Strmadna

Strmadna cave is the deepest cave of the Nanos plateau. It entrance is in altitude of 1060 m a.s.l., and it is 218 m deep. The cave is a system of shafts mostly controlled by fractures in direction NW - SE.

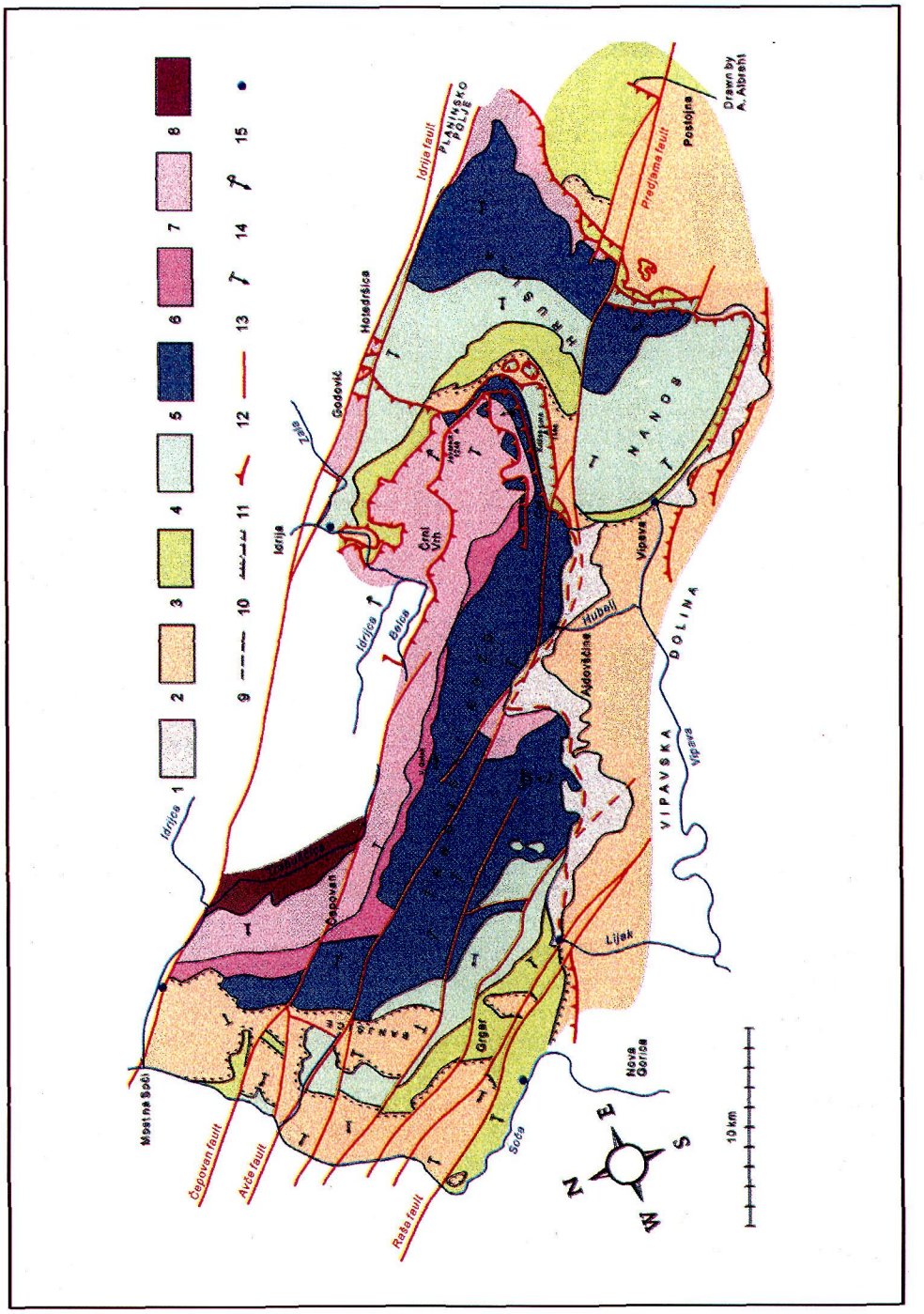
2.6. GEOLOGY AND HYDROGEOLOGY

2.6.1. Geological Description (J. ČAR)

The geological description covers the territory limited by the valleys of the Vipava, Soča, Idrijca, Trebuša, Belca and Zala rivers from the southwest, west and northeast, respectively. To the southeast the border of this territory runs along Hotenjsko podolje (Hotenja lowland) across Planinsko polje (Planina polje) through Postojnska Vrata (Postojna gate) and embraces the Pivka basin and Nanos (Mt. Nanos).

The basic data on the geological conditions on Banjška Planota (Banjščica plateau), the Trnovski Gozd (Trnovo forest), Črni Vrh plateau, Hrušica, Pivka basin and Nanos can be found on the geological maps of Gorica (BUSER 1968), Postojna (BUSER et al. 1967) and Tolmin (BUSER 1987) and in the corresponding descriptive notes and legends. More details and particularities about the geological structure of the regions may also be found in the works of BUSER (1965), MLAKAR (1969), PLACER & ČAR (1974), PLACER (1981), ČAR & GOSPODARIČ (1988) AND JANEŽ & ČAR (1990). Reviews of geological discussions of older authors are also included in the listed works. Based on the above mentioned literature, the official maps and own mapping a general geological sketchmap of the investigation area is given in Fig. 2.22.

Fig. 2.22: Geological sketchmap of Banjšice, Trnovski Gozd, Nanos and Hrušica: 1 - periglacial breccia and rubble, 2 - flysch rocks of the Upper Cretaceous, Palaeocene and Eocene age, 3 - Upper Cretaceous organogenic limestone, 4 - Lower Cretaceous bituminous limestone with inliers of dolomite, 5 - limestones and dolomites of the Jurassic age, 6 - Norian-Rhaetian limestone (Dachstein), 7 - Norian-Rhaetian dolomite, 8 - Carnian granular dolomite, alternation of silt and sandstone, 9 - normal geological boundary, 10 - erosion discordance, 11 - thrust line, 12 - fault, 13 - dip and strike of strata, 14 - dip and strike of inverse strata, 15 - karst spring.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Idrijca
Idrijca fault
PLANINSKO POLJE
Godovič
Hotedršica
Tolmin
Idrija
Čmi Vrh
Idrijca
Belca
Vipava
Hubelj
Ajdovščina
VIPAVSKA DOLINA
Vipava
Predjama fault
Postojna
Drawn by A. Albrecht
Lijek
Nova Gorica
Soča
Mostna Soči
Čepovan fault
Avče fault
Rača fault
Čepovan
Grgar
10 km
N
E
S
W

2.6.1.1. Lithostratigraphic Description

Variously coloured Carboniferous (C) and Permian (P_2^2) clastic rocks, Upper Permian (P_3) bituminous dolomites and limestones, Scythian (T_1) sandy dolomites, marlstones and silts with lenses of oolitic limestone, grey dolomite and marly limestones, crushable Anisian (T_2^1) dolomites and variegated Ladinian (T_2^2) rocks represented by a dolomite-limestone conglomerate, lime sandstone varieties and pyroclastic rocks with intercalations of silicificated limestones can only be found in the upper part of the Zala torrential stream, which partly sinks directly into the basin of the springs of Podroteja. The complicated mutual relationship of the above-mentioned rocks reflect the complexity of the entire overthrust structure in the Idrija region (MLAKAR 1969).

The Upper Triassic Carnian (T_3^1) layers are relatively modest in size in the region discussed. White, grainy non-bedded Cordevolian dolomite ($^1T_3^1$) is found in the Trebuša and Zala river valleys. The Julian-Tuvalian sandstones and siltstones and the dolomites with shale intercalations between layers build the steep slopes of the north side of the Trnovski Gozd above the Trebuša valley and smaller parts of the slopes on the right side of the Zala stream.

The Upper Triassic Norian-Rhaetian "principal" dolomite ($^1T_3^{2+3}$) is the first extensive lithostratigraphic bed in the region discussed. A broad band of this rock begins in the Idrijca valley south of Most na Soči, builds extensive terrains all the way to Čepovanski Dol (Čepovan valley) and extends to the northern periphery of the Trnovski Gozd. It builds slopes above Trebuša and Belca river valley, partially covers the Zadlog and Črni Vrh plateaux and the ridge extending to Javornik (1240 m). Norian-Rhaetian dolomite also builds the eastern slopes of Čaven (1185 m) and the southern side of Hrušica. In stratigraphically higher parts the grey layered dolomite passes into light grey layered oroganogenic Dachstein limestone. In the continuous belt it has developed between the Čepovanski Dol (Čepovan valley) and the central part of the Trnovski Gozd. It can also be found around Križna Gora (957 m) along the southeast periphery of Javornik.

Norian-Rhaetian limestones and dolomites gradually pass into Jurassic rocks. On the Banjška Planota (Banjšica plateau), in the Trnovski Gozd, on Hrušica and on the eastern part of the Nanos range, all the Liassic (J_1), Doggerian (J_2) and Malmian (J_3) lithostratigraphic units have developed, descending toward the southwest. The lithogical and according to fossils of the Lower and Middle Jurassic layers of the Trnovo Gozd is similar those of the old rocks of Nanos and Hrušica. Lithological changes of the Malmian layers are noticeable to the east of Col.

The layers of Jurassic rocks with a thickness of 1000 to 1500 meters have primarily developed in the form of limestones and dolomites with all the characteristic mutual transitions. The variously coloured thick and oolitic

limestones alternate and transform along the edges into white, grey or even brown-coloured dolomite. The Doggerian grey limestone with chert found at Banjšice and in the west part of the Trnovski Gozd is a particularity.

In the entire region discussed, the Lower Cretaceous (K_1) rocks were deposited in the form of characteristic carbonitic facies. However, significant lithological differences already appear in the development of Upper Cretaceous (K_2) rocks. The Cretaceous rocks are about 2500 to 3000 m thick.

On the periphery of the Pivka basin, on Nanos, Hrušica and in the Trnovski Gozd the Lower Cretaceous rocks have developed in the form of brownish to light-grey limestone with intercalations of grained bituminous dolomites. These are followed by grey to orogenogenic Upper Cretaceous limestones rich in shell biostromes. The carbonate Cretaceous development ends with an erosional discordance.

Palaeocene (Pc) and then Eocene (E_1) flysch rocks are lying on the eroded Upper or Lower Cretaceous limestone on the western periphery of the region discussed, on Banjšice plateau south of the Avščck valley. Upper Cretaceous limestone breccia forms the base rock of the Palaeocene flysch on the plateau west of the Kajže spring. Even greater variations can be found in the region northeast of the Avščck valley. Here the Upper Cretaceous rocks appear in the characteristic flysch development forms and turbidite type of limestone of Volče (K_2^3). These rocks lie above eroded Norian-Rhaetian, Jurassic or Cretaceous carbonates. Different types of limestone breccia with intercalations of greenish and reddish marlstone can be observed above the thin-layered limestone of Volče with chert, followed by brown marlstones and sandstones with intercalations of breccia (scaglia, ${}_4K_2^3$).

Palaeocene rocks are found in the west part of the Trnovski Gozd, at Banjšice and in the tectonic windows in the surroundings of Idrija. Typical lithological components are reddish, purple marlstones alternating with greyish red varieties and intercalations of marly limestone. On eroded Upper Cretaceous limestones near Idrija basal block limestone conglomerates are covered with greenish-grey marlstones. In the surroundings of Grgar, at Banjšice and Kanalski Vrh, flysch rocks are deposited discordantly above the Upper and Lower Cretaceous rocks of various ages. At Lijak the Upper Cretaceous limestones gradually pass into Palaeocene flysch rocks.

Eocene flysch sediments are deposited discordantly on Upper Cretaceous limestones in the Pivka basin, in the belt between Črni Vrh, Col and the Vipava Valley and on the Vipava side of Nanos. In the vicinity of Lijak the transition from Palaeocene and Eocene rocks is gradual. The Eocene flysch consists of alternating brownish to greenish grey marlstones and quartz sandstones with intercalations of calcarenites and calci-rudites of varying particle range.

Periglacial coarse-grained block breccia with reddish flowstone cement of the Quaternary age (Q) covers the flysch rocks on the south-western slopes of

the Trnovski Gozd from Vipava on the west to the Soča Valley near Mrzlek. The breccias can also be found on the periphery of Nanos.

The Holocene (al) is characterised by loams with chert found in some levelled parts of the Trnovski Gozd and extended unconsolidated slope debris from Col on the east to the Soča Valley on the west.

2.6.1.2. Tectonics

The region discussed has a very complex tectonic structure (MLAKAR 1969; PLACER 1981). The predominant tectonic elements are the extensive and complex overthrusts which, in the past alpine tectonic phase, were cut with a dense system of subvertical faults.

Thrust structure

The overthrust structure is characterised by the repetition of Palaeocene-Eocene flysch in the overthrusted and underthrusted structural units near Gorica, in the Vipava Valley, Hruševje and in the Pivka basin, Vodice above Col and Idrija (PLACER, 1981). The above-mentioned alternation of poorly pervious flysch rocks and karstified limestones and the discordant and normally placed Palaeocene-Eocene and Cretaceous flysch on the west part of the Trnovski Gozd, Banjšice and Lom near Tolmin represent the basic structural hydrological element of the south-western part of Slovenia.

The flysch of the Pivka basin as well as of the narrow flysch belt extending past the northern periphery of Nanos into the Vipava valley belongs to the Snežnik thrust sheet. Upper Triassic, Jurassic, Cretaceous, Palaeocene and Eocene rocks of the Hrušica nappe were thrust onto it. The Hrušica nappe encompasses Hrušica, Nanos and the central and northern part of the Vipava Valley to Gorica. Between the nappes at the west periphery of the Pivka basin, the Bukovnik, Debeli Vrh and Suhi Vrh interjacent slices are developed. These interjacent slices are comprised of the same rocks as Hrušica's nappe. In the Idrija region, the Hrušica overthrust unit is covered first with Lower and Upper Cretaceous limestone of the Koševnik interjacent slice, followed by a plate of Upper Triassic dolomite and Carnian rocks of the inversely positioned Čekovnik interjacent slice. These units have built the Belca river stream, the Zadlog-Črni Vrh plateau, the Hotenje lowland and part of Javornik, Križna Gora and the territory between Križna Gora and Col. The above-mentioned overthrusts and flysch rocks of the Hrušica nappe are covered by the Trnovo nappe, built of rocks from the Carboniferous to Eocene periods. It encompasses the entire Trnovski Gozd, Banjšice, Lokovec, Čepovanski Dol and the Trebuša valley.

Strike-slip faults

The region discussed is limited on the northeast side by a 300 to 1500 m wide fault zone of the Idrija fault. Within the broader fault area numerous accompanying faults are in progress, branching from the main fault plane and repeatedly joining it. The most important accompanying fault zone is the Zala fault. In the enclosed map of the Idrija fault zone it appears between Most na Soči and Hotedršcica. A significant regional fault, which cuts across the entire region discussed, is the Avče fault, whose east past is also referred to as the Predjama fault. It extends from the Soča valley near Avče to the periphery of the Pivka basin. Between Idrija and the Avče fault an even greater number of significant tectonic zones can be observed in Banjščica and in the surroundings of Grgar. These faults undoubtedly cut across the central and southeast part of the Trnovski Gozd, but were not defined in detail by previous geological mappings.

Running along the southwest side of the region discussed is the regional Raša fault, which disappears below Lijak into the flysch rocks of the Vipava Valley. The Grgar valley on the northeast side of the Raša fault is cut by several quite extensive fault zones. At present their continuation in the direction south-east is still not known.

Tectonic lithological mapping on a scale of 1:5000 proves that the areas between the above-mentioned faults are interwoven with numerous crushed zones of varying width extending in the direction north-south, east-west or north-northwest, south-southeast. A similar structure can also be expected in Hrušica, Nanos, Pivka basin and its periphery.

2.6.2. Hydrogeology (J. JANEŽ)

2.6.2.1. The review of the previous investigation

Underground water of Nanos, Trnovski Gozd and Banjšice is the subject of hydrologic and hydrogeologic investigations for about 40 years. P. HABIČ published the largest number of works and papers (HABIČ 1968, 1981, 1983, 1985, 1987.). The same researcher was the author of many waters tracing tests in the catchment area of Mrzlek, Podroteja in Hubelj. Underground water tracing investigations in Slovenia 1972-1975 (GOSPODARIČ & HABIČ 1976) confirm important water connections in the catchment area of Podroteja and Divje Jezero. PLACER & ČAR (1974) explained the regional hydrogeological position of the karst springs. ČAR & GOSPODARIČ (1988), JANEŽ (1990) and PETRIČ (1994) wrote about the Lijak boiling spring. JANEČ & ČAR (1990) defined the geology and the catchment area of the spring Kajža.