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Structure of Mt. Blegoš between the Inner and the Outer Dinarides

Zgradba Blegoša med Notranjimi in Zunanjimi Dinaridi

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Abstract

The boundary between the Inner and the Outer Dinarides in the sense of B u s e r (1987b) west of the Zagreb lineament is predominantly of overthrust character. The Inner Dinarides are ovethrusted on the Outer Dinarides. Mt. Blegoš, situated in the Outer Dinarides west of Ljubljana, on the boundary with the Inner Dinarides, consists of horses that were formed during overthrusting of the Outer Dinarides from the direction of the Dinaric carbonate platform towards the Adriatic platform, i.e. in the present sense from northeast to southwest, probably during the Upper Eocene. After Sarmatian time these horses were first folded and then rotated around the W-E axis owing to the overthrusting of the Inner Dinarides and Southern Alps from north towards south on the Outer Dinarides. The footwall nappe plane along which the Inner Dinarides in the Blegoš area were overthrusted southwards on the Outer Dinarides is besides the footwall nappe plane of the Southern Alps the most important nappe line south of the Periadriatic lineament. In the area from Ljubljana basin to Tolmin this boundary is clearly expressed, whereas westwards and eastwards it has not been uniformly defined. Along the considered footwall nappe plain the Outer Dinarides were clearly rotated towards the Inner Dinarides and the Southern Alps for 30° to 45°, and thrusted under them.

Kratka vsebina

Meja med Notranjimi in Zunanjimi Dinaridi v B u s e r j e v e m smislu (1987b) zahodno od Zagrebškega lineamenta je pretežno narivna. Notranji Dinaridi so narinjeni na Zunanje Dinaride. Blegoš v Zunanjih Dinaridih na meji z Notranjimi Dinaridi zahodno od Ljubljane je zgrajen iz lusk, ki so nastale med krovnim narivanjem Zunanjih Dinaridov iz smeri od Dinarske karbonatne platforme proti Jadranski platformi, kar pomeni v današnjem smislu od severovzhoda proti jugozahodu, verjetno v zgornjem eocenu. Te luske so bile po sarmatski dobi zaradi narivanja Notranjih

Dinaridov in Južnih Alp od severa proti jugu na Zunanje Dinaride najprej nagubane, nato pa zarotirane okoli osi W-E. Osnovna krovna narivna ploskev, ob kateri so bili Notranji Dinaridi na območju Blegoša narinjeni proti jugu na Zunanje Dinaride, je poleg osnovne krovne narivne ploskve Južnih Alp najpomembnejša krovna narivna črta južno od Periadriatskega lineamenta. Na prostoru od Ljubljanske kotline do Tolmina je ta meja jasna, medtem ko zahodno in vzhodno od tod še ni nedvoumno definirana. Ob obravnavani osnovni krovni narivni ploskvi so Zunanji Dinaridi jasno zasukani nasproti Notranjim Dinaridom in Južnim Alpam za 30° do 45° in pod le-te podrinjeni.

Introduction

In the hinterland of the Triest bay, west of the Zagreb lineament, the terms Alpine (W-E) and Dinaric (NW-SE) directions, or Alpine and Dinaric structural elements, obtained their right of existence in the geological professional jargon. They certainly cannot be used along the global extension of the Alpides, but they have a considerable value for local communication, since they efficiently illustrate the circumstances at the contact of Outer Dinarides with the Inner Dinarides (Fig. 1). On the spatially

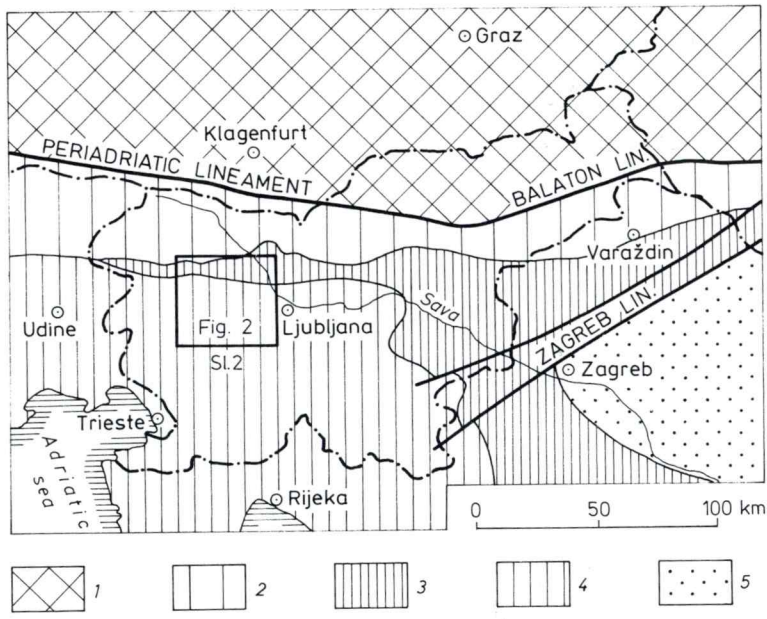

Fig. 1. Slovenia. Synthetic geotectonic sketch-map of the contact of Eastern Alps and Dinarides, after Buser (1987b), Premru (1989), Kazmer and Kovacs (1989), Csontos et al. (1992), Ravnik et al. (1995)

1 Eastern Alps; *2* Southern Alps; *3* Inner Dinarides; *4* Outer Dinarides; *5* Tisa unit

Sl. 1. Slovenija. Sintetična geotektonska skica stika Vzhodnih Alp in Dinaridov. Po predlogah: Buser (1987b), Premru (1980), Kazmer in Kovacs (1989), Csontos s sodelavci (1992), Ravnik s sodelavci (1985)

1 Vzhodne Alpe; *2* Južne Alpe; *3* Notranji Dinaridi; *4* Zunanji Dinaridi; *5* Enota Tisa

limited territory of Slovenia the structures strike in the alpine direction in the Southern Alps and the predominant part of the Inner Dinarides, while the structures in the Outer Dinarides have the dinaric direction. Only in the belt along the Inner Dinarides the dinaric structures are in places masked by the alpine trending directions, especially in areas where the Outer Dinarides consist of softer Lower Triassic and Paleozoic rocks. In this paper we are interested in the boundary between the Inner and the Outer Dinarides in western Slovenia, and its geometric and kinematic characteristics that shall be described at the example of the structure of Mt. Blegoš (1562 m) west of Ljubljana (Fig. 2), as well as the significance of these findings for the study of genesis of the present structure of the Dinarides. This research is based on geological mapping partially performed by Čar, and on kinematic analysis that was done by Placer.

Structure of Mt. Blegoš

The environs of Blegoš were mapped geologically several times, first during the Austro-Hungarian monarchy at the scale 1:75000 (K o s s m a t, 1910), then for the Basic geological map of Yugoslavia at 1:100000 (G r a d & F e r j a n č i č, 1974, 1976; B u s e r, 1986, 1987a), and finally in detail, at the scale 1:10000, in the frame of prospecting for mercury, copper and uranium (unpublished reports by Mlakar, Placer and Čar), so that the presented ideas on the structure of this area are founded on a large number of factographic data. This territory consists of three units that are all built of nappes (Fig. 1, Fig. 2). These are the **Southern Alps** in the north, consisting of Mesozoic rocks of the Julian carbonate platform, the **Inner Dinarides,** of pelagic Triassic, Jurassic and Cretaceous clastics, marl and platy limestones of the Slovenian basin and its basement, and the **Outer Dinarides** that consist in the Blegoš area of the Trnovo and the Hrušica nappes. Of the latter, the first nappe consists of Carboniferous and Permian clastics, and more southwestwards of Triassic, Jurassic and Cretaceous carbonate rocks, and the second one of Triassic carbonate rocks. The carbonate beds of the Trnovo and Hrušica nappes form the marginal part of the Dinaric carbonate platform. The Hrušica nappe appears in the studied territory in the tectonic halfwindow below the Trnovo nappe, named in the geological-morphological sense the Poljane-Vrhnika region. The latter divides the Trnovo nappe into the Idrija-Žiri region in southwest, and the Škofja Loka-Polhov Gradec region in the northeast. The internal structural elements in the Trnovo and Hrušica nappes are expressively dinaric, which is characteristic for the strike of beds and of internal thrust planes. In nappes of the Inner Dinarides the structures are generally of W-E direction. Kinematically the nappes of the Outer Dinarides are older, and theay have been overthrusted in the present sense from northeast towards southwest. The Trnovo nappe is overthrusted on the Eocene flysch of the Vipava valley, and is therefore of Upper Eocene or Lower Eocene age. The Inner Dinarides are overthrusted from north towards south on the Trnovo and Hrušica nappes. As indicated by Upper Miocene beds that were folded in the Eastern Sava folds in connection with this overthrusting, these nappes are of Post-Miocene age. With respect to the fact that the dinaric trending antiform of the Poljane-Vrhnika region reposed on the footwall nappe plane of the Inner Dinarides which is not folded, it follows that the antiform dates from time before forming of these nappes.

The general relationship between the alpine and dinaric trending overthrust structures in west Slovenia can be found in all works of earlier researchers of this territory,

Kossmat (1913, Plate V), Winkler (1923, Plate IV), Grad and Ferjančič (1974, 1976), Premru (1980) and Buser (1986, 1987a). However, Premru decidedly stated that the younger alpine trending overthrust sheets that were moved from north to south during the Rhodanian orogeny, cover the older dinaric trending overthrust sheets that were overthrusted from northeast to southwest in the Illyric-Pyrenean orogeny, an observation that at present cannot be denied.

In all nappe units appears in the Blegoš area an expressive structural geometric anomaly the center of which is the carbonate massif of Blegoš in the extreme northwestern part of the Poljane-Vrhnika region, consequently in the place where the competent carbonate rocks of the Hrušica nappe below the incompetent rocks of the Trnovo nappe come in contact with the Inner Dinarides.

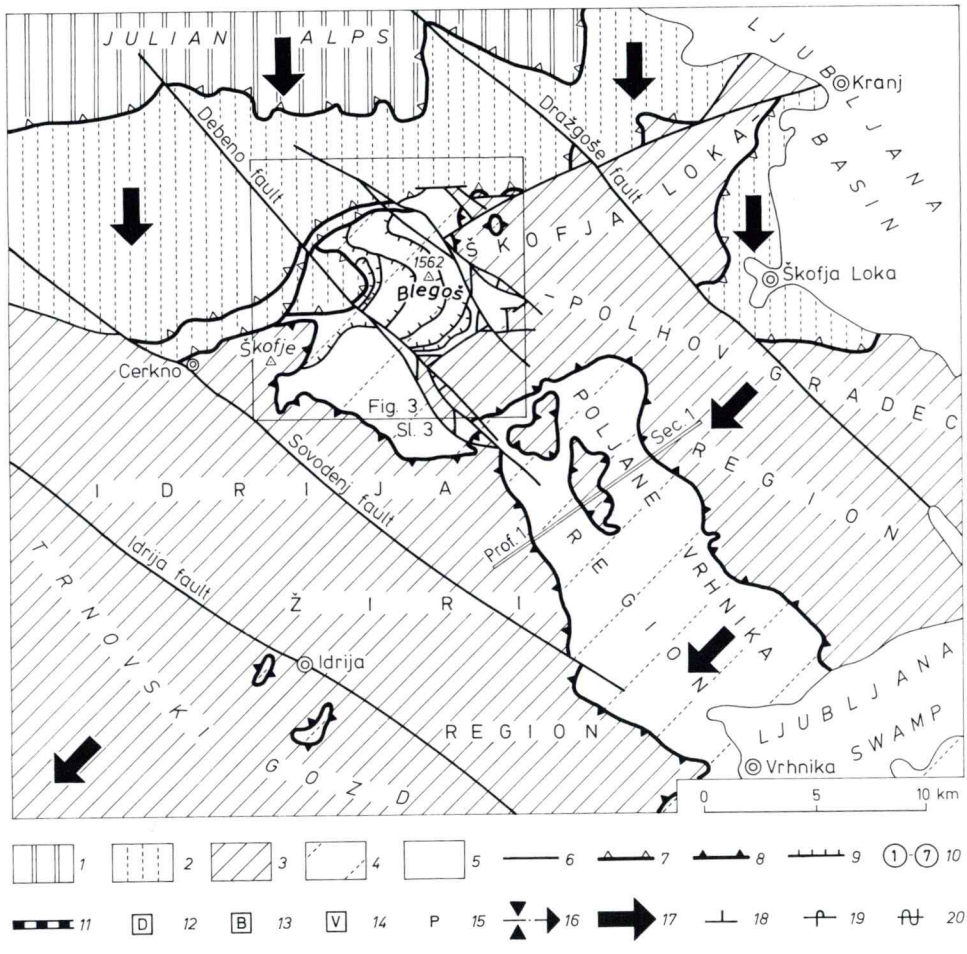

Fig. 2. Nappe subdivision of wider Blegoš surroundings
Sl. 2. Krovna rajonizacija širše okolice Blegoša

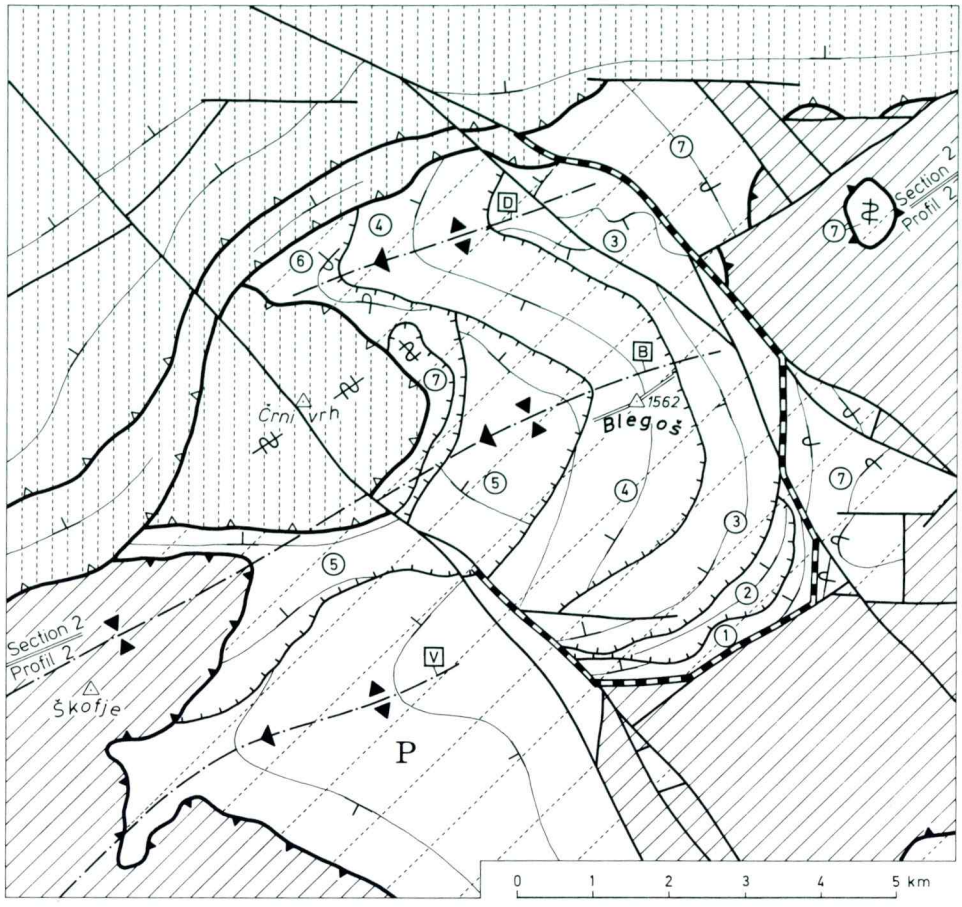

Fig. 3. Geological sketch-map of Blegoš. Used unpublished data of Mlakar (Škofje) and Čar (Črni vrh, western part of Blegoš)

1 Jelovica nappe (Grad & Ferjančič, 1974, 1976); *2* Nappes of Inner Dinarides (Fig. 2), Podmelec nappe (Fig. 3); *3* Trnovo nappe; *4* Hrušica nappe; *5* Plioquaternary and Quaternary; *6* More important subvertical fault; *7* Footwall nappe plane of Southern Alps and Inner Dinarides; *8* Thrust plane of Trnovo nappe; *9* Thrust plane within the Hrušica nappe; *10* Blegoš horses; *11* Boundary of uplift of eastern part of Blegoš; *12* Davča anticline; *13* Blegoš syncline; *14* Valovnik anticline; *15* Thermal spring in the Kopačnica Valley; *16* Inclined fold axis; *17* General directin of thrusting; *18* Normal beds; *19* Inverse beds; *20* Inverse horizontal beds

Sl. 3. Geološka skica Blegoša. Uporabljeni so neobjavljeni podatki Mlakarja (Škofje) in Čarja (Črni vrh, zahodni del Blegoša)

1 Jelovški pokrov (Grad & Ferjančič, 1974, 1976); *2* Pokrovi Notranjih Dinaridov (sl. 2), Podmelški pokrov (sl. 3); *3* Trnovski pokrov; *4* Hrušiški pokrov; *5* Pliokvartar in kvartar; *6* Pomembnejši subvertikalni prelom; *7* Osnovna krovna narivna ploskev Južnih Alp in Notranjih Dinaridov; *8* Krovna narivna ploskev Trnovskega pokrova; *9* Narivna ploskev znotraj Hrušiškega pokrova; *10* Blegoške krovne luske; *11* Meja dviga vzhodnega dela Blegoša; *12* Davška antiklinala; *13* Blegoška sinklinala; *14* Valovniška antiklinala; *15* Termalni izvir ob Kopačnici; *16* Poševna os gube; *17* Generalna smer narivanja; *18* Normalne plasti; *19* Inverzne plasti; *20* Inverzne horizontalne plasti

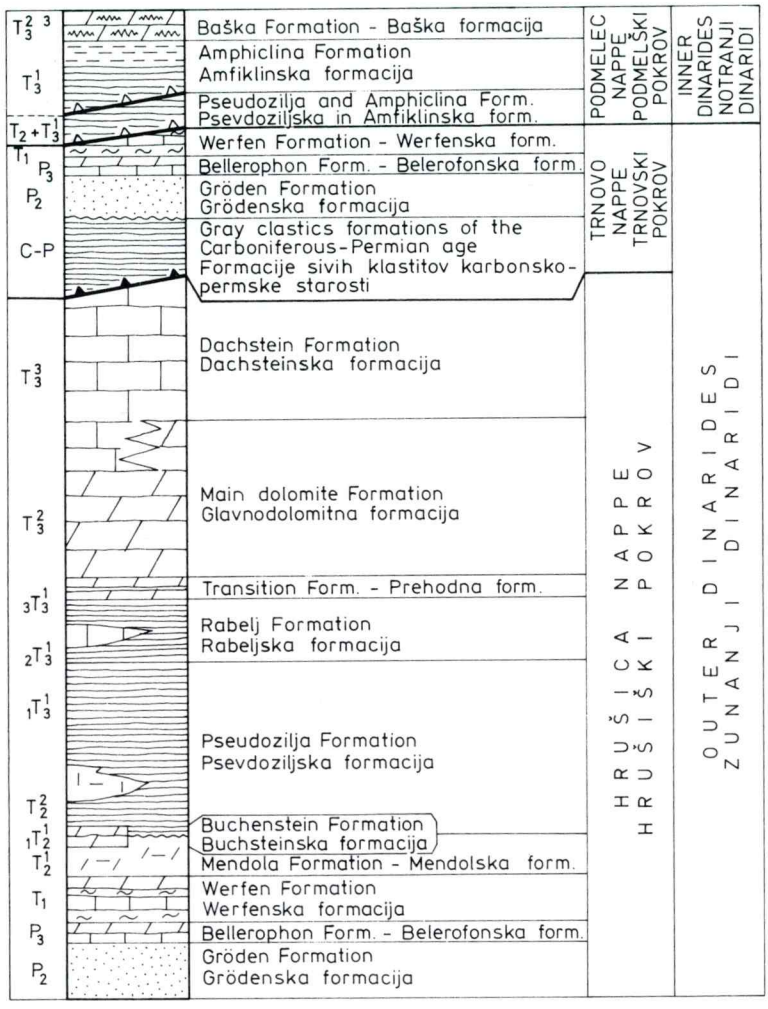

Fig. 4. Lithostratigraphic development of nappe units in the Blegoš area
Sl. 4. Litostratigrafski razvoj krovnih enot na območju Blegoša

In naming the nappe units we used the terms that are not yet generally accepted, since no consens was reached yet on the extent of individual units, and the differences in ideas usually also result in to different naming. The rocks of the Slovenian basin west of the Ljubljana basin were named, e.g. after W i n k l e r (1923) the Julian outer zone, after G r a d and F e r j a n č i č (1976) the Selce zone, they are included after P r e m r u (1980) into the Sorica and Selce overthrusts, and according to B u s e r (1986) into the Kobla, Rute and Podmelec nappes. As a curiosity it should be mentioned that for the same unit the term Tolmin nappe was proposed by K r y s t i n et al. (1994, 415). The nappe structure of the Southern Alps and Inner Dinarides was not

subdivided by us, since there is no need for it in this article. The Trnovo nappe is understood in the sense of M l a k a r (1969, Žiri-Trnovo nappe), G r a d and F e r j a n č i č (1974, 1976, Škofja Loka-Trnovo nappe), and P l a c e r (1981, Trnovo nappe), and Hrušica nappe in the sense of P l a c e r (1981).

Before continuing the regional discussion, the structure of Blegoš should be described in some more detail, as shown schematically on Fig. 3. Lithostratigraphy appears on Fig. 4. The massif of the mountain consists of the extensive Blegoš syncline (B) that steeply is inclined towards southwest. Northwards it passes over into the smaller Davča anticline (D) just below the footwall nappe plane of the Inner Dinarides, and southwards into the Valovnik anticline (V) that straightens out into the Poljane-Vrhnika region of dinaric trending beds. The axes of these three folds are subparallel, and the dip elements for the Davča anticline and the Blegoš syncline amount to 235/50, and for the Valovnik anticline 245/65. The Blegoš syncline consists of several horses named the Blegoš horses that were folded together with beds. The angle between the thrust plane of the horses and the beds is small, abot 5o only. The lowest horse in the sequence is **horse 1** consisting of normally lying Middle Triassic and Cordevolian beds of the Pseudozilja Formation in the sense of P l a c e r and K o l a r - J u r k o v š e k (1990). Follows the **horse 2** of normally lying Middle Triassic pyroclastics of the lower part of Pseudozilja Formation that discordantly overly the Carboniferous-Permian clastics and rocks of the Gröden, Bellerophon and Werfen Formation. Next is the **horse 3** of normally lying beds of the Pseudozilja, Rabelj, Transition and Main dolomite Formation the **horse 4** of normally lying beds of the upper part of Rabelj Formation and of the rocks of Transition, Main dolomite and Dachstein Formation. Above the 4th horse the **horse 5** is overthrusted. It consist of beds of the Pseudozilja Formation and lower part of Rabelj Formation in normal position, followed by the **horse 6** from the same rocks in inverse position, and finally **horse 7** of Bellerophon and Werfen Formation and discordantly deposited Langobardian pyroclastics in inverse position. The belt of overthrusted rocks at the bottom of the Podmelec nappe is formed of the Pseudozilja and Amphiclina Formation rocks. This suggests a wider overthrust zone, that structurally is not analysed yet. The internal structure of horses with normally lying beds is best exposed in horse 3 where the normal boundary between the variegated lower part of Rabelj clastics and transition beds in the northern flank of the Blegoš syncline is cut by the hanging wall thrust plane, and in the southern flank by the footwall thrust plane of the mentioned horse. Consequently, a beautiful exposure of the oblique cut within the Hrušica nappe that was formed in the stage of genesis of the nappe structure of the Outer Dinarides. The starting form for the kinematic development of Blegoš horses can be illustrated by an overthrown fold (Fig. 5) where the succession of appearing horses is well visible, and also the relations between the horses with the normal and the inverse position of beds.

The second characteristics of the Blegoš structure is its northeastern, eastern, southeastern and southern to southwestern boundary with the surrounding rocks that indicates the extreme uplift of the eastern part of the Blegoš massif (Fig. 6). The uplift can be explained by the tilt of the axes of folds towards southwest. This siginifies rotation of the originally subhorizontal folded beds and horses into the present steep position. The uplift of the eastern part of Blegoš must have happened along pre-existing subvertical faults of various directions (Fig. 2) that are marked in Fig. 3 with a special sign. The movements in question are consequently of the inherited character. East of this boundary appear inversely lying beds of the Pseudozilja Formation in discordant relationship with the Lower Triassic beds. Therefore they are compared with equal

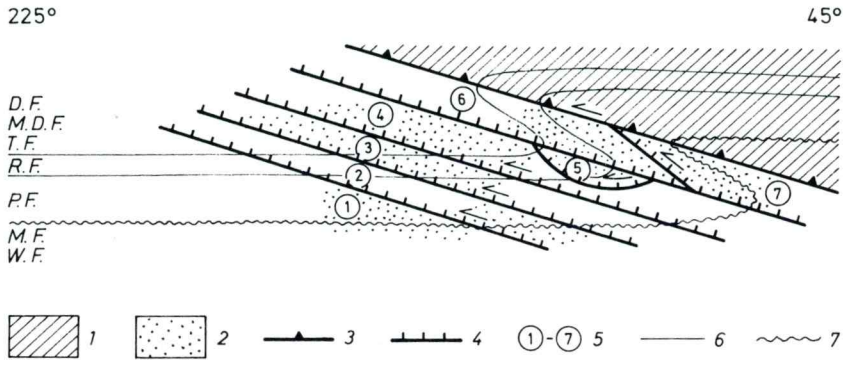

Fig. 5. Initial structure of the Blegoš horses in the Hrušica nappe

1 Trnovo nappe; *2* Lithostratigraphic structure of horses on the surface, Fig. 3; *3* Thrust plane of Trnovo nappe; *4* Thrust plane within the Hrušica nappe; *5* Blegoš horses; *6* Normal boundary; *7* Unconformity; *D.F.* Dachstein Formation; *M.D.F.* Main dolomite Formation; *T.F.* Transition Formation; *R.F.* Rabelj Formation; *P.F.* Pseudozilja Formation; *M.F.* Mendola Formation; *W.F.* Werfen Formation

Sl. 5. Izhodiščna struktura blegoških lusk v Hrušiškem pokrovu

1 Trnovski pokrov; *2* Litostratigrafska zgradba lusk na površju, sl. 3; *3* Krovna narivna ploskev Trnovskega pokrova; *4* Narivna ploskev znotraj Hrušiškega pokrova; *5* Blegoške luske; *6* Normalna meja; *7* Diskordanca; *D.F.* Dachsteinska formacija; *M.D.F.* Glavnodolomitna formacija; *T.F.* Prehodna formacija; *R.F.* Rabeljska formacija; *P.F.* Psevdoziljska formacija; *M.F.* Mendolska formacija; *W.F.* Werfenska formacija

beds of horse 7 west of the Blegoš summit. This horse is covered east of Blegoš by the Carboniferous-Permian beds of the Trnovo nappe. The nappe character of the Trnovo structure is indicated in this area by the nearby tectonic window.

The folded structure of Blegoš continues southwestward also in the Trnovo nappe. In the core of the Blegoš syncline occurs the structure of Škofje, and in the core of the Valovnik anticline the tectonic halfwindow consisting of rocks of the Hrušica nappe east of Škofje along Podplečica brook.

The geometric anomaly in the Blegoš area occurs also in the structure of the Inner Dinardes. It is expressed by a deviation of its footwall nappe plane from the W-E direction into the SW-NE direction, and with a parallel deviation of strike of beds. Tha massif of Blegoš is represented consequently by a core of competent rocks of the Hrušica nappe surrounded by incompetent rocks of the Trnovo nappe and the Inner Dinarides.

Interesting from the kinematic standpoint is certainly the question on the mechanism that resulted into the Blegoš structure. Before defining the starting data the structure of the Poljane-Vrhnika region should be reviewed somewhat more in detail (Fig. 7). This structure is represented by an anticlinal arch of rocks of the Hrušica nappe in the NW-SE direction in which occurs also the anticlinally arched thrust plane of the Trnovo nappe. The nappe is proved by tectonic klippes of Carboniferous-Permian clastics amidst the anticlinal arch, and by tectonic halfwindows in valleys transversely to the anticlinal ridge, where the carbonate rocks of the Hrušica nappe pass deeply below the clastics of the Trnovo nappe. In the C-D profile of the Basic geological map, sheet Kranj (G r a d & F e r j a n č i č, 1974) that passes across the

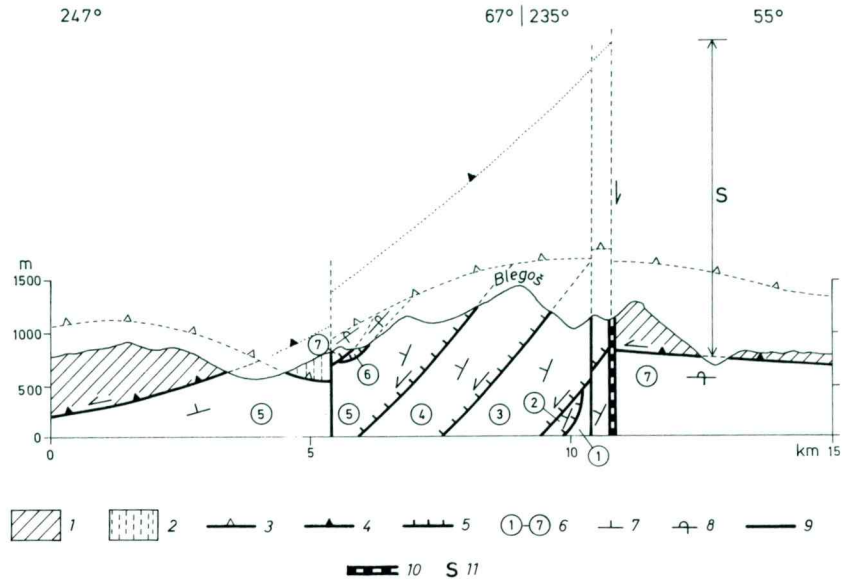

Fig. 6. Cross section across the summit of Blegoš SW-NE. Section 2. Position of the section on Fig. 3

1 Trnovo nappe; *2* Podmelec nappe; *3* Footwall nappe plane of the Inner Dinerides; *4* Thrust plane of the Trnovo nappe; *5* Thrust plane within the Hrušica nappe; *6* Blegoš horses; *7* Normal beds; *8* Inverse beds; *9* Fault; *10* Boundary of uplift of eastern part of Blegoš; *11* Virtual throw along to the boundary of uplift of eastern part of Blegoš

Sl. 6. Profil prek vrha Blegoša v smeri SW-NE. Profil 2. Lega profila na sl. 3

1 Trnovski pokrov; *2* Podmelški pokrov; *3* Osnovna krovna narivna ploskev Notranjih Dinaridov; *4* Krovna narivna ploskev Trnovskega pokrova; *5* Narivna ploskev znotraj Hrušiškega pokrova; *6* Blegoške luske; *7* Normalne plasti; *8* Inverzne plasti; *9* Prelom; *10* Meja dviga vzhodnega dela Blegoša; *11* Navidezni skok ob meji dviga vzhodnega dela Blegoša

Poljane-Vrhnika region, no thrust planes appear that would cut beds at a small angle of around 5 degrees. However, these nappes in Blegoš exist, and we presume they are either not everywhere developed, or they were not mapped. The beds of the Poljane-Vrhnika region are folded, but they are generally subhorizontal and dipping more or less steeply towards southwest in the southwestern flank, and towards northeast in the northeastern flank.

The geometry of the alpine and dinaric systems of nappes is presented in Fig. 8. Circumstances in the surroundings of Blegoš are a variant of this scheme (Fig. 9). From it the present structure of Blegoš can be derived. The starting structure is consequently represented by: (1) strike and dip of the footwall nappe plane of the Inner Dinarides, (2) strike and dip of beds in the Poljane-Vrhnika region and (3), strike and dip of internal thrust planes in this unit. The direction of the footwall nappe plane of the Inner Dinarides can be determined from the geological map, whereas the dip angle can be measured directly. For this, the dips of the nappe planes in the Inner Dinarides themselves, as given by B u s e r (1987a) on the geological map, sheets Tolmin

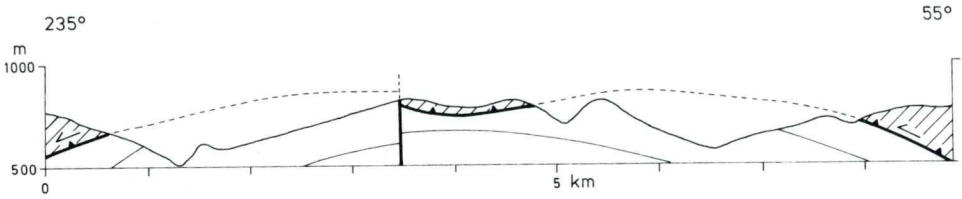

Fig. 7. Cross section of the Poljane-Vrhnika region. Section 1. Position of the section on Fig 2. Legend as on Fig. 5

Sl. 7. Prečni profil Poljansko-Vrhniškega ozemlja. Profil 1. Lega profila na sl. 2. Legenda na sl. 5

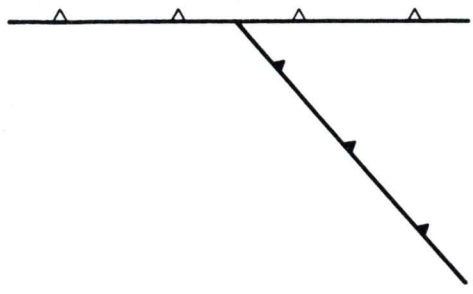

Fig. 8. Relationship between nappe thrusts of alpine and dinaric directions. Legend as on Fig. 9

Sl. 8. Odnos med krovnimi narivi alpske in dinarske smeri. Legenda na sl. 9

and Videm, amount to about 20°. Hence, the dip elements of the footwall nappe plane of the Inner Dinarides and their variation in the Blegoš area would be 310/20±10. The average dip of beds and internal thrust planes in the Poljane-Vrhnika region can be considered together, since the difference of around 5° between them is negligible in the general analysis. The dips of beds on the basic geological map, sheet Kranj (G r a d & F e r j a n č i č, 1974) vary widely, so in the analysis the dips towards southwest and northeast up to 30° were taken into account, and the subhorizontal position.

The starting point for genetic analysis of the actual Blegoš structure is the assumption that the beds and the formed horses within the Hrušica nappe owing to overthrusting of the Inner Dinarides from north southwards were first folded, and then rotated from north towards south. The axis of the peri-nappe folds is according to theory the line of intersection between the beds of the Poljane-Vrhnika region and the footwall nappe plane of the Inner Dinarides, and the rotation of the formed folds took place around the axis in the W-E direction, conformingly with overthrusting of the Inner Dinarides from north towards the south.

With respect to the enumerated variants of dips of beds exist several variants of possible intersecting lines with the footwall nappe plane of the Inner Dinarides (Fig. 10). With the dip of the footwall nappe plane of the Inner Dinarides of 310/20±10 and with variants of dips of beds (225/0-30, 45/0-30) two fields of lines of intersection result, and they are at the same time the axes of newly formed folds (fields 1 and 2).

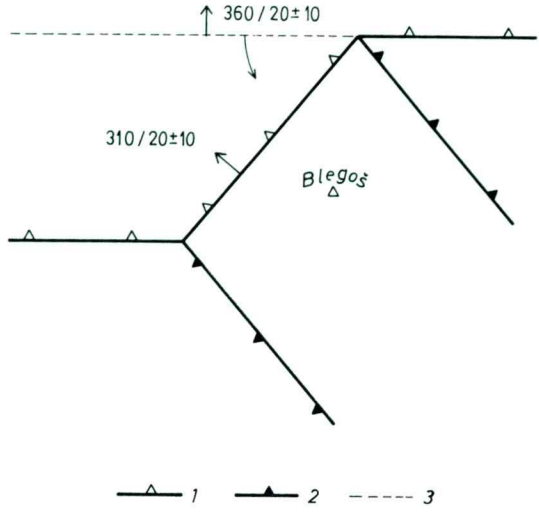

Fig. 9. Relationship between the footwall nappe plane of the Inner Dinarides and thrust plane of the Trnovo nappe in the Blegoš area

1 Footwall nappe plane of the Inner Dinarides; *2* Thrust plane of Trnovo nappe; *3* Variant of the primary position of footwall nappe plane of Inner Dinarides

Sl. 9. Odnos med osnovno krovno narivno ploskvijo Notranjih Dinaridov in krovno narivno ploskvijo Trnovskega pokrova na območju Blegoša

1 Osnovna krovna narivna ploskev Notranjih Dinaridov; *2* Krovna narivna ploskev Trnovskega pokrova; *3* Varianta prvotne lege osnovne krovne narivne ploskve Notranjih Dinaridov

With regard to the mode of formation of the present positon of the Blegoš folds (V, D, B) by rotation of the lines of intersection around the W-E axis, it becomes at the first look evident that the lines of intersection in field 1 cannot be rotated into the actual position of the axes of the Blegoš folds. This can be performed only with the segment of field 2, and this between the traces of rotation a and b that touch the external boundaries of the limits of influence of the axes of Blegoš fods V, D, B (field 3). The data on oleate show that at the selected variant of dip of the nappe basal plane 310/20±10 the dip of the beds in the Poljane-Vrhnika region in the initial phase of overthrusting of the Inner Dinarides must have been between 45/1 to 45/13, or rounded at 45/0-15. The difference between the original direction of folds (field 2) and the present position confirms the virtual uplift of the eastern part of Blegoš which amounts to around 3000 m according to construction from section across the summit of Blegoš in the SW-NE direction (Fig. 6).

Besides the described model of reconstruction a second model ought to be mentioned. In analysis on Fig. 10 the starting point was the primary anomalous position of the footwall nappe plane of the Inner Dinarides in the 220-40 direction (line 1 on the Fig. 9). However, if the general direction of the mentioned footwall nappe plane W-E

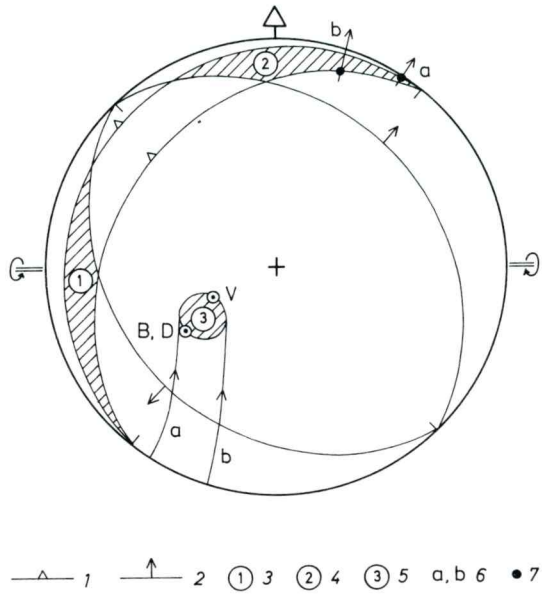

Fig. 10. Kinematic genesis of the structure of Blegoš, 1st variant

1 Footwall nappe plane of the Inner Dinarides; *2* Dip of beds of the Poljane-Vrhnika region; *3* Field of dispersion of lines of intersection between the footwall nappe plane of the Inner Dinarides and beds in southwestern flank of the Poljane-Vrhnika region; *4* Field of dispersion of lines of intersection between the footwall nappe plane of the Inner Dinarides and beds in northeastern flank of the Poljane-Vrhnika region; *5* Field of dispersion of axes of Blegoš folds; *6* Boundary traces of rotation; 7 Extreme lines of intersection in field 2

Sl. 10. Kinematska geneza strukture Blegoša, 1. varianta

1 Osnovna krovna narivna ploskev Notranjih Dinaridov; *2* Vpad plasti Poljansko-Vrhniškega ozemlja; *3* Polje sipanja presečnic med osnovno krovno narivno ploskvijo Notranjih Dinaridov in plastmi v jugozahodnem krilu Poljansko-Vrhniškega ozemlja; *4* Polje sipanja presečnic med osnovno krovno narivno ploskvijo Notranjih Dinaridov in plastmi v severovzhodnem krilu Poljansko-Vrhniškega ozemlja; *5* Polje sipanja osi blegoških gub; *6* Mejni trasi rotacije; 7 Skrajni presečnici v polju 2

is taken into account (line 3 on the Fig. 9), and the assumption is made of its later deformation owing to the hindrance of competent rocks of the Poljane-Vrhnika region, then the starting point of kinematic analysis becomes somewhat different. With the general direction of the footwall nappe plane of the Inner Dinarides 360/20±10 it is possible to reconstruct the Blegoš structure at the condition of northeastern dip of beds in the Poljane-Vrhnika region, which is identical with results of the first analysis, with the difference in the starting dip of beds that is somewhat higher, amounting to 45/8 to 45/28, or rounded 45/10-30 (Fig. 11).

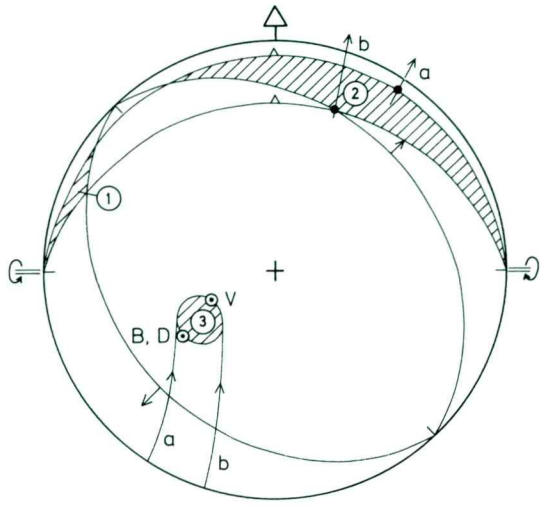

Fig. 11. Kinematic genesis of the Blegoš structure, 2nd variant. Legend as on figure 10

Sl. 11. Kinematska geneza strukture Blegoša, 2. varianta. Legenda na sliki 10

Discussion

The relationship between the Inner and the Outer Dinarides in the Blegoš area suggests the contact of two different nappe systems: (1) the south alpine system that comprises the Southern Alps and the Inner Dinarides west of the Ljubljana basin, and (2), the dinaric system that consists of the Outer Dinarides. Deformations in the alpine direction that occur in places in the dinaric system below the footwall nappe plane of the Inner Dinarides were formed owing to overthrusting from north towards the south. This signifies that the dinarically oriented structures are masked by the alpine directed structures, as witnessed by the actual structure of Blegoš and by W-E folds in incompetent clastic beds of the Trnovo nappe. The boundary between the alpine and the dinaric system of overthrusting is clear in the Ljubljana basin - Tolmin area. Less so in the west and east, where the dinaric nappe units are entirely permeated with the secondary alpine structures.

It follows from our conclusions that the footwall nappe plane of the Inner Dinarides in the Blegoš area represents the southern boundary of the south alpine nappes. This boundary has a deeper structural significance, since it does not involve local rotation of a smaller block of the Outer Dinarides with respect to the Inner Dinarides west of the Zagreb lineament, but the contact of two extensive units that had been originally most likely very far apart, the reasoning which is in hypothetical discussions of genesis of the Dinarides much too little considered. Here we deal with the contact zone whose geometry and genesis are not yet satisfactorily solved. The considered footwall nappe plane in the hinterland of the Triest Bay represents besides the footwall nappe plane of the Southern Alps the most important overthrust structure so-

uth of the Periadriatic lineament. Along it the rotation of the Outer Dinarides with respect to the Inner Dinarides and Southern Alps for 40° to 45° is well expressed.

The comparison of individual concepts on the structure of the boundary between the Inner and the Outer Dinarides was not the object of this article.

Zgradba Blegoša med Notranjimi in Zunanjimi Dinaridi

Uvod

V zaledju Tržaškega zaliva zahodno od Zagrebškega lineamenta sta se v geološkem strokovnem žargonu uveljavila termina alpska (W-E) in dinarska (NW-SE) smer oziroma alpski in dinarski elementi strukture, ki ju seveda ne moremo uporabljati v smislu planetarne razsežnosti Alpidov, temveč imata zgolj lokalni sporazumevalni pomen, saj na tem prostoru dobro ponazarjata razmere na stiku Zunanjih z Notranjimi Dinaridi (sl. 1). Na prostorsko omejenem ozemlju Slovenije potekajo strukture v alpski smeri v Južnih Alpah in pretežnem delu Notranjih Dinaridov, dinarsko smer pa imajo strukture v Zunanjih Dinaridih. Le v pasu ob Notranjih Dinaridih, predvsem tam, kjer grade Zunanje Dinaride mehkejše spodnjetriasne in paleozojske kamnine, so dinarsko usmerjene strukture ponekod maskirane z alpsko usmerjenimi. V tem prispevku nas zanima meja med Notranjimi in Zunanjimi Dinaridi v zahodni Sloveniji oziroma njene geometrijske in kinematske karakteristike, ki jih bomo opisali na primeru zgradbe Blegoša (1562 m) zahodno od Ljubljane (sl. 2) in pomen teh ugotovitev za študij geneze aktualne zgradbe Dinaridov. Prispevek Čarja v tem članku je kartografski, medtem ko je kinematska analiza Placerjevo delo.

Zgradba Blegoša

Okolica Blegoša je bila geološko kartirana večkrat, najprej v času avstro-ogrske monarhije v merilu 1:75000 (K o s s m a t, 1910), nato za Osnovno geološko karto Jugoslavije v merilu 1:100000 (G r a d & F e r j a n č i č, 1974, 1976; B u s e r, 1986, 1987a) in nazadnje podrobno v merilu 1:10000 v okviru raziskav na živo srebro, baker in uran (neobjavljena poročila Mlakarja, Placerja in Čarja), tako, da temeljijo predložena spoznanja o zgradbi tega območja na velikem številu faktografskih podatkov. To ozemlje sestavljajo tri enote, ki so vse zgrajene iz pokrovov (sl. 1, sl. 2). To so: **Južne Alpe** na severu iz mezozojskih kamnin Julijske karbonatne platforme, **Notranji Dinaridi** iz pelagičnih, triasnih, jurskih in krednih klastitov, laporja in ploščnatih apnencev Slovenskega bazena in njegove podlage ter **Zunanji Dinaridi,** ki jih na območju Blegoša sestavljata Trnovski in Hrušiški pokrov. Prvi je iz karbonskih in permskih klastitov ter bolj proti jugozahodu iz triasnih, jurskih in krednih karbonatov, drugi je iz triasnih karbonatov. Karbonatne kamnine Trnovskega in Hrušiškega pokrova sestavljajo robni del Dinarske karbonatne platforme. Hrušiški pokrov oblikuje na prikazanem ozemlju tektonsko polokno izpod Trnovskega pokrova, imenovano v geološko morfološkem smislu Poljansko-Vrhniško ozemlje, ki deli Trnovski pokrov na Idrijsko-Žirovsko ozemlje na jugozahodu in Škofjeloško-Polhograjsko ozemlje na severovzhodu. Notranji elementi strukture v Trnovskem in Hrušiškem pokrovu so izrazito dinarski, kar je značilno za smeri plasti in internih narivnih ploskev. V pokrovih

Notranjih Dinaridov imajo strukture v splošnem alpsko smer. V kinematskem smislu so pokrovi Zunanjih Dinaridov starejši in so narinjeni v današnjem smislu od severovzhoda proti jugozahodu. Trnovski pokrov je narinjen na eocenski fliš Vipavske doline, zato je zgornjeeocenske ali spodnjeoligocenske starosti. Notranji Dinaridi so narinjeni od severa proti jugu na Trnovski in Hrušiški pokrov. Po zgornjemiocenskih plasteh, ki so se v Vzhodnih Posavskih gubah nagubale v zvezi s tem narivanjem, so ti pokrovi postmiocenske starosti. Glede na to, da se dinarsko usmerjena antiforma Poljansko-Vrhniškega ozemlja naslanja na osnovno krovno narivno ploskev Notranjih Dinaridov, ki ni nagubana, ugotavljamo, da je antiforma nastala že pred oblikovanjem južnoalpskih pokrovov.

Generalno razmerje med alpsko in dinarsko usmerjenimi narivnimi strukturami v zahodni Sloveniji je razvidno v vseh delih dosedanjih raziskovalcev tega ozemlja pri K o s s m a t u (1913, tabla V), W i n k l e r j u (1923, tabla IV), G r a d u in F e r j a n č i č u (1974, 1976), P r e m r u j u (1980) in B u s e r j u (1986, 1987a). Vendar je le Premru določno zapisal, da mlajše alpsko usmerjene narivne enote, narinjene od severa proti jugu v rodanski fazi, prekrivajo starejše dinarsko usmerjene narivne enote narinjene od severovzhoda proti jugozahodu v ilirsko-pirenejski fazi, čemur danes ne moremo oporekati.

V vseh krovnih enotah nastopa na območju Blegoša izrazita strukturna geometrijska anomalija, katere središče je karbonatni masiv Blegoša v skrajnem severozahodnem delu Poljansko-Vrhniškega ozemlja, torej tam, kjer se kompetentne karbonatne kamnine Hrušiškega pokrova izpod nekompetentnih kamnin Trnovskega pokrova dotikajo Notranjih Dinaridov.

Pri poimenovanju krovnih enot smo uporabili izraze, ki še niso splošno sprejeti, ker še ni enotnega mnenja o obsegu posameznih enot, razlika v pojmovanju pa pomeni običajno tudi drugačno poimenovanje. Kamnine Slovenskega bazena zahodno od Ljubljanske kotline so npr. po W i n k l e r j u (1923) Julijska zunanja cona, po G r a d u in F e r j a n č i č u (1976) Selška cona, po P r e m r u j u (1980) so vključene v Soriški in Selški nariv, po B u s e r j u (1986) pa v Koblanski, Rutarski in Podmelški pokrov. Kot zanimivost naj navedemo, da za isto enoto predlagajo K r y s t y n in sodelavci (1994, 415) termin Tolminski pokrov. Krovne zgradbe Južnih Alp in Notranjih Dinaridov nismo razčlenjevali, ker v tem prispevku to ni potrebno. Trnovski pokrov razumemo v smislu M l a k a r j a (1969, Žirovsko-Trnovski pokrov), G r a d a in F e r j a n č i č a (1974, 1976, Škofjeloško-Trnovski pokrov) in P l a c e r j a (1981, Trnovski pokrov); Hrušiški pokrov v smislu P l a c e r j a (1981).

Preden nadaljujemo z regionalnimi razglabljanji naj podrobneje opišemo strukturo Blegoša, ki je shematizirano podana na sl. 3. Litostratigrafija je podana na sl. 4. Sam masiv gore gradi obsežna Blegoška sinklinala (B), ki strmo tone proti jugozahodu. Ta se proti severu tik pod osnovno krovno narivno ploskvijo Notranjih Dinaridov previje v neznatnejšo Davško antiklinalo (D), proti jugu pa v Valovniško antiklinalo (V), ki se izravna v Poljansko-Vrhniško ozemlje z dinarsko usmerjenimi plastmi. Osi vseh treh gub so subparalelne, elementi vpada znašajo za Davško antiklinalo in Blegoško sinklinalo 235/50, za Valovniško antiklinalo 245/65. Blegoška sinklinala je iz več lusk, imenovanih blegoške luske, ki so nagubane skupaj s plastmi. Kot med narivno ploskvijo lusk in plastmi je neznaten in znaša 5°. Najnižja v skladovnici lusk je **luska 1** iz normalno ležečih plasti Psevdoziljske formacije srednjetriasne in cordevolske starosti v smislu P l a c e r j a in K o l a r - J u r k o v š k o v e (1990). Sledi ji **luska 2** iz normalno ležečih srednjetriasnih piroklastitov iz spodnjega dela Psevdoziljske formacije, ki ležijo diskordantno na karbonsko-permskih klastitih in kamni-

nah Grödenske, Bellerophonske in Werfenske formacije. Nato sledijo **luska 3** iz normalno ležečih plasti Psevdoziljske formacije ter kamnin Rabeljske, Prehodne in Glavnodolomitne formacije, **luska 4** iz normalnih plasti zgornjega dela Rabeljske formacije in iz kamnin Prehodne, Glavnodolomitne in Dachsteinske formacije, na 4. lusko so narinjene **luska 5** iz plasti Psevdoziljske formacije in spodnjega dela Rabeljske formacije v normalni legi, nato **luska 6** iz enakih plasti v inverzni legi in končno **luska 7** iz Bellerophonske in Werfenske formacije ter diskordantno odloženih langobardskih piroklastitov spodnjega dela Psevdoziljske formacije v inverzni legi. Pas narinjenih kamnin v dnu Podmelškega pokrova grade kamnine Psevdoziljske in Amphiclinske formacije, kar kaže na širšo narivno cono, ki pa strukturno še ni razčlenjena. Notranja struktura lusk z normalno ležečimi plastmi je najlepše razvidna v luski 3, kjer je normalna meja med pisanim zgornjim delom Rabeljskih klastitov in prehodnimi plastmi v severnem krilu Blegoške sinklinale odrezana s krovninsko, v južnem krilu pa s talninsko narivno ploskvijo omenjene luske. Gre torej za lepo viden poševni rez znotraj Hrušiškega pokrova, ki je nastal v stadiju geneze krovne zgradbe Zunanjih Dinaridov. Izhodno formo za kinematski razvoj blegoških lusk je mogoče prikazati s poleglo gubo (sl. 5), kjer je nazorno razvidno zaporedje nastopajočih lusk in odnosov med luskami z normalno in inverzno lego plasti.

Druga značilnost strukture Blegoša je njena severovzhodna, vzhodna in jugovzhodna do južna in jugozahodna meja nasproti okolnim kamninam, ki kaže na ekstremni dvig vzhodnega dela masiva Blegoša (sl. 6). Dvig je razviden iz nagnjenosti osi gub proti jugozahodu, kar pomeni, da gre za rotacijo prvotno subhorizontalnih nagubanih plasti in lusk v strmo lego. Dvig vzhodnega dela Blegoša se je moral zgoditi ob že prej obstoječih subvertikalnih prelomih različnih smeri (sl. 2), ki so na sl. 3 označeni s posebno oznako. Gre torej za nasledstvene premike. Vzhodno od te meje se javljajo inverzno ležeče plasti Psevdoziljske formacije v diskordantnem odnosu s spodnjetriasnimi skladi, zaradi česar jih vzporejamo z enakimi plastmi luske 7 zahodno od vrha Blegoša. To lusko prekrivajo vzhodno od Blegoša karbonsko-permske plasti Trnovskega pokrova. Tektonsko okno nedaleč od tod dokazuje krovni značaj Trnovskega pokrova.

Nagubana zgradba Blegoša se nadaljuje proti jugozahodu tudi v Trnovskem pokrovu. V jedru Blegoške sinklinale je struktura Škofjega, v jedru Valovniške antiklinale pa tektonsko polokno iz kamnin Hrušiškega pokrova jugovzhodno od Škofjega ob Podplečici.

Geometrijska anomalija na območju Blegoša nastopa tudi v zgradbi Notranjih Dinaridov. Izražena je z odklonom njihove osnovne krovne narivne ploskve od smeri W-E v smer SW-NE in z vzporednim odklonom smeri plasti. Masiv Blegoša predstavlja potemtakem jedro kompetentnih kamnin Hrušiškega pokrova, obdano z nekompetentnimi kamninami Trnovskega pokrova in Notranjih Dinaridov.

V kinematskem smislu nas seveda zanima, kakšen mehanizem je ustvaril strukturo Blegoša. Za določitev izhodiščnih podatkov si nekoliko podrobneje oglejmo zgradbo Poljansko-Vrhniškega ozemlja (sl. 7), ki predstavlja antiklinalni svod iz kamnin Hrušiškega pokrova v smeri NW-SE, v katerem je antiklinalno usločena tudi narivna ploskev Trnovskega pokrova. Pokrov dokazujejo tektonske krpe karbonsko-permskih klastitov sredi antiklinalnega hrbta in tektonska polokna v dolinah prečno na antiklinalni hrbet, kjer se karbonati Hrušiškega pokrova zajedajo globoko pod klastite Trnovskega pokrova. V profilu C-D na osnovni geološki karti, list Kranj (G r a d & F e r j a n č i č, 1974), ki poteka prek Poljansko-Vrhniškega ozemlja, sicer ni narivnih ploskev, ki bi blago sekale plasti pod kotom okoli 5°, vendar te na Blegošu obstajajo, zato sklepamo, da niso povsod razvite ali pa niso bile kartirane. Plasti na Poljansko-

Vrhniškem ozemlju so sicer nagubane, vendar so v generalnem smislu subhorizontalne in vpadajo ponekod bolj, ponekod manj strmo proti jugozahodu v jugozahodnem krilu in proti severovzhodu v severovzhodnem krilu.

Geometrija alpskega in dinarskega sistema krovnih narivov je razvidna na sl. 8. Razmere v okolici Blegoša so varianta te sheme (sl. 9). Iz te je mogoče izpeljati sedanjo strukturo Blegoša. Izhodno strukturo torej predstavljajo: 1. smer in vpad osnovne krovne narivne ploskve Notranjih Dinaridov, 2. smer in vpad plasti na Poljansko-Vrhniškem ozemlju in 3. smer in vpad internih narivnih ploskev v tej enoti. Smer osnovne krovne narivne ploskve Notranjih Dinaridov je mogoče določiti po geološki karti, velikosti vpada pa se ne da izmeriti neposredno. Nasloniti se je treba na vpade krovnih narivnih ploskev v samih Notranjih Dinaridih, ki jih posreduje B u s e r (1987a) na geološki karti, lista Tolmin in Videm, in znašajo okoli 20°. Tako bi elementi vpada osnovne krovne narivne ploskve Notranjih Dinaridov in njegove variacije na območju Blegoša znašali 310/20±10. Povprečni vpad plasti in internih narivnih ploskev na Poljansko-Vrhniškem ozemlju lahko obravnavamo skupaj, saj je razlika med njima 5° za generalno analizo zanemarljiva. Vpadi plasti na osnovni geološki karti, list Kranj (G r a d & F e r j a n č i č, 1974) močno nihajo, zato smo pri analizi upoštevali vpade proti jugozahodu in severovzhodu do 30° in subhorizontalno lego.

Izhodišče za analizo geneze sedanje strukture Blegoša je podmena, da so se plasti in že formirane luske znotraj Hrušiškega pokrova zaradi narivanja Notranjih Dinaridov od severa proti jugu najprej nagubale in nato zasukale od severa proti jugu. Os obnarivnih gub je po teoriji presečnica med plastmi Poljansko-Vrhniškega ozemlja in osnovno krovno narivno ploskvijo Notranjih Dinaridov, sukanje nastalih gub pa se je zgodilo okoli osi v smeri W-E skladno z narivanjem Notranjih Dinaridov od severa proti jugu.

Glede na naštete variante vpadov plasti obstaja več variant možnih presečnic z osnovno krovno narivno ploskvijo Notranjih Dinaridov (sl. 10). Pri vpadu osnovne krovne narivne ploskve Notranjih Dinaridov 310/20±10 in pri variantah vpadov plasti (225/0-30, 45/0-30) dobimo dve polji presečnic, ki so hkrati možne smeri osi novonastalih gub (polji 1 in 2). Glede na to, da je današnja lega osi blegoških gub (V, B, D) nastala z rotacijo presečnic okoli osi W-E, je že na prvi pogled očitno, da presečnic v polju 1 ne moremo zarotirati v aktualno lego osi blegoških gub. To lahko opravimo le s segmentom polja 2, in sicer med trasama rotacije a in b, ki se dotikata zunanjih mej vplivnega polja osi blegoških gub V, B, D (polje 3). Iz oleate je razvidno, da je bil pri izbrani varianti vpada krovne narivne ploskve 310/20±10 vpad plasti na Poljansko-Vrhniškem ozemlju v začetni fazi narivanja Notranjih Dinaridov med 45/1 do 45/13 ali zaokroženo 45/0-15. Razlika med prvotno smerjo gub (polje 2) in sedanjo lego potrjuje navidezni dvig vzhodnega dela Blegoša, ki znaša po konstrukciji v profilu prek vrha Blegoša v smeri SW-NE (sl. 6) okoli 3000 m.

Poleg opisanega modela rekonstrukcije je treba omeniti še enega. Pri analizi na sl. 10 smo izhajali iz primarne anomalne lege osnovne krovne narivne ploskve Notranjih Dinaridov v smeri 220-40. Če pa upoštevamo generalno smer omenjene krovne narivne ploskve W-E (sl. 9) in postavimo, da se je le-ta deformirala pozneje zaradi ovire iz kompetentnih kamnin Poljansko-Vrhniškega ozemlja, je izhodišče kinematske analize nekoliko drugačno. Pri generalni smeri osnovne krovne narivne ploskve Notranjih Dinaridov 360/20±10 je mogoče rekonstruirati zgradbo Blegoša pri pogoju, da vpadajo plasti na Poljansko-Vrhniškem ozemlju proti severovzhodu, kar je identično z rezultati prve analize, le da je izhodiščni vpad plasti nekoliko večji in znaša 45/8 do 45/28 ali zaokroženo 45/10-30 (sl. 11).

Razprava

Odnos med Notranjimi in Zunanjimi Dinaridi na območju Blegoša kaže na stik dveh različnih krovnih sistemov: 1. južnoalpskega, ki zajema Južne Alpe in Notranje Dinaride zahodno od Ljubljanske kotline in 2. dinarskega, ki zajema Zunanje Dinaride. Deformacije v alpski smeri, ki nastopajo ponekod v dinarskem sistemu pod osnovno krovno narivno ploskvijo Notranjih Dinaridov, so nastale zaradi narivanja od severa proti jugu. To pomeni, da so dinarsko usmerjene strukture prekrite z alpsko usmerjenimi strukturami, na kar kažejo aktualna zgradba Blegoša in gube v smeri W-E v nekompetentnih klastičnih kamninah Trnovskega pokrova. Meja med alpskim in dinarskim sistemom narivanja je od Ljubljanske kotline do Tolmina jasna, medtem ko proti zahodu in vzhodu ni tako; tu so dinarske krovne enote povsem preparirane s sekundarnimi alpskimi strukturami.

Iz naših ugotovitev izhaja, da predstavlja osnovna krovna narivna ploskev Notranjih Dinaridov na območju Blegoša južno mejo južnoalpskih pokrovov, ki ima globlji strukturni pomen, saj ne gre za lokalno rotacijo manjšega bloka Zunanjih Dinaridov nasproti Notranjim Dinaridom zahodno od Zagrebškega lineamenta, temveč za stik dveh obsežnih enot, ki sta bili prvotno po vsej verjetnosti daleč narazen, kar je v genezi Dinaridov v dosedanjih hipotetičnih razglabljanjih premalo prisotno. Gre za stično cono, ki geometrijsko in genetsko še ni zadovoljivo rešena. Obravnavana krovna narivna ploskev v zaledju Tržaškega zaliva predstavlja poleg osnovne krovne narivne ploskve Južnih Alp najpomembnejšo narivno strukturo južno od Periadriatskega lineamenta. Ob njej je jasno izražena rotacija Zunanjih Dinaridov nasproti Notranjim Dinaridom in Južnim Alpam za 30° do 45°.

Primerjava posameznih idej o zgradbi meje med Notranjimi in Zunanjimi Dinaridi ni predmet tega prispevka.

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