GEOLOGIJA 67/1, 129-156, Ljubljana 2024

https://doi.org/10.5474/geologija.2024.007

# Tectonics and gravitational phenomena, part two: The Trnovski gozd-Banjšice-Šentviška Gora degraded plain

# Tektonika in gravitacijski pojavi, drugi del: Trnovsko-banjško-šentviška degradirana uravnava

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Prejeto / Received 22. 3. 2024; Sprejeto / Accepted 29. 5. 2024; Objavljeno na spletu / Published online 11. 6. 2024

*Key words:* External Dinarides NW, geomorphology, gravitational phenomena, karst plains, degraded karst plains, Idrija fault
*Ključne besede:* Zunanji Dinaridi NW del, geomorfologija, gravitacijski pojavi, kraške uravnave, degradirane kraške uravnave, Idrijski prelom

## Abstract

The article describes the recent conditions at the Paleogene thrust contact between the External Dinaric Thrust Belt composed of carbonate rocks and the External Dinaric Imbricate Belt composed of flysch rocks, geographically, between the Trnovski gozd (Trnovski gozd plateau) and the Vipava Valley at the northwestern end of the Dinarides. Fossil and recent gravity-related phenomena that indicate the uplift of the southwestern edge of the External Dinaric Thrust Belt and the larger complex in the hinterland are found there. However, these phenomena are not related to the reactivated Paleogene thrust tectonics, but to the Neogene-recent underthrusting as a consequence of the Microadria (Adriatic Microplate) movement towards the Dinarides. Only arguments for these processes are presented in this article.

## Izvleček

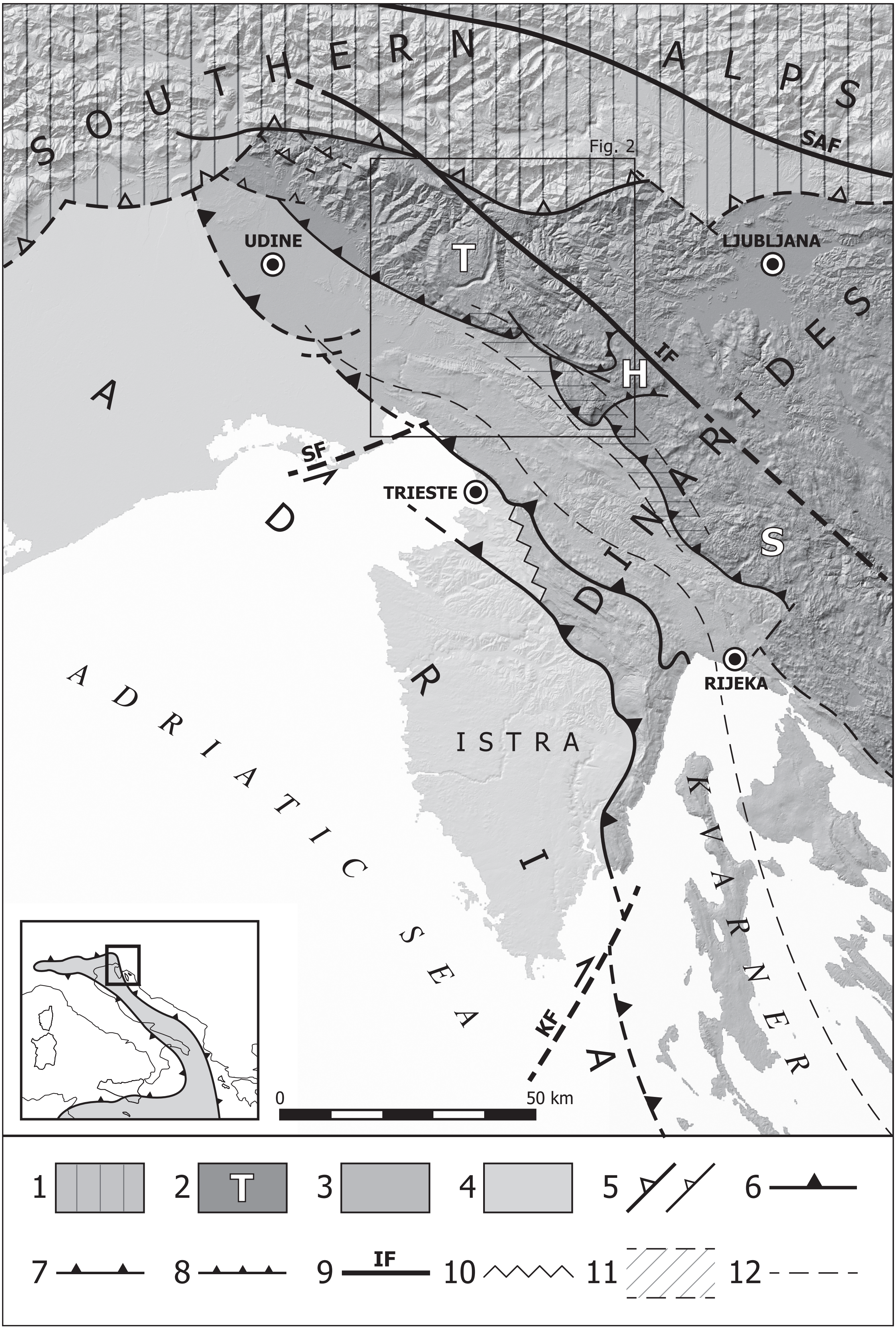
V članku so opisane recentne razmere na paleogenskem narivnem stiku med Zunanjedinarskim narivnim pasom iz karbonatnih kamnin in Zunanjedinarskim naluskanim pasom iz flišnih kamnin. Geografsko med Trnovskim gozdom (Trnovska planota) in Vipavsko dolino na severozahodnem koncu Dinaridov. Tu najdemo fosilne in recentne gravitacijske pojave, ki kažejo na dviganje jugozahodnega obrobja Zunanjedinarskega narivnega pasu in večjega kompleksa v zaledju, vendar to ni povezano z reaktivirano paleogensko narivno tektoniko, temveč z neogensko-recentnimi procesi podrivanja, ki so posledica pomikanja Mikroadrije (Jadranska mikroplošča) proti Dinaridom. V članku so predstavljene le posledice teh procesov.

## Introduction

The Microadria (Adriatic microplate) is moving towards the Dinarides, which northwestern part is described by Blašković (1991); Weber et al. (2006; 2010); Placer et al. (2010); Vrabec et al. (2018). It has not been precisely determined when the convergence process began, but in general we assume that it started in the Middle Miocene and continues today, which is why we use the term Neogene-recent activity of the Adriatic Microplate. Its characteristics have not yet been sufficiently studied, but the result of this process is the narrowing of the Dinarides, which is kinematically different from the narrowing of the Dinarides in the Paleo-

## Uvod

Mikroadrija (Jadranska mikroplošča) se pomika proti Dinaridom, za njen severovzhodni del so o tem pisali Blašković (1991); Weber et al. (2006; 2010); Placer et al. (2010); Vrabec et al. (2018). Kdaj se je pričel proces približevanja ni natančneje ugotovljeno, v splošnem pa menimo, da v srednjem miocenu in traja še danes, zato uporabljamo termin neogensko-recentna dejavnost Jadranske mikroplošče. Njene značilnosti še niso dovolj raziskane, posledica tega procesa pa je oženje Dinaridov, ki se kinematsko razlikuje od oženja le-teh v paleogenu, v zaključnem obdobju nastajanja krovne zgradbe. Razlikuje se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gene, in the final period of the formation of the nappe structure. It differs mainly in that, in addition to successive deformations, new plicative and disjunctive structures also emerged.

The Istran block is located between the Sesljan and Kvarner Faults, an integral part of the Microadria which, in contrast to the other blocks of the Microadria, is noticeably pushed towards the northeast. Its visible part is Istra (Fig. 1). As a result, an extensive Istra Pushed Area was formed in the Dinaric hinterland of the block, in which longitudinal morphostructural objects are laterally bent towards the northeast (Placer et al., 2010; 2023). This situation is illustrated by the morphostructural trajectory in the figure. The two branches of the Dinaric thrust boundary in Istra are related by the Črni Kal Anomaly, which is substantiated in the article by Placer et al. (2023, p. 18–30).

This article discusses the laterally bent Paleogene thrust boundary between the External Dinaric Imbricated Belt, composed predominantly of flysch rocks, and the External Dinaric Thrust Belt, which is composed mostly of carbonate rocks. Extensive, sub-recent and recent gravity-related phenomena have developed here, which significantly affect the geomorphology of the landscape (Komac & Ribičič, 2008; Kocjančič et al., 2019; Placer et al., 2021a). The described conditions are particularly pronounced on the northeastern part of the Vipava Valley beneath the carbonate brims of the Trnovski gozd and Nanos plateaus (Popit et al., 2022), where fossil gravity bodies are stacked in several consecutive levels, and the recent ones are spread out over them; such are e.g. the recent large Slano Blato and Razdrto planar landslides (Fig. 2). The conditions therefore show that the External Dinaric Thrust Belt is being uplifted in this area

predvsem v tem, da so poleg nasledstvenih deformacij nastale tudi nove plikativne in disjunktivne strukture.

Sestavni del Mikroadrije je istrski blok med Sesljanskim in Kvarnerskim prelomom, ki je nasproti drugim blokom Mikroadrije opazno potisnjen proti severovzhodu. Njegov vidni del je Istra (sl. 1). Zaradi tega je v dinarskem zaledju bloka nastalo obsežno istrsko potisno območje v katerem so longitudinalni morfostrukturni objekti bočno usločeni proti severovzhodu (Placer et al., 2010; 2023). To stanje ponazarja morfostrukturna trajektorija na sliki. Dva kraka narivne meje Dinaridov v Istri povezuje črnokalska anomalija, ki je utemeljena v članku Placer et al. (2023, str. 17-30).

V tem članku obravnavamo bočno usločeno narivno mejo paleogenske starosti med Zunanjedinarskim naluskanim pasom, pretežno iz flišnih kamnin in Zunanjedinarskim narivnim pasom pretežno iz karbonatnih kamnin. Tu so se razvili obsežni subrecentni in recentni gravitacijski pojavi, ki pomembno vplivajo na geomorfologijo krajine (Komac & Ribičič, 2008; Kocjančič et al., 2019; Placer et al., 2021a). Opisane razmere so posebej izrazite na severovzhodnem obrobju Vipavske doline pod karbonatnimi obronki planot Trnovski gozd in Nanos (Popit et al., 2022), kjer so fosilna gravitacijska telesa naložena v več nadstropjih, recentna pa se prožijo preko njih; taka sta npr. velika recentna planarna plazova Slano blato in Razdrto (sl. 2). Razmere torej kažejo, da se enota Zunanjedinarskega narivnega pasu na tem območju dviga (Mihael Ribičič, ustna izjava 2010), kar povzroča nestabilnost pobočij, vendar dviganje ni posledica reaktivacije krovnega nariva Zunanjedinarskega narivnega pasu paleogenske

Fig. 1. Structural sketch of the northeastern margin of Microadria. Compiled from: Geological map of Slovenia 1:250 000 (ed. Buser, S. 2009); Geological map of the Friuli Venezia Giulia 1:150 000 (ed. Giovanni Battista Carulli, 2006); Placer et al. (2021; 2023).

Sl. 1. Strukturna skica severovzhodnega obrobja Mikroadrije. Sestavljeno po predlogah: Geološka karta Slovenije 1:250 000 (ured. Buser, S. 2009); Carta geologica del Friuli Venezia Giulia 1:150 000 (ured. Giovanni Battista Carulli, 2006); Placer et al. (2021; 2023).

1 Southern Alps / Južne Alpe.

2 External Dinaric Thrust Belt. Front part of thrust unit: **T** – Trnovo Nappe, **H** – Hrušica Nappe, **S** – Snežnik Nappe / Zunanjedinarski narivni pas. Čelni del krovne enote: **T** – Trnovski pokrov, **H** – Hrušiški pokrov, **S** – Snežniški pokrov

3 External Dinaric Imbricate Belt / Zunanjedinarski naluskani pas

4 Adria Microplate (Microadria) / Jadranska mikroplošča (Mikroadrija)

5 Thrust boundary of Southern Alps; thrust fault related to the dynamics of the Southern Alps / narivna mejna Južnih Alp; nariv povezan z dinamiko Južnih Alp

6 Thrust boundary of Dinarides / narivna meja Dinaridov

7 Boundary of the External Dinaric Imbricate Belt / meja Zunanjedinarskega narivnega pasu

8 Boundary of the nappe unit within the External Dinaric Thrust Belt / meja krovne enote znotraj Zunanjedinarskega narivnega pasu

9 Subvertical fault: **SAF** – Sava Fault, **IF** – Idrija Fault, **SF** – Sistiana Fault, **KF** – Kvarner Fault / subvertikalni prelom: **SAF** – Savski prelom, **IF** – Idrijski prelom, **SF** – Sesljanski prelom, **KF** – Kvarnerski prelom

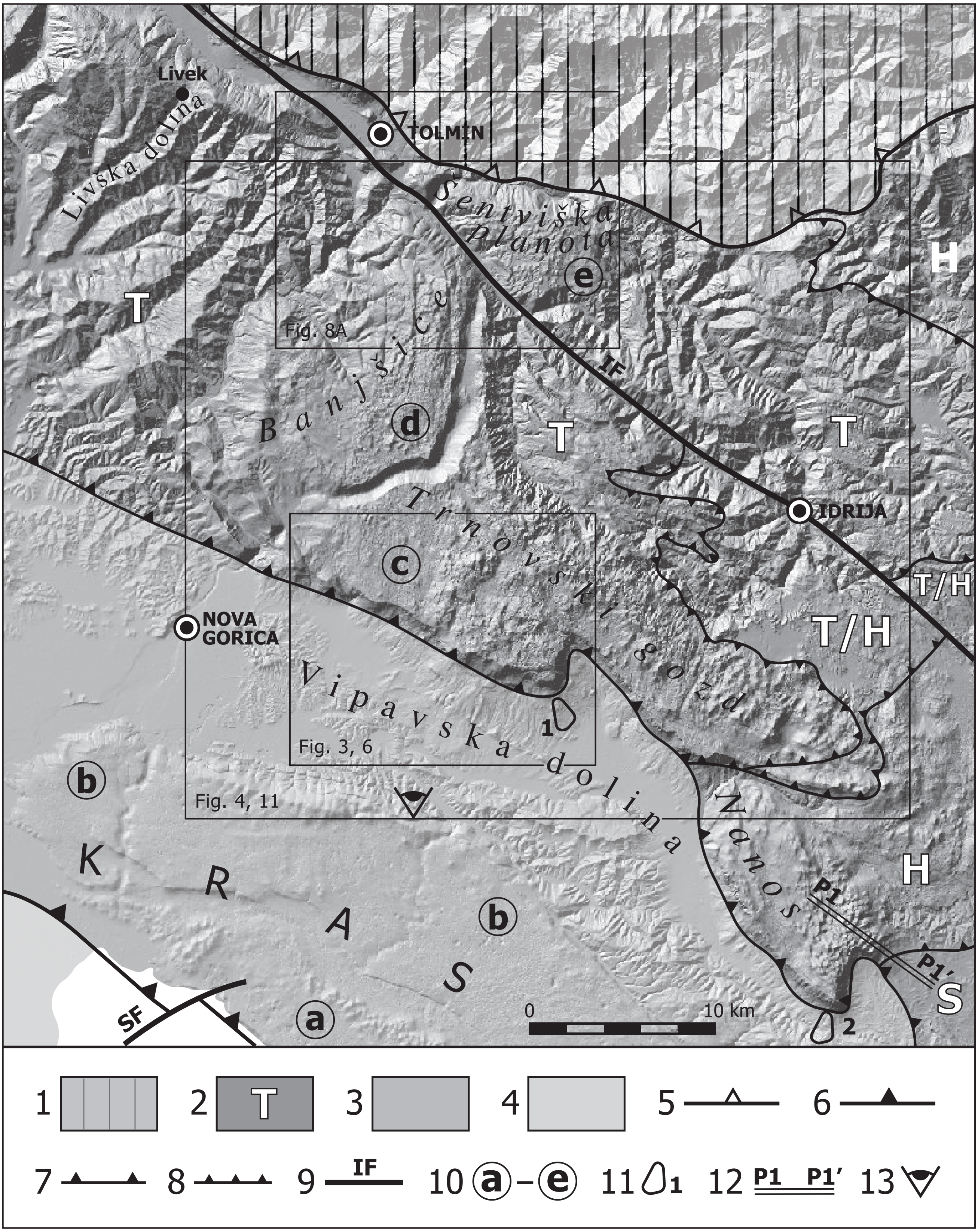
10 Črni Kal Anomaly (Placer et al., 2023, pg. 17–30) / črnokalska anomalija (Placer et al., 2023, str. 17–30)

11 Area of large gravitational phenomena / območje velikih gravitacijskih pojavov

12 Morphostructural trajectory / morfostrukturna trajektorija

(Mihael Ribičič, oral statement 2010), which introduces instability into the slopes. However, the uplift is not the result of the reactivation of the Paleogene nappe thrust of the External Dinaric Thrust Belt, but the Neogene-recent activity of the Adriatic Microplate. Paleogene overthrusts in this

starosti, temveč neogensko-recentne dejavnosti Jadranske mikroplošče. Paleogenski krovni narivi so v tem delu Dinaridov v smeri narivanja subhorizontalni in rahlo undirani (Placer et al., 2021a, str. 47; 2023, sl. 11), regionalno pa blago tonejo proti severozahodu.



part of the Dinarides are subhorizontal and slightly undulating in the direction of thrusting (Placer et al., 2021a, p. 47; 2023, fig. 11), and regionally dipping gently to the northwest.

The geomorphological step between Trnovski gozd and Nanos composed of carbonate rocks in the External Dinaric Thrust Belt and Vipava Valley composed of flysch rocks in the External Dinaric Imbricate Belt could also have been created only due to a faster denudation of flysch, however, during the mapping of the route of the highway along the Vipava Valley beneath Nanos and Trnovski gozd unequivocal signs of reverse tectonics indicating subduction (unpublished) were found. It is also important that several etages of gravity phenomena can be more easily explained by tectonic uplift than by denudation, and that a geomorphological step occurs also where both of the mentioned nappe units are composed of flysch rocks (the area of the ongoing mapping northwest of the Vipava Valley).

The events on the boundary between the Istra Autochton and the External Dinaric Imbricated Belt, where Paleogene thrust planes are antiformally folded along the Neogene-recent underthrusting reverse faults (Placer et al., 2023, Fig. 7) serve as a structural model of the recent events on the boundary between the External Dinaric Imbricated Belt and the External Dinaric Thrust Belt in the Vipava Valley. The stepped structure of the Dinarides appears to be related not only to the Paleogene nappe structure, but also to Neogene-recent underthrust reverse faults. This is also observed by Korbar et al. (2020) in the Kvarner area. Longitudinal right lateral strike-slip faults of the Dinarides are less important, only some are more important, e.g. the Idrija Fault, which it is included it in the article.

Geomorfološka stopnja med Trnovskim gozdom z Nanosom iz karbonatnih kamnin v Zunanjedinarskem narivnem pasu in Vipavsko dolino iz flišnih kamnin v Zunanjedinarskem naluskanem pasu bi lahko nastala tudi samo zaradi hitrejše denudacije fliša, vendar so bili pri kartiranju trase avtoceste po Vipavski dolini pod Nanosom in Trnovskim gozdom odkriti nedvoumni znaki reverzne tektonike, ki kažejo na podrivanje (neobjavljeno). Pomembno je tudi, da je več etaž gravitacijskih pojavov lažje razložiti s tektonskim dviganjem kot z denudacijo in da nastopa geomorfološka stopnja tudi tam, kjer sta obe omenjeni krovni enoti zgrajeni iz flišnih kamnin (območje trenutnega kartiranja severozahodno od Vipavske doline).

Kot strukturni model recentnega dogajanja na meji med Zunanjedinarskim naluskanim pasom in Zunanjedinarskim narivnim pasom v Vipavski dolini služi dogajanje na meji med avtohtonom Istre in Zunanjedinarskin naluskanim pasom, kjer so ob neogensko-recentnih podrivnih reverznih prelomih paleogenske narivne ploskve antiformno usločene (Placer et al., 2023, sl. 7). Zdi se, da stopničasta zgradba Dinaridov ni povezana samo s paleogensko krovno zgradbo, temveč tudi z neogensko-recentnimi podrivnimi reverznimi prelomi. To opažajo tudi Korbar et al. (2020) na območju Kvarnerja. Longitudinalni desnozmični prelomi Dinaridov imajo pri tem manjši pomen, pomembnejši so le nekateri, npr. Idrijski prelom, ki smo ga zato tudi vključili v članek.

V tem članku ni opisan strukturni mehanizem neogensko-recentnega dviganja Zunanjedinarskega narivnega pasu nad Zunanjedinarski naluskani pas v Vipavski dolini, temveč je obdelana le geomorfologija dvignjenih planot nad Vipavsko

Fig. 2. Major karst plains on the External Dinaric Thrust Belt and External Dinaric Imbricate Belt.
Sl. 2. Večje kraške uravnave na Zunanjedinarskem narivnem in Zunanjedinarskem naluskanem pasu.

1 Southern Alps / Južne Alpe

2 External Dinaric Thrust Belt: **T** – Trnovo Nappe, **H** – Hrušica Nappe, **S** – Snežnik Nappe, **T/H** – area of the interjacent nappe slices between Trnovo Nappe and Hrušica Nappe (Placer, 1981, fig. 9) / Zunanjedinarski narivni pas: **T** – Trnovski pokrov, **H** – Hrušiški pokrov, **S** – Snežniški pokrov, **T/H** – območje vmesnih krovnih lusk med Trnovskim in Hrušiškim pokrovom (Placer, 1981, sl. 9)

3 External Dinaric Imbricate Belt / Zunanjedinarski naluskni pas

4 Microadria / Mikroadrija

5 Thrust boundary of the Southern Alps / narivna meja Južnih Alp

6 Thrust boundary of the Dinarides / narivna meja Dinaridov

7 Boundary of the External Dinaric Imbricate Belt / meja Zunanjedinarskega narivnega pasu

8 Boundary of the nappe unit within the External Dinaric Thrust Belt / meja krovne enote znotraj Zunanjedinarskega narivnega pasu

9 Important subvertical fault: **IF** – Idrija Fault, **SF** – Sistiana Fault / pomembnejši subvertikalni prelom: **IF** – Idrijski prelom, **SF** – Sesljanski prelom

10 Larger karst plain: **a** – Aurisina Classical Karst Region, **b** – Doberdo del Lago, Kostanjevica, and Komen Classical Karst Region, **c** – Voglarska planota (Voglarji plateau), **d** – southeastern part of Banjšice (Banjšice plateau), **e** – eastern part of Šentviška planota (Šentviška Gora plateau) / večja kraška uravnava: **a** – Nabrežinski Kras, **b** – Doberdobski, Kostanjeviški in Komenski Kras, **c** – Voglarska planota, **d** – jugovzhodni del Banjške planote ali Banjšic, **e** – vzhodni del Šentviške planote

11 Active planar landslide: 1 – Slano blato, 2 - Razdrto / dejavni planarni plaz: 1 – Slano blato, 2 – Razdrto

12 Profile Nanos (hamlet) - Strane (village) / profil Nanos (zaselek) - Strane (vas)

13 Recording location of fig. 5A / stojišče snemanja sl. 5A

This article does not describe the structural mechanism of the Neogene-recent uplift of the External Dinaric Thrust Belt above the External Dinaric Imbricated Belt in the Vipava Valley, only the geomorphology of the raised plateaus above the Vipava Valley is covered. The elevation of the Trnovski gozd, Banjšice and Šentviška Gora plateau is reflected in the peculiarities of their geomorphology. This is not reflected only in the gravitational, but also in the intensity of the corrosive degradation of the karstic plains on the External Dinaric Thrust Belt – in this case on the Voglarji plateau in the northwestern part of the Trnovski gozd, in the southeastern part of the Banjšice plateau or Banjšice, and on the eastern part of the Šentviška Gora plateau. The phenomenon of corrosive degradation of the above-mentioned settlements is derived from the assumption that they were formed at a lower altitude than today. The increased corrosion is the result of harsher climatic conditions, which is most apparent when we compare the leveled parts of the External Dinaric Thrust Belt (c, d, e) with the leveled Karst, which lies at a lower altitude (a, b) (Fig. 2).

The Trnovski gozd and Banjšice plateaus are delimited by the Čepovan dry valley, a pradol according to Diercks et al. (2021). The latter is separated from the Šentviška Gora plateau by the Idrija Fault and was uplifted by about 200 m along the length of it.

The uplift of the Trnovski gozd and the Banjšice plateaus up to today's level is already evident in the very existence of the Čepovan dry valley, which could not have been formed at today's altitude because it does not have a hydrographic hinterland.

Stepišnik and Ferk (2023, p. 12–13, 17–18) defined the leveled area of the Trnovski gozd and Banjšice plateaus as a corrosive karst plain, which was thought to have been formed before the uplift of the Trnovski gozd plateau. Habič (1968) already thought the same about the uplift. In our article, we present a geological-structural view of the Trnovski gozd, Banjšice, and Šentviška Gora plateaus, which confirms some basic geographical findings but at the same time points to the possibility that the levelled area extended significantly further at the time of its formation than it does today.

## Gravitational phenomena

Quaternary gravity-related phenomena are relatively well studied on the northeastern edge of the Vipava Valley, and research so far has shown that the structure and genesis of slope sediments

dolino. Dvig Trnovskega gozda, Banjšic in Šentviške planote se odraža v posebnostih njihove geomorfologije, ta se ne odraža samo v gravitacijskih pojavih, temveč, poleg drugega, tudi v intenzivnosti korozivne degradacije kraških uravnav na Zunanjedinarskem narivnem pasu, v tem primeru na Voglarski planoti na severozahodnem delu Trnovskega gozda, na jugovzhodnem delu Banjške planote ali Banjšic in na vzhodnem delu Šentviške planote. Pojav korozivne degradacije omenjenih uravnav izpeljujemo iz predpostavke, da so nastale na nižji nadmorski višini od današnje. Povečana stopnja korozije je posledica ostrejših klimatskih razmer, kar se najlepše opazi, ko obravnavane uravnane dele Zunanjedinarskega narivnega pasu (c, d, e) primerjamo z uravnanim Krasom, ki leži na nižji nadmorski višini (a, b) (sl. 2).

Trnovski gozd in Banjško planoto razmejuje suha dolina Čepovanski dol, po Dierks et al. (2021) pradol. Slednja je od Šentviške planote ločena z Idrijskim prelomom ter ob njem dvignjena za okoli 200 m.

Dviganje Trnovskega gozda in Banjške planote na današnji nivo se kaže že v samem obstoju Čepovanskega dola, ki ni mogel nastati na današnji nadmorski višini, ker nima hidrografskega zaledja.

Uravnano območje Trnovskega gozda in Banjšic sta Stepišnik in Ferk (2024, str. 12–13, 17–18) opredelila kot korozivni kraški ravnik, ki naj bi nastal v času pred dvigom Trnovskega gozda. Enako je o dvigu menil že Habič (1968). V našem članku podajamo geološko-strukturni pogled na kraške uravnave Trnovskega gozda, Banjšic in Šentviške planote, ki potrjuje osnovne geografske ugotovitve, hkrati pa kaže na možnost, da je imelo uravnano ozemlje ob svojem nastanku bistveno večji obseg od današnjega.

## Gravitacijski pojavi

Kvartarni gravitacijski pojavi so na severovzhodnem robu Vipavske doline razmeroma dobro obdelani, dosedanje raziskave so pokazale, da je zgradba in geneza pobočnih sedimentov na tem območju izredno kompleksna. Pod čelom paleogenskega narivnega roba se nahajajo obsežne akumulacije pobočnih sedimentov, ki so nastali z različnimi mehanizmi transporta in sedimentacijskimi procesi (Popit in Košir, 2003; Popit et al., 2013; Popit, 2016). Poleg regionalnih geoloških razmer, na mesta pojavljanja in vrsto pobočnih procesov neposredno vplivajo tudi krajevni strukturni, litološki, hidrološki in geokemični pogoji.

in this area is extremely complex. Extensive accumulations of slope sediments formed by various transport mechanisms and depositional processes (Popit in Košir, 2003; Popit et al., 2013; Popit, 2016) are present beneath the front of the Paleogene thrust margin. In addition to regional geological conditions, local structural, lithological, hydrological, and geochemical conditions also directly influence the places of occurrence and type of slope processes.

Quaternary slope sediments deposited below the thrust front margin appear in the highest parts of the slope in the form of scree patches and fans. These are related to the passes between the higher lying steep carbonate walls and the gentler flysch slope below them. The scree deposits cover a considerable area and are the main source of carbonate gravels, which is deposited further down the impermeable slope by various transport mechanisms and depositional processes. Numerous larger and smaller sedimentary bodies and blocks of Quaternary slope sediments cemented into slope breccia are deposited in the lower parts of the slope. The variability of Quaternary sediments in individual sedimentary bodies is extremely large, considering the geological structure of the territory. The origin of the material is represented by two main lithological differences: sediment consisting of siliciclastic flysch rocks (sandstone, siltstone, marl, and mudstone) from the flysch base and carbonate sediment from the carbonate hanging wall in the hinterland. Based on two lithological differences, the composition and structure of Quaternary sediments would be expected to be relatively simple. According to previous research, most of the profiles investigated in detail in the Rebrnice area beneath Mt. Nanos (Popit et al., 2013) and the Selo landslide (Košir & Popit, 2002; Popit & Košir, 2003; Verbovšek et al., 2017) revealed extraordinary stratigraphic variability and lateral diversity. Several distinctly layered sediments were recorded within the landslide masses, indicating several phases of sedimentation or events.

If we focus on the area between Ajdovščina and Nova Gorica (Fig. 3), the 10 km$^2$ complex Selo landslide stands out in terms of size and shape, according to Košir et al. (2015) and is described as a long runout rock avalanche. The Selo landslide measures approximately 4.5 km in length, with the distance from the crown to the toe end measuring 5.8 km. The average sediment thickness is estimated at 19 m, and the maximum measured sediment thickness in the central part is 56 m (Popit & Košir, 2003; Košir et al., 2015). The volume of the landslide, estimated with the help of

Kvartarni pobočni sedimenti, ki so odloženi pod čelom narivnega roba se v najvišjih delih pobočja pojavljajo v obliki meliščnih zaplat in pahljač. Ti so vezani na prevoje med višje ležečimi strmimi karbonatnimi stenami in položnejšim flišnim pobočjem pod njimi. Melišča obsegajo precejšnje območje in predstavljajo glavni vir karbonatnega gruščа, ki se nadalje z različnimi mehanizmi transporta in sedimentacijskimi procesi odlaga nižje po neprepustnem pobočju. V nižjih delih pobočja so odložena številna manjša in velika sedimentna telesa in bloki kvartarnih pobočnih sedimentov mestoma sprijetih v pobočno brečo. Variabilnost kvartarnih sedimentov v posameznih sedimentnih telesih je glede na geološko zgradbo ozemlja izredno velika. Izvor materiala predstavljata dva glavna litološka različka: sediment sestavljen iz siliciklastičnih flišnih kamnin (peščenjak, meljevec, laporovec in muljevec) iz flišne podlage in karbonatni sediment iz karbonatne krovnine v zaledju. Na podlagi dveh litoloških različkov bi pričakovali, da bo sestava in zgradba kvartarnih sedimentov razmeroma enostavna. Po dosedanjih raziskavah pa se je v večini detajlno preiskanih profilov na območju Rebrnic pod Nanosom (Popit et al., 2013) in plazu Selo (Košir & Popit, 2002; Popit & Košir, 2003; Verbovšek et al., 2017) izkazala izjemna stratigrafska raznolikost in lateralna spremenljivost. Znotraj splazelih mas je bilo evidentiranih več izrazito plastnatih sedimentov, ki kažejo na več faz sedimentacije oziroma dogodkov.

Če se osredotočimo na območje med Ajdovščino in Novo Gorico (sl. 3), po velikosti in obliki močno izstopa 10 km$^2$ velik kompleksni plaz Selo, po Koširju et al. (2015) imenovan podorni tok velikega dosega (ang. long runout rock avalanche). Plaz Selo meri približno 4,5km v dolžino, razdalja od odlomnega roba do največjega dosega plazu v dolini pa 5,8 km. Povprečna debelina sedimenta je ocenjena na 19 m, največja izmerjena debelina sedimenta v osrednjem delu pa 56 m (Popit & Košir, 2003; Košir et al, 2015). Volumen plazu, ki je bil ocenjen s pomočjo terenskega dela, radarskega profiliranja in GIS-a, znaša 190 × 10$^6$ m$^3$ (Verbovšek et. al., 2017).

Poleg manjših in večjih sedimentnih teles pahljačastih in jezičastih oblik se na pobočjih na celotnem severnem robu severovzhodnega dela Vipavske doline pogosto pojavljajo tudi planarne izravnave karbonatnih breč, nastale kot posledica velikih rotacijskih plazov, in posamezni večji ali manjši karbonatni bloki nastali z rotacijsko-translacijskimi zdrsi. Na podlagi plastnatosti breče na posameznih delih blokov lahko prepoznamo, field work, GPR profiling, and GIS, is 190 × $10^6$ $m^3$ (Verbovšek et. al., 2017).

In addition to smaller and larger sedimentary fan- and tongue-shaped bodies, planar levelings of carbonate breccias, formed as a result of large rotational landslides, and individual larger or smaller carbonate blocks formed by rotational-translational landslides occur often on the slopes of the entire northern edge of the northeastern part of the Vipava Valley. Based on the layering of the breccia in individual parts of the blocks, we can recognize that the blocks rotated up to 60° towards the slope. Such an example occurs in the hinterland of the Šumljak landslide in Rebrnice (Popit, 2017). The leveled surface is developed mainly in the central parts of the planar surfaces, while steep margins appear on the outer parts of the levelings, which represent the main broken edges of the sedimentary bodies. These sedimentary bodies, especially in the upper part of the slope, were formed as a result of the remobilization of material from the outer parts of large rotational landslides, where the material was transported lower down the slope in the form of rock avalanches (Popit, 2017). In addition to planar levelings, individual carbonate partly-brecciated gravity blocks are exposed on the slopes in large numbers in the wider vicinity of Lokavec, but towards Šempeter they become smaller and less numerous. The exceptional amount and frequency of the occurrence of slope processes is indicated by e.g. the area around Ajdovščina, where there are many large sedimentary bodies along the edge of the Vipava Valley, e.g. the Podrta Gora and Gradiška Gmajna fossil landslides (Popit et al., 2022) and many large gravity (collapsing) carbonate blocks. Based on preliminary research by Placer et al. (2008), and later by Kocjančič et al. (2019), 10 carbonate gravity blocks. The results of the measurements showed that the lengths of the block movements along the slope ranged from 80 m to as much as 1,950 m (Kocjančič et al., 2019). The layered carbonate blocks changed their strike and dip when moving relative to the carbonate layers of the source area. Differences in the incidence of carbonate layers of the source area and carbonate blocks range from 4° to 59°. Larger gravity blocks that appear northwest of Lokavec are Zasod and Školj Sv. Pavla nad Vrtovinom (Verbovšek et al., 2019), Zasod pri plazu Selo, Kuclji nad Osekom, Vitovski hrib above the village of Vitovlje and many smaller translational gravity blocks (Fig. 6). To the northwest, the occurrence of carbonate blocks decreases considerably, and by the Lijak spring they are practically non-existent.

da so bloki rotirali tudi do 60° proti pobočju. Tak primer nastopa v zaledju plazu Šumljak na Rebrnicah (Popit, 2017). Izravnana površina je razvita predvsem v osrednjih delih planarnih površin, na zunanjih delih izravnav pa se pojavljajo strmi robovi, ki predstavljajo glavne odlomne robove sedimentnih teles. Ta sedimentna telesa, predvsem v zgornjem delu pobočja, so nastala kot posledica remobilizacije materiala z zunanjih delov velikih rotacijskih plazov, kjer se je material nato v obliki kamninskih plazov transportiral nižje po pobočju (Popit, 2017). Poleg planarnih izravnav so na pobočjih močno izpostavljeni posamezni karbonatni, deloma brečirani, gravitacijski bloki, ki se v velikem številu pojavljajo v širši okolici Lokavca, proti Šempetru pa jih je na pobočju vse manj tako po velikosti kot po njihovi številčnosti. Na izjemno količino in pogostnost pojavljanja pobočnih procesov kaže npr. območje v okolici Ajdovščine, kjer so vzdolž roba vipavske doline številna velika sedimentna telesa, npr. fosilni plaz Podrta Gora in Gradiška Gmajna (Popit et al., 2022) in številni veliki gravitacijski (podorni) karbonatni bloki. Na podlagi predhodnih raziskav Placerja in sodelavcev (2008), ter kasneje Kocjančičeve s sodelavci (2019), je bilo samo v okolici Lokavca identificiranih 10 karbonatnih gravitacijskih blokov. Rezultati meritev so pokazali, da so dolžine premikov blokov po pobočju znašale od 80 m do kar 1950 m (Kocjančič et al., 2019). Vpadi plastnatih karbonatnih blokov so pri premiku, glede na karbonatne plasti izvornega območja, spremenili smer in naklon. Razlike pri vpadu karbonatnih plasti izvornega območja in karbonatnih blokov pa znašajo od 4° do 59°. Večji gravitacijski bloki, ki se pojavljajo severozahodno od Lokavca so Zasod in Školj Sv. Pavla nad Vrtovinom (Verbovšek et al., 2019), Zasod pri plazu Selo, Kuclji nad Osekom, Vitovski hrib nad Vitovljami in številni manjši translacijsko gravitacijski bloki (sl. 6). Severozahodneje se pojavnost karbonatnih blokov močno zmanjša in do izvira Lijaka jih praktično ni več.

### Geomorfologija Trnovskega gozda, Banjšic in Šentviške planote

Ob pogledu na geološko karto Trnovskega gozda ter Banjške in Šentviške planote je že na prvi pogled jasno, da tvorita Trnovska in Banjška planota morfotektonski blok in da je bila nekoč Šentviška planota njegov del. Prvi dve geografsko ločuje Čepovanski dol, tretjo pa v geografskem in tektonskem pomenu od Banjšic ločuje dolina Idrijce, ki si jo je izdolbla po coni Idrijskega preloma (sl. 2).

## Geomorphology of the Trnovski gozd, Banjšice, and Šentviška Gora plateaus

Looking at the geological map of the Trnovski gozd and the Banjšice and Šentviška Gora plateaus, it is clear at first glance that the Trnovski gozd and Banjšice plateaus form one morphotectonic block, and that the Šentviška Gora plateau was once part

Vse tri planote so zgrajene pretežno iz karbonatnih kamnin (sl. 4), njihovo površje je razgibano, večji uravnani površini pa nastopata na Voglarski planoti na Trnovskem gozdu (c – zgornjejurski in spodnjekredni karbonati) in na jugovzhodnem delu Banjške planote (d – zgornjetriasni, jurski in spodnjekredni karbonati),

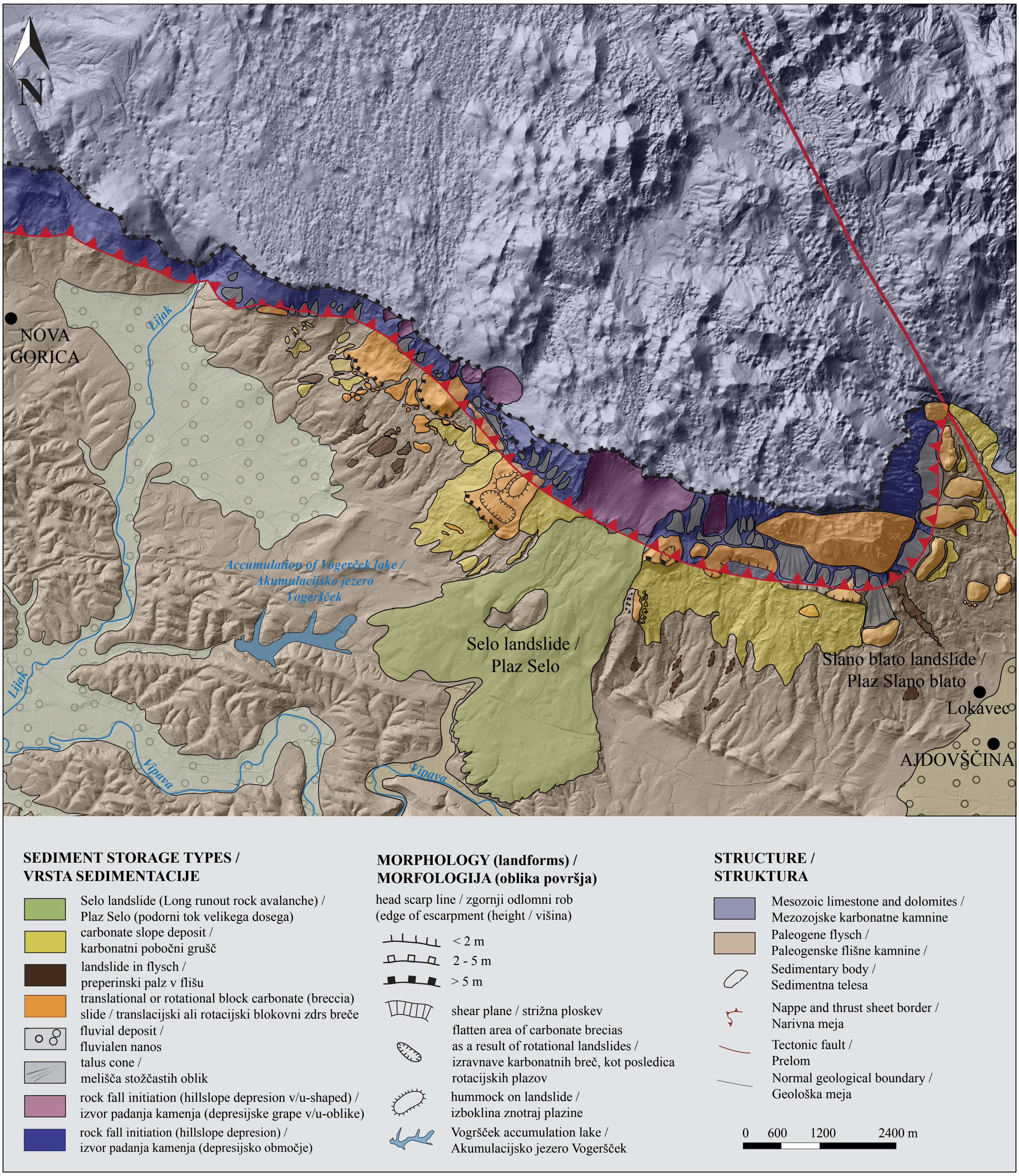



Fig. 3. Geomorphological map of the forehead of Trnovo Nappe between Lijak (spring) and Lokavec (village).

Sl. 3. Geomorfološka karta čela Trnovskega pokrova med Lijakom in Lokavcem.

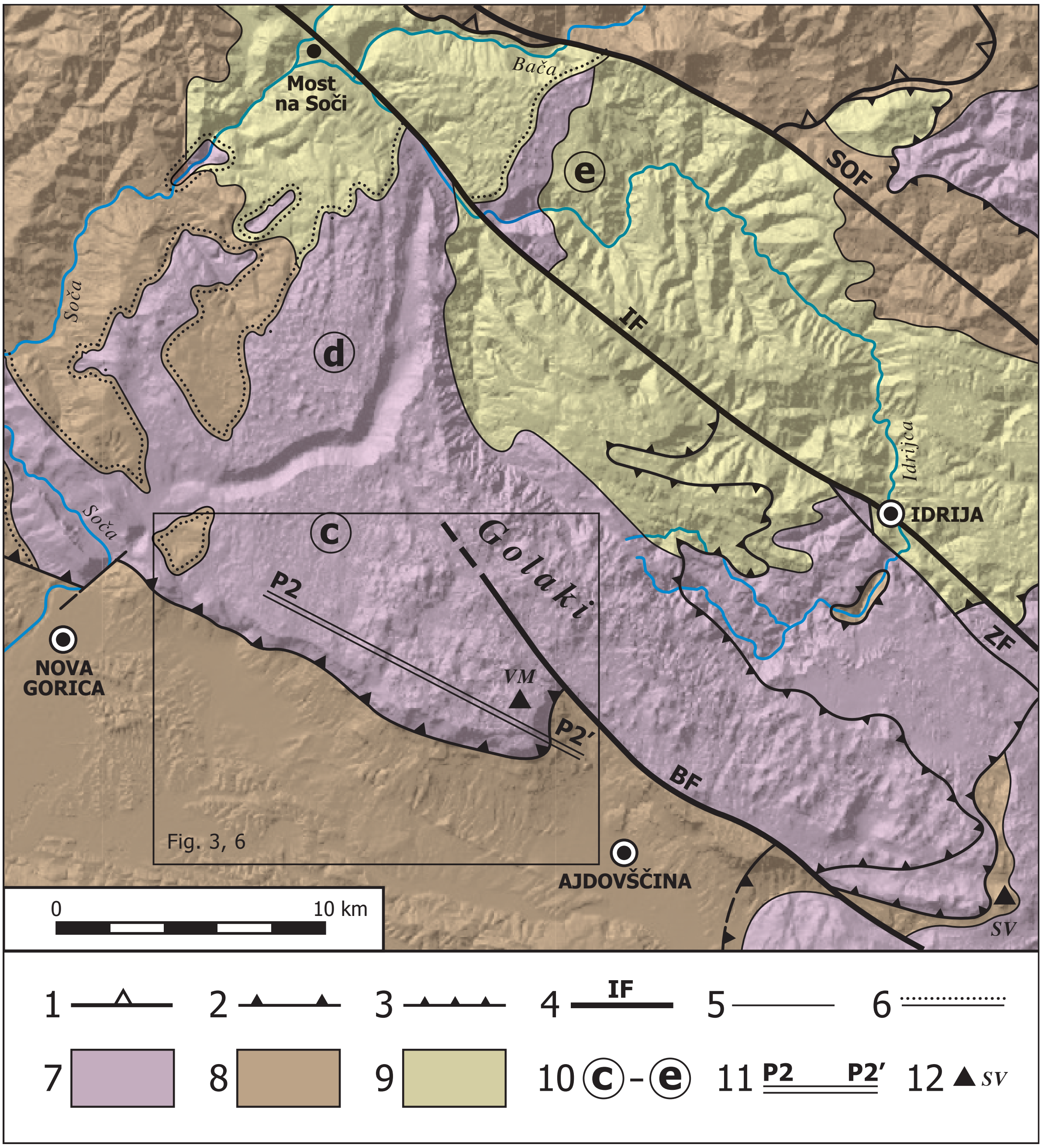



Fig. 4. Structural-lithological sketch of the Trnovski gozd, Banjšice, and Šentviška Gora plateaus. According to the Basic Geological Map of Yugoslavia 1:100 000 – OGK (sheet Gorica: Buser, 1968; sheets Tolmin in / and Videm (Udine): Buser, 1987; sheet Kranj: Grad & Ferjančič, 1974; sheet Postojna: Buser, Grad & Pleničar, 1967), Mlakar (1969, fig. 5, fig. 8), and Placer (1973, fig. 2).

Sl. 4. Strukturno-litološka skica Trnovske, Banjške in Šentviške planote. Po podatkih Osnovne geološke karte SFRJ 1:100 000 - OGK (list Gorica: Buser, 1968; lista Tolmin in Videm: Buser, 1987; list Kranj: Grad & Ferjančič, 1974; list Postojna: Buser, Grad & Pleničar, 1967), Mlakarja (1969, sl. 5, sl. 8) in Placerja (1973, sl. 2).

1 Thrust boundary of Southern Alps / narivna meja Južnih Alp

2 Boundary of the External Dinaric Thrust Belt / meja Zunanjedinarskega narivnega pasu

3 Boundary of the nappe unit within the External Dinaric Thrust Belt / meja krovne enote znotraj Zunanjedinarskega narivnega pasu

4 Fault: **SOF** – Sovodenj Fault, **IF** – Idrija Fault, **ZF** – Zala Fault, **BF** – Belsko Fault (Placer et al., 2021, fig. 6, p. 44; Buser, 1976, p. 50, Predjama Fault) / prelom: **SOF** – Sovodenjski prelom, **IF** – Idrijski prelom, **ZF** – Zalin prelom, **BF** – Belski prelom (Placer et al., 2021, sl. 6, str. 44; Buser, 1976, str. 50, Predjamski prelom)

5 Geological boundary / konkordantna geološka meja

6 Unconformity / diskordantna geološka meja

7 Predominantly carbonates / pretežno karbonati: $\mathbf{T_3^{2+3}}$, **J**, $\mathbf{K_1}$, **Pc**, $\mathbf{E_1}$

8 Predominantly clastites / pretežno klastiti: **C**, $\mathbf{P_1}$, $\mathbf{K_2}$, **Pc**, **E**

9 Carbonates and clastites / karbonati in klastiti: $\mathbf{P_2}$, $\mathbf{T_{1+2}}$, $\mathbf{T_3^1}$, $\mathbf{K_2}$

10 Karst plain: **c** – Voglarska planota (Voglarji plateau), **d** – southeastern part of Banjšice (Banjšice plateau), **e** – eastern part of Šentviška planota (Šentviška Gora plateau) / kraška uravnava: **c** – Voglarska planota, **d** – jugovzhodni del Banjške planote, **e** – vzhodni del Šentviške planote

11 Position of profile **P2 – P2´** / lega profila **P2 – P2´**

12 Top / vrh: ***VM*** – Veliki Modrasovec (1355 m), ***SV*** – Streliški vrh (1266 m)

of it. The first two are geographically separated by the Čepovanski dol (dry valley), and the third is separated from Banjšice in a geographical and tectonic sense by the Idrijca River Valley, which was carved out along the Idrija fault zone (Fig. 2).

All three plateaus are built mainly of carbonate rocks (Fig. 4), their surface is rugged, and larger level surfaces occur on the Voglarji plateau in the Trnovski gozd plateau (c – Upper Jurassic and Lower Cretaceous carbonates) and on the southeastern part of the Banjšice plateau (d – Upper Triassic, Jurassic and Lower Cretaceous carbonates), and a smaller one in the eastern part of the Šentviška Gora plateau (e – Upper Triassic carbonates). Stepišnik and Ferk (2023, p. 13–14) considered the leveled part in question (which is also called the Banjšice-Trnovski gozd plain in the geographical literature) a corrosive karst plain, which rises above the primary level due to tectonic processes. Habič (1968) also thought the same.

For a complex understanding of the geomorphology, in addition to the corrosive influence, it is also necessary to take into account the structural and tectonic aspects of the genesis of the territory, which are significantly supplemented with respect to older interpretations. Therefore, we examine Trnovski gozd, and the Banjšice and Šentviška Gora plateaus from the point of view of recent research. The most important question is whether the non-peneplained areas of the plateaus under consideration were once peneplained. On the shaded digital elevation model (DMV) obtained from lidar data, three basic structural-morphological surface types can be observed on the mentioned plateaus (Fig. 4): 1. an otherwise leveled (peneplained) but corrosively affected surface, on which morphologically poorly responsive cracks in the SSW-NNE direction are noticeable, 2. sharply furrowed surface along a fracture system in the SSW-NNE direction in Trnovski gozd, which stretches from the boundary of the leveled (peneplained) Voglarji plateau to Veliki Modrasovec (1355 m) and Streliški vrh (1266 m) and 3. the softer, irregularly corroded and eroded surface on the western part of the Banjšice and Šentviška Gora plateaus, on which various structural forms such as folds, layers, and fractures can be observed. The narrow strip of peneplained territory on the southwestern side of the Trnovski gozd plateau from Predmeja to Vodice is not covered in this article, as such would require a broader structural interpretation.

We know from general data that carbonate rocks are more prone to corrosion, limestones more than

manjša pa na vzhodnem delu Šentviške planote (e – zgornjetriasni karbonati). Del obravnavanega uravnanega sveta, ki je v geografski literaturi poimenovan tudi Banjško-trnovski ravnik, sta Stepišnik in Ferk (2023, str. 13–14) obravnavala kot korozijsko kraško uravnavo, ki je zaradi tektonskih procesov dvignjena nad primarni nivo. Enako je menil tudi Habič (1968).

Za kompleksno razumevanje geomorfologije je poleg korozivnega vpliva potrebno upoštevati tudi strukturni in tektonski vidik geneze ozemlja, ki sta glede na starejše interpretacije bistveno dopolnjena. Zato si oglejmo Trnovski gozd ter Banjško in Šentviško planoto z vidika novejših raziskav. Kot najpomembnejše se postavlja vprašanje ali so bila neuravnana območja obravnavanih planot nekoč uravnana. Na senčenem digitalnem modelu višin (DMV) pridobljenem iz lidarskih podatkov je na omenjenih planotah opaziti tri osnovne strukturno-morfološke tipe površja (sl. 4): 1. sicer uravnano toda korozivno prizadeto površje, na katerem so opazne morfološko slabo odzivne razpoke v smeri SSW-NNE, 2. ostro razbrazdano površje po sistemu razpok v smeri SSW-NNE na Trnovskem gozdu, ki se razteza od meje uravnane Voglarske planote do Velikega Modrasovca (1355 m) in Streliškega vrha (1266 m) in 3. mehkejše nepravilno korodirano in erodirano površje na zahodnem delu Banjške in Šentviške planote, na katerem je opaziti različne strukturne oblike kot gube, plasti in prelome. Ožji pas uravnanega ozemlja na jugozahodni strani Trnovske planote od Predmeje do Vodic v tem članku ni zajet, ker bi to zahtevalo širšo strukturno razlago.

Iz splošnih podatkov vemo, da so koroziji najbolj podvržene karbonatne kamnine, bolj apnenci kot dolomiti, manj klastične kamnine, vendar so erozijsko manj odporne, zato je na sl. 4 prikazana strukturno-litološka skica na kateri so izrisane meje treh skupin kamnin, pretežno karbonatnih, pretežno klastičnih in mešanih. Razdelitev je groba in namenjena le predstavitvi v tem članku obravnavanih vprašanj. Če se omejimo samo na Trnovski gozd, Banjšice in Šentviško planoto, je uravnano površje razvito pretežno na karbonatnih kamninah zgornjetriasne, jurske in kredne starosti. Enako velja za močno razgibano površje. Mehkejše razgibano površje pa je razvito na območjih z mešanimi in klastičnimi kamninami zgornjekredne in paleogenske starosti.

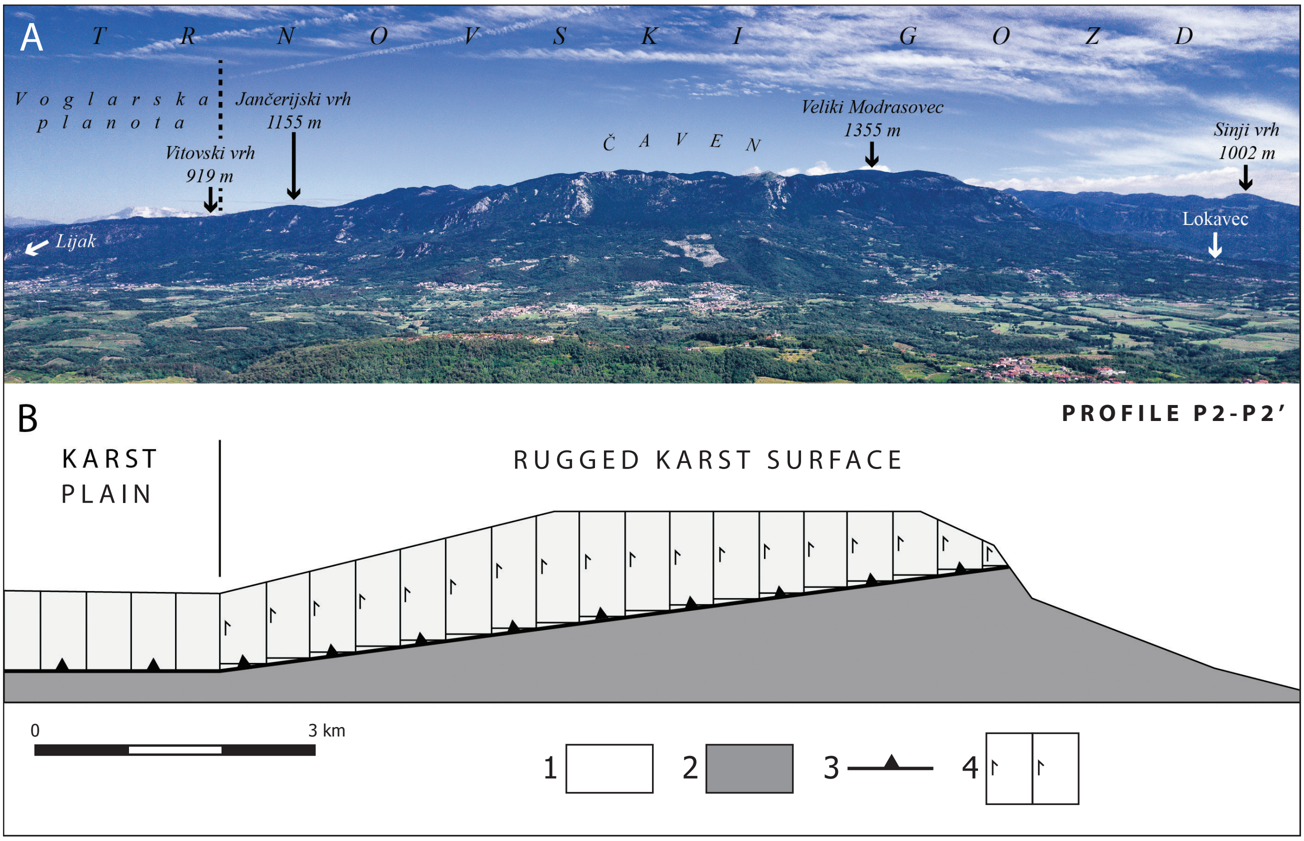



Fig. 5. Geomorphological profile P2 – P2´: Voglarska planota (Voglarji plateau) – Čaven (ridge) – Veliki Modrasovec (1355 m) – Lokavec (village). Position of profile in fig. 4.

Sl. 5. Geomorfološki profil P2 – P2´: Voglarska planota – Čaven – Veliki Modrasovec – Lokavec. Lega profila na sl. 4.

A – Panoramic shot of the thrust face of Trnovo Nappe. Recording location in fig. 2 / Panoramski posnetek narivnega čela Trnovskega pokrova. Stojišče snemanja na sl. 2.

B – Geomorphological profile P2 – P2´ as a kinematic model of this part of the Trnovo Nappe. Profile runs perpendicular to the regional sub-vertical fractures in direction SSW-NNE / Geomorfološki profil P2 – P2´ kot kinematski model tega dela Trnovskega pokrova. Profil poteka pravokotno na regionalne subvertikalne razpoke v smeri SSW-NNE.

1 Carbonates / karbonati

2 Clastites (flysch) / klastiti (fliš)

3 Thrust fault surface of the Trnovo Nappes / narivna ploskev Trnovskega pokrova

4 Kinematics of regional sub-vertical fractures in direction SSW-NNE / kinematika regionalnih subvertikalnih razpok v smeri SSW-NNE

dolomites, and clastic rocks less so, but they are less resistant to erosion; so in Figure 4 a structural-lithological sketch on which the boundaries of three groups of rocks, predominantly carbonate, predominantly clastic and mixed, are drawn. The division is rough and intended only to present the issues discussed in this article. If we limit ourselves to Trnovski gozd, and the Banjšice and Šentviška Gora plateaus, the flat surface is developed mainly on carbonate rocks of Upper Triassic, Jurassic, and Cretaceous age. The same applies to highly uneven surfaces. A softer rugged surface is developed in areas with mixed and clastic rocks of Upper Cretaceous and Paleogene age.

How then do we approach the question of whether the entire area of the Trnovski gozd plateau and the Banjšice and Šentviška Gora plateaus was completely levelled before some certain time, or before the uplift of the territory? On all three

S čim torej utemeljujemo vprašanje ali je bilo celotno območje Trnovskega gozda ter Banjške in Šentviške planote pred določenim časom, oziroma pred dvigom ozemlja, v celoti uravnano? Na vseh treh planotah, kjer nastopajo karbonatne kamnine, izstopa sistem enako usmerjenih razpok v smeri SSW-NNE, ki pa je na uravnanih delih komaj ali slabo viden, na razgibanih delih pa predstavlja glavno strukturno diskontinuiteto po kateri se je oblikovalo površje. V tem smislu je najbolj povedno ozemlje Voglarske planote in Čavna do Velikega Modrasovca (1355 m) za katerega je izdelana geomorfološka karta na sl. 3. Pri predpostavki, da je bilo celotno območje uravnano na nižjem nivoju in pozneje dvignjeno, postavljamo domnevo, da je bilo dviganje neenotno, uravnani del Trnovskega gozda (Voglarska planota) se je dvigal enakomerno, območje jugovzhodno od tod pa neenakomerno

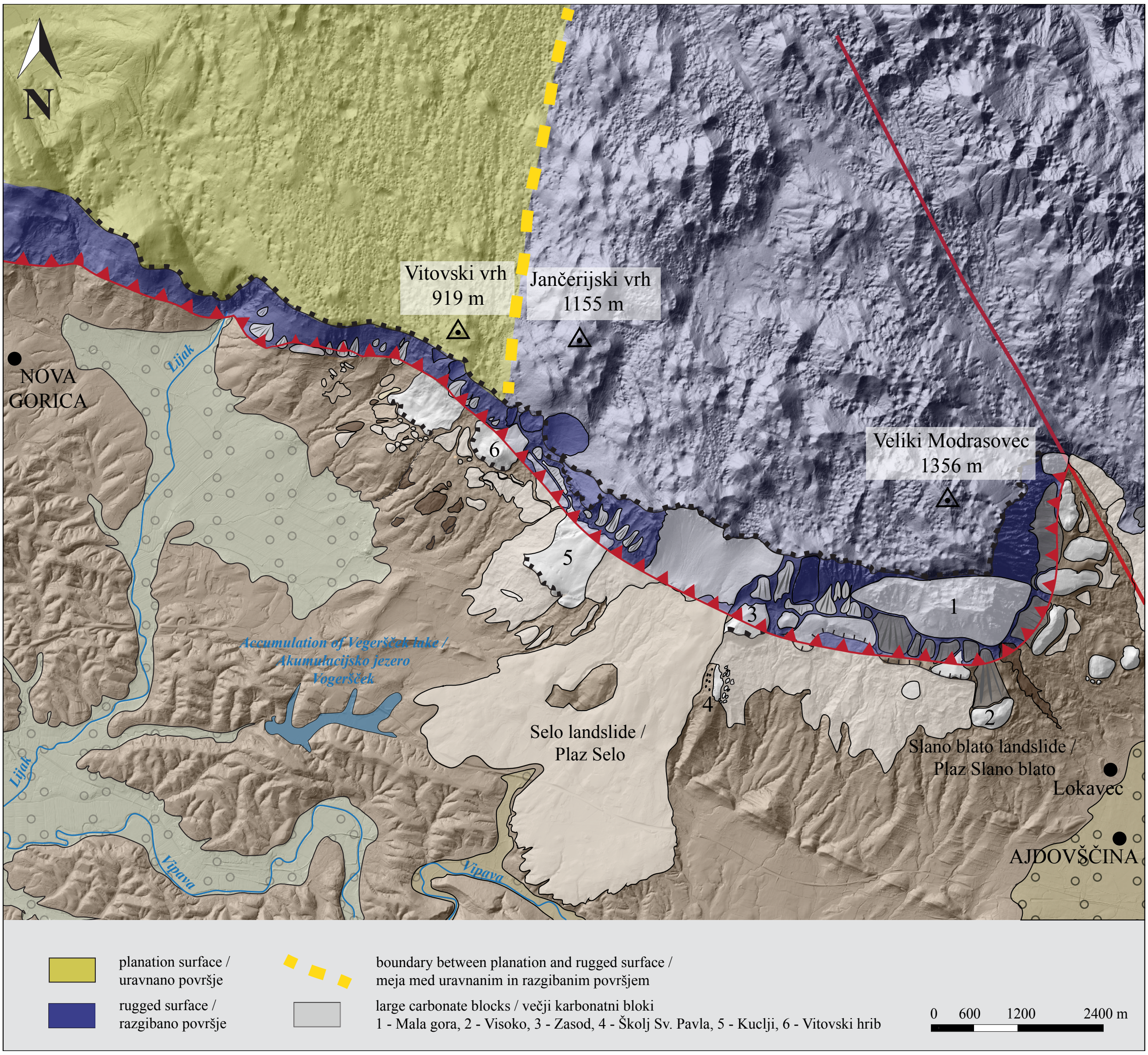



Fig. 6. Relation between geomorphology of Trnovski gozd (Trnovski gozd plateau) and gravitational phenomena.
Sl. 6. Povezava med geomorfologijo Trnovskega gozda in gravitacijskimi pojavi.

plateaus where carbonate rocks occur a system of similarly oriented fractures in the SSW-NNE direction stands out, which, however, is only barely visible on the levelled parts, and on the rugged parts represents the main structural discontinuity along which the surface was formed. In this sense, the most telling area is the territory of Voglarji plateau, Mt. Čaven and Mt. Veliki Modrasovec (1355 m), for which the geomorphological map in fig. 3. is elaborated. On the assumption that the entire area was levelled at a lower level and later uplifted, we suggest that the uplift was uneven, the levelled part of Trnovski gozd (Voglarji plateau) uplifted evenly, and the area southeast of it uplifted faster and unevenly, which resulted in successive movements along the exposed fracture system and a certain degree of crushing. This was followed by

in hitreje, zaradi česar je prišlo do nasledstvenih premikov po izpostavljenem sistemu razpok in določene stopnje drobljenja. Temu je sledila izdatnejša korozija. Učinek tega procesa je prikazan na sl. 5, panoramskemu posnetku na sl. 5A je priložena grobo shematizirana kinematska skica opisanega dogajanja v profilu med Voglarsko planoto in Velikim Modrasovcem na sl. 5B. Bloki (makrolitoni) med razpokami sistema SSW-NNE so na Voglarski planoti ostali nepremaknjeni, jugovzhodno od tod pa je med njimi prišlo do premikanja. Posledice opisanega stanja so prikazane na sl. 6, kjer so večji gravitacijski karbonatni bloki posejani le po pobočju pod robom planote z razgibanim reliefom, medtem ko jih pod robom uravnane Voglarske planote ni. Meja med obema tipoma reliefa je zaznamore extensive corrosion. The effect of this process is shown in Figure 5. A roughly schematic kinematic sketch of the described event in the profile between Voglarji plateau and Veliki Modrasovec in Figure 5B is attached to the panoramic snapshot in Figure 5A. The blocks (macrolithons) between the fractures of the SSW-NNE system remained unmoved on the Voglarji plateau, but movement took place between them southeast of the area. The consequences of the described condition are shown in Figure 6, where larger gravity carbonate blocks are only scattered along the slope below the edge of the plateau with rugged relief, while they are absent below the edge of the flat Voglarji plateau. The border between the two types of relief is marked by a yellow dashed line running in the SSW-NNE direction of fractures, which is why it is almost flat and, in our opinion, indirectly proves

movana z rumeno prekinjeno črto, ki poteka v smeri razpok SSW-NNE, zaradi tega je skoraj ravna in po našem mnenju posredno dokazuje, da je na tem mestu razpoklinski sistem glavni usmerjevalec geomorfološke podobe površja. Kot navidezna izjema deluje plazišče severozahodno od Vitovlja, vendar leži pod Vitovskim vrhom (919 m), za katerega menimo, da je nastal kot posledica selektivne korozije. Osameli griči so namreč pogost pojav velikih kraških uravnav.

Profil P2 – P2´ na sl. 5B je v kinematskem smislu soroden vzdolžnemu profilu P1 – P1´ (sl. 7) na jugovzhodnem delu bližnjega Nanosa (sl. 2), kjer obstoja enak sistem regionalnih razpok v smeri SSW-NNE (Placer et al., 2021a, sl. 11, profil 1a). Enake razmere obstojajo tudi na ostalem delu Trnovskega gozda do Streliškega vrha (1266 m) (sl. 4).

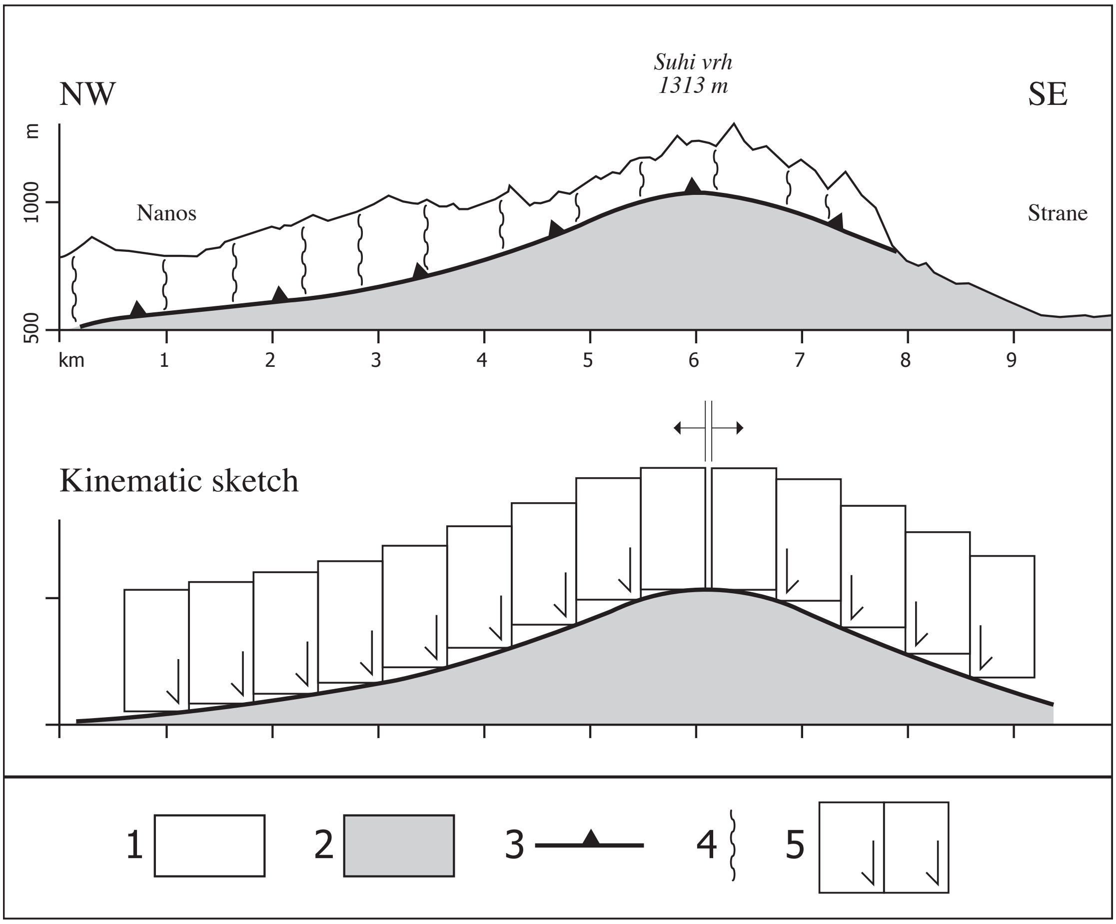



Fig. 7. Geomorphological profile P1 – P1´ as a kinematic model of Hrušica Nappe unit at the southeastern end of Nanos plateau. The profile runs perpendicular to the regional sub-vertical fractures SSW-NNE. After Placer et al. (2021, fig. 11, profile 1a), Nanos (hamlet) – Strane (village). Position of profile in Fig. 2.

Sl. 7. Geomorfološki profil P1 – P1´ kot kinematski model krovne grude Hrušiškega pokrova na jugovzhodnem koncu planote Nanos. Profil poteka pravokotno na regionalne subvertikalne razpoke SSW-NNE. Povzeto po Placer et al. (2021, sl. 11, profil 1a), Nanos (zaselek) - Strane (vas). Lega profila na sl. 2.

1 Carbonate / karbonati

2 Clastites (flysch) / klastiti (fliš)

3 Thrust surface of the Hrušica Nappe / narivna ploskev Hrušiškega pokrova

4 SSW-NNE system fracture / razpoka sistema SSW-NNE

5 Kinematics of regional subvertical fractures SSW-NNE / kinematika regionalnih subvertikalnih razpok SSW-NNE

that the fracture system is the main guide of the geomorphological surface image at this place. As an apparent exception, there is a landslide northwest of Vitovlje, but it lies below Mt. Vitovski vrh (919 m) which we believe was formed as a result of selective corrosion. Inselbergs are a frequent feature of large karst formations.

Profile P2 – P2´ in fig. 5B is kinematically related to the longitudinal profile P1 – P1´ (Fig. 7) in the southeastern part of nearby Mt. Nanos (Fig. 2), where the same system of regional fractures in the SSW-NNE direction exists (Placer et al., 2021a, Fig. 11, profile 1a). The same conditions also exist in the rest of the Trnovski gozd plateau up to Mt. Streliški vrh (1266 m) (Fig. 4).

In the area of rugged relief, the ridge of Mt. Veliki Golak and Mt. Mali Golak (Fig. 4) stands out, along with some peaks or groups of peaks raised above the surroundings. The Mt. Veliki and Mali Golak ridge was formed during a long period of selective corrosion because it lies in the area of Lower and Middle Jurassic carbonates, which in some places are relatively less soluble than those from the Upper Jurassic. Individual peaks or groups of peaks outside the ridge are the result of the general post-thrust structural and geomorphological development of the Trnovski gozd plateau, when successive and new deformations occurred. Glaciation also had a part in shaping the surface (Kodelja et al., 2013).

## Čepovanski dol (Dry Valley)

The Čepovanski dol dry valley is a witness to the tectonic events in the wider area. The valley's essential characteristics consist in a river that ran along it, and that it is tectonically raised together with the Trnovski gozd and Banjšice plateaus in the northeast above the Šentviška Gora plateau and in the southwest above the Vipava Valley. Above the Šentviška Gora plateau, it is raised along the Idrija Fault, and above the Vipava Valley the uplift is the result of a temporally, dynamically, and kinematically complex post-thrust Neogene-recent process. In this article the process itself is not discussed, only its consequences are pointed out. As a result, the relief elevation above the Vipava Valley is not comparable to the elevation of the relief along the Idrija Fault.

Let's take a look at the Idrija fault. According to Mlakar (1964), the horizontal component of the offset along the fault is about 1950 m in Idrija. The horizontal component of the offset according to Placer (1982, p. 57) is about 2360 m, but this length also includes offsets along the Zala Fault and parallel faults between Zala and Idrija Faults

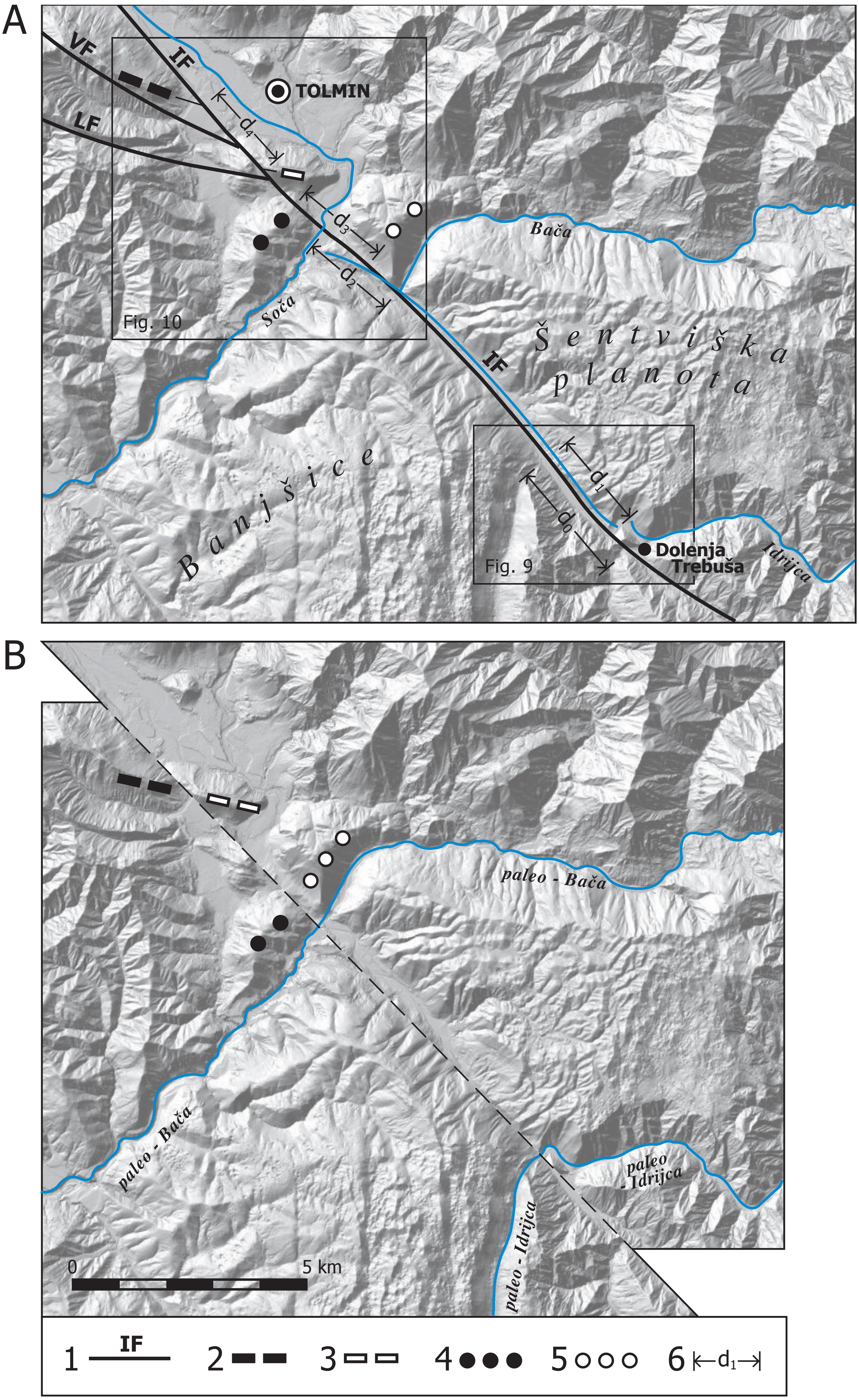
Na območju razgibanega reliefa izstopa npr. greben Golakov (sl. 4), ki leži v smeri slemenitve plasti NW-SE in nekaj vrhov ali skupin vrhov dvignjenih nad okolico. Greben Golakov je nastal skozi dolgo obdobje selektivne korozije, ker leži v območju spodnje in srednjejurskih karbonatov, ki so ponekod relativno slabše topni od zgornjejurskih. Posamezni vrhovi ali skupine vrhov izven Golakov pa so posledica splošnega postnarivnega strukturnega in geomorfološkega razvoja Trnovskega gozda, ko so nastale nasledstvene in nove deformacije. Svoj delež pri oblikovanju površja je imela tudi poledenitev (Kodelja et al., 2013).

## Čepovanski dol

Čepovanski dol je pričevalec tektonskega dogajanja na širšem prostoru. Njegovi bistveni značilnosti sta, da je po njem tekla reka, in da je skupaj s Trnovsko in Banjško planoto tektonsko dvignjen; na severovzhodu nad Šentviško planoto, na jugozahodu nad Vipavsko dolino. Nad Šentviško planoto je dvignjen ob Idrijskem prelomu, nad Vipavsko dolino pa je dvig posledica časovno, dinamsko in kinematsko kompleksnega postnarivnega neogensko-recentnega procesa, ki ga v tem članku ne obravnavamo, temveč le opozarjamo na njegove posledice. Dvig nad Vipavsko dolino zaradi tega ni primerljiv z dvigom ob Idrijskem prelomu.

Oglejmo si Idrijski prelom, v Idriji znaša horizontalna komponenta premika ob njem po Mlakarju (1964) okoli 1950 m, po Placerju (1982, str. 57) okoli 2360 m, vendar so v to dolžino všteti tudi premiki ob Zalinem prelomu in vzporednih prelomih med Zalinim in Idrijskim prelomom. Torej premiki ob glavni prelomni coni in ob prelomih ožjega dela idrijske izravnalne zgradbe (Placer et al., 2021b, 239). Celotni premik ob idrijski izravnalni zgradbi pa je nekaj večji, saj bi morali vrednosti 2360 m prišteti še premike širšega dela izravnalne zgradbe, kot sledi iz podatkov Geološke karte idrijsko-žirovskega hribovja med Stopnikom in Rovtami 1:25 000 (Čar, 2010). Velikost teh pa ni znana, le sklepamo lahko na okoli 100 do 200 m. Mlakarjev podatek je vezan le na premik ob glavni prelomni coni. V Idriji je severovzhodno krilo ugreznjeno, višina strukturnega skoka znaša v Idriji okoli 480 m (Placer, ibid.), vendar je ta podatek navidezen, prava višina je bistveno manjša, vendar ni bila določena.

V našem primeru opisujemo razmere med Tolminom in Dolenjo Trebušo (sl. 8A). Pri Dolenji Trebuši (sl. 9) poteka Idrijski prelom po dolini


A
VF
IF
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TOLMIN
d4
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Bača
Soča
Fig. 10
Šentviška planota
IF
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Fig. 9
Dolenja Trebuša
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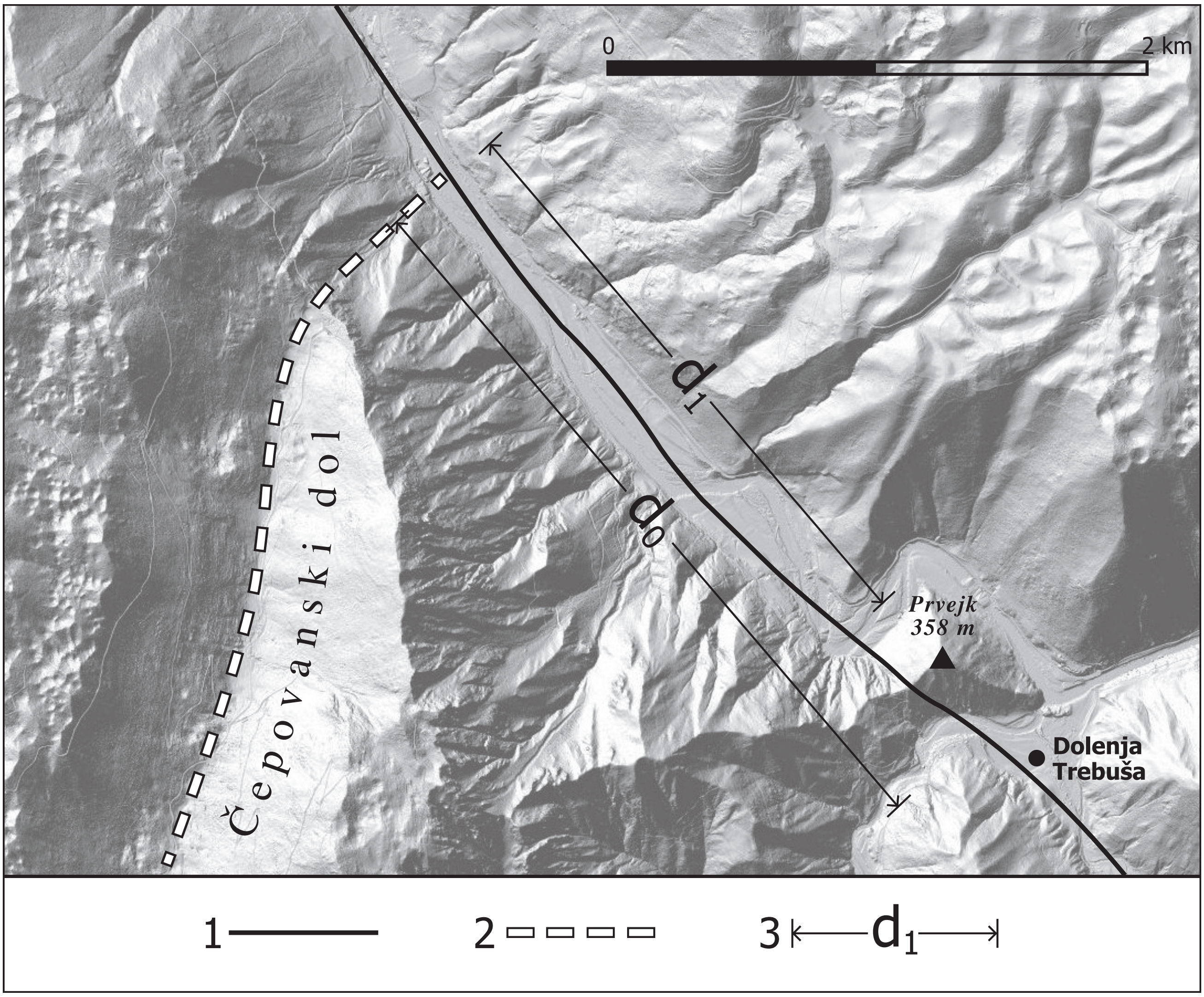


Fig. 9. Corrosive record of the Čepovanski dol (Čepovan dry valley) floor in the left slope of the Idrijca Valley indicating a connection with the Idrijca Valley under the northwestern slope of the Prvejk hill (358 m). Position of figure in fig. 8A.

Sl. 9. Korozivni odtis dna Čepovanskega dola v levem pobočju doline Idrijce, ki kaže na povezavo z dolino Idrijce pod severozahodnim pobočjem Prvejka (358 m). Lega slike na sl. 8A.

1 Idrija Fault, approximate position of the main fault zone / Idrijski prelom, približna lega glavne prelomne cone

2 Čepovanski dol (Čepovan dry valley) floor / dno Čepovanskega dola

3 Horizontal componente of displacement along the Idrija Fault: **d0** – the entire movement, **d1** – segment movement / vodoravna komponenta premika ob Idrijskem prelomu: **d0** – celotni premik, **d1** – segmentni premik

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Fig. 8. The influence of the Idrija Fault on the formation of the relief between Tolmin (town) and Dolenja Trebuša (village). Position of figure in fig. 2.

Sl. 8. Vpliv Idrijskega preloma na oblikovanje reliefa med Tolminom in Dolenjo Trebušo. Lega slike na sl. 2.

A – Current situation / Sedanje stanje.

B – Situation before the formation of the Idrija Fault / Stanje pred nastankom Idrijskega preloma.

1 Fault: visible, covered or assumed: IF – Idrija Fault, VF – Volče Fault, LF – Livek Fault / prelom: viden, prekrit ali domneven: IF – Idrijski prelom, VF – Volčanski prelom, LF – Livški prelom

2 Hlevnik ridge (886 m) - Senica (576 m) / greben Hlevnik (886 m) - Senica (576 m)

3 Bučenica ridge (498 m) / greben Bučenica (498 m)

4 Selski vrh ridge (588 m) - Mrzli vrh (590 m) / greben Selski vrh (588 m) - Mrzli vrh (590 m)

5 Senica ridge (658 m) / greben Senica (658 m)

6 Horizontal component of the dextral movement of the valleys and ridges that were transversely cut by the Idrija Fault: **d0** – Idrijca Valley, Dolenja Trebuša ↔ Čepovanski dol (Čepovan dry valley), **d1** – Idrijca Valley, Mt. Prvejk ↔ Čepovanski dol, **d2** – Bača Valley ↔ Soča Valley, **d3** – Senica (658 m) ridge ↔ Selski vrh (588 m) – Mrzli vrh (590 m) ridge, **d4** – Bučenica (498 m) ridge ↔ Hlevnik (886 m) – Senica (576 m) ridge; **d1** ≈ **d2** ≈ **d3** ≈ **d4** ≈ 2200 m / vodoravna komponenta desnega premika dolin in grebenov, ki jih je prečno presekal Idrijski prelom: d0 – dolina Idrijce, Dolenja Trebuša ↔ Čepovanski dol, **d1** – dolina Idrijce, Prvejk ↔ Čepovanski dol, **d2** – dolina Bače ↔ dolina Soče, **d3** – greben Senica (658 m) ↔ greben Selski vrh (588 m) - Mrzli vrh (590 m), **d4** – greben Bučenica (498 m) ↔ greben Hlevnik (886 m) - Senica (576 m); **d1** ≈ **d2** ≈ **d3** ≈ **d4** ≈ 2200 m

and represents the sum of offsets along the Idrija main fault zone and the offsets in the narrower zone of the Idrija adjusting structure (Placer et al., 2021b, 239). The total offset along the Idrija adjusting structure is somewhat larger, as the offsets of the wider part of the adjusting structure, should be added to the value of 2360 m as follows from the data of the Geological map of the Idrija-Žirovski vrh between Stopnik and Rovte in the 1:25,000 scale (Čar, 2010). The size of these is not known, but we can only conclude that they sum to around 100 to 200 m. Mlakar's information is only related to movement along the main fault zone. In Idrija, the northeastern block (of the Idrija Fault) is subsided, the height of the structural offset in Idrija is around 480 m (Placer, ibid.), but this information is easily available; the true height is significantly lower, but was not determined.

For our purposes, the situation between Dolenja Trebuša and Tolmin is described (Fig. 8A). At Dolenja Trebuša (Fig. 9) the Idrija Fault runs along the Hotenja Valley, across the saddle on Mt. Prvejk (358 m) and further towards Tolmin along the Idrijca Valley. The horizontal displacement along it has two measurable values, the first one is the distance between the axis of the outlet of Čepovanski dol in the left slope of the Idrijca Valley, and the axis of the Idrijca Valley northwest of Mt. Prvejk, which is denoted by d1 (around 2200 m), the second is the distance between the bottom of Čepovanski dol and the extension of the Idrijca Valley southeast of Mt. Prvejk, which is marked with d0 (around 2650 m). The distance of 2650 m is close to the total displacement in Idrija 2360 + 100 to 200 m = 2460 to 2560 m and represents the entire displacement in the area of Dolenja Trebuša, however, we will see that the 2200 m displacement is more important for the interpretation of the relief between Dolenja Trebuša and Tolmin. The discussion about the structure of the fault zone of the Idrija Fault and the formation of the valley network around Dolenja Trebuša is beyond the scope of this article, but the important fact is that the displacement d1 (2200 m) is also reflected in the relief around Tolmin. When the axis of the Idrijca Valley on the northwestern side of Mt. Prvejk is placed opposite the bottom of the corrosive imprint of Čepovanski dol, the mouth of the Bača River is positioned opposite the middle part of the Soča Valley near the village of Most na Soči (Fig. 8B). This probably means that the Idrija Fault was originally segmented, with two segments meeting at Dolenja Trebuša, which today are combined into a single zone. This question cannot be solved without detailed mapping, which is why the area around Dolenja Trebuša in Fig. 8B is structur-

Hotenje, čez sedlo na Prvejku (358 m) in naprej proti Tolminu po dolini Idrijce. Horizontalni premik ob njem ima dve izmerljivi vrednosti, prva je razdalja med osjo izteka Čepovanskega dola v levem pobočju doline Idrijce in osjo doline Idrijce severozahodno od Prvejk, kar je označeno z d1 (okoli 2200 m), druga je razdalja med dnom Čepovanskega dola in podaljškom doline Idrijce jugovzhodno od Prvejka, kar je označeno z d0 (okoli 2650 m). Razdalja 2650 m je blizu skupnemu premiku v Idriji 2360 + 100 do 200 m = 2460 do 2560 m in predstavlja celotni premik na območju Dolenje Trebuše, kljub temu pa bomo videli, da je za razlago reliefa med Dolenjo Trebušo in Tolminom pomembnejši premik 2200 m. Razprava o zgradbi prelomne cone Idrijskega preloma in o nastanku dolinske mreže okoli Dolenje Trebuše presega okvir tega članka, pomembno pa je dejstvo, da se premik $d_1$ (2200 m) odraža tudi v reliefu okoli Tolmina, ko namreč postavimo os doline Idrijce na severozahodni strani Prvejka nasproti dna korozivnega odtisa Čepovanskega dola, se ustje Bače postavi nasproti sredine doline Soče pri Mostu na Soči (sl. 8B). To verjetno pomeni, da je bil Idrijski prelom prvotno segmentiran pri čemer sta se v Dolenji Trebuši srečala dva segmenta, ki sta danes združena v enotno cono. Tega vprašanja ni mogoče rešiti brez detajlnega kartiranja, zato je prostor okoli Dolenje Trebuše na sl. 8B strukturno neobdelan.

Ko stoji dolina Bače nasproti doline Soče (sl. 8B) se; greben Selski vrh (588 m) - Mrzli vrh (590 m) se postavi nasproti grebena Senice (658 m) nad Modrejem (sl. 8A, d3), greben Bučenice (498 m) nad Modrejcami se postavi v vzhodno-jugovzhodni podaljšek grebena Hlevnik (886 m) - Senica (576 m) nad Volčami (sl. 8A, d4). Iz slike 8B je torej mogoče povzeti, da je paleo-Idrijca tekla po Čepovanskem dolu in da je paleo-Bača tekla po sedanji dolini Soče južno od Mosta na Soči. Na podlagi gornjih ugotovitev smatramo razdaljo okoli 2200 m za referenčni premik ob Idrijskem prelomu na območju Tolmina in Dolenje Trebuše. To lahko izrazimo z zapisom $d1 \approx d2 \approx d3 \approx d4 \approx 2200$ m. Do kvalitativno enake ugotovitve o vplivu Idrijskega preloma na odnos doline Idrijce do Čepovanskega dola in doline Bače do doline Soče južno od Mosta na Soči, so prišli Miklavž Feigel (ustna izjava, 1973) in Moulin et al. (2016, sl. 5).

Podatka o premiku d1 in d2 sta visoko pričevalna, medtem ko ima d3 ob d2 le vzporeden pomen. Podatek d4 je lahko realen ali slučajen, saj glede na nadaljnje izvajanje ne moremo

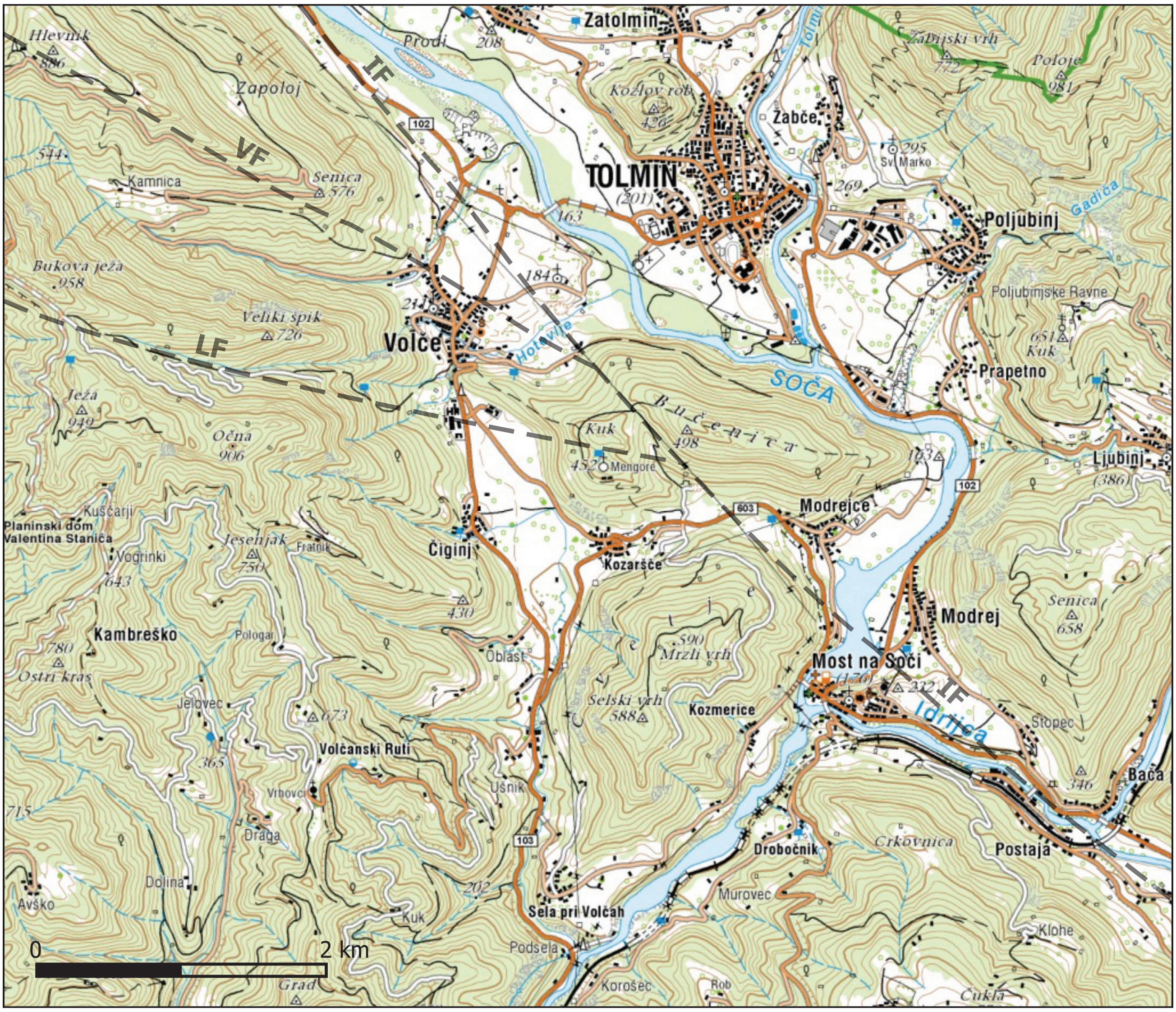


Fig. 10. Topographic map of the wider area around the Soča confluence, Tolminka, and Idrijca rivers. According to Geopedia – interactive online atlas and map of Slovenia. Explanation in Fig. 8.

Sl. 10. Topografska karta širše okolice sotočja Soče, Tolminke in Idrijce. Povzeto po Geopedia - interaktivni spletni atlas in zemljevid Slovenije. Legenda na sl. 8.

ally not resolved. The course of the Fault in the Tolmin area is described in more detail, which is why a topographical sketch is attached for easier orientation (Fig. 10). The terms "total displacement" for d0 and the "segmental displacement" for d1 in Figure 9 are only relevant for explaining the situation in the Dolenja Trebuša area.

When Bača Valley is positioned opposite the Soča Valley Mt. Selski vrh ridge (588 m) – Mt. Mrzli vrh (590 m) is located opposite the Mt. Senica ridge (658 m) above Modrej village (Fig. 8A, d3), the Mt. Bučenica ridge (498 m) above Modrej is located in the east-southeastern extension of the Mt. Hlevnik ridge (886 m) – Mt. Senica (576 m) above Volče (Fig. 8A, d4). It can therefore be concluded from Figure 8B that the paleo-Idrijca flowed along the Čepovanski dol and that the paleo-Bača flowed along the present Soča Valley south of the village of

trditi, da je greben Hlevnik - Senica - Bučenica obstajal že pred nastankom Idrijskega preloma. Trasa preloma na sl. 8 sloni na interpretaciji kot jo je podal Buser (1986; 1987) na Osnovni geološki karti, lista Tolmin in Videm; od sedla med Bučenico in Kukom nad Kozarščem poteka proti severozahodu, oziroma proti Kobaridu, ne pa proti zahodu-severozahodu proti Volčam, kot menijo Moulin et al. (2016, sl. 5). Za tako odločitev obstoja več razlogov: 1. razvoj pliocenskega porečja Soče po Meliku (1956), 2. geološki podatki na Osnovni geološki karti 1:100.000, lista Tolmin in Videm (Buser ibid.), 3. ugrez severovzhodnega krila Idrijskega preloma in 4. kriterij desnozmičnega premika 2200 m na območju Tolmina in Dolenje Trebuše, kot je prikazan v tem članku.

Most na Soči. Based on these findings, we consider a distance of around 2,200 m as a reference offset along the Idrija fault in the area of Tolmin and Dolenja Trebuša. This can be expressed as d1 ≈ d2 ≈ d3 ≈ d4 ≈ 2200 m. Miklavž Feigel (oral statement, 1973) and Moulin et al. (2016, Fig. 5) came to the same qualitative conclusion about the impact of the Idrija Fault on the relationship between the Idrijca Valley, the Čepovanski dol, the Bača Valley, and the Soča Valley south of Most na Soči (2016, Fig. 5).

The data on the d1 and d2 offsets are highly testimonial, while d3 has only a parallel meaning with d2. The d4 data may be representative or coincidental, since according to further implementation we cannot claim that the Hlevnik - Senica - Bučenica ridge already existed before the formation of the Idrija Fault. The Idrija Fault trace in Figure 8 is based on the interpretation given by Buser (1986; 1987) on the Basic Geological Map, sheet Tolmin and Videm; from the saddle between Mt. Bučenica and Mt. Kuk above the village of Kozaršče, it runs towards the northwest, or rather towards Kobarid, but not WNW towards Volče, as Moulin et al. (2016, Fig. 5) suggested. There are several reasons for such a decision: 1. the development of the Pliocene Soča basin according to Melik (1956), 2. geological data on the basic geological map 1:100,000, the Tolmin and Videm sheets (Buser, ibid), 3. the subsidence of the northeastern block of the Idrija Fault, and 4. the criterion of a 2,200 m dextral offset in the area of Tolmin and Dolenja Trebuša, as shown in this article.

Ad 1. Melik (1956, Fig. II) in his discussion about the Middle Pliocene assumes that the paleo-Soča flowed through the valley between Kobarid and Robič, and then through the present-day Nadiža gorge towards the south. Melik (ibid) also assumed that the paleo-Idrijca river flowed through the Čepovanski dol valley, and that today's hanging Livek Valley SE of the village of Livek (Fig. 2) had a wide watershed in its hinterland, which was fed from the area northeast of Livek and today appears completely denuded. The description applies to the situation before the formation of the Idrija Fault. It is also indirectly proven by the flow of the Soča River, which flows north of Kobarid across the frontal part of the Southern Alps thrust independently of the bundle of faults that were created later and which we believe are related to the Idrija Fault. The assumption is supported by the 1:100,000 scale Basic geologic map, Tolmin and Videm sheet (Buser, 1986; 1987).

The Livek hanging valley is the main geomorphological object that indicates the flow of the paleo-Soča River towards the present-day Nadiža

Ad 1. Melik (1956, sl. II) v svoji razpravi za obdobje srednjega pliocena domneva, da je paleo-Soča tekla po dolini med Kobaridom in Robičem, nato pa po današnji soteski Nadiže proti jugu, da je paleo-Idrijca tekla po Čepovanskem dolu in da je imela danes viseča Livška dolina (sl. 2) tedaj široko zaledje. Napajala se je z območja severovzhodno od Livka, ki je danes povsem denudirano. Opis velja za stanje pred nastankom Idrijskega preloma, kar posredno dokazuje tudi tok Soče, ki severno od Kobarida teče preko čelnega dela nariva Južnih Alp neodvisno od pozneje nastalega snopa prelomov, za katere menimo, da so povezani z Idrijskim prelomom. Podlaga za to domnevo so podatki Osnovne geološke karte, lista Tolmin in Videm (Buser, 1986; 1987).

Viseča Livška dolina je glavni geomorfološki objekt, ki kaže na tok paleo-Soče proti današnji dolini Nadiže. Na območju Livka ima med Kolovratom in Matajurjem značilnosti pradoline, katere pobočja dosežejo do 500 m višine, pri Čepovanskem dolu pa največ okoli 400 m. Na podlagi tega je moč sklepati, da je imelo denudirano porečje zgornjega dela livške paleoreke znaten obseg.

V času nastanka Melikove razprave so Idrijski prelom obravnvali kot disjunktivno deformacijo, ki naj bi imela ponekod učinek reverznega, ponekod normalnega preloma. Rakovec (1956, str. 79) ga je potegnil do Kobarida in Učje. Desnozmično komponento Idrijskega preloma je utemeljil Mlakar (1964).

Ad 2. Po podatkih Osnovne geološke karte (OGK), lista Tolmin in Videm (Buser, ibid.), je trasa Idrijskega preloma od sedla med Bučenico in Kukom nad Kozarščem (sl. 10), usmerjena proti severozahodu. Naprej poteka pod severovzhodnim pobočjem grebena Hlevnik - Senica in po Soški dolini do Kobarida ter po severovzhodnem pobočju grebena Mali vrh (1405 m) - Starijski vrh (1146 m) proti spodnjemu delu doline Učje nad Žago (Čar & Pišljar, 1993; Gosar, 2022). Pri Libušnjah se na severovzhodno stran cone Idrijskega preloma naslanja narivna meja Južnih Alp, ki se pri Kobaridu od nje odcepi. Zahodno od tod se nadaljuje pod imenom prelom Barcis - Staro selo. Premik narivne meje Južnih Alp ob Idrijskem prelomu je desnozmičen, navidezna dolžina premika znaša okoli 3,5 km, vendar gre za učinek, ki je posledica ugreza severovzhodnega krila Idrijskega preloma in položnega vpada narivne meje Južnih Alp. Dejanski desnozmični premik je manjši, vendar njegove velikosti ni mogoče ugotoviti.

Valley. In the area of the village of Livek, between Mt. Kolovrat and Mt. Matajur, it has the characteristics of a deep valley, with slopes that reach a height of up to 500 m, while the maximum valley depth at Čepovanski dol is around 400 m. With this in mind, we can conclude that the denuded basin of the upper part of the Livek paleo-river had a significant extent.

At the time of Melik's treatise, the Idrija Fault was treated as a brittle deformation, which was supposed to have the effect of a reverse fault in some places, and a normal fault in others. Rakovec (1956, p. 79) drew it to Kobarid and Učja. The dextral offset component of the Idrija Fault was established by Mlakar (1964).

Ad 2. According to the Basic Geological Map 1:100,000 (OGK), sheet Tolmin and Videm (Buser, ibid.), the Idrija Fault trace from the saddle between Mt. Bučenica and Mt. Kuk above Kozaršče village (Fig. 10) is directed towards the northwest. It continues under the northeastern slope of the Mt. Hlevnik – Mt. Senica ridge and along the Soča Valley to Kobarid and along the northeastern slope of the Mt. Mali vrh (1405 m) – Mt. Starijski vrh (1146 m) ridge towards the lower part of the Učja Valley above the village of Žaga (Čar & Pišljar, 1993; Gosar, 2022). Near Libušnje, the thrust boundary of the Southern Alps leans on the northeastern side of the Idrija Fault zone, which splits off near Kobarid. To the west it continues as the Barcis - Staro selo Fault. The offset of the thrust boundary of the Southern Alps along the Idrija Fault is dextral, with an apparent offset of about 3.5 km. The actual dextral displacement is smaller due to the subsidence of the northeastern block of the Idrija Fault and the gentle dip of the Southern Alps boundary thrust. The true offset, however, cannot be ascertained.

On the saddle between Mt. Bučenica and Mt. Kuk, before Volče, the stratigraphically and geomorphologically responsive Volče Fault (Fig. 8) splits off from the Idrija Fault, which runs along the southwestern slope of the Mt. Hlevnik – Mt. Senica ridge. Due NW it continues across the saddle between Mt. Hlevnik (886 m) and the Mt. Kolovrat ridge into the Soča Valley. Between Mt. Kuk and Mt. Mengore (just south of it), another fault branches off from the Idrija Fault (Jamšek Rupnik et al., 2022), whose route, in our opinion, passes the village of Livek and continues due NW towards Robič. The fault between Robič and Livek was mapped by Buser, who marked it due southeast to the upper Idrijca River and named it the Livek Fault. However, the structural and remote detection data indicate a connection from Livek to the aforementioned saddle above Kozaršče, so we suggest that the lat-

Na sedlu med Bučenico in Kukom se pred Volčami od Idrijskega preloma odcepi stratigrafsko in geomorfološko jasno odziven Volčanski prelom (sl. 8), ki poteka po jugozahodnem pobočju grebena Hlevnik - Senica. Nato se prevesi preko sedla med Hlevnikom (886 m) in grebenom Kolovrata v Soško dolino. Med Kukom in Mengorami nad Kozarščem se od Idrijskega preloma odcepi drugi prelom (Jamšek Rupnik et al., 2022), katerega trasa po našem mnenju poteka mimo Livka in naprej proti Robiču. Prelom med Robičem in Livkom je kartiral Buser, potegnil ga je proti jugovzhodu na zgornjo Idrijco in ga poimenoval Livški prelom. Toda strukturni podatki in zaznambe daljinske detekcije, kažejo na povezavo od Livka proti omenjenemu sedlu nad Kozarščem, zato predlagamo, da se slednja varianta obravnava kot Livški prelom (sl. 8). Naše mnenje temelji na primerjavi podatkov Geološke karte Benečije Julijske krajine (Carulli, 2006) in Osnovne geološke karte Jugoslavije merila 1: 100.000, listov Tolmin in Videm (Buser, 1986; 1987). Ta je pokazala, da se zahodno od Idrijskega preloma uveljavlja drugačna dinamika neogensko-recentnih deformacij. To se odraža v njihovi smeri in kinematiki, vendar razprava o tem presega okvir tega članka.

Ad 3. Sklepamo, da je Idrijski prelom odrezal zgornje povirje livške paleoreke od njenega osrednjega in spodnjega toka. Rez je bil učinkovit zato, ker se je severovzhodno krilo preloma ugreznilo, oziroma jugovzhodno krilo dvignilo in s tem preprečilo odtok voda zgornjega povodja livške paleoreke proti jugozahodu. Te so se potem lahko odvajale le proti severozahodu ali jugovzhodu. Pričel se je proces nastajanja doline med Kobaridom in Tolminom, ki je bil učinkovit tudi zaradi bližine narivne meje Južnih Alp. Najprej sta nastali porečji dveh potokov od katerih je eden napajal paleo-Sočo, drugi paleo-Bačo. Sčasoma je nastala dolina, v katero se je iz doslej še neraziskanih razlogov preusmerila Soča.

Dolina med Kobaridom in Tolminom bi lahko nastala tudi zaradi same narivne meje Južnih Alp brez Idrijskega preloma, vendar kažeta Volčanski prelom in desni premik narivne meje Južnih Alp med Kobaridom in Libušnjami na traso, kot so jo razumevali Rakovec (1956), Arsovski & Feigel (1973) in Buser (1986, 1987).

ter variant be considered the Livek Fault (Fig. 8). Our opinion is based on a comparison of the data of the Geological Map of the Veneto Julian Region (Carulli, 2006) and the Basic Geological Map of Yugoslavia, 1:100,000 scale, Tolmin and Videm sheet (Buser, 1986; 1987). This showed that a different dynamic of Neogene-recent deformations is taking place west of the Idrija Fault, which is reflected in their direction and kinematics, but discussion of this is beyond the scope of this article.

Ad 3. We conclude that the Idrija Fault cut off the upper headwaters of the Livek paleo-river from its central and lower course. The cut was effective because the northeastern flank of the fault subsided, or the southeastern flank rose, thereby preventing drainage of the waters of the upper catchment of the Livek paleo-river towards the southwest. These waters could then be discharged only towards the northwest or southeast. Thus, the process of formation of the valley between Kobarid and Tolmin began, which was also effective due to the proximity of the Southern Alps Thrust Boundary. First, the basins of two watersheds were formed, one of which fed the paleo-Soča, the other the paleo-Bača River. Over time, a valley was formed into which the Soča River diverted for as yet unexplained and unexplored reasons.

The valley between Kobarid and Tolmin may also have been formed by the Southern Alps Thrust Boundary without the Idrija Fault, but the Volče Fault and the right lateral shift of the Southern Alps Thrust Boundary between Kobarid and the village of Libušnje show the trace as understood by Rakovec (1956), Arsovski & Feigel (1973), and Buser (1986; 187).

Ad 4. The displacement criterion of 2200 m can be used for displacements d2, d3, and d4 in the Tolmin area (Fig. 8A), while the of valley network between Tolmin and Sela pri Volčah indicates a multiphase development. This only reinforces the assumption that before the formation of the Idrija Fault, the paleo-Soča did not flow here and that the area between Tolmin and Sela pri Volčah was formed by several streams that fed the paleo-Bača River from the northwestern side. In Figure 8B, no variant on the geomorphological development of this area is given, but we would like to draw attention to the Mt. Selski vrh – Mt. Mrzli vrh – Mt. Senica (658 m) ridge, which was probably continuous, before the formation of the Idrija Fault, so the water of all the streams flowed into the paleo-Bača River in the area of Sela pri Volčah exclusively.

The above four considerations lend a relatively high probability to the interpretation of the paleo-Soča flow from Kobarid to the west and to the

Ad 4. Kriterij zmika 2200 m je na območju Tolmina mogoče uporabiti pri premiku d2, d3 in d4 (sl. 8A), medtem ko splet dolin med Tolminom in Selami pri Volčah kaže na večfazni razvoj. To le utrjuje domnevo, da pred nastankom Idrijskega preloma paleo-Soča tu še ni tekla in da je prostor med Tolminom in Selami pri Volčah oblikovalo več potokov, ki so napajali paleo-Bačo s severozahodne strani. Na sl. 8B ni podane nobene variante o geomorfološkem razvoju tega prostora, opozorili bi pa na greben Selski vrh - Mrzli vrh -Senica (658 m), ki je bil pred nastankom Idrijskega preloma verjetno sklenjen, zato je voda vseh potokov odtekala v paleo-Bačo le na območju Sel pri Volčah.

Navedeni štirje premisleki dajejo sorazmerno visoko stopnjo verjetnosti interpretaciji toka paleo-Soče od Kobarida proti zahodu in interpretaciji trase Idrijskega preloma od sedla med Bučenico in Kukom proti severozahodu. Vendar je potrebno obe tezi kljub temu preveriti. Katera reka je urezala dolino med Robičem in Kobaridom bi se dalo ugotoviti s sondiranjem, s katerim bi določili smer imbrikacije ploščatih prodnikov; če je ta nagnjena proti zahodu je dolino izdolbla Soča, v nasprotnem primeru Nadiža. Sondiranje bi moralo odgovoriti tudi na vprašanje morebitne ojezeritve in njene starosti. Traso Idrijskega preloma je mogoče preveriti z razkopi ali geofizikalnim profiliranjem v dolini Soče, najprimernejše mesto preverbe je prostor pod severovzhodnim pobočjem grebena Hlevnik - Senica. Raziskave v Modrejcah (Jamšek Rupnik- et al., 2022) so bile izvedene korektno, niso pa mogle dati odgovora na to vprašanje.

Prispevek o genezi rečnega reliefa na območju zgornje Nadiže (Diercks et al., 2021) ne posega v to razpravo, čeprav je v njem uporabljena interpretacija Moulin et al. (2016, sl. 5), da je Nadiža urezala dolino med Robičem in Kobaridom.

Pred nastankom Idrijskega preloma sta Banjška in Šentviška planota tvorili enovito »Banjško-Šentviško planoto« (sl. 8B). Če bi hoteli bolj dosledno rekonstruirati takratno stanje, bi morali Šentviško planoto dvigniti za okoli 150 m, ali obratno, in odmisliti dolino Idrijce med njima.

V tem članku ne opisujemo strukturnih razmer na jugozahodni strani Banjške in Trnovske planote nad Vipavsko dolino, ugotavljamo pa, da so litološka sestava (eocenski fliš ter kredni, paleocenski in eocenski karbonati), razporeditev (fliš v talnini, karbonati v krovnini, meja med njimi subhorizontalna krovna narivna ploskev) in kinematika, primerljivi z istrsko-furlansko narivno-podrivno cono (Placer et al., 2023, sl. 1, str. 13). V profilu interpretation of the route of the Idrija Fault from the saddle between Mt. Bučenica and Mt. Kuk to the northwest. However, it is still necessary to verify both theses. Which river cut the valley between Robič and Kobarid could be determined by probing, which would determine the direction of imbrication of flat pebbles; if it is inclined to the west, the valley was carved out by the Soča River, and if inclined otherwise by the Nadiža. Sounding should also answer the question of possible lake formation there and the age of such. The Idrija Fault trace can be verified by trenching or geophysical profiling in the Soča Valley; the most suitable place for verification is the area under the northeastern slope of the Mt. Hlevnik – Mt. Senica ridge. Research at the village of Modrejce (Jamšek Rupnik et al., 2022) was carried out correctly but did not provide a conclusive answer to the question.

The paper on the genesis of the river relief in the area of the upper Nadiža River (Diercks et al., 2021) does not play a role in this discussion, though it does use the interpretation of Moulin et al. (2016, Fig. 5) that the Nadiža cut the valley between Robič and Kobarid.

Before the formation of the Idrija Fault, the Banjšice and Šentviška Gora plateaus formed a single plateau (Fig. 8B). If we wanted to reconstruct a more consistent picture of the situation at the time, we would have to raise the Šentviška, Gora plateau by about 150 m, or vice versa, and discard the Idrijca Valley between them.

In this article we do not describe the structural conditions on the southwestern side of the Banjšice and Trnovski gozd plateaus above the Vipava Valley, but we note that the lithological composition (Eocene flysch and Cretaceous, Paleocene, and Eocene carbonates), distribution (flysch in the footwall, carbonates in the hanging wall and subhorizontal thrust plane between them) and kinematics are comparable to the Istra-Friuli Thrust-Underthrust Zone (Placer et al., 2023, Fig. 1, p. 13). In the profile of the Istra-Friuli Thrust-Underthrust Zone (ibid., fig. 8), two types of deformations stand out: underthrust reverse faults and antiformally bent Paleogene thrust surfaces located next to them; both are related to the uplift of the hanging wall of the underthrust reverse faults. The equivalent of the antiformally bent nappe thrust plane on the boundary between the Vipava Valley (External Dinaric Imbricated Belt) and the Trnovski gozd plateau with Mt. Hrušica (External Dinaric Thrust Belt) is the Nanos-Čaven antiform (Placer et al., 2021a, p. 56-58; 2023, p. 38), the equivalent of the underthrust reverse faults are represented by structures whose description requires extensive substantiation, so istrsko-furlanske narivno-podrivne cone (ibid., sl. 8) izstopata dva tipa deformacij, podrivni reverzni prelomi in ob njih antiformno usločene paleogenske narivne ploskve; oboje je povezano z dvigom krovninskega krila podrivnih reverznih prelomov. Ekvivalent antiformno usločene krovne narivne ploskve na meji med Vipavsko dolino (Zunanjedinarski naluskani pas) in Trnovskim gozdom s Hrušico (Zunanjedinarski narivni pas), je nanoško-čavenska antiforma (Placer et al., 2021a, str. 56–58; 2023, str. 38), ekvivalent podrivnih reverznih prelomov pa predstavljajo strukture, katerih opis zahteva obširno utemeljevanje, zato bodo predstavljene v posebnem prispevku.

Za dokaz dviga uravnanega območja Trnovskega gozda in Banjške planote zadostuje že sam obstoj Čepovanskega dola, saj dol kot nekdanja rečna dolina ni mogel delovati na sedanji nadmorski višini, urezovanje v primarno uravnavo na začetku njegovega nastajanja pa se je moralo dogajati na še nižjem nivoju.

## Sklep

Nad severovzhodnim obrobjem Vipavske doline, ki je zgrajena iz flišnih kamnin Zunanjedinarskega naluskanega pasu, se dvigajo karbonatne kamnine Zunanjedinarskega narivnega pasu (planote Banjšice, Trnovski gozd, Nanos), ki so bile tja narinjene v paleogenu v zaključnem obdobju narivne faze nastajanja Dinaridov. Narinjene karbonatne kamnine se danes gravitacijsko sprožajo v Vipavsko dolino, ta proces traja že subrecentno in recentno obdobje, zato sklepamo, da se omenjene planote postopoma dvigajo.

Dviganje ob severovzhodnem obrobju Vipavske doline se ne dogaja ob paleogenskih krovnih narivnih ploskvah, ki so tu subhorizontalne in blago tonejo proti severozahodu, temveč ob podrivnih reverznih prelomih smeri NW-SE, ki pa so šele v fazi proučevanja. Ti so posledica pomikanja Jadranske mikroplošče (Mikroadrija) proti Dinaridom. Desnozmični prelomi v smeri NW-SE imajo v tem primeru podrejeno vlogo.

Premikanje Mikroadrije proti Dinaridom poteka domnevno vse od srednjega miocena, zato ga obravnavamo kot neogensko-recentno dogajanje. Poleg splošnih geomorfoloških pojavov na širšem prostoru severozahodnih Dinaridov (istrsko potisno območje) to dokazujejo tudi pojavi na Banjšicah in Trnovskem gozdu: 1. Kraških uravnav na Trnovskem gozdu (Voglarska planota) in Banjšicah (jugovzhodni del) ne moremo razlagati s krajevno omejenimi procesi. 2. Korozivna degradacija teh uravnav je povezana s poostritvijo klimatskih razmer zaradi dviganja Zunanjedinarskega they are to be presented in a special, separate paper.

The very existence of the Čepovanski dol is enough to prove the elevation of the peneplained area of the Trnovski gozd and the Banjšice plateaus, since the Čepovanski dol, as a former river valley, could not function at its current altitude, and the cutting into primary regulation at the beginning of its formation had to take place at a level even lower that of today.

## Conclusions

The carbonate rocks (Banjšice and Trnovski gozd plateaus, Nanos) that were overthrusted there in the Paleogene during the final period of the thrust phase of the formation of the Dinarides rise above the northeastern edge of the Vipava Valley, which is built from the flysch rocks of the External Dinaric Imbricated Belt. The eroded carbonate rocks are now gravitationally launched into the Vipava Valley, which process has been going on over the course of the sub-recent and recent periods, so we conclude that the mentioned plateaus are gradually rising.

The uplift along the northern margin of the Vipava Valley does not take place along the subhorizontal Paleogene nappe thrust planes, dipping slightly to the northwest, but rather along the NW-SE trending underthrust reverse faults which are still in the study phase. These are a consequence of the Microadria movement towards the Dinarides where the right lateral NW-SE trending strike-slip faults play a subordinate role.

The movement of the Microadria towards the Dinarides has presumably been going on since the Middle Miocene, so we treat it as a Neogene-recent event. In addition to the general geomorphic phenomena in the wider area of the northwestern Dinarides (Istran Pushed Zone), this is also proven by phenomena in the Banjšice and Trnovski gozd plateaus: 1. The karstic peneplanation in the Trnovski gozd plateau (Voglarji plateau) and the Banjšice plateau (southeastern part) cannot be explained by locally limited processes. 2. The corrosive degradation of these peneplains (plateaus) is related to the aggravation of climatic conditions due to the uplift of the External Dinaric Thrust Belt. 3. Čepovanski dol was active (hosted a river) at a lower altitude, and at the beginning of cutting into the levelled karst surface it must have lay even lower.

We note that in addition to the existing karstic peneplanations in the Banjšice and Trnovski gozd plateaus, the rest of the Trnovski gozd area was also peneplained from the Voglarji plateau in the southeast to Mt. Veliki and Mt. Mali Modrasovec narivnega pasu. 3. Čepovanski dol je bil pretočno aktiven na nižjem nadmorskem nivoju, na začetku urezovanja v uravnano kraško površje pa je moral ležati še nižje.

Ugotavljamo, da je bil poleg obstoječih kraških uravnav na Banjšicah in Trnovskem gozdu, uravnan tudi preostali del Trnovskega gozda od Voglarske planote proti jugovzhodu do Velikega in Malega Modrasovca nad Lokavcem in Streliškega vrha nad Podkrajem pri Colu. Enako domnevamo tudi za danes neuravnani del Banjšic in Šentviške planote. Zato uvajamo termin trnovsko-banjško-šentviška degradirana uravnava.

Obseg trnovsko-banjško-šentviške degradirane uravnave je prikazan na sliki 11. Pri nižji nadmorski višini je bilo celotno območje uravnano, med dviganjem pa je strukturno in denudacijsko degradiralo. Degradacija ni bila enotna temveč podrejena litološki sestavi, strukturi in dinamiki dviganja. Danes so na tem prostoru razviti trije različni tipi reliefa, ki so nastali po načinu degradacije prvotne uravnave. Na relativno umirjenem delu iz karbonatnih kamnin, kjer strukturna degradacija ni imela vpliva, so vidne le posledice ostrejših klimatskih pogojev, ta del je označen kot korozivno degradirana kraška uravnava (I); del iz karbonatnih kamnin, ki je danes razgiban, je označen kot strukturno in korozivno degradirana kraška uravnava (II); del iz mešanih kamnin, ki je danes umirjeno razgiban je označen kot strukturno degradirana in denudirana uravnava (III), tu je delež korozivne degradacije podrejen zaradi prisotnosti klastičnih kamnin. Vplivno območje korozivno degradiranih kraških uravnav (I) je identično z vplivnimi območji c, d in e (I ≡ c, d, e) (sl. 2, 4).

Trnovsko-banjško-šentviška degradirana uravnava leži na najvišjem območju Trnovskega pokrova, ki je zgrajeno iz karbonatnih kamnin. Ta del je proti jugovzhodu ohranjen le do Streliškega vrha (1266 m), od tu naprej pa je erodiran; na mestu je torej domneva, da je bila obravnavana uravnava ob svojem nastanku večja od površine kot je predstavljena na sl. 11, zato bi sodila po definiciji Stepišnika in Ferkove (2023, 12–13) v razred korozijskih uravnav. Temu pritrjuje tudi sodobni pogled na njihovo genezo (ibid. 17–18).

V tem članku ni obdelan geološki pomen Ponikvanske tektonske krpe na Šentviški planoti. Obdelan ni tudi pomemben podatek, da je Šebreljska planota vzhodni podaljšek Šentviške planote na drugi strani doline Idrijce.

Vsa našteta dejstva in domneve terjajo temeljit premislek o ponarivni, oziroma popaleogenski genezi Dinaridov.

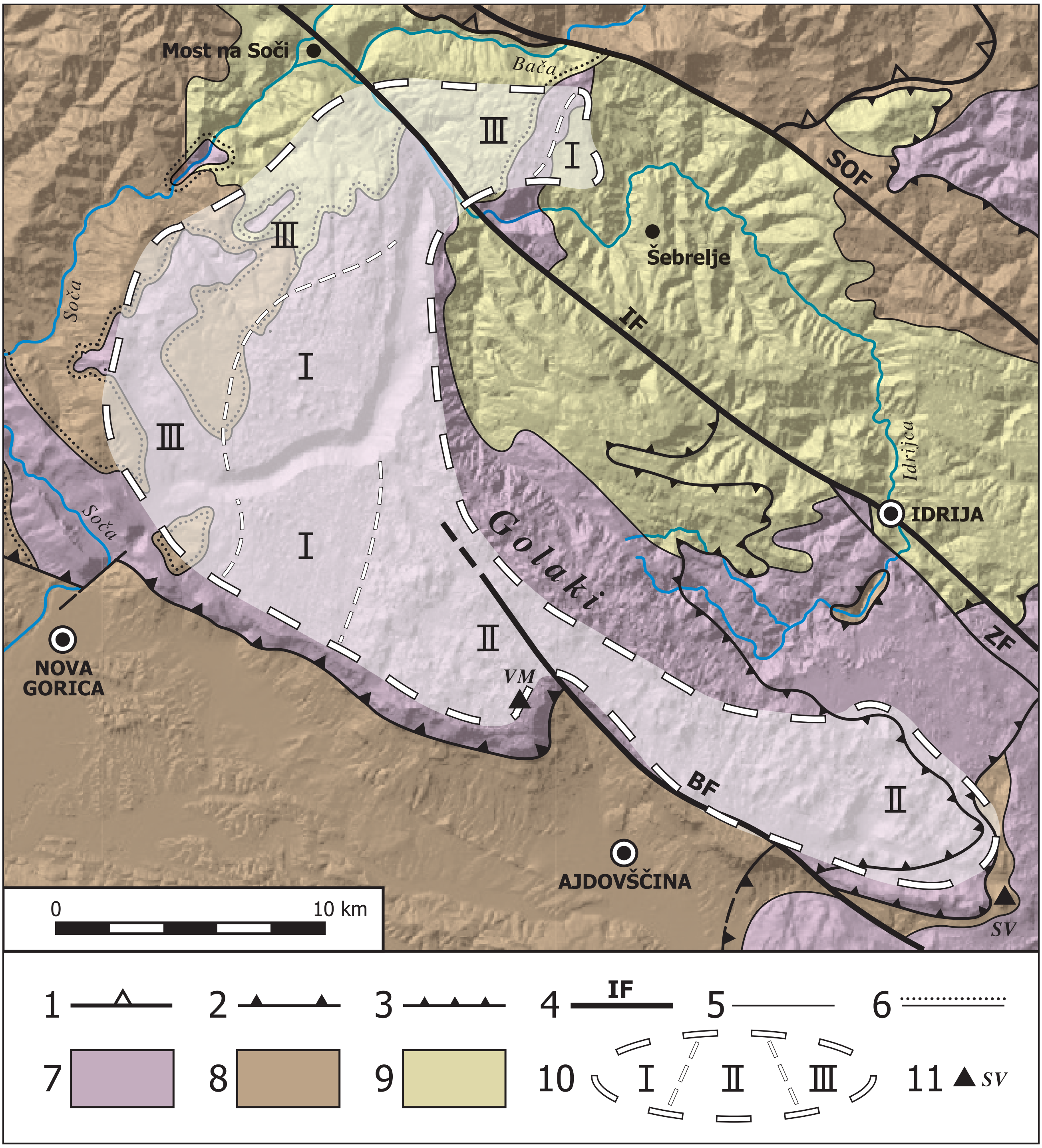


Fig. 11. Trnovski gozd-Banjšice-Šentviška planota degraded plain.
Sl. 11. Trnovsko-banjško-šentviška degradirana uravnava.

1 Thrust boundary of Southern Alps / narivna meja Južnih Alp
2 Boundary of the External Dinaric Thrust Belt / meja Zunanjedinarskega narivnega pasu
3 Boundary of the nappe unit within the External Dinaric Thrust Belt / meja krovne enote znotraj Zunanjedinarskega narivnega pasu
4 Fault: **SOF** – Sovodenj Fault, **IF** – Idrija Fault, **ZF** – Zala Fault, **BF** – Belsko Fault (Placer et al., 2021, fig. 6, p. 44; Buser, 1976, p. 50, Predjama Fault) / prelom: **SOF** – Sovodenjski prelom, **IF** – Idrijski prelom, **ZF** – Zalin prelom, **BF** – Belski prelom (Placer et al., 2021, sl. 6, str. 44; Buser, 1976, str. 50, Predjamski prelom)
5 Concordant geological border / konkordantna geološka meja
6 Discordant geological border / diskordantna geološka meja
7 Predominantly carbonates / pretežno karbonati: $\mathbf{T_3^{2+3}}$, **J**, $\mathbf{K_1}$, **Pc**, $\mathbf{E_1}$
8 Predominantly clastites / pretežno klastiti: **C**, $\mathbf{P_1}$, $\mathbf{K_2}$, **Pc**, **E**
9 Carbonates and clastites / karbonati in klastiti: $\mathbf{P_2}$, $\mathbf{T_{1+2}}$, $\mathbf{T_3^1}$, $\mathbf{K_2}$
10 Area of the Trnovski gozd-Banjšice-Šentviška planota degraded plain / območje trnovsko-banjško-šentviške degradirane uravnave. Type of dominant degradation: **I** – corrosive degradation (**I** ≡ **c**, **d**, **e**: see fig. 2, fig. 4), **II** – structural and corrosive degradation, **III** – structural degradation and denudation / tip prevladujoče degradacije: **I** – korozivna degradacija (**I** ≡ **c**, **d**, **e**: glej sl. 2, sl. 4), **II** – strukturna in korozivna degradacija, **III** – strukturna degradacija in denudacija
11 Top / vrh: **VM** – Veliki Modrasovec (1355 m), **SV** – Strelişki vrh (1266 m)

above Lokavec and Mt. Streliški vrh above Podkraj pri Colu. We assume the same for the currently non-peneplained part of Banjšice and the Šentviška Gora plateaus – which is why we here introduce the term Trnovski gozd-Banjšice-Šentviška Gora degraded peneplain.

The extent of the Trnovski gozd-Banjšice-Šentviška Gora plateaus degraded peneplanation is shown in Figure 11. At a lower altitude the entire area was levelled, but during the uplift it degraded structurally and denudationally. The degradation was not uniform but subordinated to the lithological composition, structure, and uplift dynamics. Today, three different types of relief have been developed in this area, formed according to the type of degradation of the original peneplain. On the relatively unactive part built of carbonate rocks, where structural degradation had no effect, only the consequences of harsher climatic conditions are visible; this part is designated as corrosively degraded karst plain (I); the part built of carbonate rocks, which is uneven today, is designated as a structurally and corrosively degraded karst plain (II); the part made of various (carbonate and clastic) rocks, which today is moderately rugged, is designated as structurally degraded and denuded plain (III); here the proportion of corrosive degradation is subordinate due to the presence of clastic rocks. The influence zone of corrosively degraded karst plains (I) is identical to the influence zones c, d, and e (I ≡ c, d, e) (Figs. 2, 4).

The Trnovski gozd-Banjšice-Šentviška Gora degraded plain lies on the highest part of the Trnovo Nappe, which is composed of carbonate rocks. This part towards the southeast is preserved only up to Mt. Streliški vrh (1266 m), while from here on it is eroded. It is appropriate, therefore, to assume that at the time of its formation the considered level was more extensive than the surface as presented in Figure 11; according then to the definition of Stepišnik and Ferk (2023, p.12–13) it would belong to the class of corrosion plains. This is also confirmed by the modern view of their genesis (ibid. p.17–18).

The geological significance of the Ponikve klippe on the Šentviška Gora plateau is not discussed in this article. The important fact that the Šebrelje plateau represents the eastern extension of the Šentviška Gora plateau on the other side of the Idrijca Valley is also not dealt with herein.

All of the above facts and assumptions require a thorough consideration of the post-thrust or post-Paleogene genesis of the Dinarides.

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