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Inner structure of Hronicum

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Abstract. The inner structure of Hronicum has been documented in Chočské vrchy Mts., Nízke Tatry Mts. and Malá Fatra Mts. The transport direction of Hronicum partial nappes has a NW orientation in these mountains. In order to determine original spatial arrangement of nappe bodies of Hronicum the palaeogeographic situation in Triassic was used. We understand the depositional environment in this system as a system of carbonate platforms and intraplatform basins, which were structured into individual subordinate nappes during the Hronicum displacement.

Key words: West Carpathians, nappe tectonics, Hronicum, palaeogeography

Introduction

A basic structure of the West Carpathians is a nappe structure consisting of Paleozoic (possibly also of pre-Cambrian) to Tertiary rock complexes (Uhlig 1907, Andrusov et al. 1973). The Central West Carpathians and Inner Carpathians occur in the south and the Outer Carpathians separated by Klippen Belt occur in the north (Matějka & Andrusov 1931, Andrusov et al. 1973). The pre-Senonian nappe structure consists of nappe systems of two categories (Biely & Fusán 1967). The first one is composed of pre-Late Carboniferous fundament and normally overlying Late Paleozoic and Mesozoic. The second category is represented by rootless nappes consisting of Mesozoic, occasionally also of Late Paleozoic which entirely lost connection with their basement (Andrusov et al. 1973, Mello in Gregor et al. 1976, Mello & Polák 1978). The nappe system of Hronicum is assigned to the second type of category.

Hronicum was defined by Andrusov, Bystrický and Fusán (1973). According to their definition it consists of two facial areas (Čierny Váh and Biely Váh area) and of two wide-spread nappes (lower Šturec and upper Choč nappes). The authors identified the Šturec nappe with the Čierny Váh facial area and the Choč nappe with Biely Váh facial area. The Hronicum is formed by bed succession ranging from Carboniferous to Neocomian. On the basis of the latest research the Hronicum represents a system of subordinate nappes. It occurs in a form of more blocks individualized either by erosion or tectonically (Fig. 1).

Methodology

In the paper we document division of Hronicum into a system of nappes and we defined a direction of tectonic transport of subordinate nappes in Malá Fatra Mts., Low Tatras and Chočske vrchy Mts. The structural study includes interpretation of mesoscopic indications of ductile deformation. We processed statistically fold axis orientations, bedding plane orientations and constructional β-axes orientation of flexures and/or direction of β-axes of folds of Hronicum subordinate nappes.

In order to determine spatial relationships of Hronicum partial nappes we used the palaeogeographic situation during Triassic. The characteristics of the Triassic depositional environment have been chosen according to the fact that Hronicum nappes are to a great extent composed of Triassic rocks.

Nappe system of Hronicum

Hronicum represents a system of imbricated nappes of which spatial connection among individual mountains is often problematic. The nappes are mainly composed of Triassic members, Late Paleozoic and locally preserved Jurassic-Cretaceous formations sporadically occurring in some of them. Termination of deposition in the Early Cretaceous (Hauterive) dates the commencement of the tectonic transport.

We understand the depositional environment of Hronicum in the Triassic (Late Pelsonian - Early Tuvalian) as a system of carbonate platforms and intraplatforms basins (Fig. 2). On the basis of facial analysis it is possible to divide two basins and two carbonate platforms (from the northwest to the southeast) - Dobrá Voda Basin, carbonate platform of so called upper nappe, Biely Váh Basin and Čierny Váh carbonate platform. The palaeogeographic position of the last one carbonate platform has not yet been satisfactory solved (Havrila, 1993). We can identify both intraplatform basins, which have not probably been interconnected, with the Biely Váh facial area on the basis of lithologic content. Similarly we can identify both carbonate platforms with Čierny Váh facial area.

Čierny Váh facial area is characterized by a sequence of carbonate platform which is represented by a succession: Ramsau dolomite; laterally interfingering Wetterstein

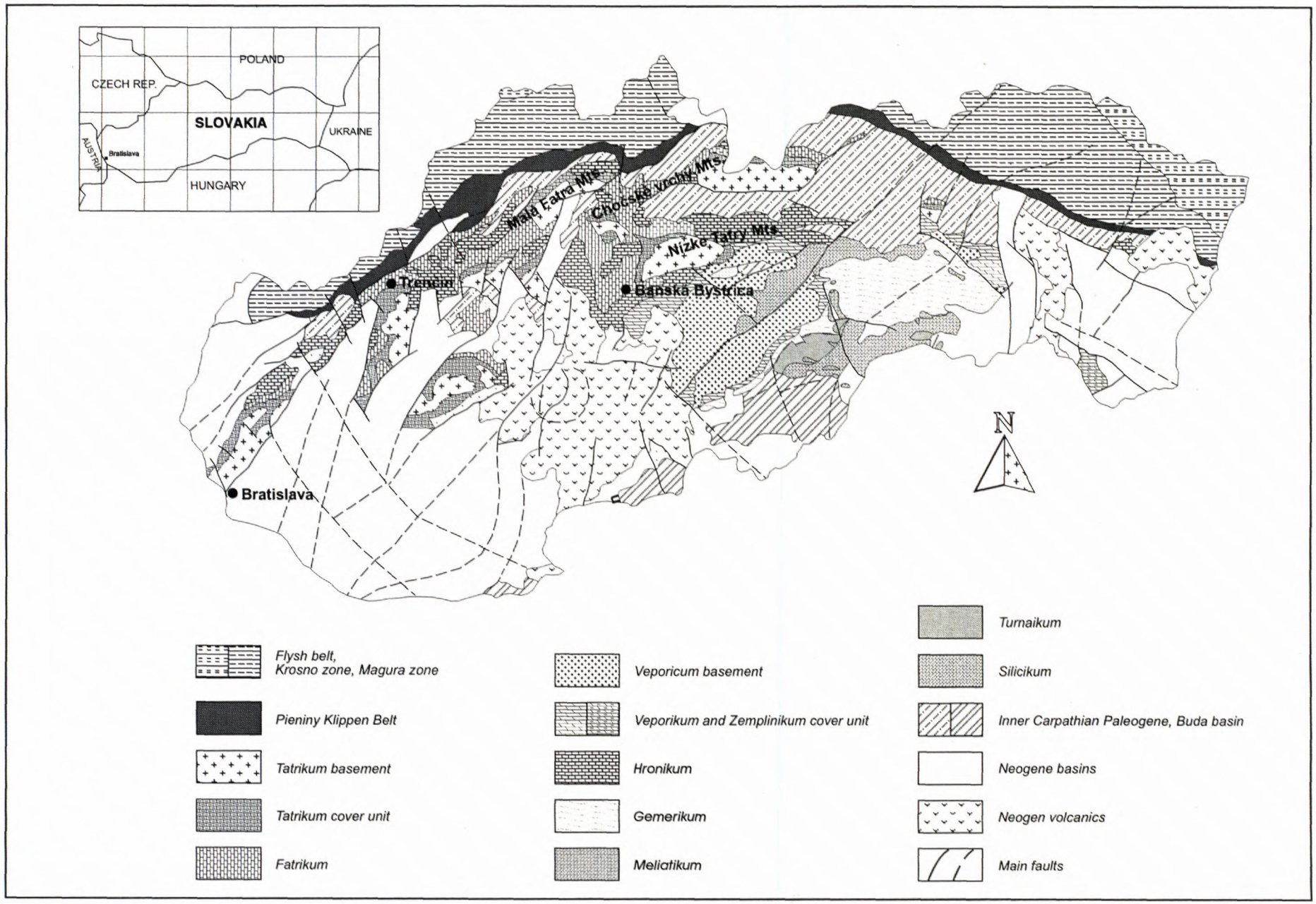


Fig. 1 Tectonic sketch of the Slovak part of West Carpathians

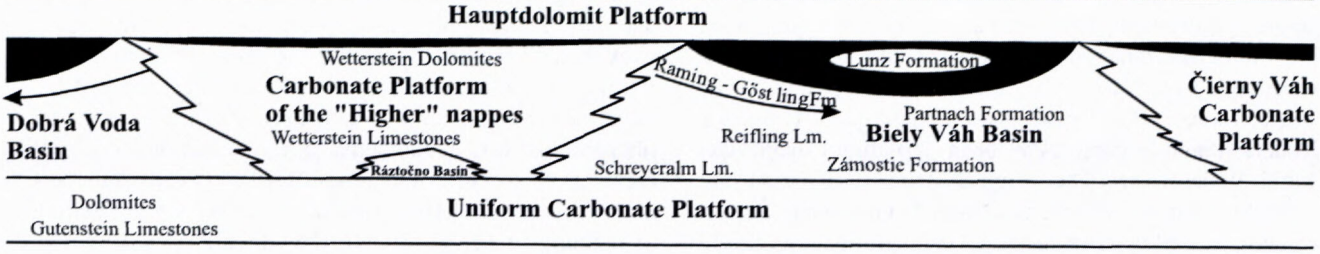


Fig. 2 The inferred original distribution of Triassic rocks across the Hronicum sedimentary area

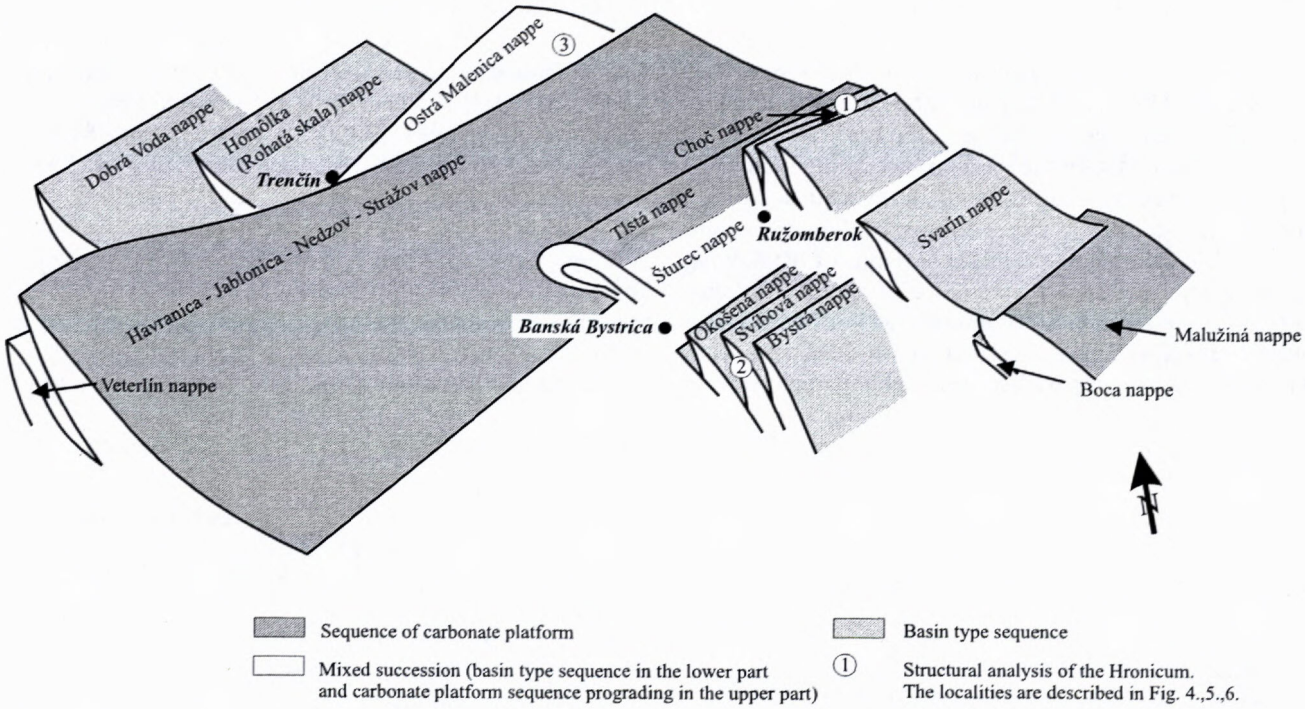


Fig. 3 Nappe system of Hronicum

limestones and dolomites comprising a margin of a platform; thin layer of Lunz beds. Biely Váh facial area is characterized by a basin type sequence, represented by a succession of lithostratigraphic units: Farkašovce breccias, Zámostie limestones, Reifling dolomites, Reifling limestones, Schreyeralm limestones, Partnach Member, Raming limestones, Göstling limestone, Aon shales, Korytnica limestone, Lunz Member. The boundary between the basic facies is represented by mixed succession consisting of basin type sequence in the lower part and carbonate platform sequence prograding over the basin succession in the upper part.

Triassic of Hronicum has three evolution stages: 1) Uniform Middle Triassic carbonate ramp underlies both successions 2) The above mentioned basic successions are capped by Lunz Member even if differently thick. They fill basin depressions and they are not present or they only reach a small thickness above carbonate platforms. It proves together with the occurrence of Raming-Göstling turbidite limestones, located along carbonate platform margin, lateral position of both basic types of Hronicum (Havrila in Gross et al., 1993, Havrila 1993). The Triassic evolution is terminated by a carbonate platform of the Hauptdolomit.

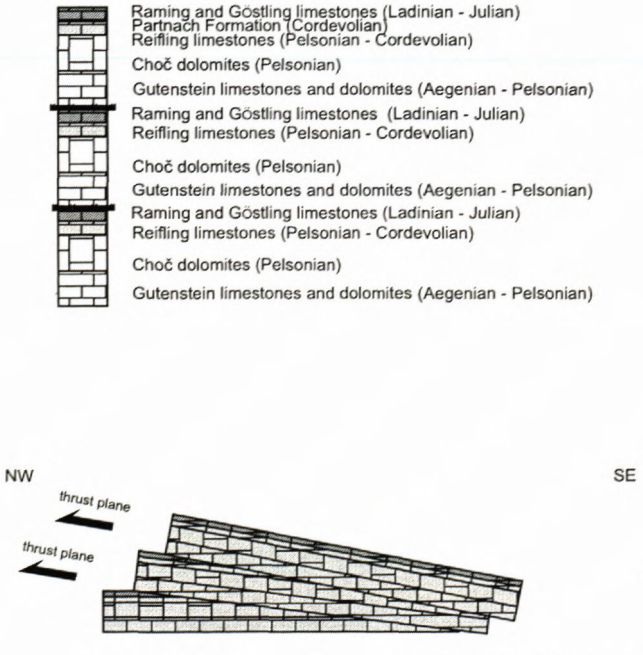
The displacement of the nappe body of Hronicum from its depositional environment occurred during the Cretaceous deformation of the Carpathian orogen (Andrusov et al. 1973, Bystrický 1973). The thrust plane did not follow the same stratigraphic level. As a result of an oblique cut of individual lithostratigraphic members Mesozoic complexes consisting mainly of carbonate members occur in the frontal part of the Hronicum nappe. They were separated from their Late Paleozoic basement along horizons of clayey Lower Triassic shales. Backward the subordinate nappes of Hronicum also contain Late Paleozoic members.

During the Hronicum displacement a desintegration of an originaly uniform body into a system of subordinate nappes occurred (Fig. 3). Their structural - tectonic position within the framework of the Hronicum nappe system is controlled on the basis of sedimentological and facial characteristics. The Dobrá Voda nappe and Homôlka (Rohatá skala) nappe have been structured from the Dobrá Voda Basin. The original depositional environment of the nappes of Veterlin, Ostrá Malenica and Šturec was situated on the boundary between carbonate platform and basin. The Triassic members of so called upper nappes (Havran, Jablonica, Nedzov and Strážov nappes) and nappe of Tlstá indicate depositional environment of carbonate platform. Biely Váh Basin was a depositional environment of a nappe system distinct in the whole Čočské vrchy Mts., Pohronie and Považie.

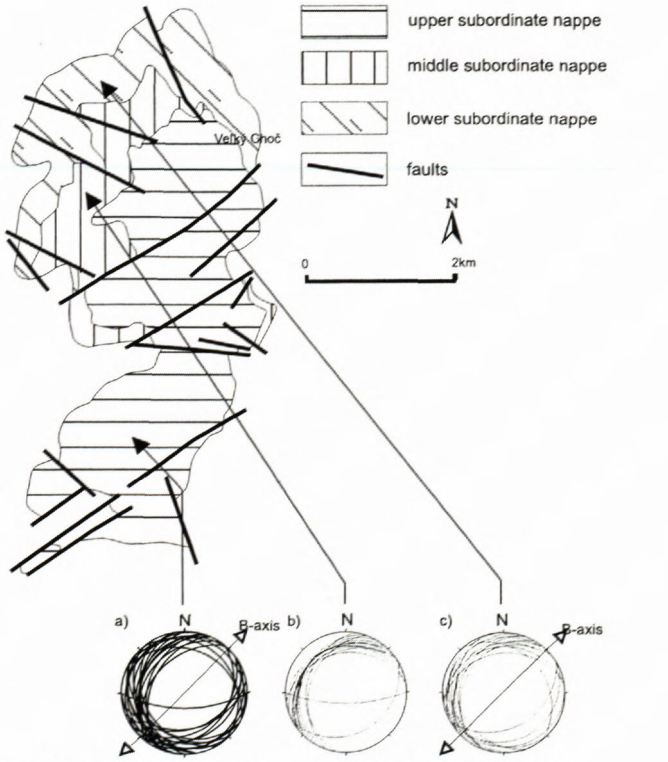
The inner structure of the Hronicum and the tectonic transport direction were analysed in Čočské vrchy Mts., Nízke Tatry Mts. and Malá Fatra Mts. Hronicum is represented by a basin type sequence in the eastern part of the Čočské vrchy Mts. In the western part of the mountains it is represented by a carbonate platform sequence with a stratigraphic span from the lowermost Middle Triassic to Norian. The deformation of basal horizons of the moving nappe is indicated by an occurrence of tectonic breccias on the overthrust plain of tectonic outliers of Hronicum in the western part of the Čočské vrchy Mts. The Hronicum nappe system is composed of three subhorizontally lying slab bodies with analogous bed succession. Lithological character of the Middle Triassic members belonging to the bed succession of the lower two tectonic bodies shows their original location in the marginal part of the Biely Váh Basin nearby its contact with carbonate platform. It is evidenced by outcropping of the proximal members of Raming- Göstling turbidite system. The placement of the upper subordinate nappe was basinward of the carbonate platform and it is documented by the occurrence of distal members of Raming- Göstling turbidite system and Partnach Formation. Statistic evaluation shows slight bending of bedding planes in the NE-SW direction in the lower and upper subordinate nappes (Fig. 4). It suggests NW-SE direction of tectonic transport. During the displacement of the Hronicum nappe a development of imbricated structure without distinct fold structures took part in the area of today's Čočské vrchy Mts.

On the southern slopes of the Nízke Tatry Mts. in the area of Lopej valley and adjacent Bystrá foreland three partial Hronicum nappes of local extent occur (Matějka & Andrusov 1931, Kettner 1940, 1958, Biely 1963). They overthrust each other (Fig. 5) - Bystrá nappe, Svibová nappe, Okošená nappe (Biely et al. 1988, Biely et al. 1997). Their stratigraphic span is Permian - Late Triassic.

Biely (1963) explains the genesis of subordinate nappes by cleaving of a uniform nappe slab by a reverse dis placement with south vergency. Later he considers a system of Hronicum nappes in this area as a pre-Gosau having a northern vergency (Biely et al. 1998). Similarly this same interpretation he applies for the northern side of Low Tatras where three subordinate nappes of Hronicum (Boca, Malužiná and Svarín) occur. He does not term



Idealized sketch of Hronicum nappe system in the Čočské vrchy Mts.



Bedding planes of Hronicum nappes are shown by stereographic projection (Schmidt net, lower hemisphere). Projection of planes are represented by great circles. Statistic evaluation of bedding planes shows slight bending with NE-SW oriented B-axis. a) upper, b) middle, c) lower subordinate nappe

Fig. 4 The Hronicum nappe system in Čočské vrchy Mts.

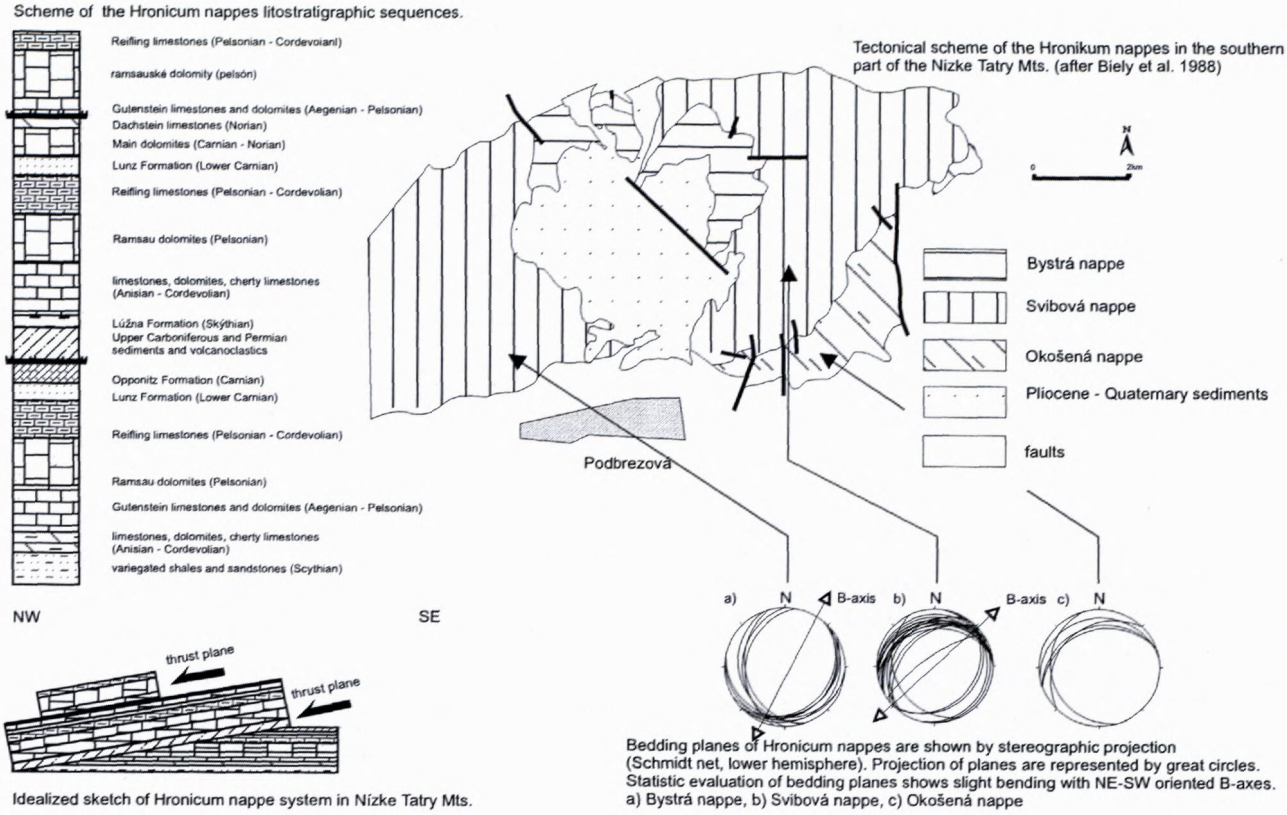


Fig. 5 The Hronicum nappe system in southern part of the Nízke Tatry Mts.

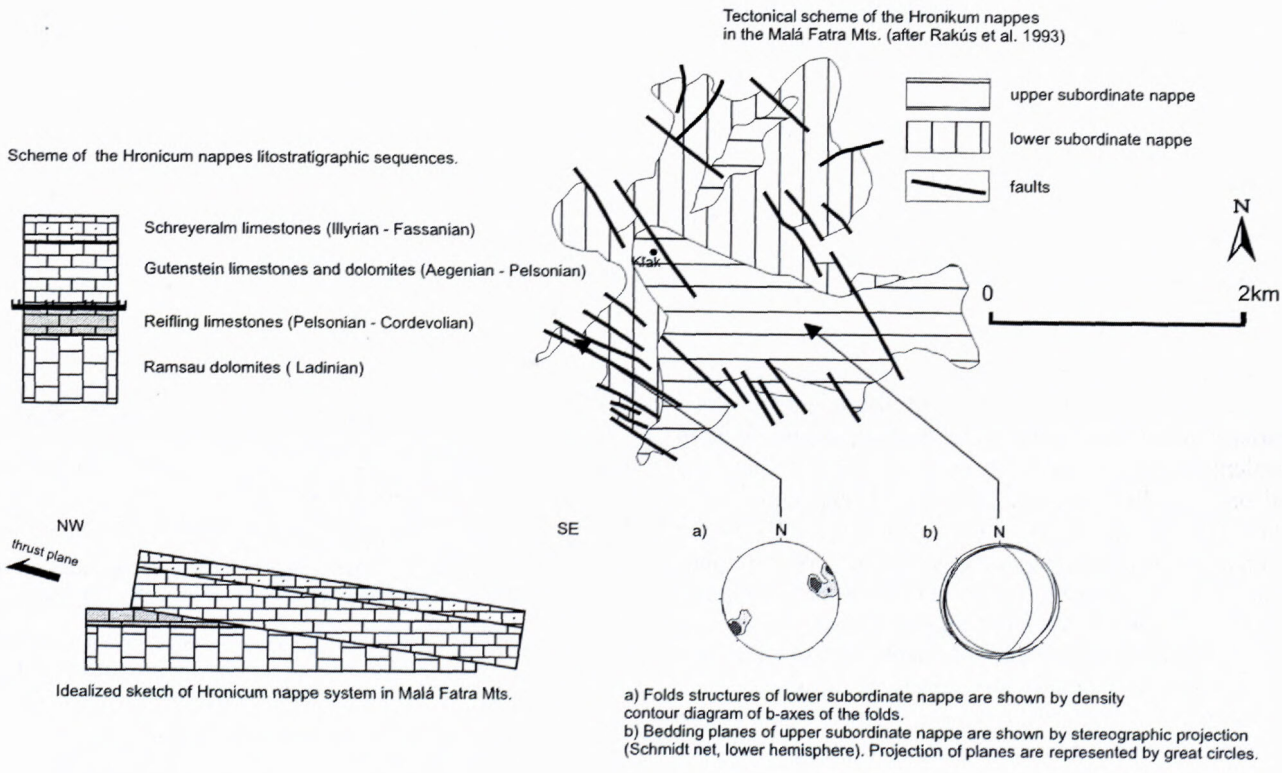


Fig. 6 The Hronicum nappe system in Malá Fatra Mts.

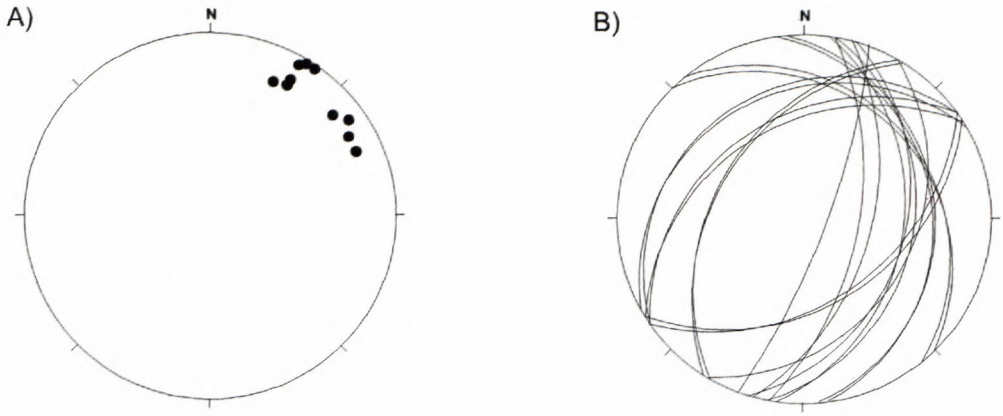


Fig. 7A Orientation of folds structures from abandoned quarry near village Turie is shown by β-axes of the folds, Fig.7B Bedding planes are shown by stereographic projection (Schmidt net, lower hemisphere). Projection of planes are represented by great circles

anyone of the subordinate nappes in the area of Lopejská valley and Bystrá foreland as Choč nappe, but he does not exclude that some of them originally formed together with an outlier comprising Veľký Choč, an uniform body. The Triassic of Hronicum subordinate nappes on the southern slopes of Low Tatras consists of basin type sequence while individual tectonic bodies comprise flat bent slabs which frequently are strongly broken. Palaeogeographically they were located in the central part of the Biely Váh Basin. Structural analysis of bedding planes documents a slight refolding with NE-SW orientation of b-axis in the upper and middle partial thrust sheet (Fig. 5).

A complicated inner structure of the Hronicum is documented by folds in nappe outlier of Kľak (Fig. 6) and by an abandoned quarry nearby village Turie (Fig. 7) in the Malá Fatra Mts. Orientation of b-fold axes shows orientation of tectonic transport from SE to NW. According to the occurrence of Schreyeralm limestones in the bed sequence of the upper subordinate nappe we assume its palaeogeographic position on the basin margin. Today we are not able to identify whether it was Dobrá Voda Basin or Čierny Váh Basin.

Conclusion

Hronicum represents a system of imbricated subordinate nappes. They occur in a form of nappe outliers which spatial connectivity among individual mountains is often problematic. They mainly consist of Triassic members and only locally preserved Jurassic - Cretaceous formations. The original deposition environment of Hronicum in Triassic we understand as a system of carbonate platforms and intraplatform basins - Dobrá Voda Basin, carbonate platform of so called upper nappes, Biely Váh Basin and carbonate platform of Čierny Váh, which comprises individual subordinate nappes of Hronicum. The inner structure of Hronicum indicates generally consistent direction of movement of its nappe segments. The tectonic transport of subordinate nappes of Hronicum in the area of Malá Fatra Mts., Nízke Tatry Mts. and in the area of Chočske vrchy Mts. is toward northwest.

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