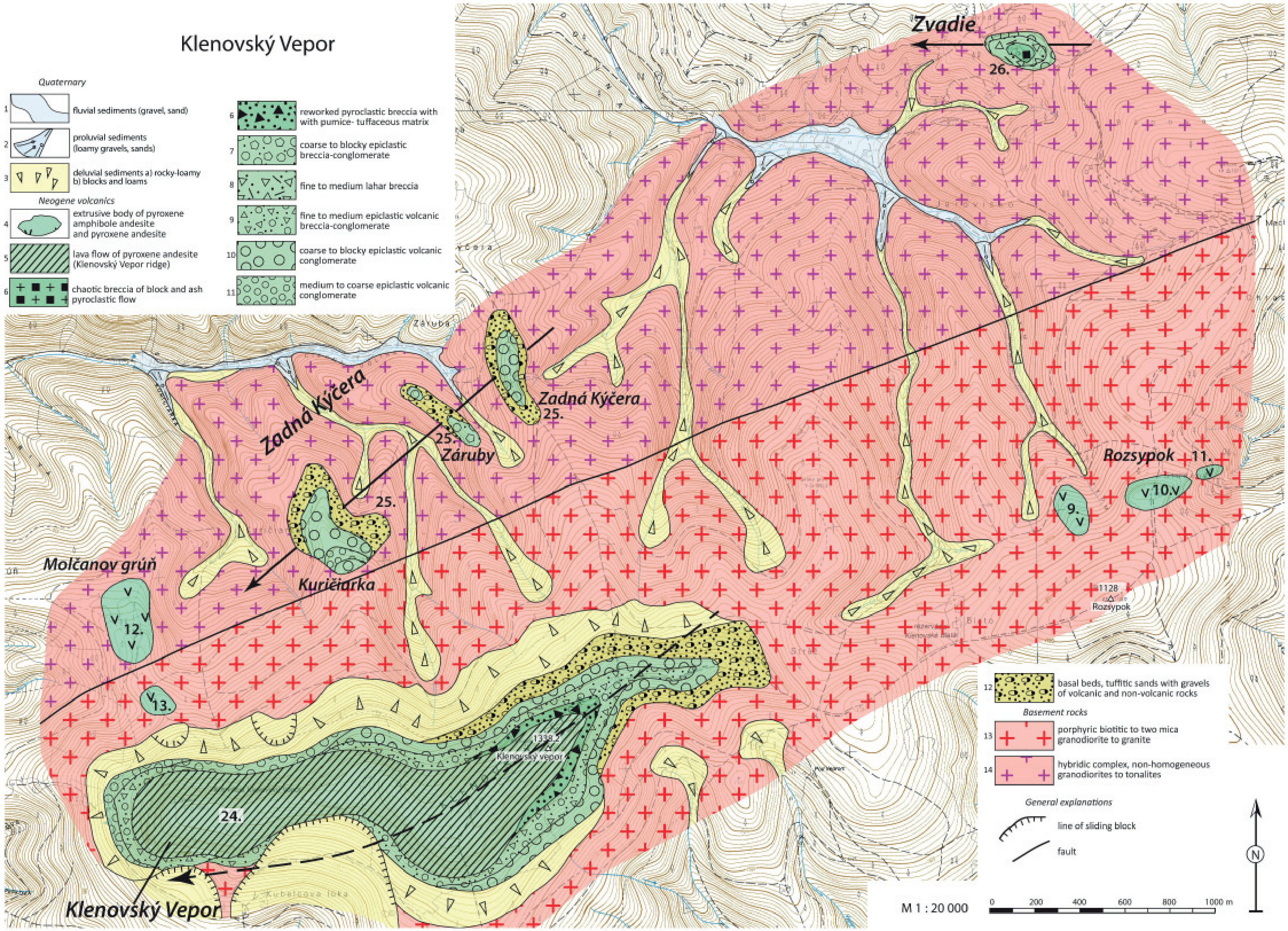


Fig. 44. Distribution of relics of paleovalleys fillings in SW sector of the Vepor stratovolcano. A – Klenovský Vepor; B – Zadná Kýčera and C – Zvadie paleovalleys.

reaches about 150 m. There is not possible to exclude that a total thickness of andesite body is a result of several lava flows. After removing of rock forming inner slopes of original paleovalley by erosion, the more resistant andesite lava flow is now in position of the top of mountain ridge (Fig. 45). It is a classical example of the relief inversion.

Andesite lava flow exposed in walls on the eastern edge of mountain ridge is characteristic with platy jointing at basal levels (fluidality planes) with inclination 5–8° to west. Andesite is dark-grey, medium porphyric with plagioclase and pyroxene phenocrysts (1–2 mm). Groundmass is microlithic to hyalopilitic and consists of glass and microliths of plagioclase and pyroxene.

25 – The Zadná Kýčera paleovalley

Relics of volcaniclastic rocks, forming the filling of the Zadná Kýčera paleovalley, are identified on the northern slopes of the Klenovský Vepor ridge (Fig. 44). These relics of volcaniclastic rocks firstly occur on the ridge south of

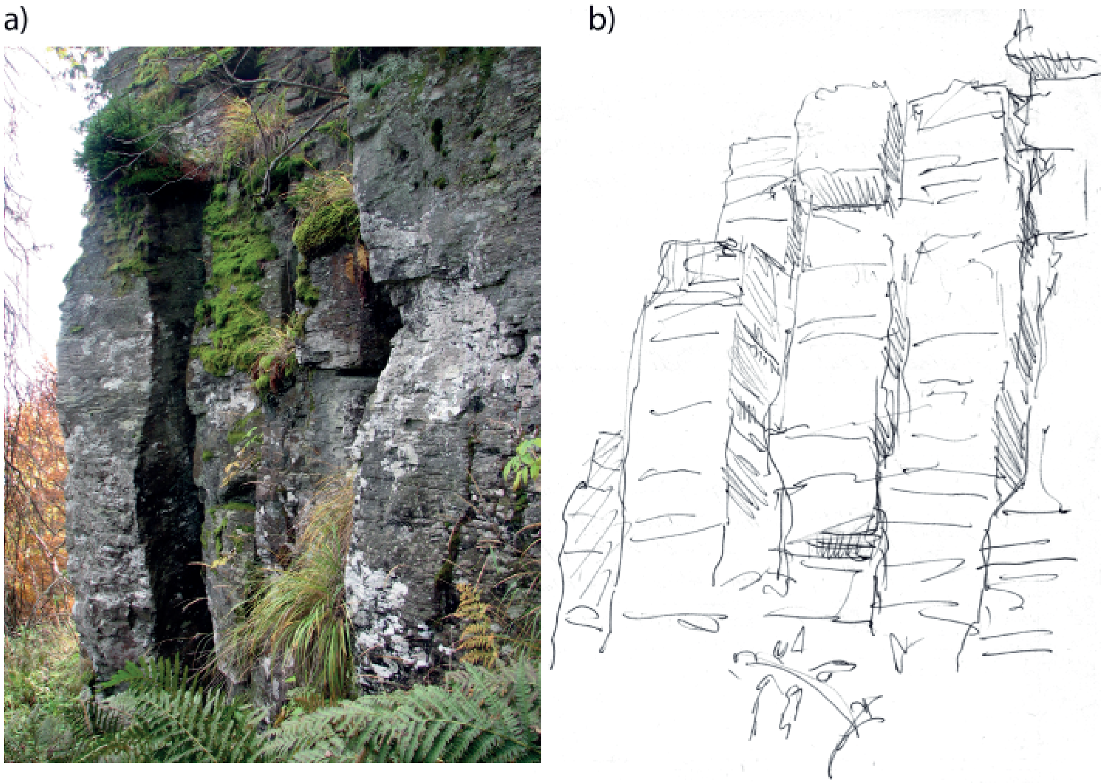


Fig. 45. Rock cliffs of pyroxene andesite in the eastern margin of the Klenovský Vepor ridge (a, b).

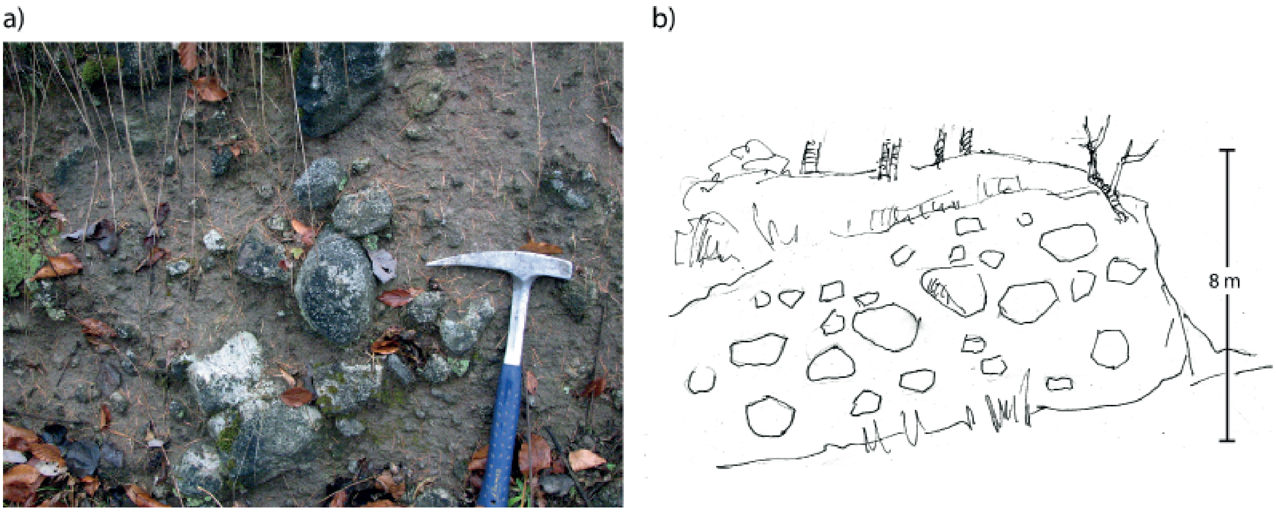


Fig. 46a, b. Coarse to blocky epiclastic volcanic conglomerate exposed in outcrop on the ridge with e.p. 980 SE of Zadná Kýčera at level 970 a.s.l.

locality Zadná Kýčera at level 960 m a.s.l., continue to SW as isolated relics on the Záruby ridge at level 925 m a.s.l. and terminate more SW on the Kuričiarka ridge also as isolated remnant at level 920 m a.s.l. Relics of volcaniclastic rock exposed in different outcrops on ridges in length about 1.4 km, indicate the paleovalley course SW–NE and deepening to SW.

Bed of tuffitic sands with pebbles of nonvolcanic and volcanic rocks is deposited on the base of the paleovalley filling of all three localites. Pebbles with dimensions from 1 cm to 5–10 cm (rare up to 20 cm) consist dominantly of quartz, Hercynian granitoids and crystalline schists. Pebbles of amphibole pyroxene andesites are only subordinary. Thickness of fluvial sediments varies from 0.5 m to 2 m.

Coarse to blocky epiclastic volcanic conglomerates overlie basal fluvial sediments. Rounded andesite blocks large 15-30 cm dominarte, blocks up to 50–80 cm are rare. Matrix consists of the coarse-grained epiclastic volcanic sandstone containing following small fragments: 1 – fine porphyric pyroxene andesites, 2 – coarse amphibole pyroxene andesite and 3 – pyroxene amphibole andesite (amphibole up to 3–4 mm). Sorting of clastic material of two fractions was observed, the finer fraction having dimensions 5–10 cm and coarser one 20–30 cm. The rock exposure is located on the ridge south of Zadná Kýčera locality (Fig. 46a, b). The conglomerate material alternating with epiclastic volcanic sandstones is deposited with the dip of 8–10° to SW in the direction of paleovalley (Fig. 46a, b). Facies of coarse to blocky conglomerates contain rounded andesite blocks with diameter 2.5-3 m in the locality Kuričiarka ridge. Thickness of coarse to blocky conglomerate bed is variable, maximum thickness up to 25 m was found on the Kuričiarka ridge at the western margin of the paleovalley.

The facies of coarse to blocky epiclastic volcanic breccia-conglomerate occurs on the Záruby ridge above basal fluvial sediments. Beside rounded blocks, the angular blocks of andesite are present with dimensions 20–40 cm. Tuffaceous matrix of the brown-grey colour contains dispersed rounded pumice. Clastic volcanic material belongs dominantly to amphibole pyroxene andesite. Facies of the breccia-conglomerate in this locality represents probably product of mass flow of lahar type.

Medium to coarse epiclastic volcanic conglomerate is deposited immediatelly above facies of coarse to blocky conglomerate in the Kuričiarka ridge. Rounded fragments and blocks with dimensions dominantly 5–25 cm (rarely to 30 cm) belong to medium porphyric pyroxene andesite (pyroxene 2–4 mm). Matrix is formed of the coarse epiclastic volcanic sandstone with content of small andesite fragments. Facies of medium to coarse volcanic conglomerate in this locality is overlain again by the coarse to blocky epiclastic volcanic conglomerate. Conglomerate deposits show general inclination to north into central deeper part of the paleovalley which is directed to SW.

26 – The Zvadie paleovalley

Relics of volcaniclastic rocks are present on the top of Zvadie Hill with e.p. 947 south of the Chlípavica settlement. *Medium to coarse epiclastic volcanic conglomerate* is deposited at the level 925 m a.s.l at the base of paleovalley filling. Fragments and blocks are well rounded, dominantly with dimensions 10 to 25 cm (rarely to 30 cm). Matrix is epiclastic, sandy and coarse grained. *Lahar breccia* is deposited above bed of medium to coarse conglomerate. Fragments and blocks dominantly with dimensions from 5 cm to 5–20 cm are angular to subangular, matrix is tuffaceous. Chaotic deposition of clastic material points to the mass flow of lahar type (debris flow). Clastic material belongs to medium porphyric amphibole pyroxene andesite.

Pyroclastic breccia is exposed on the top of the Zvadie Hill (e.p. 947) in abandoned small quarries. Pyroclastic fragments and blocks with dimensions 5–20 cm are subangular, primary spheroidal, porous to strongly vesiculated. Matrix is tuffaceous, rich on small vesiculated fragments with signs of welding. Chaotic deposition of pyroclastic material points to transport by pyroclastic flow.

Because the relic of volcaniclastic rock on the top of the Zvadie Hill is the only occurrence in this area, it is not possible to estimate direction of original palleovalley used for transport of volcaniclastic material. The base of filling in the Zvadie locality at level 925 m a.s.l. is about 25 m lower than the level of basal beds of the Zadná Kýčera paleovalley at its eastern edge. Therefore it is assumed that volcaniclastic rocks of the Zvadie locality represent the filling of different paleovalley without any connection with the Zadná Kýčera palleovalley. The second argument points to different lithological character of the filling of both paleovalleys.

NW sector of stratovolcano

27 – The Hájna hora Hill paleovalley

The Hájna hora volcanosedimentary complex represents the most extensive remnant of paleovalley filling in the western area of the Vepor stratovolcano. Volcaniclastic material was transported during volcanic activity through paleovalley further to the west, where it was deposited in the peripheral area at proluvial plain. The volcanosedimentary complex Hájna hora Hill in the recent morphology forms a conspicuous NW–SE trending ridge with flat top, reaching in eastern side level about 970 m a.s.l. In continuation to west, the level of flat top gradually declines to 930 m a.s.l. in the middle part and to 760 m a.s.l. at the western edge. Mountain ridge with flat top is limited from the northern and southern sides with steep slopes and numerous outcrops. Eastern part of the Hájna hora mountain ridge is forested, the middle and western parts of the flat top are covered with meadows. At the western side, the deep valleys divide the flat top relief to three ridges: Suchá ridge e.p. 850.6, Koreňová ridge e.p. 860.3 and Hnusné ridge e.p. 800. Brooks flowing in the valleys between ridges are drained to NW into the Hron river at the Brezno.town

The Hájna hora volcanosedimentary complex represents a unique record of volcanic events acting during evolution of stratovolcano and forming different facies of epiclastic and pyroclastic rocks, episodically transported and deposited in the paleovalley. The paleovalley, directed to NW, cuts crystalline rocks (hybrid complex with migmatites, ortogneisses, hybrid granites, paragneisses and leucocrate granites at the SW margin of the paleovalley). Bottom of the paleovalley gradually inclines from the east (850 m a.s.l.) to west (650 m a.s.l.). Thickness of the volcanosedimetary complex increases from the east (about 130 m) to west (more than 200 m).

Volcanosedimentary complex Hájna hora Hill was initially mapped into topographic maps at a scale 1 : 5 000 and later geological-lithofacial map was compiled at a scale 1 : 10 000, being supplemented by lithological sections of northern and southern slopes (Apps. 5 and 6).

Filling of the paleovalley consists of numerous facies of volcaniclastic rocks with following characterization in lithological succesion:

Tuffitic sands with pebbles of nonvolcanic and volcanic rocks are deposited on the base of volcanosedimentary complex in variable thickness from 2 m up to 10–15 m. In several parts these fluvial sediments are missing and on the surface of crystalline rock there are deposited epiclastic volcanic sandstone and/or epiclastic volcanic conglomerates (southern slopes of the Hájna hora Hill). Tuffitic sands of grey-greenish and grey-brown colours are incoherent, well sorted, locally they have higher content of pumice. Pebbles of nonvolcanic and volcanic rocks have dimensions from 3 cm up to 10–15 cm. Among nonvolcanic pebbles there dominate quartz, quartzites, granitoids, ortho and paragneisses. Locally on the base of volcanosedimentary complex a high concentration of blocks of crystalline rocks with dimensions from 30 cm to 50 cm is observed (at the foothill of northern slope of Hájna hora Hill bellow e.p. 926 and e.p. at level 775 m a.s.l.). Pebbles of volcanic rocks belong dominantly to amphibole pyroxene and pyroxene amphibole andesite. Tuffitic sands with pebbles of nonvolcanic and volcanic rocks pass in upper part gradually to overlying thicker beds of epiclastic volcanic sandstones.

Basal bed of tuffitic sands with pebbles of nonvolcanic and volcanic rocks represents fluvial deposits of ephemeral streams. Nonvolcanic clastic material is derived dominantly from eroded slopes and bottom of paleovalley, which consists of Hercynian granitic rocks and crystalline schists. Volcanic material was produced by erosion of volcanic structures from the early evolutionary stage. Different levels of basal bed on southern slopes of the Hájna hora Mts. have subjected vertical tectonic movement (PF-13 to PF-22).

Chaotic breccia of pyroclastic flow with material of biotite pyroxene amphibole dacite to rhyodacite follows immediatelly above basal tuffitic sediments at the western edge of volcanosedimentary complex. Chaotic breccia is exposed at the foothill of the slopes Koreňová e.p. 860.3 at level 655 a.s.l. (Fig. 47), at foot of slopes Suchá ridge with e.p. 850.6 and also in both slopes of the Breznianský potok brook valley. Breccia consists of fragments surrounded by tuffaceous matrix. Fragments with dimensions 5–30 cm are angular to subangular in shape, have glassy groundmass and are often vesiculated. Strongly vesiculated spheroidal fragments are subordinary. Fragments belong to medium and coarse porphyric dacite to rhyodacite with phenocrysts of plagioclase (2–3 mm), pyroxene (to 2 mm), amphibole (3–4 mm, rarely up to 6 mm) and biotite (to 3 mm). Tuffaceous matrix forming about 40–60 % consists of volcanic ash with crystalloclasts of plagioclase, pyroxene, amphibole, biotite and fragments of glass. In the matrix there are dispersed small pumice fragments (0.5–3 cm), angular to subangular and partly rounded. Small grains and pebbles of quartz and crystalline rocks are also seldom present. Matrix is locally consolidated and compacted into firm mass. Distribution of clastic material is chaotic. Lithology and textures indicate transport and deposition in the form of pyroclastic blocks and ash flow.

Reworked (redeposited) ash-pumice tuffs with material of biotite pyroxene amphibole dacite to rhyodacite follows in higher position above chaotic breccia on the slope of the Koreňová ridge (e.p. 860.3) at level 690 m a.s.l. near the western margin of the volcanosedimentary complex. Major content of ash-pumice tuff (about 60–70 %) consists of pumice fragments with diameters 0.5–3 cm (rarely up to 5 cm) of grey-white, light-grey colours, dispersed in darker ash matrix with smaller pumice fragments. Pumice fragments are strongly vesiculated, often rounded and contain phenocrysts of plagioclase, pyroxene, amphibole and biotite. The same minerals are also present in ash matrix. Less frequent there are grains and small pebbles of quartz and crystalline rocks (granites and crystalline schists). Textures of graded bedding and granulometric sorting are occasionally present in outcrops.

Reworked pyroclastic breccia with material of biotite pyroxene amphibole dacite to rhyodacite overly reworked dacite tuff on the western slope of Koreňová at the level 700 a.s.l. Angular to subangular fragments, glassy and vesiculated with dimensions about 5 to 15 cm are dispersed in ash-pumice matrix. Small part of fragments is rounded. Textures like bedding, sorting, rounding of some fragments point to a character of reworked pyroclastic material.

Epiclastic volcanic sandstones overlay basal bed of tuffitic sands with pebbles of nonvolcanic and volcanic rocks. According to their position, the bed of epiclastic volcanic

Fig. 47. Chaotic breccia of block and ash pyroclastic flow exposed in small abandoned quarry at the foothill of slope of Koreňová ridge e.p.860.3. Dark angular fragments belong to rhyodacite with glassy groundmass, white fragments are pumices. Distribution of clastic material is chaotic.

sandstones in the lower part of volcanosedimentary complex of the Hájna hora Hill is classified also as a *lower bed of epiclastic volcanic sandstones*. Epiclastic volcanic sandstone in lower bed is typically developed in the eastern part of the volcanosedimentary complex, where it is exposed in many outcrops on the northern and southern slopes of the Hájna hora Hill. Gradual transition from underlying basal beds of tuffitic sands is accompanied by increased content of tuffaceous volcanic material. Thickness of lower bed of epiclastic volcanic sandstones is about 10–15 m and locally it can reach 25–30 m. Sequence of epiclastic volcanic sandstones consists of alternations of layers of epiclastic volcanic sandstones with occasional bedding. Thin layers of pumice, intercalations of gravells and fine volcanic conglomerates are often present. Intercallations of gravells and fine volcanic conglomerates including layers of fine breccias are more frequent in the western part in the lower bed of epiclastic volcanic sandstone.

Lower bed of epiclastic volcanic sandstones is exposed in several outcrops in the lower part of volcanic slope bellow Zrazy e.p. at level 825 m a.s.l. Layers of massive nonbedded medium- to coarse-grained epiclastic volcanic sandstones with thickness from several dm up to 0.8 m are separated with thin layers of fine-grained tuffs and silts (Fig. 48a, b). Layers of nonbedded epiclastic volcanic sandstones are products of mass flows, type of hyperconcentrated flows. Rare andesite fragments with dimensions of several cm, angular to subangular in shape, occasionally rounded, are chaotically dispersed within body of epiclastic volcanic sandstone. Beside andesite fragments a small pebbles of quartz and crystalline rocks from underlying Hercynian basement are also present. Dispersed pumices in bodies of nonbeded epiclastic volcanic sandstones point to synchronous volcanic activity of plinian type. Thin layers of tuffs and tuff-silts separating bodies of nonbedded epiclastic volcanic sandstones are products of ash-falls and/or ash which was washed dawn from slopes of volcano.

Deposition of thick lower bed of the epiclastic volcanic sandstones occurred in the early stage of the Vepor stratovolcano evolution during explosive activity with production of large volumes of ash-pumice tuffs. After deposition on slopes of stratovolcano, the ash-pumice tuff was episodically washed down and transported as a hyperconcentrated flows with deposition on the bottom of paleovalleys (eventually it was transported further to west in proluvial plain).

Rhyodacite material as pebbles and rounded blocks are present within epiclastic volcanic sandstones near the base of the Hájna volcanosedimentary complex at the eastern edge. A big isolated block of ryodacite with diameter about 15–20 m was found at the forest road on the southern slope of the Hájna hora Hill at altitude 825 m a.s.l. Rhyodacite material was probably produced by the destruction of extrusive body (extrusive dome) located more to the east. Dimensional rhyodacite blocks were transported by gravitational energy and deposited at the bottom of the paleovalley. Extrusive rhyodacite volcanism and destruction of extrusive body evidently preceeded the evolution of the Vepor stratovolcano.

In the upper part of the lower bed of epiclastic volcanic sandstones there has increased a number of conglomerate intercalations and interbeds, and there are also present larger isolated blocks, transported by gravitational energy from higher positions. Also textures of cross bedding and graded bedding are more frequent in the upper part of the sequence of epiclastic volcanic sandstones which point to deposition from ephemeral diluted streams.

Above the lower sequence of the epiclastic volcanic sandstones, a bed of coarse to blocky conglomerate follows at the eastern part of the Hájna hora Hill volcanosedimentary complex.

Facies of coarse to blocky epiclastic volcanic conglomerate as the most frequent facies occur in different levels of volcanosedimentary complex (Fig. 49). Rounded andesite blocks dominantly with dimensions from 30 cm up to 60 cm (rare blocks 2–3 m an more) form the main volume of this facies. Regarding to lithological succesion, the facies of coarse to blocky conglomerate are deposited immediately over lower sequence of epiclastic volcanic sandstone.

a)

b)

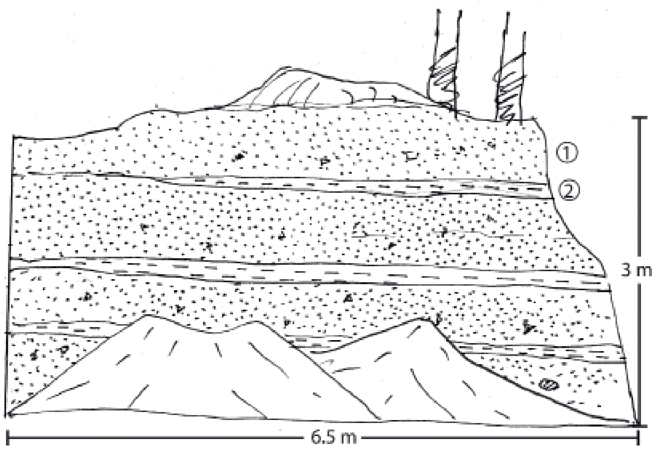


Fig. 48. Outcrop of nonbedded epiclastic volcanic sandstones at forest road with length about 10 m at the foothill of slope bellow Zrazy at level 825 a.s.l. In scheme of outcrop: 1 – nonbedded epiclastic volcanic sandstones, 2 – thin layer of ash-silt.

Bed of coarse to blocky epiclastic volcanic conglomerate is exposed along forest road on the northern slope of the Hájna hora Mts. Erosive channel in the upper part of epiclastic volcanic sandstones is filled with coarse to blocky conglomerate (Fig. 49a, b, c, d). Epiclastic volcanic sandstones are coarse-grained, sorted, containing textures of cross bedding and gradation bedding. Outcrops demonstrate that after the deposition of lower sequence of epiclastic volcanic sandstones, its upper part was dissected by many erosive cuts (channels of ephemeral streams) and later filled with coarse to blocky conglomerates.

Similar situation is observed on the southern slope of Hájna hora Hill at eastern edge of the volcanosedimentary complex (Fig. 50). Erosive channel on the surface of lower sequence of epiclastic volcanic sandstones (1) is filled with coarse to blocky epiclastic volcanic conglomerates (2).

Extensive exposures of lower sequence of epiclastic volcanic sandstones occur on the southern slopes of the Hájna hora Hill bellow e.p. 860 Kabátovo at level 800 m a.s.l. (Fig. 51A, B). Erosional channels on the surface of epiclastic volcanic sandstones are filled with coarse to blocky epiclastic volcanic conglomerates (Fig. 51A, B).

Coarse to blocky epiclastic volcanic conglomerates form several layers in different levels in vertical profile of the volcanosedimentary complex Hájna hora (see lithological profiles PF-1 to PF-26). Number of conglomerate layers gradually increases in the western part of the volcanosedimentary complex, where about eight beds of coarse to blocky conglomerates were indentified in vertical

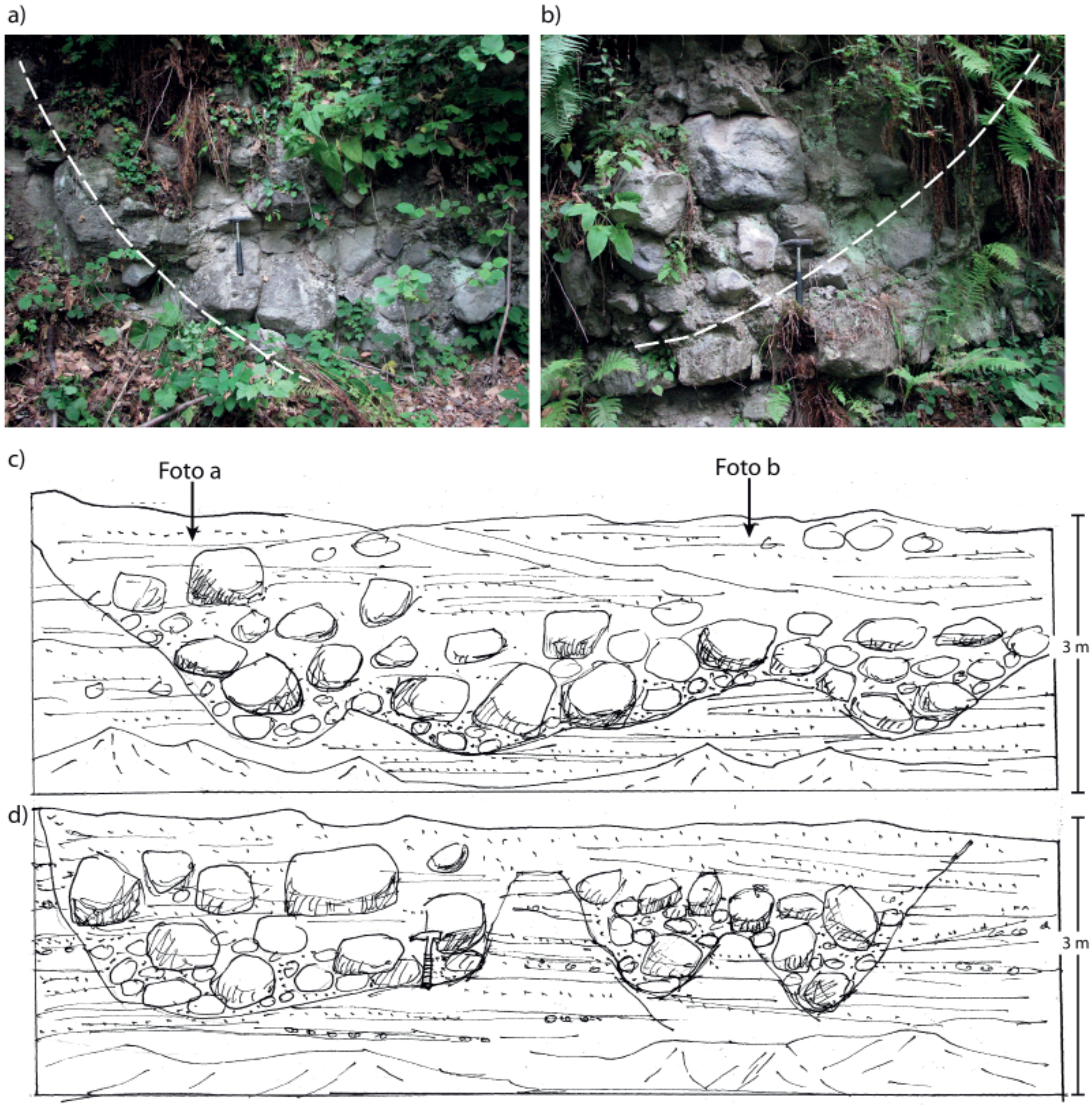


Fig. 49a, b, c, d. Lower sequence of epiclastic volcanic sandstone is exposed along forest road on the northern slope of Hájna hora (east of e.p. 973 Zrazy) at altitude 840 m a. s. l. with length of about 50 m. Erosive cuts (channels) on the surface of epiclastic volcanic sandstones are filled up with well rounded and partly rounded andesite blocks with diameters from 30 to 50–60 cm (rare up to 80 cm). Photo a and photo b, document situation on scheme c. Continuation of outcrop to eastward is shown in scheme d.

section (profile PF-1). Many layers of coarse to blocky epiclastic volcanic conglomerates are wedging out in the western margin of the volcanosedimentary complex and/or they are replaced by facies of medium to coarse epiclastic volcanic conglomerates. Geological mapping confirmed that coarse to blocky conglomerates form flat bodies dominantly with orientation and inclination to north-west (see lithological profiles).

Outcrops in the western part of the volcanosedimentary complex Hájna hora Hill on Hnusné ridge document textures of coarse to blocky conglomerate in higher level of lithological sequence (Fig. 52A, B).

With layers of block epiclastic volcanic conglomerate often associate *fine to medium epiclastic volcanic conglomerate* in the western part of volcanosedimentary complex Hájna hora Hill. In outcrop on the Hnusné ridge the

Fig. 50. Profile through the lower sequence of epiclastic volcanic sandstones long about 30 m and high 3.5 m is exposed along forest road on the ridge of southern slope of Hájna hora Hill at altitude 840 m a.s.l. Coarse to blocky rounded and partly rounded andesite blocks with diameters mostly 30–50 cm are filling erosive channel (2) on the surface of lower sequence of the epiclastic volcanic sandstones (right part of the erosive channel 2).

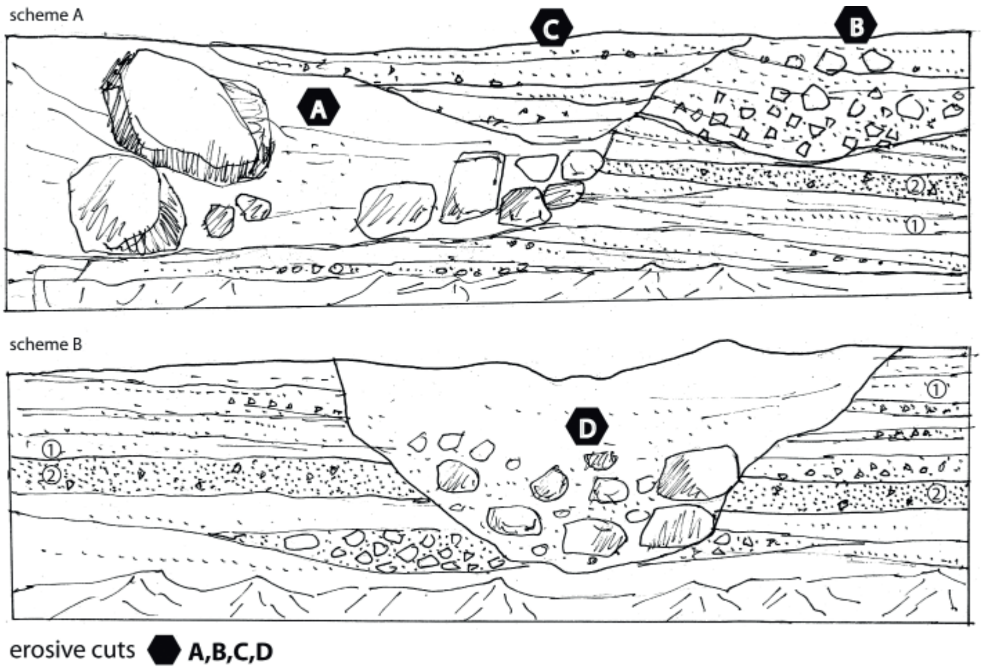


Fig. 51A, B. Outcrop in the forest road cut on the south slope of Kabátovo ridge bellow e.p. 860 at altitude 800 m a.s.l. on the southern slope of the Hájna hora Hill. ***Scheme A.*** Medium to coarse epiclastic volcanic sandstones with small andesite fragments and textures of parallel and crossed bedding (1) alternate with layers of nonbedded epiclastic volcanic sandstones (2) which probably represent the deposits of hyperconcentrated flows. Sequence of epiclastic volcanic sandstones is dissected by several channels on its surface, being filled with the coarse to blocky conglomerate material with blocks large from 20–30 cm to 80–100 cm (A), with smaller angular to subangular andesite fragments (B) and coarse, bedded epiclastic volcanic sandstones with smaller andesite fragments (C). ***Scheme B.*** Outcrop of epiclastic volcanic sandstones continues without interruption to the west. Channel on surface of epiclastic volcanic sandstones is filled-up with rounded to partly rounded andesite blocks and in the upper part with epiclastic volcanic sandstone (D).

layers of coarse to block epiclastic volcanic conglomerate alternate with layers of fine to medium epiclastic volcanic conglomerates (Fig. 53).

Well rounded andesite blocks are often present in the uppermost level of volcanosedimentary complex. In eastern part of the Hájna hora complex on northern slope of ridge bellow e.p. 973 Zrazy at level 965 m a.s.l. a block about 3 m in diameter is present in filling of erosive cut (Fig. 54).

Big to huge rounded andesite blocks with diameters 3 x 2 x 1.5 m occur also in the western part of the Hájna hora volcanosedimentary complex at ridge Suchá at level 827 m a.s.l. Huge blocks with diameters 3 x 2 x 2 m are also found on the southern slope of the Koreňová ridge at level about 806 m a.s.l.

Presence of andesite blocks of great dimensions in the uppermost levels of the Hájna hora Hill volcanosedimentary complex relatively far from the central volcanic zone are explained as a consequence of huge extended stratovolcanic structure occurring high above the paleorelief. Stratovolcanic structure of such dimesions was built only in more advanced stages of its evolution, which corresponds to increasing of gravitatioal energy and ability to transport a greater blocks over longer distances from stratovolcano.

Higher degree of sorting of clastic material by dimensions and weight was observed at increasing distance from stratovolcano. This was observed in outcrop on the southern slopes of the Suchá ridge at western part of the Hájna hora Hill volcanosedimentary complex (Fig. 55a, b).

Medium to coarse epiclastic volcanic conglomerates occur in different levels of volcanosedimentary complex. Andesite clastic material is well rounded to partly rounded with prevailing dimensions 15-30 cm. Facies of medium to coarse epiclastic volcanic conglomerate are closely associated with layers of coarse to blocky conglomerates and in continuation to the west that facies of coarse to blocky conglomerate often substitute and/or alternate with medium to coarse epiclastic volcanic conglomerate. Facies

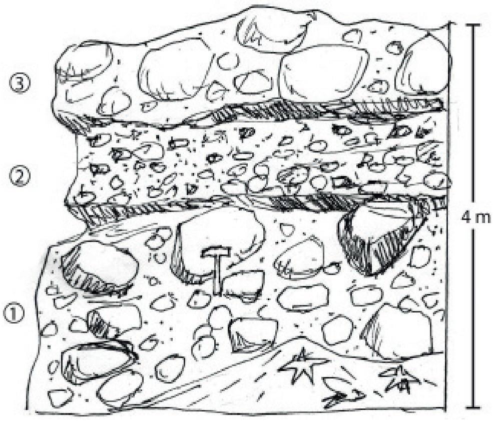


Fig. 53. Outcrop on the Hnusné ridge at altitude 890 m a.s.l. with length 8 m and hight 4 m, representing following facies: 1 – Coarse to blocky conglomerate with andesite block of dimensions 30–60 cm and coarse sandy matrix in lower part of the outcrop. 2 – Fine to medium epiclastic volcanic conglomerate, well sorted with pebbles large ca 5–10 cm deposited above coarse to blocky epiclastic volcanic conglomerate. 3 – Coarse to blocky epiclastic volcanic conglomerate with well rounded and sorted andesite blocks. The dominating blocks with dimensions 40–60 cm occur in the uppermost part of the outcrop.

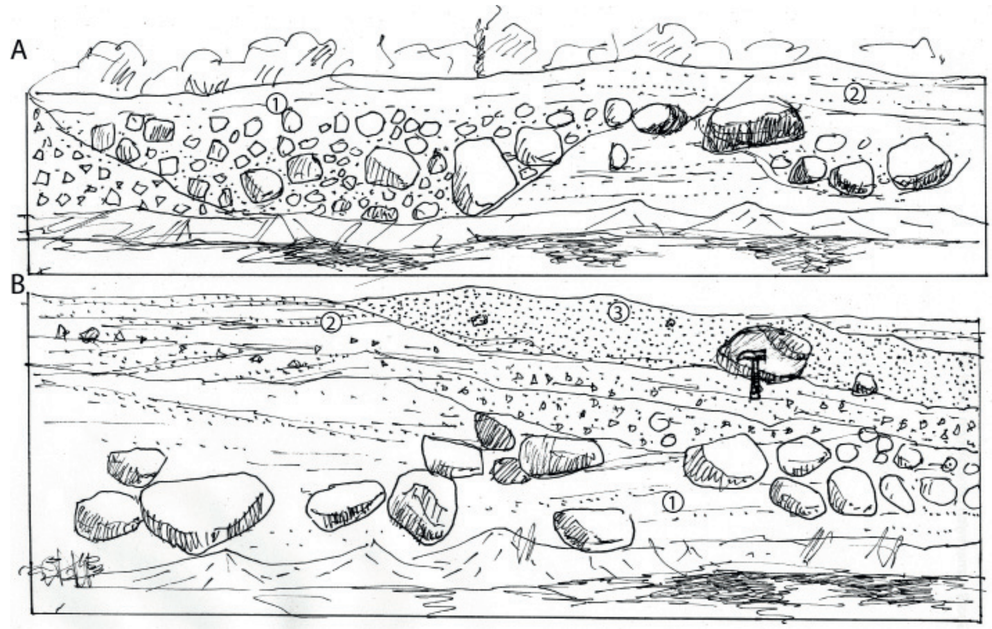


Fig. 52. Outcrops on the Hnusné ridge long ca 10–15 m at the level 855 m a.s.l. on the western part of volcanosedimentary complex Hájna hora Hill. ***Scheme A.*** Two erosive channels (1, 2) on the surface of bedded epiclastic volcanic sandstones are filled with coarse to blocky epiclastic volcanic sandstones. Andesite blocks with dimensions 15–50 cm are well rounded and partly rounded as well. ***Scheme B.*** Layer of coarse to blocky epiclastic volcanic conglomerate, alternating with epiclastic volcanic sandstone (1), is overlain with coarse bedded epiclastic volcanic sandstones with higher amount of small angular andesite fragments (2). Epiclastic volcanic sandstones are deposited on eroded surface of conglomerate layer (1). In the uppermost part of outcrop the layer of nonbedded epiclastic volcanic sandstone (3) with chaotically dispersed small andesite fragments and isolated block (near hammer) is deposited on uneven, eroded surfice.This layer corresponds to deposition of material from mass flow, probably hyperconcentrated flow with transition to debris flow.

of medium to coarse epiclastic volcanic conglomerate is exposed in outcrop on the Hnusné ridge in the western part of Hájna hora Hill volcanosedimentary complex (Fig. 56).

Fine to medium epiclastic volcanic conglomerates often associate with coarse to blocky and medium to coarse conglomerates and they occur also as an individual layers within sequences of epiclastic volcanic sandstones. Clastic material with dimensions 5–15 cm is well rounded, occasionally present is also partly rounded material. Fine to medium epiclastic volcanic conglomerate overlies coarse to blocky epiclastic volcanic conglomerate in the outcrop on the southern slope of the Hájna hora Mts. (Fig. 57a, b).

Fine to medium epiclastic volcanic conglomerate overlying sequence of the epiclastic volcanic sandstones crops out on the southern slope of the Hájna hora Mts. (Fig. 58a, b).

Chaotic breccia of block and ash pyroclastic flow with material of amphibole pyroxene andesite follows in lithologic succesion above the layer of coarse to blocky epiclastic volcanic conglomerate on the northern slopes of the Hájna hora Hill in the eastern part of volcanosedimentary complex. Breccia of pyroclastic flow is exposed in several small outcrops and scattered blocks on the ridge bellow e.p. 973 Zrazy at the levels 895–905 m a.s.l. Breccia is dominantly formed of fragments and blocks with dimensions 5–25 cm (blocks up to 30 cm are rare) spheroidal in shape, often strongly vesiculated. Fragments and blocks angular in shape are less frequent. Several blocks showing disintegration along system of radial cracks point to processes of autoclastic disintegration in hot stage during transport within pyroclastic flow (Fig. 59b). Ash-tuff matrix with amount of small vesiculated fragments of lapilli size and higher amount of dispersed pumice fragments is consolidated and partly welded with vesiculated fragments (Fig. 59a). Distribution of clastic material in ash-tuff matrix is chaotic. Lithology and textures of pyroclastic breccia correspond to transport and deposition of block and ash pyroclastic flow.

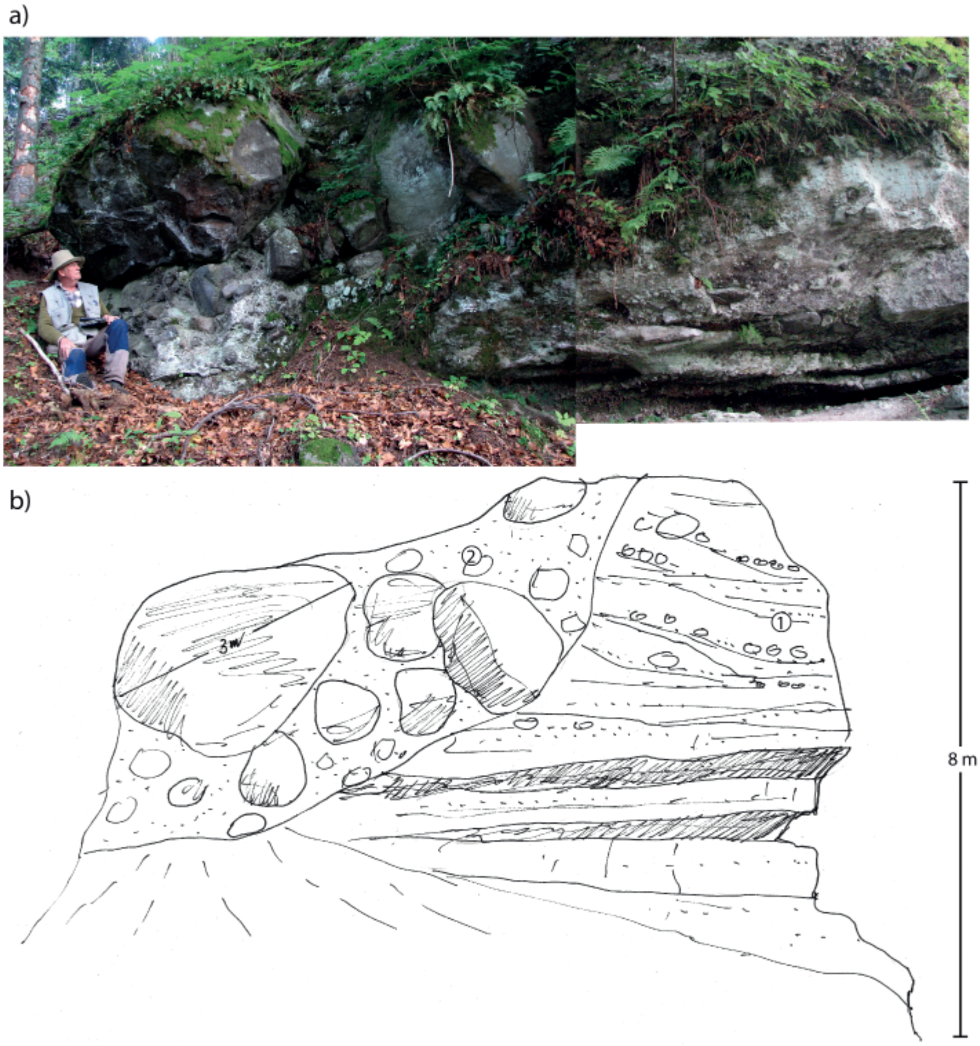


Fig. 54. Rock cliff high about 8 m on northern slope of Zrazy ridge at level 965 m on the northern slope of the Hájna hora Hill. On right side of the cliff a sequence of epiclastic volcanic sandstones with planar and cross bedding is exposed (photo a and scheme b 1). Filling of erosive cut on the left side of the cliff cosists of rounded andesite block with dimensions 30–60 cm and larger block with diameter about 3 m (photo a and scheme b 2).

Chaotic pyroclastic breccia is exposed in several small outcrops and blocks the on northern slope of Hnusné ridge in the western part of volcanosedimentary complex in the altitude 850 m a.s.l. Breccia is formed from fragments and blocks of variable size from several cm up to blocks with dimensions 60–80 cm. Ash-tuff matrix is welded with small vesiculated fragments. Distribution of fragments and blocks is chaotic. Pyroclastic material belongs to amphibole-pyroxene andesite. Two pyroclastic flows are

Fig. 56. Medium to coarse epiclastic volcanic conglomerates are exposed in outcrop with length 20 m and height about 3 m at level 870 m a.s.l. on ridge Hnusné in western part of volcanosedimentary complex. Layer of epiclastic volcanic sandstones forms lower part of the rock wall (1). Above epiclastic volcanic sandstone follows fine to medium epiclastic volcanic conglomerate with small rounded fragments 5–15 cm (2). Medium to coarse epiclastic volcanic conglomerate forms upper part of outcrop (3). Andesite blocks are well rounded with dimensions 15 to 30 cm and deposited subhorizontally with longer diameter. All facies in outcrop are are inclined 5–7° to west.

a) b)

Fig. 55. Coarse to blocky epiclastic volcanic conglomerate is exposed in outcrop with length 15 m and hight about 3–4 m on the southern slope of Suchá ridge at level 763 m a.s.l. in the western part of the Hájna hora Hill volcanosedimentary complex. Two fractions of rounded clastic andesite dominate: fraction of well rounded blocks (5–15 cm) deposited in the bedded epiclastic volcanic sandstones and second fraction with blocks with dimensions from 0.7 m up to 1.5 m.

a) b)

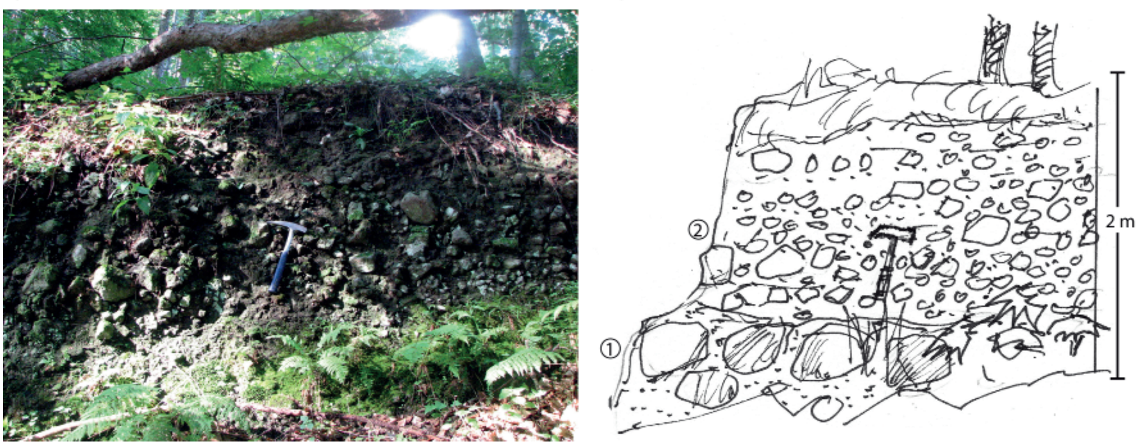


Fig. 57. Fine to medium epiclastic volcanic conglomerate is exposed in the outcrop with length about 15 m and hight 2 m along cut of the forest road on the southern slope of Hájna hora Hill at altitude 810 m a.s.l. Fine to medium conglomerate (2) with well rounded and partly rounded fragments with dimensions 5–10 cm (rare to 15 cm) overlies coarse to blocky epiclastic volcanic conglomerate (1). Deposition of clastic material with alternation of coarser and finner coglomerate fractions exhibits signs of subhorizontal bedding.

distinguished on the northern slopes of the Hájna hora Hill in western part of volcanosedimentary complex (see geological-lithological map and lithological section of the Hájna hora Hill volcanosedimentary complex).

Breccia with reworked pyroclastic material overlying the chaotic breccia of pyroclastic flow was identified on the northern slope of Hájna hora Hill in the eastern part of volcanosedimentary complex. Reworked pyroclastic breccia consists of fragments dominantly of spheroidal to subangular shape and tuffaceous matrix with higher content of small vesiculated fragments and pumices. Reworked character of pyroclastic material documents textures of sorting and bedding in outcrop on the northern slope of Hájna hora Hill (Fig. 60a, b).

Breccia with reworked pyroclastic material in the western part of volcanosedimentary complex continues in the same level as pyroclastic flow in the eastern part of volcanosedimentary complex. Clastic material of reworked pyroclastic breccia probably commes from eroded and disintegrated layer of pyroclastic block and ash flow finishing in the middle part of volcanosedimentary complex. Outcrops of reworked pyroclastic breccia are found on the northern slopes of Hájna hora Hill in the western side of volcanosedimentary complex at level 860 m a.s.l. (Fig. 61).

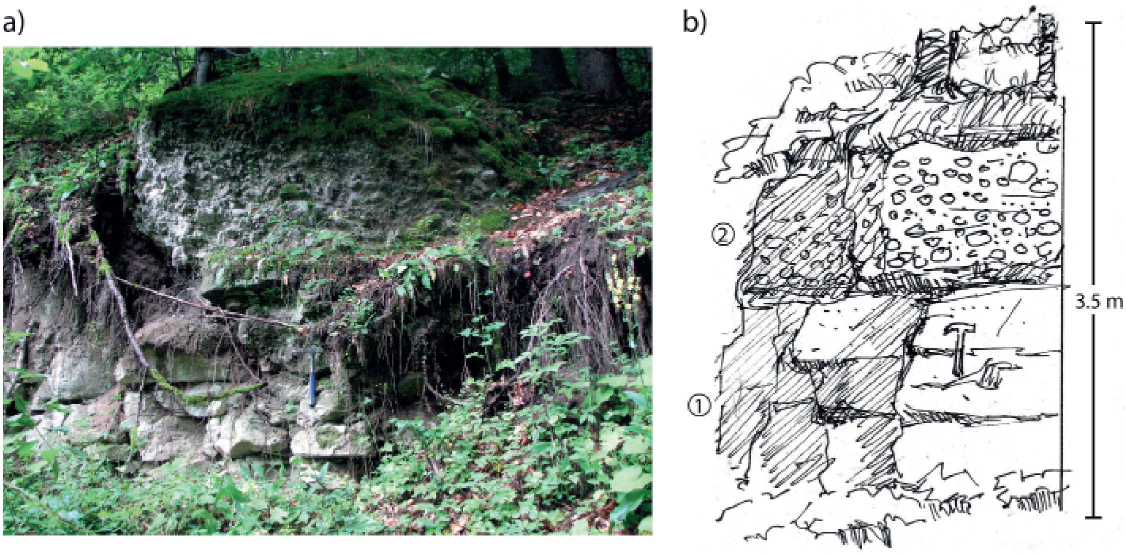


Fig. 58. Epiclastic volcanic sandstone with layer of fine to medium epiclastic volcanic conglomerate with length 8–10 m and hight 3.5 m is exposed along forest road cut on the southern slope of the Hájna hora Hill at altitude 840 m a.s.l. Sequence of epiclastic volcanic sandstones with subhorizontal bedding (1) is overlain in upper part with fine to medium epiclastic volcanic conglomerate (2). Clastic material dominantly of dimensions 5–10 cm (rare to 15 cm) is well rounded and deposited with signs of subhorizontal bedding.

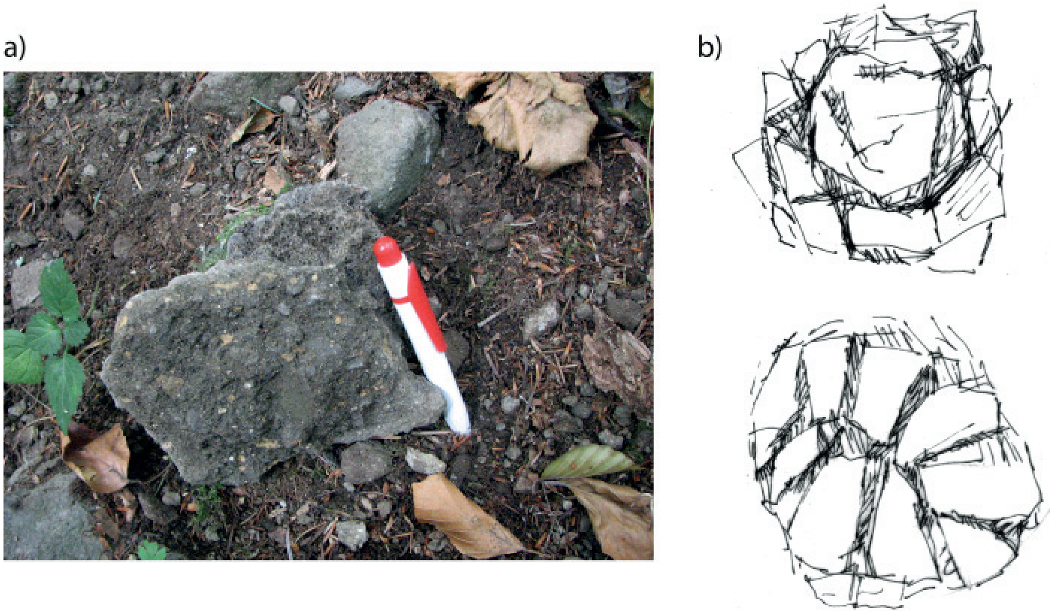


Fig. 59. Matrix of chaotic breccia contains small fragments of pumice and larger fragments of vesiculated andesite. The outher boundary of vesiculated fragments is obscured due to welding with matrix (a). Radial and partly concentric jointing of blocks is result of disintegration during movement in the pyroclastic flow (b).

Larger block coming from the primary volcanic structure is present on the northern slopes of Hájna hora Hill at level of reworked pyroclastic breccia (Fig. 62a, b).

Large block is comming from primary volcanic structure near crater area. After destruction of this part of volcanic structure during volcanic eruption, this block was probably transported by pyroclastic block and ash flow. After destruction and redeposition of pyroclastic flow breccia, the block of primary volcanic structure occurs now in the level of facies with reworked pyroclastic breccia.

Facies of reworked pyroclastic breccia is overlain with layer of coarse to blocky epiclastic breccia- conglomerate in the western part of volcanosedimentary complex (Fig. 63a, b).

Breccia with reworked pyroclastic material was identified also on the southern slope of Hájna hora Hill at level 790 m m a.s.l. on the ridge bellow e.p. 889 m. Pyroclastic fragments of dimensions 5–20 cm are dominantly spheroidal in shape. Subangular fragments are less frequent, they are light grey, vesiculated, and often with phenocrysts of amphibole (5–8 mm). Pyroclastic material is sorted and deposited with signs of bedding. Coarse to blocky conglomerate overlies breccia with reworked pyroclastic material in the western part of volcanosedimentary complex.

Lahars represent another type of mass flows transporting volcanoclastic material from western slopes of stratovolcano westward in the Hájna hora paleovalley. *Lahar breccias* as an important component of volcanosedimentary complex were identified on northern, as well as southern slopes of the Hájna hora Hill. Unlike of hyperconcentrated flows transporting finer tuffaceous volcanic material and which deposits are more abundant in the lower level of volcanosedimentary complex within epiclastic volcanic sandstones, the lahar breccia dominates in the middle and especially in upper part of volcanosedimentary complex. Lahars resp.

Fig. 61. Reworked pyroclastic breccia on the nothern slope of Hájna hora Hill is exposed in several outcrops between altitudes 860–870 m a.s.l. In the lower part of the rock wall there occurs a coarse pyroclastic breccia with vesiculated fragments and spheroidal blocks with diameters from several cm to 30–40 cm (1). Angular fragments are less frequent. Ash-tuff matrix contains large amount fragments of pumices. Depositon of material shows signs of bedding with inclination to NW. Fine to medium pyroclastic material with signs of reverse graded bedding and inclination 15° to NW dominates in the higher part of the outcrop (2).

a) b)

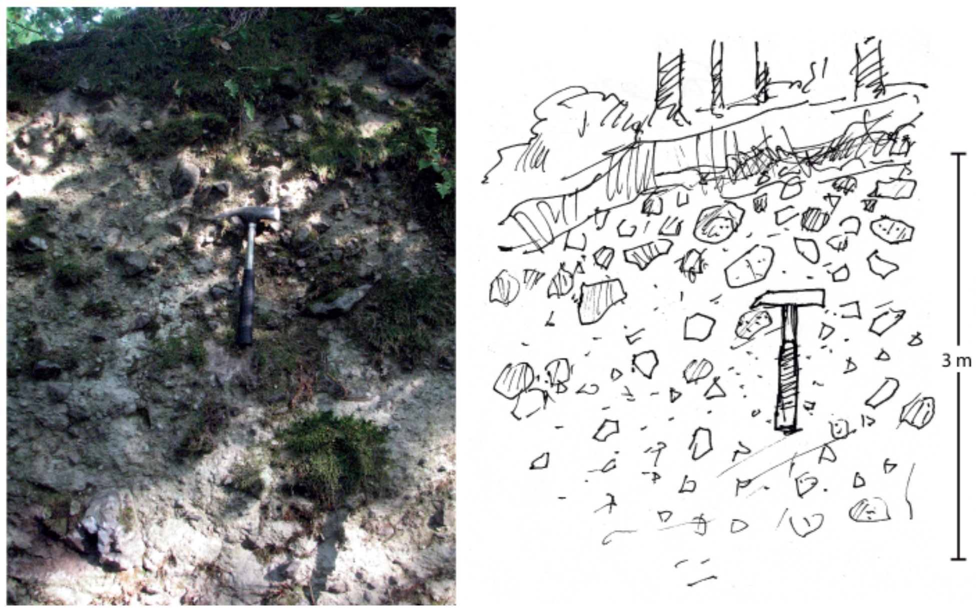


Fig. 60. Breccia with reworked pyroclastic material is exposed in cliff with length about 10 m and hight 3 m on the ridge with e.p. 973 Zrazy on the northern slopes of the Hájna hora Hill at altitude 910 m a.s.l. Pyroclastic material with dimensions 5–8 cm (rare to 10 cm) is angular to subangular, smaller fragments with vesiculated structure are spheroidal to subspheroidal in shape. Deposition of pyroclastic material shows reversal gradation with inclination to NW.

debris flows transporting beside fine tuffaceous material also coarse to blocky material, originated on the higher slopes of stratovolcano due to disturbance in stability of incoherent watter saturated volcanic material (heavy rains, seismicity, etc.). Following movement of lahars to western base of stratovolcano and through paleovalley further to west was controlled by the gravitational energy. According to dimensions of clastic material, two categories of lahar breccias were distinguished: a) coarse to blocky lahar breccias, b) fine to medium lahar breccias.

Coarse to blocky lahar breccia is exposed in rock cliffs on the northern slopes of Hájna hora Hill (Fig. 64a, b, c).

Coarse to blocky lahar breccia is identified also in the lower levels of northern slope of Hájna hora Hill (Fig. 65).

Several outcrops of coarse to blocky lahar breccia are found in the western part of volcanosedimentary complex on the norhwestern ridge Suchá at level 790 m a. s. l. Lahar breccia consists of subangular to angular fragments and blocks from 5–8 cm up to 80 cm and partly from fragments spheroidal in shape and have vesiculated structure. Matrix is tuffaceous with higher content of pumice. Deposition of clastic material is chaotic.

Bodies of fine to medium lahar breccias occur in different levels of volcanosedimentary complex, these are

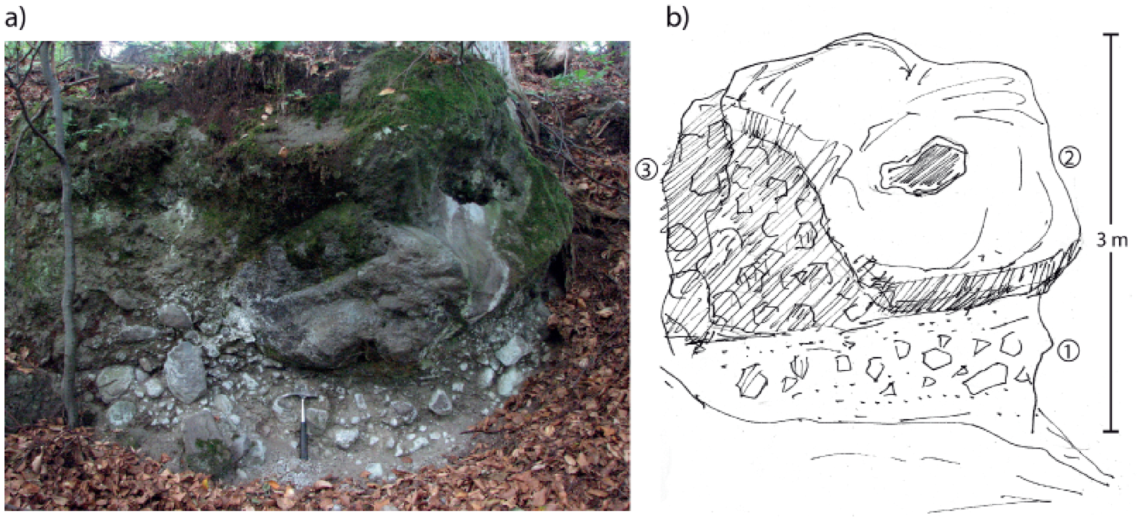


Fig. 62. Block of primary volcanic structure with dimensions 3 x 6 m is exposed on the northern slope of the Hájna hora Hill at level 875 m a.s.l. In the lower part of the outcrop there is a chaotic pyroclastic breccia with ash-tuff matrix (1). In the right side of the outcrop above pyroclastic breccia there is andesite block (2) with strongly vesiculated structure and lithophyses after escaping gasses. On the left side of andesite block there is strongly agglutinated pyroclastic breccia (3).

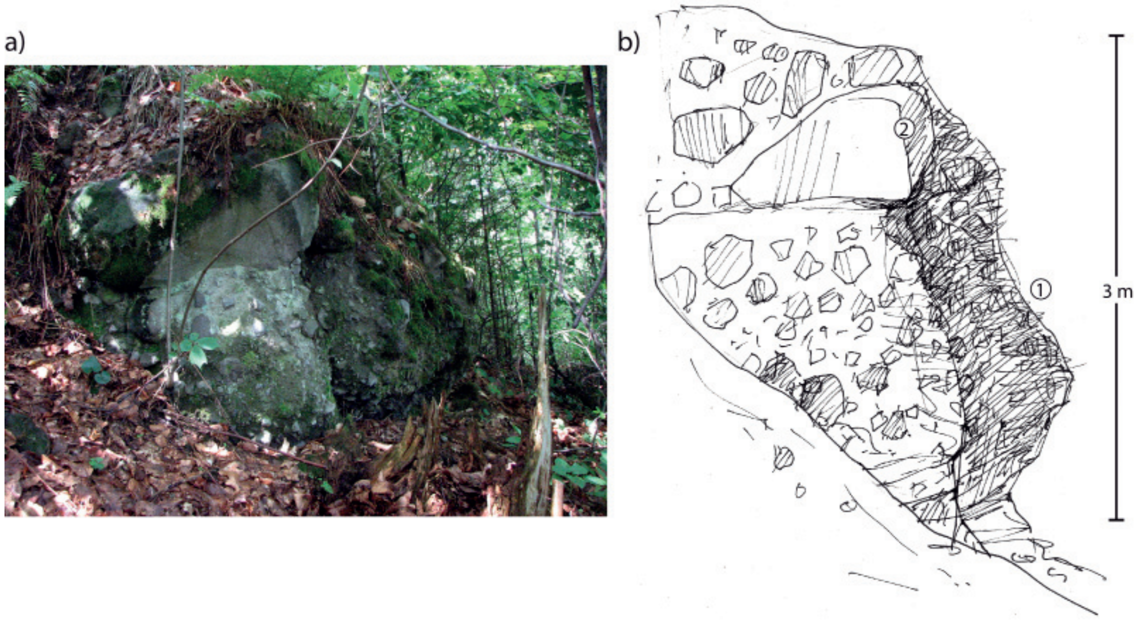


Fig. 63. Reworked pyroclastic breccia with length 5 m and height 3 m is exposed on the northern slopes of the Hájna hora Hill at level 878 m a.s.l. Breccia with pyroclastic fragments of angular, subangular and spheroidal shapes and dimensions 3–15 cm, forming lower part of outcrop, is roughly sorted and bedded (1). Matrix is tuffaceous without signs of welding. Breccia is covered in the upper part of outcrop with coarse to blocky epiclastic volcanic breccia-conglomerate (2).

more frequent in the western part of this complex. Fine to medium lahar breccia is exposed in outcrop on the northern slope of the Suchá ridge at western edge of volcanosedimentary complex (Fig. 66).

Andesite fragments of several petrographic types in lahar breccia are evidently derived from different levels of eroded volcanic stucture. Part of clastic material, especially well rounded fragments, was mobilized from fluvial sediments on the paleovalley bottom during the transport of lahar. Bodies of lahars with fine to medium breccia are identified also on the northern and western slopes of Koreňová ridge at level about 840 m a.s.l. and also on southern slopes of the Hájna hora Hill at level 850 m a.s.l.

Coarse to blocky epiclastic volcanic breccias as well as lahar breccia often contain clastic material of several petrographic types, derived by destruction of primary pyroclastic and epiclastic deposits and also from andesite bodies from different levels of volcanic structure. In contrast to lahars, the deposits of epiclastic volcanic breccias exhibit signs of sorting and bedding of clastic volcanic material, what indicates the fact that their depositon was not a result of single one event as in the case of lahars. Beds of coarse to blocky epiclastic volcanic breccias are frequent in different levels of volcanosedimentary complex of the Hájna hora Hill.

Coarse to blocky epiclastic volcanic breccia is exposed on the western slope of the Hnusné ridge in the western part of volcanosedimentary complex (Fig. 67).

Fine to medium epiclastic volcanic breccia similarly as the coarse and blocky epiclastic volcanic breccia is present in different levels of volcanosedimentary complex. Breccia of this type is characterized with dominancy of fragments from several cm up to 15–20 cm and with signs of sorting and bedding. Fine to medium epiclastic volcanic breccia

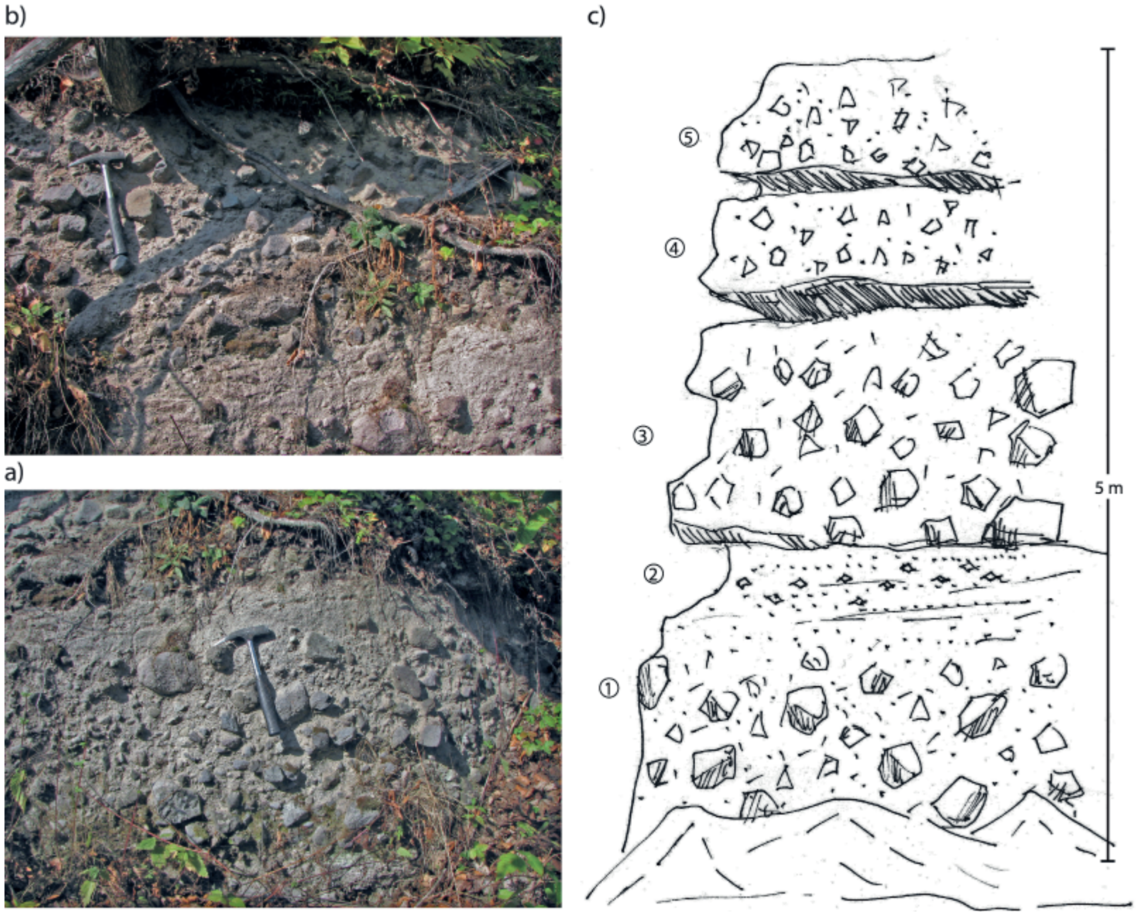


Fig. 64. Rock cliff with several bodies of lahar breccia, length 10–15 m, hight 4–5 m, altitude 910 m a.s.l., is exposed on northern side of the Hájna hora Hill. In the lower part of outcrop there is a coarse to blocky epiclastic volcanic breccia dominantly with angular to subangular fragments of dimensions 5–30 cm (photo a, scheme c/1). Clastic material shows positive (normal) gradation with transition to coarse epiclastic volcanic sandstone and to fine epiclastic tuffaceous sandstone with pumice in the uppermost part (photo a, b, scheme c/2). Above lower epiclastic volcanic breccia there follows the coarse to blocky chaotic lahar breccia (photo b, scheme c/3) with sharp base on underlying tuffaceous sandstone with pumice. Lahar breccia consists of fragments and blocks of variable dimensions from 5 to 20–30 cm and rare up to 40 cm. Smaller fragments are angular to subangular in shape, some larger fragments are partly rounded. According to petrography, the clastic volcanic material belongs dominantly to medium and coarse porphyric amphibole pyroxene andesite with phenocrysts of plagioclase (2–3 mm), pyroxene (1–2 mm) and amphibole (3–4 mm, rare to 8 mm). Matrix is sandy tuffaceous, grey, with smaller andesite fragments and with higher content of pumice. Distribution of fragments and blocks is chaotic. Two lahar bodies with smaller thickness follow in higher part of the cliff (scheme c/4, 5). Mobilization of lahar bodies probably took place in a close relation with explosive activity. This is confirmed by presence of pumice rich tuff at the base of lahar No. 3 and also dispersed pumices in matrix of lahar No. 3.

is exposed on the northern slope of the Suchá ridge in western part of volcanosedimentary complex (Fig. 68a, b).

Lihological profile of several facies of volcaniclastic rocks is exposed in eastern part of volcanosedimentary complex on the northern slopes of Hájna hora Hill (Fig. 69).

Fig. 65. Outcrop of coarse to blocky lahar breccia with length 10 m and hight 2–3 m is exposed on the northern slope of Hájna hora Hill at level about 885 m a.s.l. Fragments and blocks of variable dimension (5–10 cm) and blocks up to 50 cm are dominantly angular to subangular in shape and some greater blocks are rounded (right above hammer). Clastic material belongs to several varietes of amphibole pyroxene and pyroxene andesites: 1 – fine porphyric pyroxene andesite with amphibole, 2 – medium amphibole pyroxene andesite, 3 – fine porhyric to aphanitic pyroxene andesite, 4 – strongly vesiculated pyroxene andesite. Matrix is sandy tuffaceous with higher content of smaler andesite fragments. Distribution of clastic material is chaotic.

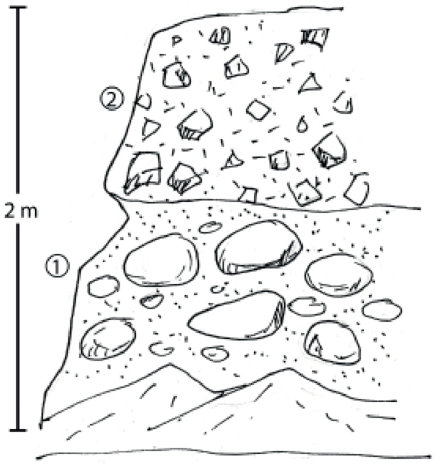


Fig. 66. Fine to medium lahar breccia is exposed in rock cliff with length about 10 m and hight 2 m on the northern slope of Suchá ridge at level 710 m a.s.l. In lower part of outcrop a coarse to blocky conglomerate is exposed (1). Above there follows fine to medium lahar breccia with fragments dominantly of dimensions 5–15 cm, rarely to 30 cm with variable shape from angular, subangular to partly well rounded (2). Fragments of pyroclastic type (vesiculated and primary subsspheroidal) are scarse. Matrix is tuffaceous, sandy, with higher content of small angular fragments and pumices. Chaotic distribution of clastic material. Different petrographic types of andesite fragment are present: 1 – medium to coarse porphyric pyroxene amphibole andesite (with amphibole to 3–4 mm), 2 – light grey low vesiculated fine porphyric to afanitic pyroxene andesite, 3 – fine porphyric pyroxene andesite (± amphibole).

Outcrops of epiclastic volcanic breccia continue in cliffs on lower slopes of the Zrazy ridge (Fig. 70a, b).

Several outcrops of fine to medium epiclastic volcanic breccia continue in lower levels of Zrazy ridge on northern slope of the Hájna hora Hill (Fig. 71a, b, c).

Other outcrops of epiclastic volcanic breccias alternating with epiclastic volcanic sandstones and conglomerates are exposed on the nothern slope of Hájna hora Hill at level 920 m a.s.l. (Fig. 72a, b).

Fine to medium epiclastic volcanic breccias are present also in lower levels of volcanosedimentary complex of the Hájna hora Hill at level 835 m a.s.l. (Fig. 73a, b).

Coarse to blocky epiclastic volcanic breccia-coglomerate represent complex facies, including bodies of coarse to blocky conglomerates and also coarse to blocky epiclastic volcanic breccias. This complex of facies was accepted for mapping for the cases when thick cover of Quaternary sediments can not allow to distinquish individual facies and these are evaluated only from stony debris. In other case, the complex of facies of epiclastic volcanic breccia-conglomerates is used when in outcrops with vertical dimensions several layers with rounded and angular epiclastic volcanic material alternate (Fig. 74a, b).

Facies of coarse to blocky epiclastic volcanic breccia-coglomerates are frequent also on the southern slopes of Hájna hora Hill bellow e.p. 850 Suchá in western part

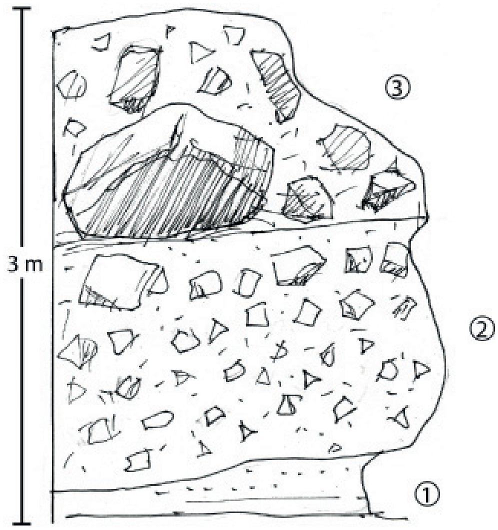


Fig. 67. Outcrop of coarse to blocky epiclastic volcanic breccia with length 5 m and hight 3 m occurs on the western slope of Hnusné ridge at level 895 m a.s.l. Epiclastic volcanic sandstone is exposed in the lower part of outcrop (1). Epiclastic volcanic breccia follows above epiclastic volcanic sandstone (2). Breccia with angular to subangular fragments with dimensions from 4 to 10 cm (rarely up to 20 cm) shows reverse gradation. Matrix of epiclastic volcanic sandstone represents about 40–50 % of volume. Coarse to blocky epiclastic volcanic breccia forms the uppermost part of outcrop. Andesite fragments and blocks of variable dimensions from 5 to 30 cm (rarely to 60 cm) are angular to subangular, some blocks are partly rounded. Matrix of epiclastic volcanic sandstone contains amounts of smaller andesite fragments. Clastic material has normal gradation with larger blocks accumulated at the base. Another outcrops of coarse to blocky epiclastic volcanic breccia are documented on northern slope of the Hájna hora Hill at level 910 m a.s.l.

of the volcanosedimentary complex at levels 785 m and 810 m a.s.l. (see geological-lithological map of Hájna hora Hill volcanosedimentary complex).

Facies of fine to medium epiclastic volcanic breccia--conglomerate includes volcaniclastic beds with clastic material of variable degree of rounding from agular, subangular to partly rounded and also well rounded andesite fragments of conglomerate type. Clastic material is dominantly of dimensions 5–20 cm. Facies of fine to medium epiclastic volcanic breccia-conglomerate is present in diferent levels of volcanosedimentary complex. Number of outcrops of fine to medium epiclastic volcanic breccia-conglomerates are found mainly on very steep northern slopes of the Hájna hora Hill (Fig. 75a, b).

More outcrops of this facies are identified in the western part of volcanosedimentary complex on northern slope of Hnusné at level 780 m a.s.l. and also on the southern slope of the Hájna hora Hill e.p. 871 Kabátovo at level 825 m a.s.l. (see geological-lithological map of the Hájna hora Hill volcanosedimentary complex and lithological sections).

Epiclastic volcanic sandstones (often with intercalations of andesite gravels and pumices) occur as an individual layers separating bodies of pyroclastic and epiclastic volcanic breccias and conglomerates. Thickness and lengths of individual layers of epiclastic volcanic sandstone is variable in a great scale. In a case when thickness and length of invidual layers is sufficient, they are expressed in

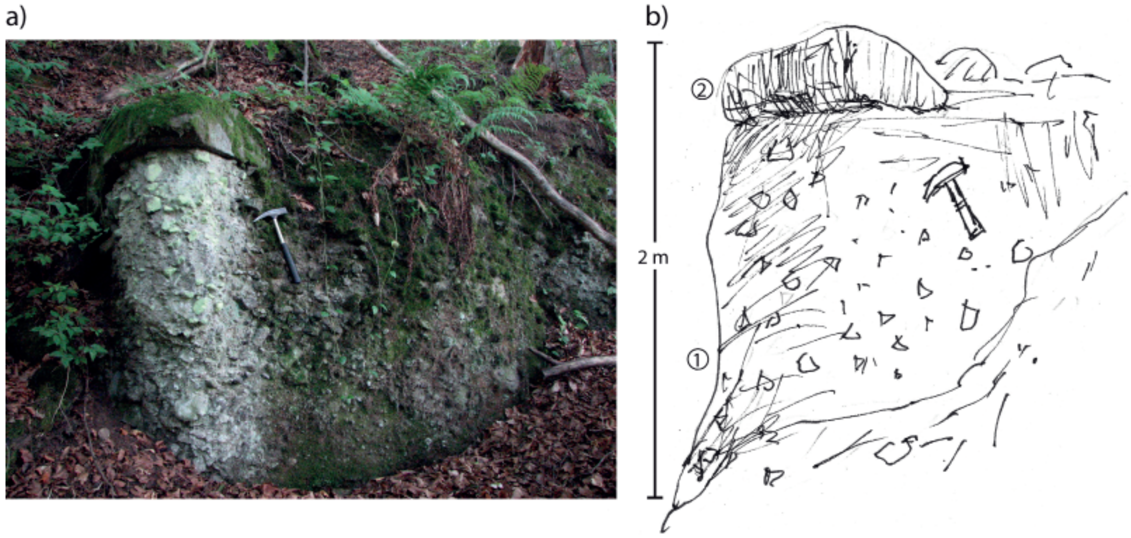


Fig. 68a, b. Epiclastic volcanic breccia is exposed in the outcrop with length 8 m and hight 2 m on the norhern slope of the Suchá ridge at level 750 m a.s.l. Clastic material, angular to subangular in shape with dimensions from several cm to 10 cm (rare to 20 cm), is sorted with local signs of bedding (photo a, scheme b/1). Sporadic fragments of primary spheroidal shape with vesiculated structure (pyroclastic fragments) are also present. Matrix is formed by coarse epiclastic volcanic sandstone with smaller angular fragments. In the uppermost part of outcrop there follows a bed of block conglomerate (scheme b2).

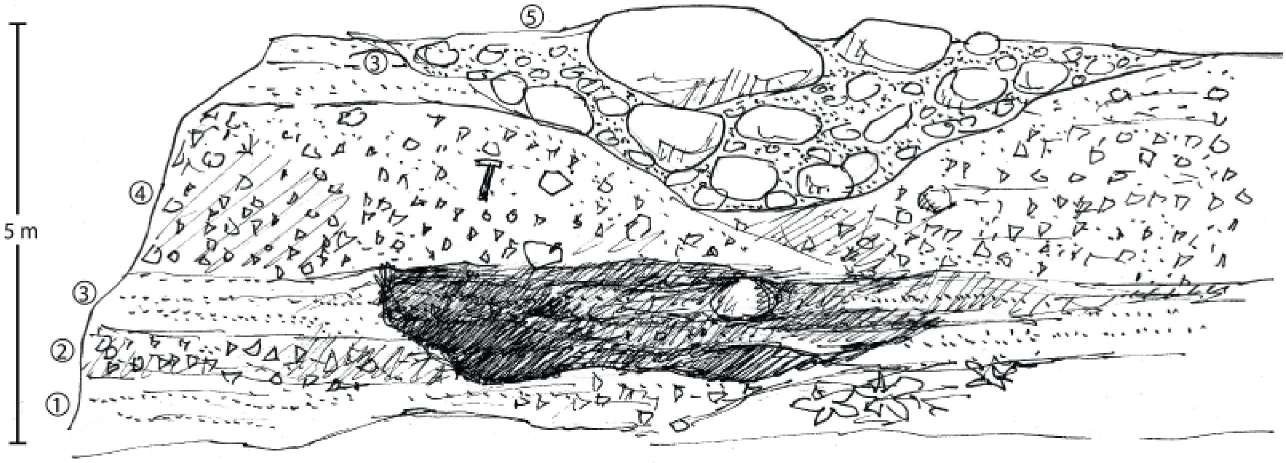


Fig. 69. Volcaniclastic rocks are exposed in rock cliff with length about 15 m and hight 5 m on the Zrazy ridge at level 935 m a.s.l. Two layers of fine to medium epiclastic volcanic breccia were distinguished. Lower epiclastic volcanic breccia with angular to subangular fragments up to 5 cm (2) with thickness about 30–50 cm alternates with two layers of coarse-grained epiclastic volcanic sandstones (1, 3). The second thicker body of epiclastic volcanic breccia (4) contains angular to subangular fragments dominantly with dimensions from several cm to 10 cm. Matrix is sandy and tuffaceous. Clastic material is sorted and deposited with normal graded bedding. Body of epiclastic volcanic breccia is dissected in the upper part by erosive channel filled-up with coarse to blocky epiclastic volcanic conglomerate (5).

geological map and lithological sections. Otherwise they are documented only in schemes and in photos.

Volcanic material of epiclastic volcanic sandstones comes from primary pyroclastic ash-tuff deposits as well as from weathering and destruction of pyroclastic and epiclastic deposits and lava bodies on stratovolcanic slope. Sandy-tuffaceous volcanic material was episodically transported from slope of stratovolcano with gravity flows (lahars, hyperconcentrated flows) and with dilute ephemeral streams and deposited in paleovalley an/or transpoted further to the west in the area of proluvial plain.

Layers of epiclastic volcanic sandstones show a great variability in lithology and textures.They vary from fine grained to coarse grained epiclastic volcanic sandstone, often with intercalations of andesite gravels. Local intercallations of pumice documents temporal explosive eruptions. In relation to type of transport of sandy and ash material and conditions of its deposition, a large scale of textures were observed as normal and reversal graded bedding, cross bedding, masive and other textures.

Facies of fine epiclastic volcanic conglomerates and sandstones is represented with rounded clastic material (pebbles) with dimensions from several cm to 15 cm. Fine epiclastic volcanic conglomerates form intercallations and irregular layers of small thicknes within beds of epiclastic volcanic sandstones. Textures of cross bedding and subhorizontal bedding are often observed. When their thickness and extent are sufficient, they are expressed in geological-lithological map. More continuous beds of fine epiclastic volcanic conglomerates occur in the western part of volcanosedimentary complex on the western slope of e.p. 860.3 Koreňová at several levels and also in eastern part of Hájna hora Hill (see lithological sections Nos. 1 and 11). Beside volcanic material, the pebbles of quartz and crystalline rock are often present.

Summary about lithologies of paleovalleys filling on the western slope of the Vepor stratovolcano

The Klenovský Vepor paleovalley represents relatively the most shallow level of erosive cut within paleovalleys in the SW sector of the stratovolcano. Bottom of the paleovalley at the eastern edge is 1050 m a.s.l., westward it is gradually decreasing to around 950 m a.s.l. At the bottom of the paleovalley fluvial gravels and sands with volcanic and non-volcanic material are deposited. Pebbles of several petrographic types of andesites (1 – fine-grained pyroxene andesite, 2 – fine- to medium-grained porphyric amphibole pyroxene andesite, 3 – medium- to coarse-grained clinopyroxene amphibole dacitic andesite to dacite and 4 – coarse-grained amphibole pyroxene andesite rich in plagioclase with size up to 3–4 mm) point to the fact that at the time of erosive cut the volcanic structure, subjecting the

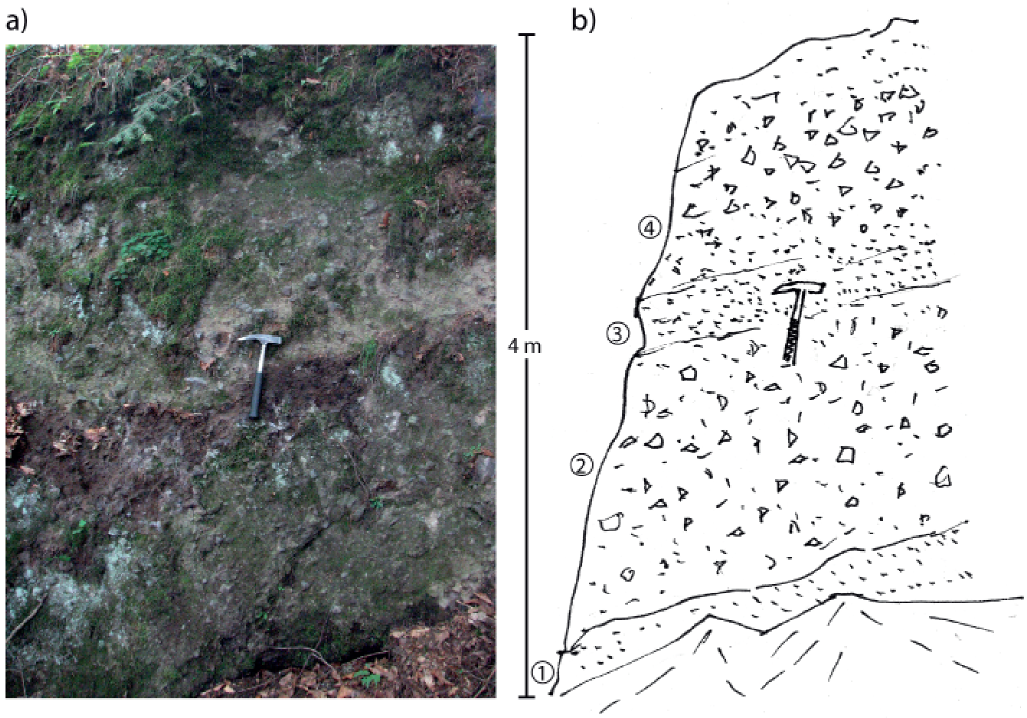


Fig. 70a, b. Fine to medium epiclastic volcanic breccia is exposed in cliff with length ca 20 m and height 3.5 m on the northern slope of the Zrazy ridge at level 930 m a.s.l. Epiclastic volcanic sandstone is exposed in the lower part of the cliff (1). Above epiclastic volcanic sandstone there follows the volcanic breccia with chaotically distributed fragments of angular to subangular shape and with dimensions 5–8 cm (2). Fragments belong dominantly to amphibole pyroxene andesite. Matrix is sandy tuffaceous with higher content of pumice. Breccia corresponds to debris flow (lahar). Thin layer of epiclastic volcanic sandstone follows higher in lithological profile (3). Medium to coarse epiclastic volcanic breccia forms the uppermost part of the cliff (4). Angular to subangular andesite fragments with dimensions dominantly from 5 to 10 cm are present. Matrix is sandy-tuffaceous. Clastic material is sorted with reverse gradation in the lower part of the body and normal gradation in its upper part. The volcaniclastic sequence inclines about 15° to NW.

Fig. 71. Epiclastic volcanic breccia is exposed in small cliff with height about 4–5 m on the Zrazy ridge at level 925 m a.s.l. Fine to medium epiclastic volcanic breccia at lower part of cliff consists dominantly of angular to subangular andesite fragments with dimensions from 5 cm to 15 cm rarely up to 20 cm (foto a and scheme c/1). Partly rounded and well rounded fragments are scarse. Matrix is sandy-tuffaceous with higher content of pumice. In the lower part of the outcrop a reverse gradation of clastic material is observed (foto a, scheme c/1). On the top of the cliff there is well rounded andesite block with dimension 3 x 2 m from overlying conglomerate bed (foto b, scheme c/2).

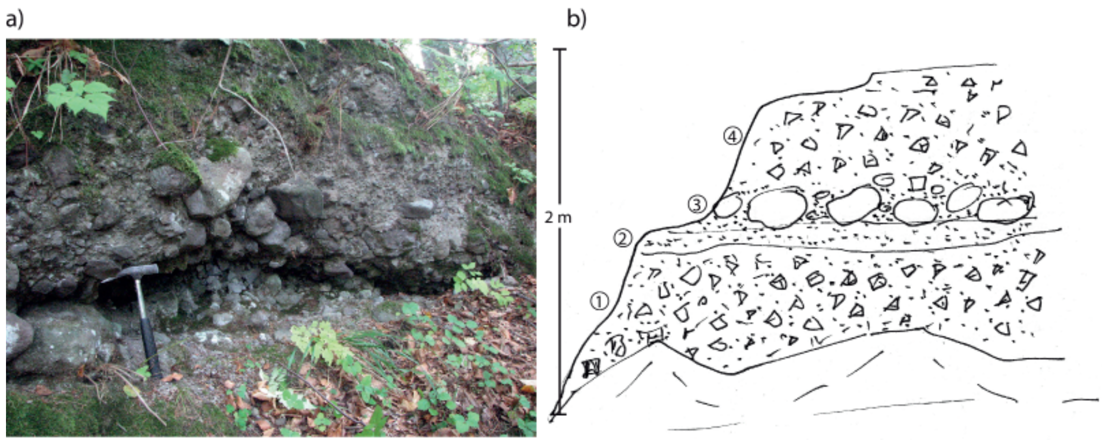


Fig. 72. Epiclastic volcanic breccia with angular to subangular fragments with dimensions dominantly 5–15 cm is exposed in the lower part of outcrop (1 in scheme b). Layer of epiclastic volcanic sandstone following above breccia (2 in scheme b) is disturbed in the upper part with deposition of coarse epiclastic volcanic conglomerate (3 in scheme and foto a). Fine to medium epiclastic volcanic breccia forms upper part part of outcrop (4 in scheme). Breccia consists of angular to subangular fragments up to 10 cm with normal graded bedding.

denudation, was already in advanced stage of development and has been built by wider range of petrographic types of andesitic rocks. Within paleovalley in the following period the temporary fluvial flows have deposited rounded fragments and blocks of andesite material (mostly pyroxene aphanitic to fine porphyric andesites), as a medium to coarse facies of epiclastic volcanic conglomerates and breccia-conglomerates. Its transport and deposition to a paleovalley indicates continuing growth and expansion of stratovolcanic structure. The presence of pumices in the tuff, deposited below the lava flow, indicates explosive activity, preceeded effusive activity. Lava flows after entering the paleovalley moved southwest and followed the configuration of the paleovalley westward turning. Base of the lava flow at the eastern edge decreases from 1250 m to 1100 m a.s.l. The difference is about 150 m. K/Ar dating of pyroxene andesite lava flow to 11.56 ± 0.43 Ma, corresponds to Sarmatian period.

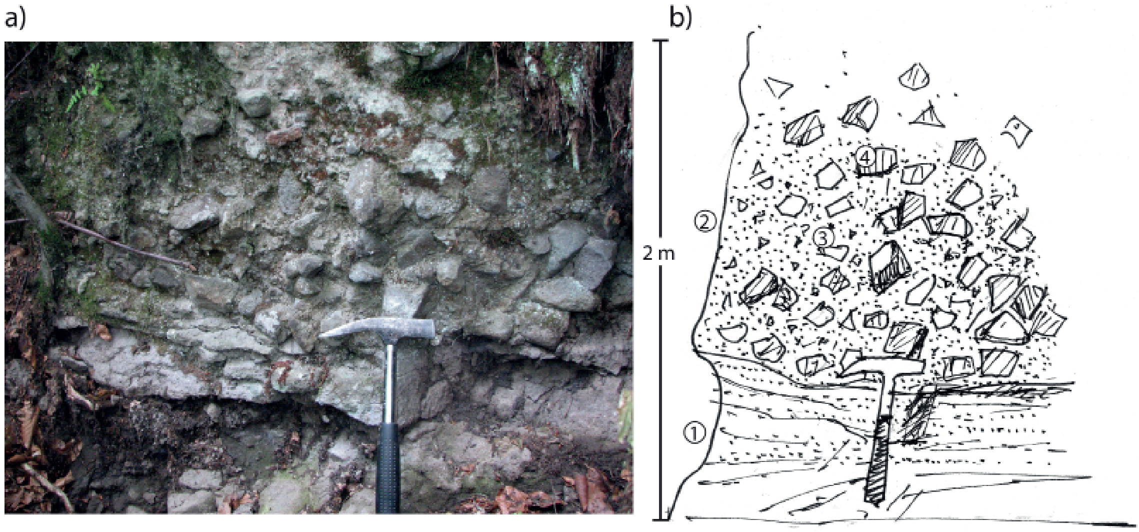


Fig. 73a, b. Bedded epiclastic volcanic sandstone with higher content of dispersed pumice is exposed in the lower part of outcrop (foto a, scheme b 1). Layer of epiclastic volcanic sandstone is disturbed in its upper part with deposition of epiclastic volcanic breccia (foto a, scheme b 2). Breccia consists of angular to subangular andesite fragments dominantly with dimensions 5–10 cm. Blocks of underlying crystalline rocks are present only seldom. Deposition of clastic material shows normal graded bedding.

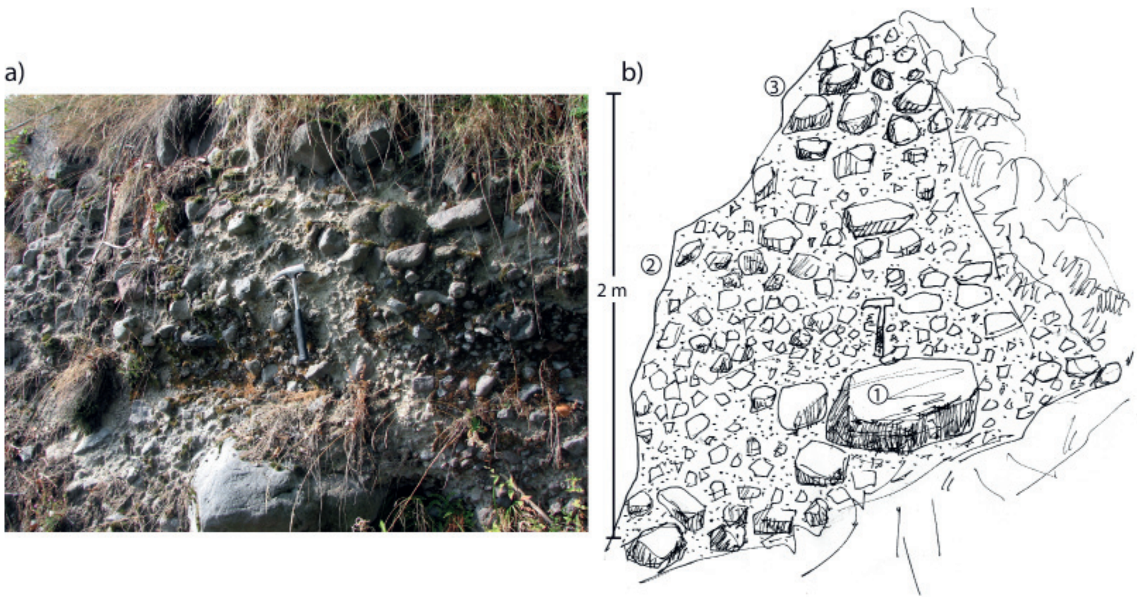


Fig. 74a, b. Rock cliff with length about 10 m and height 15 m is situated on the northern slope of the Hájna hora Hill bellow e.p. 931 at level 830 m a.s.l. Coarse to blocky angular and partly rounded andesite material with blocks about 30–40 cm up to 70 cm is exposed on lower part of the rock wall (No. 1 in scheme b). Medium to coarse epiclastic volcanic breccia follows in the middle part of rock wall (No. 2 in scheme b). Angular to subangular fragments with dimension from 5 to 20 cm (rare to 30 cm) show reverse gradation. Coarse to blocky breccia-conglomerate with material partly rounded, angular to subangular of dimensions up to 35 cm with normal graded bedding is exposed in the uppermost part of the cliff (3). Middle part of outcrop is shown in foto a (No. 2 in sheme b).

The paleovalley Zadná Kýčera on the northern slope of the Klenovský Vepor ridge has SW orientation according denudation relics. Comparing this paleovalley with the Klenovský Vepor paleovalley, it has relatively deeper erosive cut, its bottom at the eastern edge is at 960 m a.s.l. and in the SW direction it slightly decreases to the level of 920 m a.s.l. Like in case of the Klenovský Vepor paleovalley, at the base of erosive cut there is deposited layer of fluvial sediments in the form of sand and gravel with volcanic and non-volcanic material. The pebble material is represented by similar petrographic types of andesites as in the Klenovský Vepor paleovalley. Above the basal layer there is stored coarse to block clastic material of pyroxene and amphibole pyroxene andesites (coarse to blocky epiclastic volcanic conglomerates and medium to coarse epiclastic volcanic conglomerates). Higher part of the original filling of the paleovalley has been removed by denudation.

Paleovalley Zvadie is represented by a single denudation remnant oriented in the W–E direction, just south of the Chlípavica village (NE from paleovalley Zadná Kýčera). Unlike paleovalley Kýčera, the base fillings of the paleovalley is situated lower in the level of 925 m and lithological character of the filling is also different. On the base of crystalline rocks, there are deposited medium to coarse epiclastic volcanic conglomerates, at higher position lahar breccia and above there is chaotic breccia of pyroclastic flow. The overall direction of original paleovalley is not possible to decide from one single denudation remnant. Lithology of this relic corresponds to its position closer to the expected margin of the stratovolcanic slopes.

The paleovalley of the Hájna hora Hill, located in the NW sector, represents the most comprehensive and relatively preserved original paleovalley filling at the western foot of the stratovolcanic structure. To understanding the structure of lithological filling, beside compilation of lithological--lithofacial map at a scale 1 : 10 000, there contributed the compilation of a series of lithological profiles in the area of the ranges in the northern and southern slopes of the Hájna hora Hill at the same scale (App. 6). Lithological profiles arranged in two parallel lines in accordance with the orientation of the major axis of the paleovalley in the direction WWN–EES enable to imagine the position and lateral changes of individual facies in filling of the paleovalley from the eastern to the western edge. Northern line starts at the eastern edge of the range east of elevation 973 Zrazy, and ends in the west at the foot of the ridge with e.p. 860.3 Koreňová. Southern line begins similarly in the eastern part south of the e.p. 973 Zrazy and ends on the western edge at the western foot of the range Ungrová (e.p. 759). Schematic section of the paleovalley filling of the Hájna hora Hill is in Fig. 76.

The bottom of the paleovalley at the eastern edge is situated at 800 m a.s.l. In the direction to the west the bottom gradually deepens and at the end of southern line it is at around 700 m a.s.l. In the case of the northern side of Hájna hora Hill at the western edge, the more significant deepening is observed and bottom of the paleovalley is located at around 640 m a.s.l. (foot of the ridge under the e.p. 860.3 Koreňová). It follows that the more northward situated profile that is north edge of the Hájna hora complex, presents a more central, deeper part of the original paleovalley.

1 – Basal layer of the paleovalley represents fluvial sediments in the form of tuffitic sands and gravels rich

a) b)

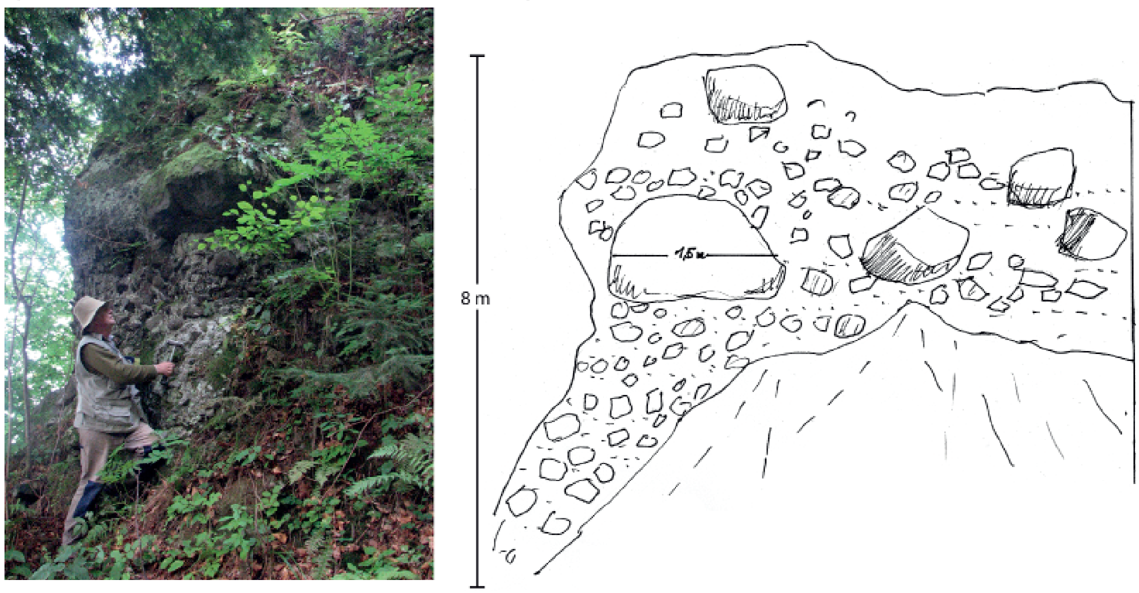


Fig. 75. Fine to medium epiclastic volcanic material from angular, subangular to partly rounded with dimensions from 5 cm to 15 cm is observed in the lower part of the outcrop on the northern slope of the Hájna Hora Hill at altitude 940 m a.s.l. (photo a, scheme b). Matrix is coarse sandy. Clastic material is sorted with signs of bedding. Several petrographic types of clastic material were distinguished: 1 – fine porphyric to aphanitic amphibole pyroxene andesite; 2 – medium to coarse porphyric pyroxene amphibole andesite (amphibole 2–4 mm). Big blocks up to 1.5 m partly rounded are present in the higher level of the outcrop.

in non-volcanic material, derived from eroded basement crystalline rocks. The intensive erosion and rapid deepening of the bottom of the paleovalley is indicated also in addition to the fine clastic material by the presence of larger blocks of rounded material of granitoids and crystalline schists up to the size 0.4–0.6 m.

2 – Products of acid explosive volcanism of rhyodacitic type in the form of chaotic breccia block and ash pyroclastic flow with a high proportion of ash-pumice component are deposited immediately above the basal bed at the western side on the slope of the ridge with e.p. 860.3. Petrographic composition of pyroclastic material corresponds to pyroxene-biotite-amphibole rhyodacite. Above there follows the redeposited rhyodacite tuffs. Deposition of pyroclastic flow represents the initiation of volcanic activity of acid volcanism before the formation of the andesite Vepor stratovolcano. At the eastern edge of the paleovalley, the presence of the block-ash flow layer in the basal level was not detected. Sporadically on the base of the filling there occur small fragments and rounded pebbles of rhyodacites in the layer of epiclastic volcanic sandstone. Large rhyodacite block is on the base of the filling on the southern slope south of the elevation 973 Zrazy. We assume that it is a block comming from the explosive destruction of extrusive dome, which was subsequently by gravitation transported and stored at the bottom of the paleovalley. The absence of the position of the block-ash flow and redeposited pyroclastic of acid volcanism on the bottom of the fillings of the paleovalley in its eastern part, is explained by it was primary missing or after its deposition the destruction took place, being followed by redeposition of material to lower levels of the paleovalley in the western part.

3 – Deposition of complex of epiclastic volcanic sandstones with intercalations of pumice tuffs and higher content of scattered pumice above basal bed in central and eastern parts of paleovalley indicates prevailing explosive activity at an early stage of development of andesite stratovolcano. The primary beds of ash and pumice material and pyroclastics deposited on the western slope of the stratovolcano was subjected to destruction, being followed by transport of material by flushing, ephemeral flows and gravitational flows (hyperconcentrated flows and debris flows) with deposition of redeposited material in the form of epiclastic layers on the bottom of the paleovalley.

4 – After deposition of epiclastic volcanic sandstones it was eroded and disturbed. This fact is indicated by numerous erosive cuts filled with boulder conglomerate material. Coarse to blocky andesite material demonstrates the rapid growth and spatial extension of primary stratovolcanic structure. Thicker and more continual beds of coarse and blocky conglomerates were deposited mainly in the central and western part of the paleovalley.

5 – Explosive eruptions in the next period of development of the stratovolcano took place at following periods, producing block and ash pyroclastic flows. These mass flows were derived mainly from the collapse of eruptive columns of Vulcanian type eruptions, or from explosive destruction of extrusive domes. These flows moved from the higher levels of the western slope stratovolcano and entered into paleovalley, where deposited their contents in the eastern and central part of paleovalley in the form of chaotic pyroclastic breccias. The presence of larger blocks of agglutinated pyroclastics suggests that the eruptions occurred during the destruction of the upper levels of volcanic structures in the near-crater zone. Except for block and ash flows, there was transported material into the space of the paleovalley on the western slope of the stratovolcano, which was derived from erosion and destruction of the original pyroclastic deposits and iwas deposited as redeposited pyroclastic breccias and tuffs. Facies of this type are present in the filling of the paleovalley at several levels especially in the eastern and central part of the paleovalley. In the western part of the paleovalley the facies of epiclastic type dominate with a prevalence of conglomerates.

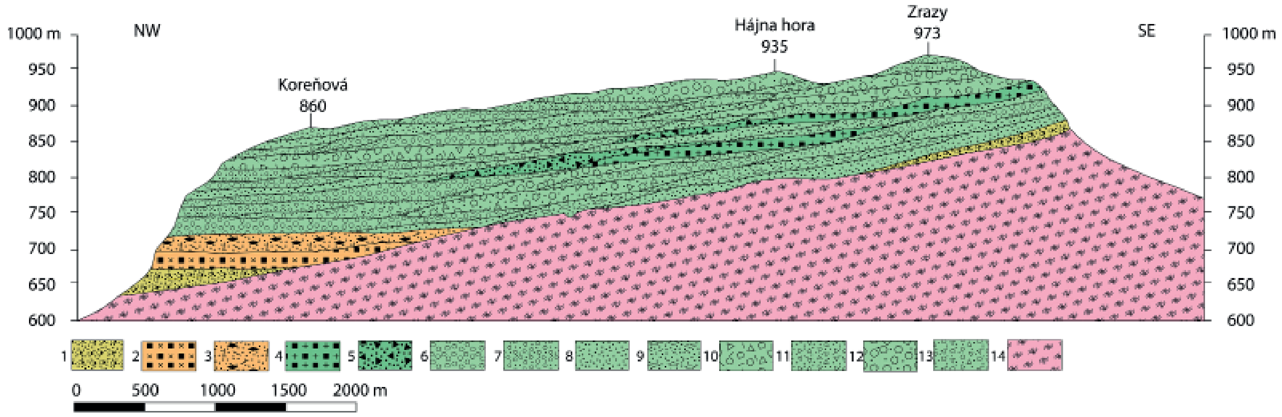


Fig. 76. Schematic section of volcaniclastic complex Hájna hora Hill in distal volcanic zone. 1 – basal beds, tuffitic sands with volcanic and non-volcanic gravels; 2 – chaotic breccia of pyroclastic flow with biotite, pyroxene, amphibole dacite to rhyodacite; 3 – reworked ash pumice tuffs and reworked pyroclastic breccia of dacite to rhyodacite; 4 – chaotic breccia of pyroclastic flow with material of amphibole pyroxene andesite; 5 – reworked pyroclastic breccia with material of amphibole pyroxene andesite; 6 – coarse to blocky epiclastic volcanic conglomerate; 7 – medium to coarse epiclastic volcanic conglomerate; 8 – epiclastic volcanic sandstone; 9 – epiclastic volcanic sandstone with layers of pumice and fine clastic volcanic material; 10 – coarse to blocky lahar breccia; 11 – fine to medium epiclastic volcanic breccia; 12 – coarse epiclastic volcanic breccia-conglomerate; 13 – medium epiclastic volcanic breccia-conglomerate; 14 – migmatites, orthogneisses, hybrid granitoids, less paragneisses and amphibolites, hybrid complex.

6 – Fine to coarse clastic volcanic material coming from denudated parts of volcanic structures was in advanced stage transported by fluvial streams and by gravitation into the paleovalley, where the material was deposited in the middle to upper levels of the paleovalley filling in the form of beds of coarse to blocky conglomerates and epiclastic volcanic breccias. The continued explosive eruptions during this period are indicated by intercalations of pumice tuffs in the layers of epiclastic volcanic sandstones, separating layers of conglomerates and epiclastic volcanic breccias. Another type of mass transport were lahars (hyperconcentrated flows and debris flows), resulting in deposition of volcanic bodies of epiclastic volcanic sandstones without signs of sorting, bedding and beds of lahar chaotic breccias. The presence of large blocks of diameter 3–4 m demonstrates the high gravitational energy that points to the steep and high relief of the western stratovolcanic slope in this more advanced stage of the stratovolcano development. Isolated large andesite blocks with laminar texture in the flat top of the Hájna hora Hills on the surface of volcanoclastic complexes represent probably denudation remnants of the original lava flows. This fact evidences the effusive activity producing lava flows at a more advanced stage of development of the stratovolcano. The above assumption is supported by the existence of relic lava flow on the top of the paleovalley filling of the Klenovský Vepor ridge.

Conclusion

The results of research on relics of volcanic and intrusive bodies exposed by denudation in the northwestern part of the Slovenské rudohorie Mts. (area of the Veporské vrchy hills) can be summarized as a follows:

– Evolution of volcanic activity occurred in subaerial (terrestrial) environment in the area with relatively flat and peneplenized relief, which is proved by the relics of Paleogene sediments preserved in local grabens (Breznianska kotlina Basin, Horehronské Podolie Valley and relics of Paleogene sediments below summit of the Magnetový vrch Hill).

– Areal distribution of relics of volcanic rocks (pyroclastic, epiclastic rocks and lava flows) and intrusive bodies, exposed by denudation, confirms the existence of volcanic structure of a great extent. The assumed volcanic structure - the andesite stratovolcano - was removed by later erosion due to postvolcanic areal uplifting of the northwestern part of the Slovenské rudohorie Mts.

– The central volcanic zone of supposed stratovolcano was identified by detail mapping of intrusive complex in larger area of the Magnetový vrch Hill (north of the Tisovec town), where the intrusive complex is uncovered by denudation in vertical extent of about 460 m. The stock-like diorite bodies, penetrating through the Hercynian granodiorite-granite massif are exposed in the lower part of slopes of the Rimava river valley. In higher slopes below Magnetový vrch Hill a several apophyses of diorite-like sills penetrate into Mesozoic carbonates. Petrological studies (especially xenoliths) and field research have confirmed the multistage evolution of the diorite subvolcanic complex.

– Origin of skarn mineralization (magnetite skarns) is associated with contact-metasomatic processes during emplacement of diorite sills within Mesozoic carbonate rocks.

– After formation of subvolcanic diorite complex (pluton), the intrusive activity in central volcanic zone continued by ascent and emplacement of laccoliths and shallow intrusive bodies of andesite to diorite porphyry at the northwestern side of the central diorite complex. Younger intrusive phase represents a magma ascent of dykes and dyke swarms with variable composition (from amphibole-pyroxene diorite porphyry to pyroxene-amphibole andesite porphyry and pyroxene andesite) with prevailing orientation to ENE–WSW. Areal extent of dyke system overpasses the dimensions of the central subvolcanic diorite complex. In the final stage of intrusive activity, the dykes and dyke swarms of basaltic andesites have originated. They are concentrated on the western slopes of the Pacherka ridge to SW of the central diorite complex. Basalt-andesite dyke system probably represents the feeding system of smaller parasitic volcano on the southwestern slopes of andesite stratovolcano.

– In the area of transitional volcanic zone (proximal zone), numerous intrusive and extrusive bodies of variable composition (from andesite to dacite and rhyodacite and from andesite porphyry to diorite porphyry) were studied, using geophysical methods. The forms like extrusive domes, laccoliths, stocks and necks were identified.

– A new Stožka (Kľak) volcano with smaller dimensions was defined in the area of Mesozoic carbonate complex (Silicicum nappe) to NNE of the central zone. The Stožka volcano consists of relics of pyroclastic cone with central neck of pyroxene andesite.

– Lithofacial analyses of volcaniclastic rocks in the filling of paleovalleys brought important information for further paleo-reconstructions of the development of volcanic activity in the studied territory, and Slovakia as well. According results of these analyses the explosive activity of dacite-ryodacite type preceeded andesite volcanism. Products of that activity like pyroclastic block and ash flows and pumice tuffs are deposited on the base paleovalley filling Hájna hora Hill south of the Brezno town. Early stage of andesite volcanism of explosive type represents deposition of thicker beds of ash pumice tuffs, reworked tuff and epiclasic volcanic sandstones in the lower part of paleovalley filling of the Hájna hora Hill. After eruptions of pumice-ash tuffs there follows the eruptions of pyroclastic block and ash flows. In a more advanced evolution of the stratovolcano, the effusions of the lava flows, occurred as it is proved by the relic of lava flow in the uppermost part of the filling of the paleovalley of Klenovský Vepor Hill

– From areal distribution of volcanic products and their lithology, the asymmetrical character of primary volcanic structure with maximum extent to south can be assumed, where the volcaniclastic products have deposited in the delta-lake environment, forming the Pokoradza Formation.

In the following paper (part II), there will be discussed the geological structures and lithology of volcanic relics as volcaniclastic rocks on the southern slopes of the Slovenské rudohorie Mts. and volcanosedimentary complexes of the Pokoradza Fm. of the Pokoradzská tabuľa and Blžská tabuľa plateaus. Moreover, in part II there will be presented the results of petrological studies of magmatic evolution, results and interpretation of radiometric K/Ar dating and paleovolcanic reconstruction of the Vepor stratovolcano evolution, related to development of southern sedimentary delta-lake basin of the Pokoradza Formation.

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References

Bacsó, Z., 1964: Potriasové skarnové ložiská pri Tisovci. *Geol. Práce, Zpr., 31, 13 – 45.*

Bacsó, Z. & Valko, P., 1969: Záverečná správa a výpočet zásob, 1. časť: Horehronie, lokalita Tisovec-Hnúšťa, prieskum nerastných surovín Fe, stav k 1. 11. 1968. GP. Spišská Nová Ves – GS Rožňava. *Manuskript. Archív Geofond, Bratislava, 200 s.*

Bezák, V., 1994: Návrh nového členenia kryštalinika Západných Karpát na základe rekonštrukcie hercýnskej stavby. *Miner. Slov., 26, 1 – 6.*

Bezák, V. (ed.), 2008: Prehľadná geologická mapa Slovenskej republiky 1 : 200 000. Mapový list 36 – Banská Bystrica. (Ed.: V. Bezák, M. Polák a V. Konečný; autori: A. Biely, M. Elečko, I. Filo, J. Hók, Ľ. Hraško, M. Kohút, J. Lexa, J. Madarás, J. Maglay, J. Mello, M. Olšavský, J. Pristaš, P. Siman, L. Šimon, D. Vass, J. Vozár). *Št. Geol. Úst. D. Štúra, Bratislava.*

Bezák, V. (ed.), Dublan, L., Hraško, Ľ., Konečný, V., Kováčik, M., Madarás, J., Plašienka, D. & Pristaš, J., 1999a: Geologická mapa Slovenského rudohoria 1 : 50 000 – západná časť. *GSSR, Vyd. D. Štúra, Bratislava.*

Bezák, V., Hraško, Ľ., Kováčik, M., Madarás, J., Siman, P., Pristaš, J., Dublan, L., Konečný, V., Plašienka, D., Vozárová, A., Kubeš, P., Švasta, J., Slavkay, M. & Liščák, P., 1999b: Vysvetlivky ku geologickej mape Slovenského rudohoria – západná časť, 1: 50 000. *GSSR, Vyd. D. Štúra, Bratislava, 178 s.*

Burian, J., Slavkay, M., Štohl, J. & Tözsér, J., 1985: Metalogenéza neovulkanitov Slovenska. *Alfa, Bratislava, 269 s.*

Davidson, J. and Shan de Silva, 2000: Composite volcanoes p. 663–681: In: Encyclopedia of volcanoes, ACADEMIC PRESS, London, 2000.

Elečko, M., Gaál, Ľ., Lexa, J., Mello, J., Pristaš, J., Vass, D. & Vozárová, A., 1985: Geologická mapa Rimavskej kotliny a priľahlej časti Slovenského rudohoria v mierke 1 : 50 000. *GÚDŠ, Bratislava.*

Hedberg, H., 1976: International Stratigraphic guide: A guide to stratigraphic classification, terminology and procedure. *J. Wiley and Sons, New York, 1 – 224.*

Ivanička, J., Bajaník, Š., Halouzka, R., Konečný, V., Lexa, J., Planderová, E., Dovina, V., Modlitba, I., Šucha, P., Kováčik, M. & Vážna, Ľ., 1986: Vysvetlivky ku geologickej mape 1 : 25 000, list Pohronská Polhora (36-241). *Manuskript. Archív GÚDŠ, Bratislava, 91 s.*

Klinec, A., 1976: Geologická mapa 1 : 50 000 – Slovenské rudohorie – stred, Nízke Tatry – východ. *GÚDŠ, Bratislava.*

Konečný, V., 1969: Litofaciálna analýza stavby vulkano-sedimentárnych formácií južnej periférie neovulkanitov. *Kand. dizert. práca. Manuscript. Archív GÚDŠ, Bratislava.*

Konečný, V., 1970: Vývoj neogénneho vulkanického komplexu Štiavnického pohoria. *Geol. Práce, Spr., 51, 5 – 43.*

Konečný, V., 1971: Evolutionary stages of the Banská Štiavnica Caldera and its postvolcanic structures. *Bull. Volc., XXXV, 95 – 116.*

Konečný, V., Pristaš, J. & Vass, D., 1979: Geologická mapa Ipeľskej kotliny a južnej časti Krupinskej planiny 1 : 50 000. *GÚDŠ, Bratislava.*

Konečný, V. & Lexa, J., 1995b: Structure of the Neogene stratovolcanoes in central Slovakia. *Proceedings XVth CBGA congress. Athens, Geological Society of Greece Spec. Publ., 4, 539 – 544.*

Konečný, V., Lexa, J. & Hojstričová, V., 1995a: The Central Slovakia Neogene volcanic field: A review. *Acta Vulcanologica (Pisa – Roma), 7, 2, 63 – 78.*

Konečný, V., Lexa, J., Šimon, L. & Dublan, L., 2001: Neogénny vulkanizmus stredného Slovenska. *Miner. Slov., 33, 159 – 178.*

Konečný, V., Kováč, M., Lexa, J. & Šefara, J., 2002: Neogene evolution of the Carpatho-Pannonian: An interplay of subduction and back arc diapiric uprise in the mantle. EGS Special Publication Series 1, 165 – 194.

Konečný, V. & Konečný, P., 2010: Paleovulkanická rekonštrukcia veporského stratovulkánu. Čiastková záverečná správa k projektu: Aktualizácia geologickej stavby problémových území Slovenska v mierke 1 : 50 000. *Št. Geol. Úst. D. Štúra, Bratislava.*

Korikovskij, S. P. & Miko, O., 1992: Nízkoteplotné sedimenty kraklovskej formácie veporidného kryštalinika. *Miner. Slov., 24, 381 – 391.*

Kuthan, M., Biely, A., Böhm, V., Čechovič, V., Fusán, O., Hovorka, D., Mazúr, E. & Regásek, F., 1963: Vysvetlivky k prehľadnej geologickej mape ČSSR 1 : 200 000, list Zvolen. *GÚDŠ, Bratislava, 132 s.*

Lexa, J. & Konečný, V., 1974: The Carpathian volcanic arc: A discussion. *Acta geol. Acad. Sci. hung., 8, 279 – 293.*

Lexa, J. & Konečný, V., 1979a: Relationship of the Carpathian volcanic arc to geodynamic evolution of the Pannonian Basin. *In: Geodynamic investigations in Czechoslovakia. Veda, Bratislava.*

Lexa, J., Konečný, V., Kaličiak, M. & Hojstričová, V., 1993: Distribúcia vulkanitov karpatsko-panónskeho regiónu v priestore a čase. *In: Rakús, M. & Vozár, J. (eds.): Geodynamický model a hlbinná stavba Západných Karpát. GÚDŠ, Bratislava, 57 – 70.*

Lexa, J., Konečný, V., Kováč, M. & Nemčok, M., 1995: Relationship among convergence back-arc extension and volcanism in the Western Carpathians during Neogene. Abstract in Europrobe workshops – Pancardi. *Slov. Akad. Vied, Bratislava, 65 – 66.*

Lexa, J. & Konečný, V., 1998: Geodynamic aspect of the Neogene to Quaternary volcanism. *In: Rakús, M. (ed.): iEGS expand the mantle Geodynamic development of the Western Carpathians. GÚDŠ, Bratislava, 219 – 240.*

Němejc, F., 1960: Zpráva o floristicko-stratigrafických výzkumech v neogénu karpatském (týka se hlavne jižního Slovenska). *Zpr. geol. Výzk. v Roce 1958, Praha, 112 – 114.*

Němejc, F., 1967: Paleofloristické studie v neogéne Slovenska. *Sbor. Nár. Muz. (Praha), Ř. B, 23, B/1, 1 – 32.*

Repčok, I., 1981: Datovanie niektorých stredoslovenských neovulkanitov metódou stop po delení uránu. *Západ.*

Karpaty, Sér. Mineral. Petrogr. Geochém. Metalogen., 8, 59 – 104.

Salters, J. M., Hart, S. R. & Pantó, 1998: Origin of Late Cenozoic volcanic rocks of the Carpathian arc, Hungary. *In: Royden, L. & Horwáth, F. (eds.): The Pannonian Basin. A study in basin evolution AA.PG. Memoir, 45, 17 – 26.*

Sitár, V. & Dianiška, J., 1979: Flóra v mladoterciérnych vulkanitoch od Vyšného a Nižného Skálnika. *Západ. Karpaty, Sér. Paleont., 4, 147 – 159.*

Póka, T., 1988: Neogene and Quaternary volcanism of the Carpatho-Pannonian region: Changes in chemical composition and its relationship to basin formation. *In: Royden, L. & Horwáth, F. (eds.): The Pannonian Basin. A study on basin evolution. AA.PG. Memoir, 257 – 276.*

Vojtko, R., 1999: Geológia a tektonika tisoveckého krasu a jeho okolia. Diplomová práca. *Manuskript. Archív PF UK, Bratislava, 1 – 77.*

Vojtko, R., 2000: Are there tectonic units derived from the Meliata-Hallstatt trough incomporated into the tectonic structure of the Tisovec karst? (Muráň karstic plateau, Slovakia). *Slovak Geol. Mag., 6, 4, 335 – 346.*

Vass, D., Elečko, M., Pristaš, J., Lexa, J., Hanzel, V., Modlitba, I. & Jánová, V., 1989a: Geológia Rimavskej kotliny. *GÚDŠ, Bratislava, 1 – 162.*

Vass, D., Bodnár, J., Elečko, M., Gaál, Ľ., Hanáček, J., Hanzel, V., Lexa, J., Mello, J., Pristaš, J. & Vozárová, A., 1989b: Vysvetlivky ku geologickej mape Rimavskej kotliny a priľahlej časti Slovenského rudohoria. *GÚDŠ, Bratislava, 187 s.*

Paleovulkanická rekonštrukcia neogénneho Veporského stratovulkánu (stredné Slovensko), časť I

Východne od areálu neogénneho vulkanizmu stredného Slovenska v oblasti kryštalinického masívu západného veporika sa nachádzajú sporadické relikty vulkanických a intruzívnych hornín neogénneho veku vrátane rozsiahlejšieho reliktu vulkanoklastických hornín Hájna hora východne od Brezna. K nim sa radia aj zvyšky vulkanoklastických hornín na južných svahoch Slovenského rudohoria, ktoré vo väčšom rozsahu budujú náhorné plošiny v podobe Pokoradzskej a Blžskej tabule pri severnom okraji Rimavskej kotliny. Súhrnne boli tieto relikty zmapované v súvislosti so zostavením prehľadnej geologickej mapy 1 : 200 000 (Kuthan et al., 1963). So zameraním na nerastné suroviny v podobe skarnovej mineralizácie boli v oblasti Magnetový vrch (severne od Tisovca) na základe prieskumných prác získané nové poznatky o stavbe intruzívneho komplexu (Bacsó, 1964, 1960). Mapovanie reliktov vulkanických a intruzívnych hornín v súvislosti so zostavením regionálnej mapy 1 : 50 000 Slovenské rudohorie-stred a Nízke Tatry-východ previedol Klinec (1976). V rámci monografie Metalogenéza neovulkanitov Slovenska (Burian et al., 1985) boli okrem záverov o metalogenéze územia západného veporika vyslovené aj názory o stavbe a pozícii vulkanických a intruzívnych telies v tejto oblasti. Výsledky štúdia a mapovania reliktov neogénneho vulkanizmu, ktoré previedli V. Konečný a Lexa, boli zahrnuté do zostavenia geologických máp regiónov v mierke 1 : 50 000 (Bezák et al., 1999; Elečko et al., 1985) a bližšie komentované v monografickej práci (Vass a Elečko et al., 1989). Výskumné práce, ktoré previedol v oblasti tisoveckého krasu Vojtko (2000), zahrnujú aj nové poznatky o pozícii a sukcesii intruzívnych telies v širšej oblasti Magnetový vrch, významné je najmä zistenie bazaltových dajok ako najmladšieho člena intruzívneho radu.

Nerovnaké úrovne poznatkov získaných v rôznych obdobiach výskumných prác pri uplatnení rozdielnych kritérií pri popise vulkanických a intruzívnych hornín a interpretácii ich foriem a štruktúr boli dôvodom prijatia a realizácie čiastkovej tematickej úlohy T 07/08 Paleovulkanická rekonštrukcia veporského stratovulkánu v rámci hlavnej úlohy Aktualizácia geologickej stavby problémových území Slovenskej republiky v mierke 1 : 50 000 (vedúci úlohy RNDr. Ľ. Hraško, PhD.). Cieľom tematickej úlohy bolo previesť systematické mapovanie reliktov neogénneho vulkanizmu v SZ časti Slovenského rudohoria v oblasti kryštalického masívu veporika, analyzovať formy a štruktúry vulkanických a intruzívnych hornín, ich mineralogicko-petrografické zloženie, ako aj definovať fácie vulkanoklastických hornín a ich pozíciu v rámci vulkanickej stavby. Na základe získaných poznatkov previesť v závere paleovulkanickú rekonštrukciu primárnej vulkanickej stavby predpokladaného veporského stratovulkánu odstráneného neskoršie denudačnými procesmi. Úloha bola realizovaná počas terénneho výskumu v rokoch 2008 až 2010 (V. Konečný a P. Konečný). V priebehu riešenia úlohy sa prejavila nutnosť spracovať v podrobnejšom meradle 1 : 10 000 relikty vulkanosedimentárnych hornín na južných okrajoch Slovenského rudohoria a v oblasti náhorných plošín Pokoradzskej a Blžskej tabule v rámci nadväzujúcej čiastkovej úlohy č. T 02/11 Geologické profilovanie a stavba produktov neogénneho vulkanizmu v severnej časti Rimavskej kotliny (pokoradzské súvrstvie). Táto druhá čiastková úloha bola realizovaná v rokoch 2011 – 2012.

Výsledky štúdia vulkanických a intruzívnych hornín v oblasti západného veporika získané v priebehu riešenia prvej čiastkovej úlohy sú prezentované v tejto prvej časti práce (časť I). Analýza stavby a litológie vulkanoklastických a vulkanosedimentárnych hornín na južných svahoch Slovenského rudohoria a pri severnom okraji Rimavskej kotliny (pokoradzská formácia) sú predmetom druhej časti prezentovanej práce (časť II). V tejto druhej časti uvádzame výsledky petrologického štúdia hornín a údaje K/Ar rádiometrického datovania vulkanických a intruzívnych telies. Súčasťou tejto druhej časti je paleovulkanická rekonštrukcia a evolúcia veporského stratovulkánu vo vzťahu k vývoju južného sedimentačného priestoru pokoradzskej formácie.

V oblasti centrálnej vulkanickej zóny zahrnujúcej širšiu oblasť Magnetového vrchu (cca 8 km SZ od Tisovca) bola detailným mapovaním do topografického podkladu 1 : 2 000 zostavená geologická mapa v mierke 1 : 10 000 (Appendix 1) a prevedená analýza intruzívneho komplexu s polyštadiálnym vývojom. Subvulkanická intrúzia (dioritový pluton) odkrytá hlbokým denudačným zrezom v nižšej úrovni svahov doliny riečky Rimavica strmo preráža cez hercýnsky granit – granodiorit v podobe štokov. Vo vyššej úrovni západného svahu doliny Rimavy pod Magnetový vrch intrúzia prechádza do niekoľkých apofýz prenikajúcich do mezozoických karbonátových hornín (wettersteinské vápence a dolomity stredného triasu). Pri kontakte intrúzie s karbonátovými horninami sú vyvinuté pásma magnetitových skarnov (v minulosti intenzívne ťažených pre železiarne v Tisovci) a sporadický výskyt Pb-Zn-Cu mineralizácie. Lokálne sú v podobe xenolitov v dioritovej intrúzii uzatvárané úlomky andezitových porfýrov pochádzajúce z deštrukcie starších prívodových systémov v súvislosti s umiestnením dioritovej intrúzie.

Nasledujúcim intruzívnym procesom v oblasti centrálnej vulkanickej zóny bol výstup a umiestnenie plytších lakolitových telies a prienikov andezitových až dioritových porfýrov pri SZ okraji dioritovej intrúzie. Cez dioritovú intrúziu prenikajú mladšie dajkové roje variabilného petrografického zloženia (od pyroxénických andezitových porfýrov, pyroxénicko-amfibolických andezitových porfýrov až do pyroxénických andezitov) s prevládajúcou orientáciou v smere VVS – ZZJ. Rozšírenie dajkových rojov presahuje rozmer dioritového subvulkanického komplexu. Najmladším členom intruzívnej sukcesie je dajkový roj bazaltických andezitov až bazaltov situovaný JZ od centrálneho dioritového komplexu (západné svahy chrbta Pacherka). Dajkový roj svedčí pravdepodobne o prítomnosti menšieho parazitického vulkánu na

JZ svahu veporského stratovulkánu. Pri severnom okraji centrálnej dioritovej intrúzie cez hercýnsky granodiorit – granitový masív preráža menšie teleso dioritu až dioritového porfýru štokového typu na svahu bočnej doliny Spuzlová a ďalšie menšie teleso na svahu v doline potoka Rimava.

V oblasti prechodnej (resp. proximálnej) vulkanickej zóny externe od centrálnej zóny vystupuje väčší počet extruzívnych a intruzívnych telies odhalených denudačným zrezom. Extruzívne a intruzívne telesá sa vyznačujú pestrým petrografickým zložením (od pyroxénických andezitov, hypersténicko-amfibolických andezitov s granátom, amfibol-pyroxénických andezitových porfýrov a amfibol-biotitických dacitov až do ryodacitov). Pri terénnom výskume s použitím metód geomagnetického profilovania boli identifikované telesá typu domatických extrúzií, typu lakolitov, strmých prienikov, štokov a nekov. Severne od centrálnej zóny v prostredí mezozoických karbonátových hornín muránskeho krasu bol identifikovaný relikt vulkánu Stožka (Kľak) menších rozmerov tvorený pyroklastickým kužeľom s centrálnym andezitovým nekom.

Relikty vulkanoklastických hornín západne od centrálnej vulkanickej zóny v pásme prechodu do periférnej (distálnej) vulkanickej zóny predstavujú zvyšky výplní pôvodných paleodolín, ktorými bol vulkanoklastický materiál transportovaný do väčších vzdialeností od vulkánu. Orientácia paleodolín je radiálna vo vzťahu k pozícii centrálnej vulkanickej zóny s postupne sa prehlbujúcou úrovňou dna v smere k západu. Litologická analýza vulkanoklastickej výplne paleodolín poskytuje významné informácie pre paleovulkanickú rekonštrukciu veporského stratovulkánu a vývoja vulkanických udalostí. Najrozsiahlejším reliktom výplne paleodoliny orientovanej v smere na SZ je vulkanosedimentárny komplex Hájna hora JV od Brezna v podobe horského masívu s plochým vrcholom v úrovni cca 930 m nad morom zvažujúcim sa postupne v smere na západ. Na báze výplne pri západnom okraji výplne paleodoliny sú uložené produkty explozívnej aktivity ryodacitového vulkanizmu v podobe blokovo-popolových prúdov a popolovo-pemzových prúdov (Appendix 5, Appendix 6). Ryodacitový vulkanizmus predchádzal vývoju andezitového veporského stratovulkánu. Počiatočné štádiá vývoja veporského stratovulkánu sa vyznačujú prevahou explozívnych erupcií popolovo-pemzových tufov uložených spolu s epiklastickými vulkanickými pieskovcami v spodných úrovniach výplne paleodoliny. V pokročilejšom štádiu vývoja stratovulkánu nasledovali erupcie blokovo-popolových prúdov, ktorými boli transportované aj bloky pyroklastík pochádzajúce z deštrukcie prikráterovej zóny. Ďalším typom masového transportu vulkanoklastického materialu boli úlomkové prúdy – lahary a hyperkoncentrované prúdy. V obdobiach dočasného vulkanického pokoja bol vo výplni paleodoliny ukladaný materiál pochádzajúci z deštrukcie vulkanickej stavby v podobe epiklastických vulkanických konglomerátov, konglomerátov – brekcií a epiklastických vulkanických pieskovcov.

Južne od Hájnej hory sú na severných svahoch Klenovského vepora sporadické relikty výplne paleodoliny Zadná Kýčera orientovanej v smere na VVS – ZZJ. Denudačné relikty predstavujú spodné až bazálne úrovne výplne pôvodnej paleodoliny v podobe epiklastických vulkanických konglomerátov a pieskovcov. Relikt výplne paleodoliny Zvadie SV od paleodoliny Zadná Kýčera reprezentuje v spodnej úrovni poloha epiklastického vulkanického konglomerátu, vyššie laharová brekcia a vo vrchnej úrovni brekcia pyroklastického prúdu.

Výrazný horský chrbát Klenovského vepora predstavuje výplň paleodoliny orientovanej v smere na JZ – SV až ZZJ – VVS. V spodnej úrovni výplne paleodoliny je uložený komplex fluviálnych sedimentov v podobe polymiktných štrkov a pieskov s nevulkanickým aj vulkanickým materiálom, vyššie nasledujú epiklastické vulkanické konglomeráty a konglomeráty – brekcie a v ich nadloží poloha redeponovaných pyroklastík s pemzami bezprostredne pod lávovým prúdom. Vrcholovú časť horského chrbta Klenovského vepora (1338,2) tvorí lávový prúd pyroxénického andezitu, ktorého báza je uklonená v smere na západ. Na základe morfológie reliktu lávového prúdu je možné usúdiť na zmenu orientácie pôvodnej paleodoliny zo smeru na JZ na smer ZZJ. Lávový prúd vo vrcholovej oblasti horského chrbta Klenovského vepora svedčí o efuzívnej aktivite v pokročilejších štádiách vývoja veporského stratovulkánu. Po odstránení hornín z oblasti svahov pôvodnej paleodoliny sa lávový prúd ako rezistentnejší element voči erózii ocitol v pozícii vrcholového chrbta a týmto predstavuje priam klasický prípad inverzie reliéfu.

Rozsiahlejšie denudačné relikty vulkanoklastických hornín na južných svahoch Slovenského rudohoria predstavujú výplne pôvodných paleodolín, ktorými bol vulkanoklastický materiál transportovaný ďalej na juh, kde bol deponovaný v sedimentačnom prostredí delty – jazera v podobe mocného vulkanosedimentárneho komplexu pokoradzskej formácie. Súvislejšie zvyšky tejto výplne predstavujú náhorné plošiny Pokoradzskej a Blžskej tabule pri severnom okraji Rimavskej kotliny. Vnútorná stavba vulkanosedimentárnej výplne je prístupná štúdiu najmä na strmých svahoch pri okrajoch uvedených plošín. Stavbe a litológii reliktov tejto južnej oblasti je venovaná druhá časť tejto práce (časť II). Ako sme uviedli vyššie, súčasťou tejto druhej časti je aj celková paleovulkanická rekonštrukcia vývoja veporského stratovulkánu vo vzťahu k južnému sedimentačnému priestoru.

Appendix

Appendix 1. Geological map of the intrusive complex of the Vepor stratovolcano, 1 : 10 000.
Appendix 2. Legend to geological map of the intrusive complex of the Vepor Stratovolcano.
Appendix 3. Geological map of the intrusive complex of the Vepor stratovolcano with geophysical profiles and intrusive segments, 1 : 10 000.
Appendix 4. Rock types of intrusive complex Magnetový vrch, a petrographical description.
Appendix 5. Geological map of the Hájna hora volcanosedimentary formation, 1 : 20 000.
Appendix 6. Cross sections of the Hájna hora volcanosedimentary formation, 1 : 20 000.