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Tectonic position of Veporicum and Hronicum Tribeč Mts.

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Abstract. In the northeastern – Rázdiel part of the Tribeč Mts. a position of the Tatricum, Veporicum and Hronicum tectonic units was determined more precisely. The Tatricum is an allochthonous unit consisting of crystalline fundament and Late Paleozoic and Mesozoic rocks. The Veporicum is composed of a newly defined sequence of Veľké Pole represented by a crystalline rock complex and subautochthonous rock sequence of the Late Paleozoic and Mesozoic and Krížna nappe. The topographic projection of the Veporicum fault sole is an equivalent of the Čertovica lineament which represents a tectonic boundary of the first order in the West Carpathians. The Hronicum comprises tectonically scaled sequences of the Late Paleozoic and subordinary represented Mesozoic rocks. The displacement of Veporicum on the Tatricum from SE and E toward NW and W was defined by the kinematic indicator analyses. The overthrust of Hronicum occurred from SW toward NE after the overthrust of Veporicum. The tectonic ramp originated by piling of the Tatricum and Veporicum rock complexes resulted in tectonic scaling of the Hronicum.

Key words: West Carpathians, Tribeč Mts., tectonics, Tatricum, Veporicum, Čertovica lineament

Introduction

The Tribeč Mountain is the westernmost extremity of the inner zone of the core mountains exposed from the Tertiary deposits of the Danube Basin. Morphologically it comprises a NE-SW direction horst with the dip of the axial part toward SW.

From the point of view of regional-geologic division (Vass et al. 1988) the Tribeč Mts. is divided into Zobor and Rázdiel part (Fig. 1). The southern Zobor part consists of granitoids, imbricated Mesozoic cover sequence and Krížna nappe. The Rázdiel part is composed of the pre-Permian metamorphic rocks, granitoids and stratigraphically reduced sedimentary cover sequence with conspicuously represented Permian basal formation as well as Veporicum, Krížna nappe and Hronicum.

The basic conception of the geologic map of the Tribeč Mts. is expressed on geologic map at scale 1:50 000 (Biely 1974). The geological structure of the Tribeč Mts. was mainly studied by Biely (1962), Krist (1959, 1971), Rekošová (1987), Kopál (1989), Ivanička & Hók (1992), Hók et al. (1994), Hók (1997), Ivanička et al. (1992, 1994, 1995, 1996, 1998) and others.

Working methods and results obtained

The submitted article sources from the results of the basic geological mapping at the scale 1:25 000 and 1:10 000. Taking into account the geologic structure of the Tribeč Mts., the problematics of the tectonic relations between the Tatricum, Veporicum and Hronicum was solved in the Rázdiel part. More types of granitoid rocks and crystalline schists were divided and more precious distribution of the Permian deposits was done. We defined the imbricated geological structure of the crystalline complex and cover sequence (Kopál 1989, Hók et al. 1994, Ivanička et al. 1996, 1998).

Tatricum

More types of granitoid rocks were divided within the crystlline complex of the Rázdiel part (Ivanička et al. 1998). The tectonically lowermost structural unit is composed of leucocratic granitoids overlain by their normal sedimentary cover in the stratigraphic range of the Late Paleozoic and Middle Triassic. The Permian rocks only occur in the Rázdiel part and they are represented by Skycov and Slopňa Formations (Vozárová & Vozár 1988, Vozárová & Vozár in Ivanička et al. 1998). The Mesozoic complexes of the cover series mainly crop out in the area of Zobor massif. They are represented by formations of the basal Early Triassic clastics occurring up to the Early Cretaceous (Tab. 1). One of its characteristic feature is a shallow-marine development of the Jurassic lithostratigraphical units. The whole cover sequence of the Tribeč Mts. is typical by metamorphosed reworking of its members.

Veporicum

The lowermost member of the higher positioned structural unit is represented by mylonitized granitoids

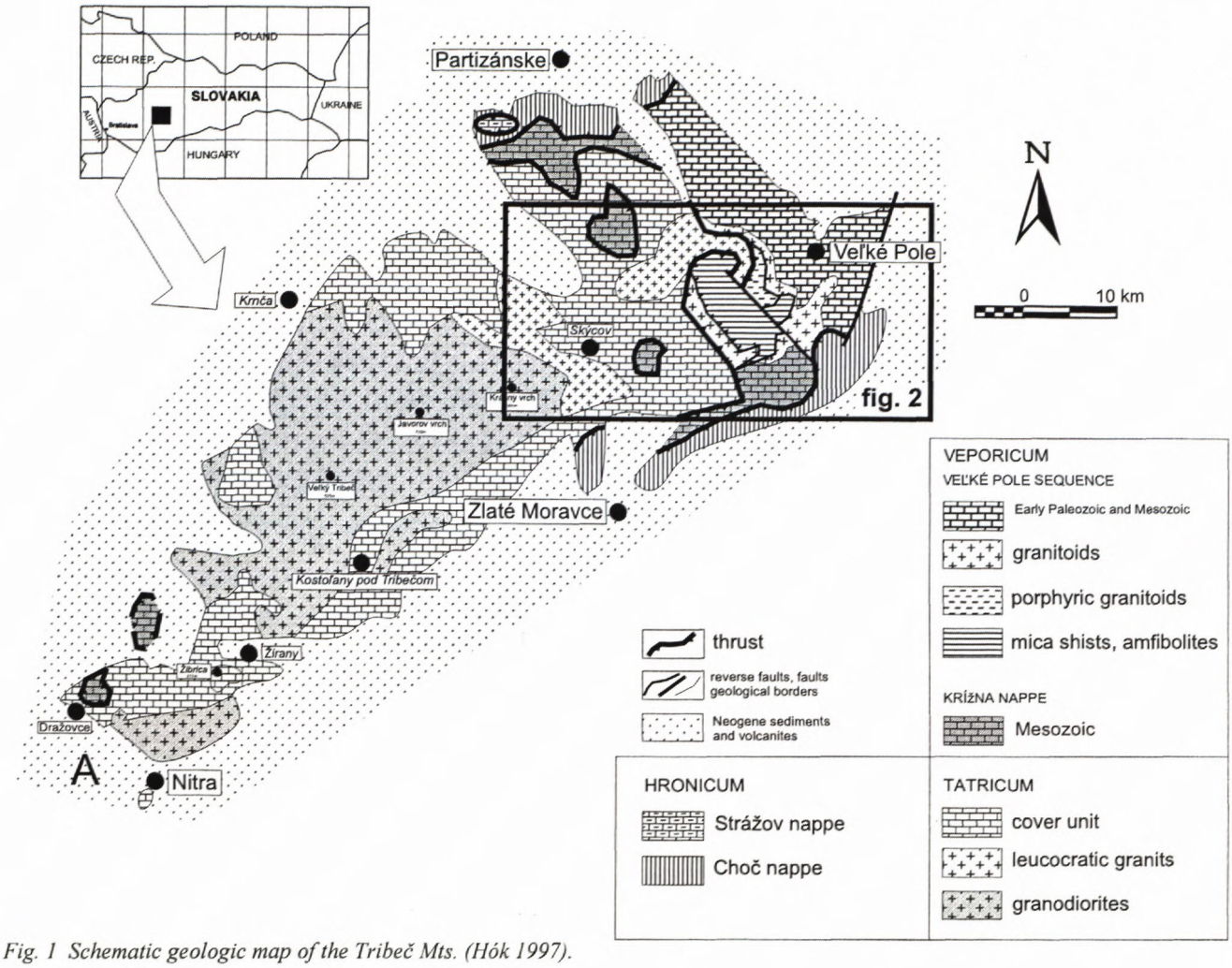


Fig. 1 Schematic geologic map of the Tribeč Mts. (Hók 1997).

(blastomylonites) and Permian deposits overlain by shist phyllites in tectonic position which are in turn overlain by deformed granitoids. The whole sequence is capped by deformed granitoids (blastomylonites) with subautochthonous sedimentary sequence in the stratigraphical range from the Permian up to the Middle Cretaceous. According to ambiguous tectonic position above the Tatric rock members, we assign this structural unit to the Veporicum.

The results of a new investigations, especially the cartographic division of the crystalline complex, give an answer to the tectonic position of Veporicum and Krížna nappe in Rázdiel part of the Tribeč Mts. Solving the problem of the tectonic position of the Krížna nappe Biely (1972) states: „ The mentioned facts imply different position of the Zliechov Serie in the different parts of the mountain. In the most part of the area it occurs in a „cover„ position, in the smaller part in a displaced position.„ The ambiguous interpretation was hindered by missing knowledge about the occurrence, tectonic position and relation of the crystalline fundament to the metamorphosed Late Paleozoic and Mesozoic as well as structural position of the Mesozoic, which is individualized (often stratigraphically reduced) and lies on the cover – tatrid unit, which apparently consists of a normal bed succession. The connection of the sedimentary sequences to the fundament was interpreted unambiguously in the past. Biely (1961a, 1962a) assumed that the Krížna nappe is autochthonous here similarily to the „Štiavnica island„ and „Staré Hory island„. Later Biely (1974), convinced about the occurrence of the cover replacement phenomenon (remplacement de couverture) revised his opinion and he located the fault sole between the Early Triassic formation and Middle Triassic carbonates. The conception is also expressed in the geologic map 1:50 000 (Biely 1974). The model solved above all the situation from the viewpoint of the Krížna nappe outliers occurring in the NW Rázdiel part and S of Skýcov (Fig. 2), which lie on the undoubtably Tatric basement and are not related to their fundament. However, the bed succession commences by either Early Triassic or even by Late Triassic (elevation point Kruh, 580 m) and only in one case it commences by the Middle Triassic which should represent basal formation above the decollement plane or fault sole, respectivelly. From the viewpoint of the knowledge level concerning the crystalline structure,

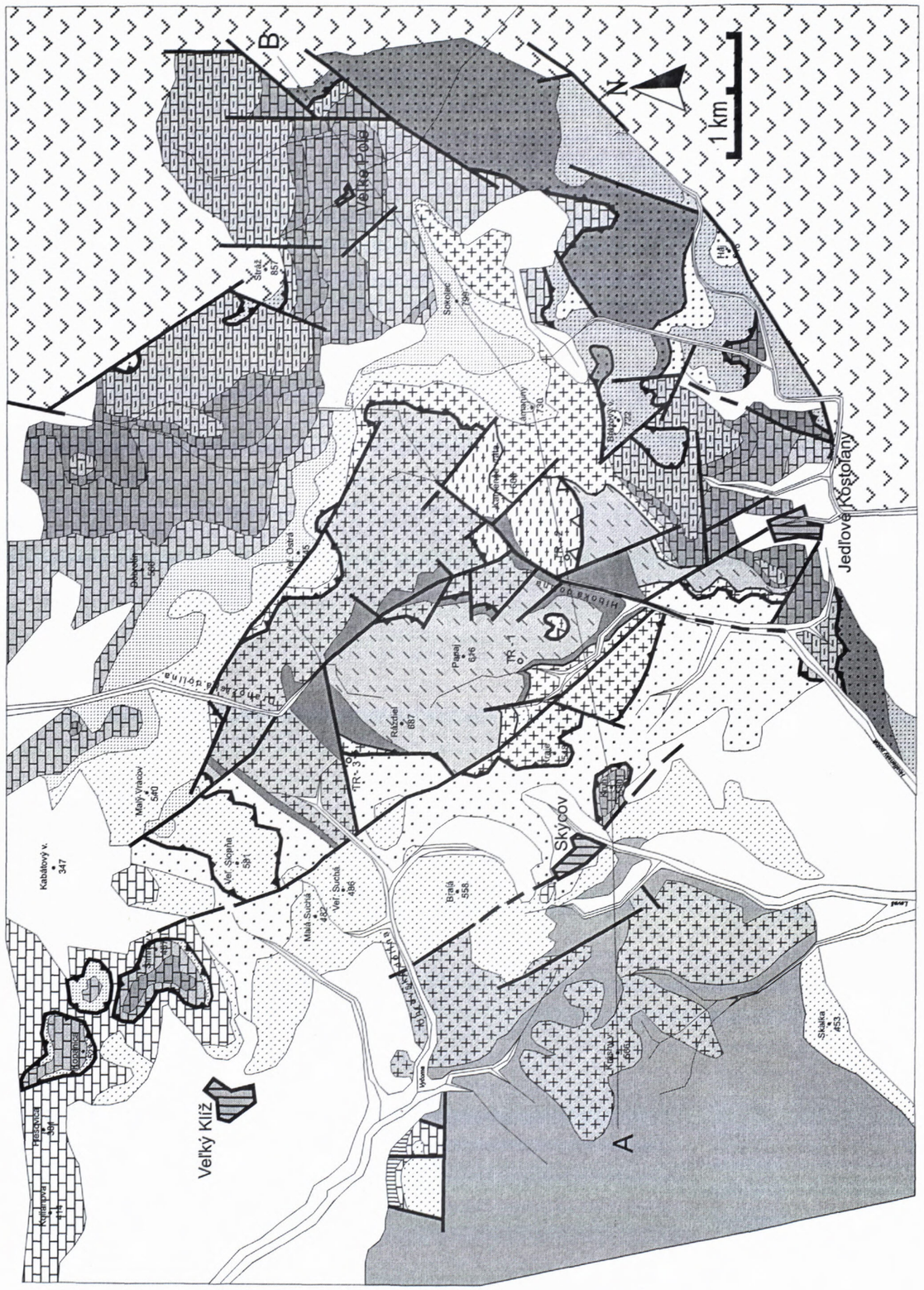


Fig. 2 Schematic geologic map of the Rázdiel part of the Tribeč Mts. (constructed by Hók 1997 based on Ivanička, Polák & Vozár)

QUATERNARY

- deluvial and fluvial sediments

TERTIARY

- volcanic and volcanosediments (Middle Badenian - Middle Sarmatian)

HRONICUM

- Benkovský potok Formation (Early Triassic)
- arcoses, greywacs and volcanits, volcanosediments - Permian
- dark grey shales, sandstones Carboniferous

VEPORICUM
VEĽKÉ POLE AND KRÍŽNA NAPPE

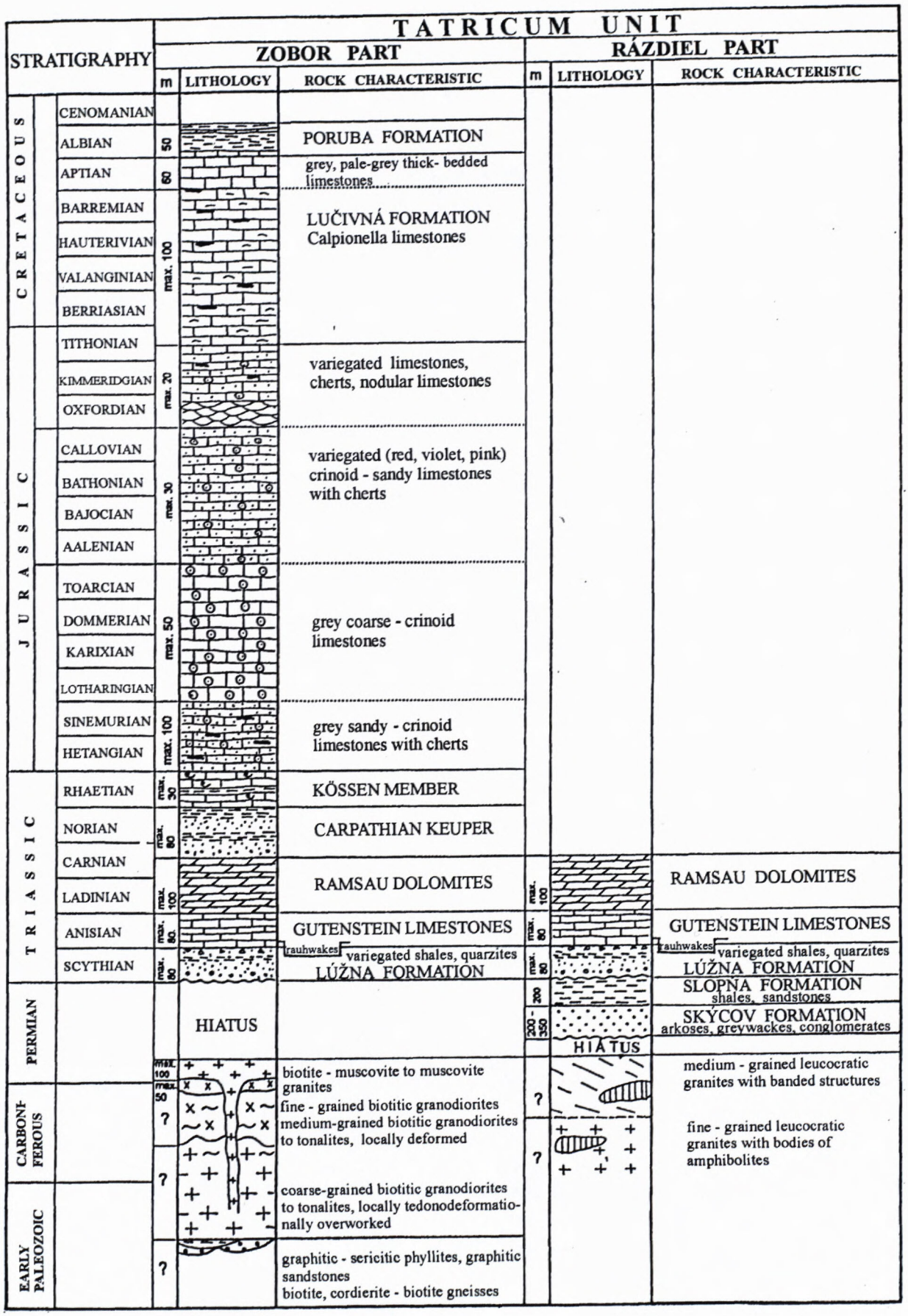
- marly shales, marls, sandstones and limestones (Tithonian - Albian)
- radiolarites,nodular limestones, shales,fleckenmergel (Hetangian - Kimeridgian)
- sandstones, shales, dolomites, dark limestones (Carnian - Rhaetian)
- light limestones and dolomites (Anisian - Ladinian)
- Lúžna Formation (Early Triassic)
- variegated arcoses, greywacks,shales (Permian)
- porphyric granitoides
- amphibolites
- micaschists
- granodiorites (partly mylonitized)

TATRICUM

- dark limestones with cherts (Lias)
- grey limestones and dolomites (Anisian - Ladinian)
- Lúžna Formation (Early Triassic)
- arcoses, greywacs and variegated shales (Permian)
- leucocratic granitoides, aplites
- granodiorites

general explanations

- a) geological boundaries
  b) thrust linie
- a) Hercynian thrust
  b) Alpine thrust
- a) faults observed
  b) faults supposed
- TR - 3 O boreholes



Tab. I: Lithostratigraphic table of Tatricum (Ivanička et al., 1998)

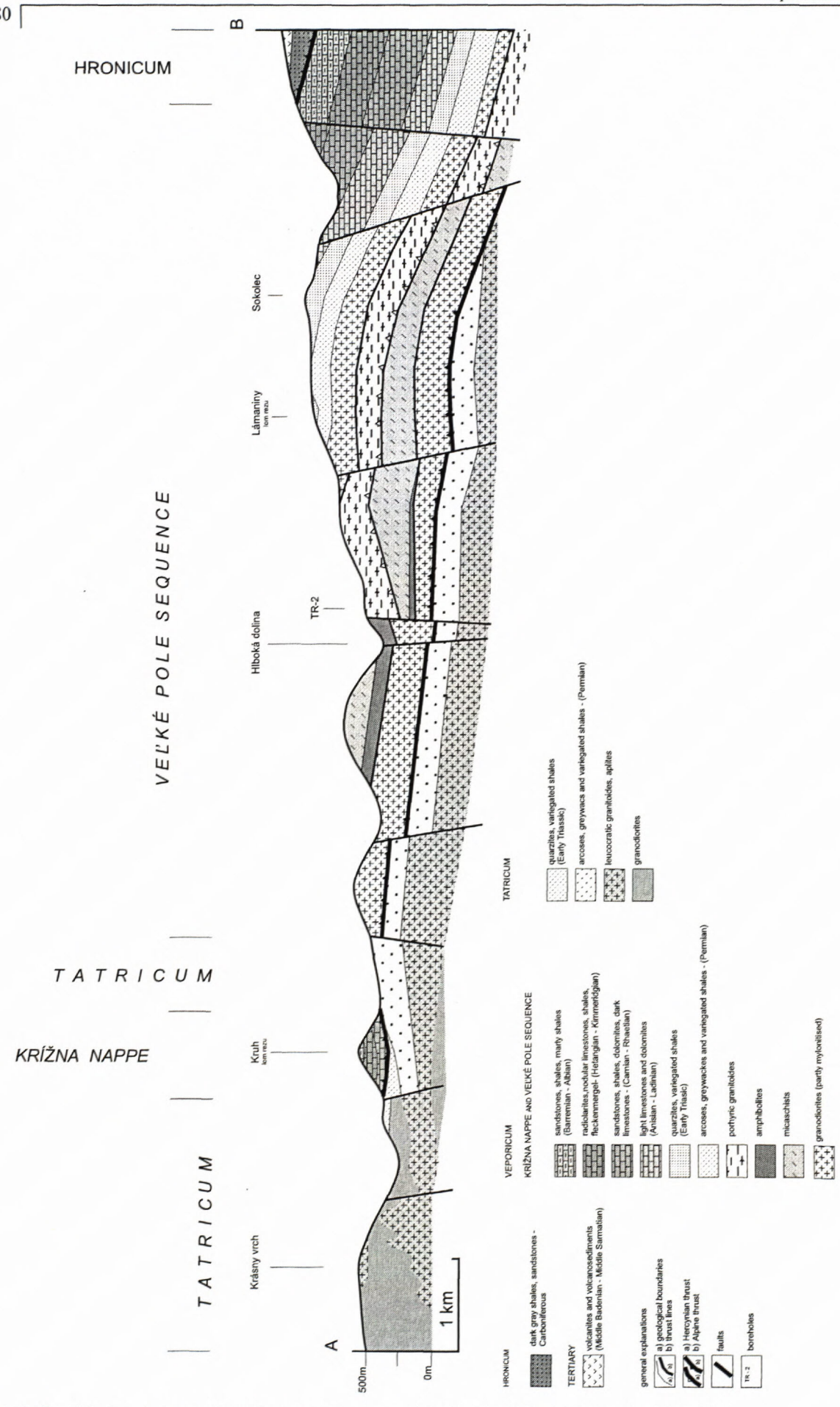
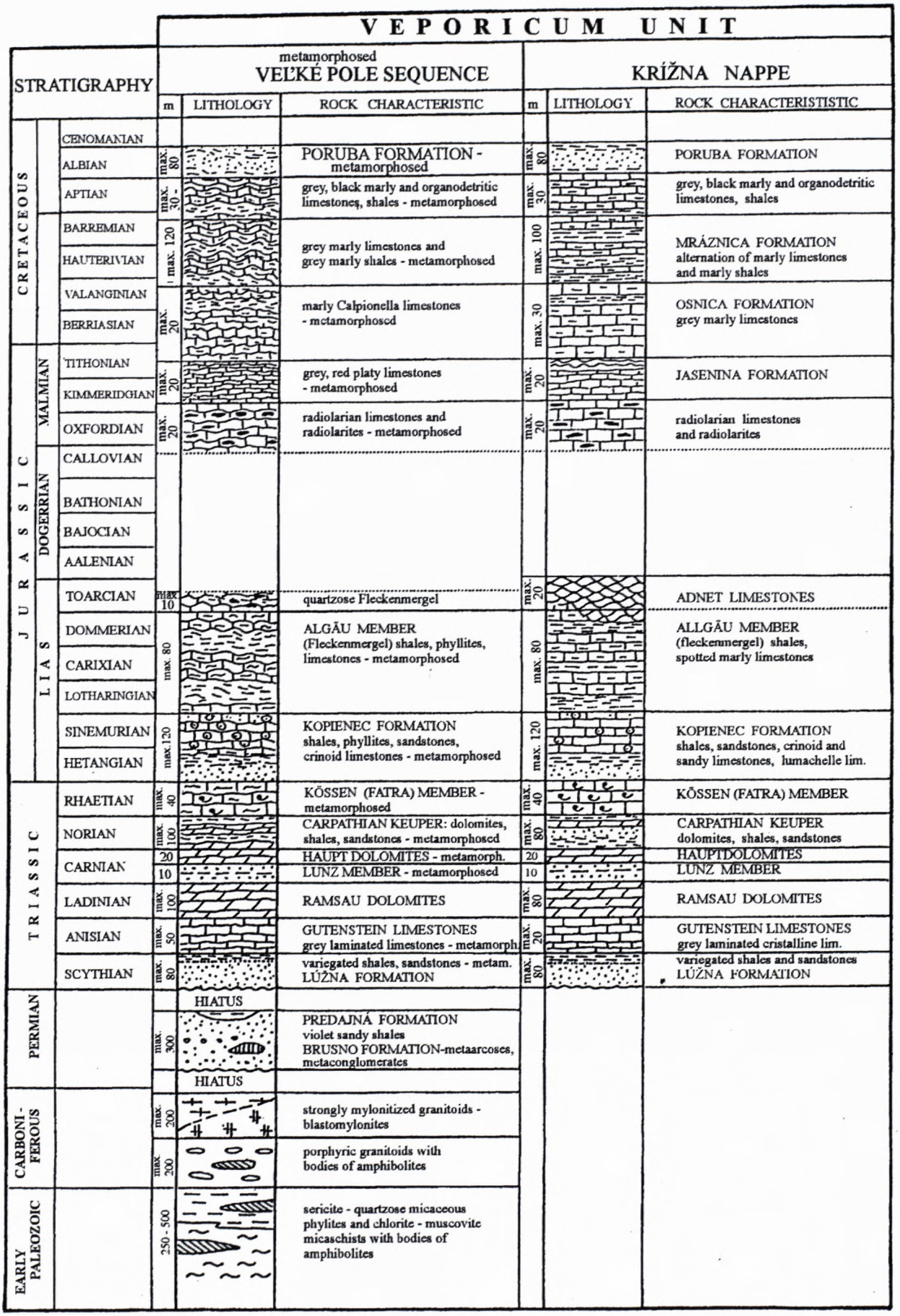


Fig. 3: Simplified geologic profile of the Rázdiel part of the Tribeč Mts. (Hók, Ivanička & Polák 1998).



Tab. II: Lithostratigraphic table of Veporicum (Ivanička et al. 1998)

the conception of structuralization and tectonic position of the Krížna nappe in the given area was fully acceptable.

A new geologic mapping (Kopál 1989, Ivanička et al. 1992, 1996, 1998, Hók et al. 1994, Hók 1997) showed that the crystalline rocks underlying sedimentary sequences consist of more petrographic types and it has nappe/overlap characteristics from the tectonic point of view. The metamorphosed sedimentary beds of Krížna nappe (sensu Biely 1974), ranging from the Permian to Albian, are related to their crystalline fundament and together with it they lie in the nappe position on the crystalline rocks and Mesozoic which Tatric tectonic assignement is undoubtable. These sedimentary beds may be from the viewpoint of their tectonic position, lithology and metamorphosis correlated with the Veľký Bok sequence. From this reason we assigned to the Veporicum also the structure of the metamorphosed Late Paleozoic – Mesozoic bed succession together with the crystalline beds (shist phyllites, porphyric granitoids and blastomylonites) which during the displacement remain attached to its crystalline basement. We termed the whole sequence as a Veľké Pole Sequence (Polák in Ivanička et al. 1998). Unmetamorphosed Mesozoic bed succession of Zliechov type which covers the Tatricum basement without its crystalline fundament was assigned to the Krížna nappe (Tab. II).

The structural analysis of the Krížna nappe, Veľké Pole sequence and rocks of Tatricum suggests a system of relatively flat overfaults with repeating stratigraphic or tectonic sequence which does not show reverse bed successions (Fig. 3). Such an arrangement of individual structures is typical for imbricated and duplex structure, respectivelly. Thus the displacement of Veporicum and Krížna nappes occurs on the system of flat displacement/nappe faults following suitable rock boundaries.

Kinematic indicators, analysed in the framework of Krížna nappe and Veľké Pole sequence show the orientation of overlap from SE, ESE toward NW, which is confirmed by results of the previous works (Rekošová 1987, Kopál 1989, Hók et al. 1994).

Hronicum

Similarly to the Veporicum, also rock sequences of Hronicum only occur in Rázdiel part of the Tribeč Mts. The tectonic unit of Hronicum includes Choč and Strážov nappe which are understood as tectonic analogue of the originally unified nappe body sensu Havrila & Buček (1992) and Havrila (1993).

Hronicum is mainly represented by the Late Carboniferous Nižná Boca Formation and Permian Malužiná Formation (Vozár & Vozárová 1988) occurring predominantly on the SE margin of the Rázdiel part. Mesozoic prevailingly consists of the Triassic members commmencing the Early Triassic Benková Formation and terminating by Haupt Dolomites of the Norian age (Tab. III). Hronicum comprises a duplex structure consisting of two scales (duplexes) which structure is predominantly formed by the Early Paleozoic members. Their position and occurrence of individual lithostratigraphic members implies an existence of a structure elevation or tectonic ramp before the displacement of Hronicum in the studied area. The elevation was most probably formed by piles of Veporicum structural units originated during the tectonic individualization of Krížna nappe. The ramp resulted in scaling of the basal

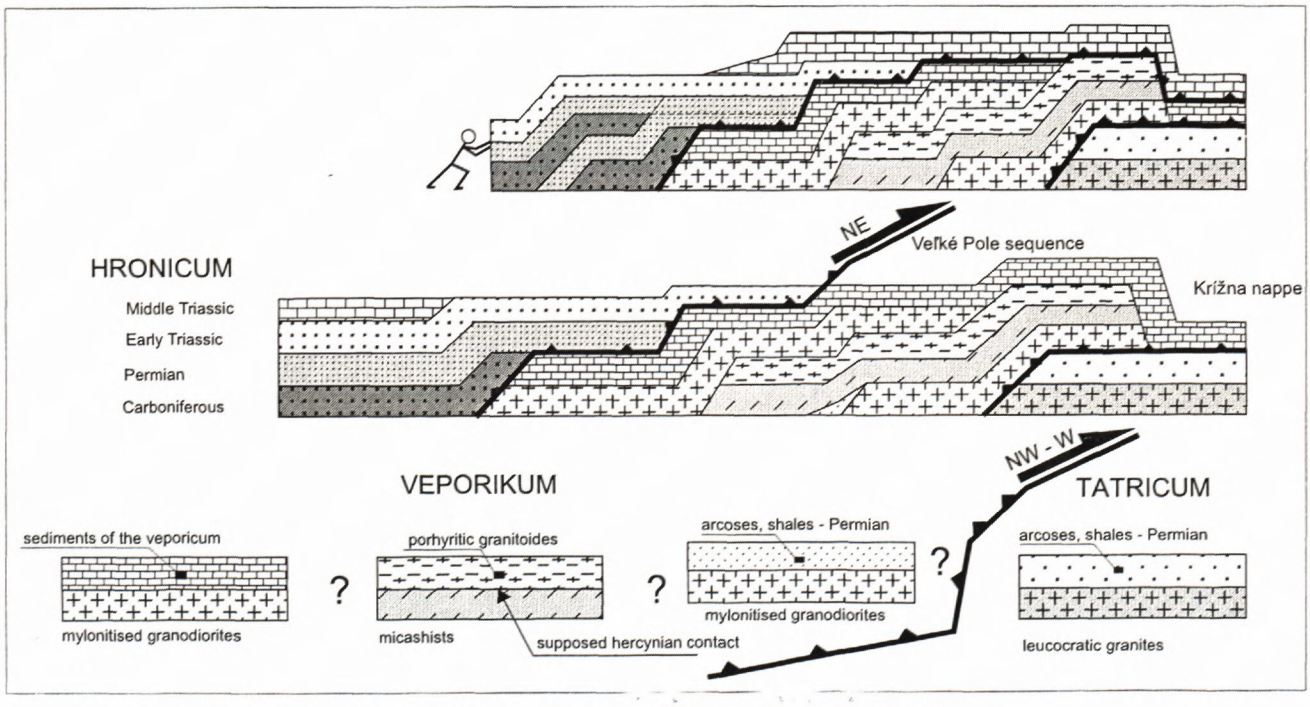


Fig. 4 Model of overlapping of tectonic units in the Rázdiel part of the Tribeč MTs. (Hók, 1997

STRATIGRAPHY		HRONICUM UNIT					
		CHOČ NAPPE			STRÁŽOV NAPPE		
		m	LITHOLOGY	ROCK CHARACTERISTIC	m	LITHOLOGY	ROCK CHARACTERISTIC
TRIASSIC	RHAETIAN						
	NORIAN	max. 100		HAUPTDOLOMITES			
	CARNIAN	max. 20		LUNZ MEMBER			
	LADINIAN	max. 80		RAMSAU DOLOMITES	max. 25		WESTERN LIMESTONES
	ANISIAN	max. 50		GUTENSTEIN LIMESTONES			
	SCYTHIAN	20		variegated shales, sandstones			
		max. 60		BENKOVSKÝ POTOK FORMATION quarzites, sandstones, shales			
PERMIAN		max. 150		MALUŽINÁ FORMATION sandstones, siltstones, shales with bodies of basalts			
CARBONIFEROUS		max. 50 - 250		NIŽNÁ BOCA FORMATION sandstones with conglomerate and shale intercalations, vein bodies of porphyrites			

Tab. III: Lithostratigraphic table of Hronicum (Ivanička et al. 1998)

Hronicum lithostratigraphic members. The upper members were detached and further displaced on their foreland. The stratigraphically uppermost rock complexes of the Late Triassic only occur in the NW part of Rázdiel area. It is also possible to untangle the assumed overlap mechanism from the geologic map (Fig. 2), c.f. also Biely (1974), Ivanička et al. (1998). Both scales of Choč nappe are present in the southern part of Rázdiel area. They are above all represented by Late Paleozoic members, folded Early Triassic formation and occasionally preserved rauhwacked , probably Middle Triassic carbonates. Toward the north and northwest only the upper scale is developed where the carbonates on the base of the nappe are substituted by the deposits of the overlying Permian (c.f. Vozárová & Vozár 1988). The obvious impliciation from the map is that the main overlap sole was originating gradually on the base of the upper stratigraphic levels of the Early and finally of the Middle Triassic.

Discussion

On the basis of the facts obtained, we tried to reconstruct tectonic history of the Veporicum and Hronicum structures in the Rázdiel part of the Tribeč Mts. (Fig. 4). The original distribution of the individual structural elements assumes an autochthonous unit (Tatricum) generaly located north of the future allochthonous units of Veporicum and Hronicum. It is difficult to estimate the width of the space shortening between individual segments. We assume a shortening in an order of tens kilometers. In the subsequent etape the Krížna nappe starts to individualize as an allochthon. The Hronicum was overlapped on such an structural elevation and during its overpassing an inner structuralization underwent resulting in origin of partial scale structures. The lower structure was probably metamorphosed in higher conditions assuming mainly from the bigger deformation of the Early Triassic deposits and preserved relic of the Middle Triassic carbonates changed into rauhwacs. The overlying structure of the Choč nappe individualized gradually in the higher stratigraphic members during its advance toward the foreland.

Conclusion

In the Rázdiel part of the Tribeč Mts. a position of the Tatricum, Veporicum and Hronicum units was made more precise by a detail geologic mapping. From the tectonic point of view Tatricum comprises the lowermost autochthonous unit consisting of granitoids, Late Paleozoic cover deposits and Mesozoic. Veporicum overlies Tatricum in a nappe position. It consists of tectonic structures of the Krížna nappe and a newly divided Veľké Pole sequence. The Veľké Pole sequence is a tectonic equivalent of the Veľký Bok sequence. It is composed of crystalline fundament and rock complexes of the Late Paleozoic and Mesozoic, which are tectonically bounded to it. Based on the kinematic analysis in the Veporicum rocks it is possible to determine its overlap from SE and E toward NW and W. The topographic projection of the displacement/nappe sole of the Veporicum on Tatricum represents an equivalent of the Čertovica lineament (sensu

Biely & Bezák 1997) in the Rázdiel part of the Tribeč Mts.

The Hronicum is mainly composed of the Late Paleozoic deposits and volcanics, Mesozoic deposits are less frequent. Similarly to Veporicum, its inner structure consists of two tectonic scales predominantly composed of Late Paleozoic rocks. The overlap of Hronicum occurred from SW toward NE.

Based on the distribution of the rock complexes of individual tectonic units and their tectonic deformation we assume that the overlap of Hronicum followed the overlap of the Veporicum. During the process of tectonic individualization of Veporicum a structural and probably also a morphological elevation (tectonic ramp) formed which made a barrier for overlapping Hronicum.The stratigraphic lower members of Hronicum stuck on the foreland of the tectonic ramp and displacement/nappe line gradually generated on higher stratigraphic levels responsible for origin of further tectonic structures/ scales.

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