Geologic Structure of Kozjansko between Savinja River and Rudnica Mountain
Part one: Younger Paleozoic and Mesozoic

Geološka zgradba Kozjanskega med Savinjo in Rudnico
Prvi del: mlajši paleozoik in mezozoik

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Abstract: The geological structure of the area between the Savinja River and Loka at Žusem, comprising the Tertiary complex and its Pre-Tertiary basement, has been described in this paper. Geologically, this area belongs to the Sava Folds, and with regard to geography to the western and central part of Kozjansko. The area between the Savinja River and Loka at Žusem is built of the Younger Paleozoic, Mesozoic, Tertiary and Quaternary rocks. The most extended are the synclinally folded Tertiary beds, whereas the Paleozoic and Mesozoic rocks crop out along the edge of the Tertiary synclines. Among the Paleozoic rocks only the Younger Paleozoic ones have been ascertained at the surface. The Triassic system is more or less completely developed, while the Cretaceous and Jurassic rocks are preserved only in part and locally. The Tertiary system consists of the Pseudo-Socka, Egerian, Badenian and Sarmatian beds. The geological and geophysical investigations showed an extremely strong tectonic displacement of the whole area. Such structure is a consequence of folding and later cutting of the area with numerous faults in various directions. Tectonics reached generally as the Tertiary as the Quaternary beds and the Pre-Tertiary basement. The rocks were subjected to several types of deformations. The strongest folding was in Ottnangian and Karpatian. Strong deformations of the Tertiary beds also originated after the deposition of the Sarmatian beds during the Attic orogenetic phase, which was active in the Lower Pliocene. The main folding was caused by forces taking an active part in direction from north to south.

Izvleček: V tem članku opisujemo geološko zgradbo ozemlja med reko Savinjo in Loko pri Žusmu, ki obsega terciarni kompleks in njegovo predterciarno podlago. Geološko pripada to ozemlje Posavskim gubam, geografsko pa zahodnemu in osrednjemu delu Kozjanskega. Ozemlje med Savinjo in Loko pri Žusmu je zgrajeno iz mlajšepaleozojskih, mezozojskih, terciarnih in kvartarnih kamnin. Najbolj razširjene so sinklinalno nagubane terciarne plasti, paleozojske in mezozojske kamnine pa izdanjajo v jedrih antiklinal in na obrobju terciarnih sinklinal. Med paleozojskimi kamninami so na površini ugotovljene le mlajšepaleozojske. Triasni sistem je bolj ali manj popolno razvit, kredne in jurske kamnine pa so ohranjene le delno in lokalno. Terciarni sistem sestavljajo psevdosoteške, egerijske, badenijske in sarmatijske plasti. Geološke in geofizikalne raziskave so pokazale izredno močno tektonsko dislociranost celotnega ozemlja. Taka zgradba je posledica gubanja in naknadnega razkosanja ozemlja z množico prelomov različnih smeri. Tektonika

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je zajela v splošnem tako terciarne kot kvartarne plasti in predterciarno podlago. Kamnine so bile podvržene več vrstam deformacij. Največje gubanje je bilo v ottnangiju in karpatiju. Močne deformacije terciarnih plasti so nastale tudi po odložitvi sarmatijskih plasti v času attiške orogenetske faze, ki je delovala v spodnjem pliocenu. Glavno gubanje so povzročili pritiski, ki so delovali v smeri od severa proti jugu.

Key words: Stratigraphy, tectonics, environment, paleogeography, Sava Folds, Eastern Slovenia.

Ključne besede: stratigrafija, tektonika, okolje, paleogeografija, Posavske gube, vzhodna Slovenija.

INTRODUCTION

The Kozjansko area between the Savinja River and the Rudnica Mountain was mapped in detail on the scale of 1:10 000 in the frame of the investigation programme for the underground gas storage. According to the Petrol Ljubljana order several localities in Slovenia were proposed by the Geological Survey of Ljubljana. In accordance with afore mentioned Petrol Ljubljana, DO Zemeljski Plin and Geological Survey Ljubljana made a contract to do a geological and geophysical prospection among other of two following localities: Šmarjeta-Lahomno and the Rudnica Anticline. A detailed geological mapping of the Šmarjeta-Lahomno area was carried out in the year 1983. As the basis of our mapping served the Geological Map of Slovenia S 1:100 000 (BUSER, 1978), made by Geological Survey of Ljubljana. With the scope of underground gas storage construction fundamental geologic, geoelectric and magnetometric investigations for reconnaissance of underground geologic structure of the area between Šentjur, Planina, Trobni Dol and Loka at Žusem were performed in the years 1985 and 1986.

REVIEW OF PREVIOUS INVESTIGATIONS

The ZOLLIKOFER'S (1861/62) description of the Tertiary beds among the Konjiška Gora, Macelj, the Sotla and the Savinja River was one of the first and most important geological publications. This work was the basis for the BITTNER'S (1884) and other subdivisions of the Tertiary in this area. STUR (1871a, b) described the Neogene beds of the wider area. He noticed that the "Socka" Beds of Laško originated in the fresh water enviroment and that toward the east a brackish and marine fauna prevails. Bittner divided the Tertiary beds between Laško and Zagorje into the: 1.) "Socka" Beds with coal, 2.) the marine Miocene beds (Marine Clay and Green Sandstone, the Lower Leitha Limenstone, the Laško Marl and the Upper Leitha Limestone) as well as 3.) the brackish Sarmatian beds. TELLER (1889) brought into the geological terminology the name Pseudo-Zilian Beds. With this name he designated the shales and claystones from the Celje castle, for which the previous researchers beleived, they were of the Carboniferous age. PETRASCHECK (1926/29) assigned the "Socka" Beds to Chattian. Within the Tertiary beds he distinguished two coal horizons: (1) – older, from the limnic and brackish "Socka" Beds and (2) – younger, from the Aquitanian marine beds. He quoted two dis-

cordances within the Tertiary succession. MUNDA (1939, 1942, 1953) correlated the "Socka" Beds of Senovo, Trobni Dol, Zagorje, Medvode and Bohinj. Taking into account their fossil contents, he came to the conclusion, that the coal formation cannot be of Miocene age. HAMRLA (1954, 1955) described in detail the Pre-Tertiary basement as well as Oligocene and Miocene beds along the northern border of the Laško Syncline east of the Savinja River. In the second article, he described the geology of the Rudnica area with regard to the occurrence of some ores. NOSAN (1956) distinguished three facial types of the "Socka" Beds: a) – the "Socka" Beds at Zagorje-Hrastnik-Trbovlje, b) the "Socka" Beds in the Senovo Basin and c) – the "Socka" Beds between Pohorje and Bohor. PLENIČAR AND NOSAN (1958) presented the paleogeography of the Pannonian borderland in Slovenia. According to the authors the Pannnonian Sea transgressed the central part of Slovenia during the Upper Oligocene. RIJAVEC (1958, 1959, 1965, 1966, 1970, 1971, 1974, 1976 a, b, 1983) determined the Tertiary microfauna between the Rudnica and Boč Mt., Loka at Žusem, Šmarje at Jelše, in the Trobni Dol area as well as between Laško and Grahovše. NOSAN (1960) reported on the geological mapping of the area between the Konjiška Gora and the Sava River. He emphasized that the folding affected the Tertiary sediments as well as the Tertiary basement. GRAD (1961, 1967) described geological conditions between the Rudnica Mountain and the Sava River as well as the geology of the Kozjansko area. He considered that the main folding in the area was Post-Pannonian. KUŠČER (1962, 1967) wrote a dissertation about Zagorje Tertiary. He attributed the main folding to the Lower Miocene Attic phase. For the designation of the tectonic structure of the Tertiary belt in the Laško Syncline, composed of several parallel synclines and separated by anticlines and dislocations, he used the name synclinorium. PLENIČAR (1971) wrote the explanatory text of the Celje Map Sheet 1:100 000 describing the geological structure of this area. PREMRU (1975) exposed the nappe structure of the central part of the Sava Folds. He gave another informations proving the nappe structure of the Sava Folds. KUŠČER (1975) did not agree with the Premru's nappe interpretation of this area, disagreeing especially with the existence of larger nappe structures. BABIĆ (1979) examined the limestones with calpionellids in several small outcrops on the Rudnica Mountain. The *Calpionella alpina* and *Calpionella elliptica* subzones and the *Calpionellopsis* zone have been recognized corresponding to the Uppermost Tithonian and Berriasian.

Most of field and laboratorial data have been obtained so far at systematic geological investigations in the frame of the Basic Geological Map of SFRY S 1:100 000 on the Map Sheet Celje. In the manuscript and printed materials of the Map Sheet Celje various lithological developments, lithostratigraphic units and members, fossil findings, traces of volcanic activity, mineral deposits and tectonical structures of the area have been represented and described in detail. Hower, the data of the systematic regional mapping and investigations contributed most informations to the knowledge of the geological structure of Kozjansko and wider neighbourhood. The results of this mapping are presented in the explanatory text written by BUSER (1978, 1979 a). The above-mentioned author combined the results of the geological mapping and reconnaissance in

the Celje Map Sheet area 1:100 000 and gave the most detailed description of all mapping units. He attributed the main folding to Ottnangian and Karpatian. Since the Sarmatian and Mio-Pliocene beds were folded as well, he considered, there was another folding phase in the Middle Pliocene, but not so strong as in Ottnangian and Karpatian. The geologic structure of the neighbouring Map Sheet Ljubljana 1:100 000 has been described by PREMRU (1983 a, b).

In connection with problematics of gas storage in Slovenia geological and geophysical investigations in the area of 40 km^2 between Šmarjeta and Lahomno were performed in 1983. These investigations comprised a detailed geological mapping on the scale of 1:10 000, a geoelectric sounding down to the Pre-Tertiary basement, a data interpretation and previously evaluation of the locality perspective. The detailed geological mapping of the investigated area was carried out by S. Dozet, B. Stojanovič, M. Žnidarčič and M. Demšar. The annual geological report was made by S. DOZET (1983). The final report (MIOČ ET AL., 1983) was compiled by P. Mioč (geology), D. Ravnik (geophysics) and M. Hamrla (summary and conclusion). The detailed geological map of the area between Šmarjeta and Lahomno on the scale of 1:10 000, made by S. Dozet, P. Mioč, M. Žnidarčič, B. Stojanovič and M. Demšar, is enclosed to the final report (MIOČ ET AL., 1983). Micropaleontological determination of the Tertiary microfauna was made by L. Rijavec. Geologic investigations in the Trobni Dol area were carried out in the frame of the coal exploration programme in Slovenia as well. The scope of these investigations was to study the geology of the abandoned Trobni Dol and Pojerje coal mines as well as the area between Trobni Dol, Breze and Pojerje. With this purpose about 16 km^2 of the terrain among Breze, Trobni Dol and Pojerje was mapped in detail (PETRICA, 1983). In the year 1984 two deep explorations boreholes were bored west and north of the abandoned coal mine Trobni Dol. For understanding lithostratigraphic conditions of the wider area the borehole Tdp-1/84 with the deepness of 385 metres reaching the Tertiary basement is important. Due to tectonic conditions the second borehole (Tdp-2/84), being bored up to 400 m, did not reach the Pre-Tertiary basement. Simultaneously with the geological mapping the sampling of the Tertiary rocks and coal was performed. The Tertiary microfauna was determined by L. RIJAVEC (1983, 1984 a, b, 1986). Petrographic analyses of the Oligocene and Miocene rocks were carried out by S. OREHEK AND P. KOVIČ (1984). X-Ray analysis was done by M. MIŠIČ (1984). Chemical analysis of the coal samples has been executed in the laboratory of REK Trbovlje by T. Žuža. The Tertiary macrofauna has been revised by V. Mikuž. M. MIŠIČ (1984) analysed with X-Ray method the volcanic succession from the borehole Tdp-1/84 in the hanging wall of the "Socka" Beds. B. JELEN (1984) examined palinologically the samples of the Oligocene Marine Clay and the "Socka" Beds from the borehole Tdp-1/84. P. KOVIČ (1984, 1985) described and sistematically classified the Tertiary rocks of the Trobni Dol area by means of microscopic examination of thin sections. JURKOVŠEK (1983, 1984) defined the Fassanian beds with daonellas as well as Langobardian beds with daonellas and posidonias in Slovenia. The geologic structure of the neighbouring Map Sheet Rogatec area has been described by ANIČIĆ AND JURIŠA (1984, 1985). The geologic structure of the

Sava Folds between Vače and Litija has been studied by Mlakar (1985/86, 1993) and Mlakar et al. (1992). Most of their attention has been accorded to the Carboniferous beds bearing Pb, Zn, Cu and Ba ores. The dark clastic rocks succession has been generally subdivided in three lithostratigraphic units.

With the scope of underground gas storage construction fundamental geologic, geoelectric and magnetometric investigations for reconnaissance of underground geologic structure of the area between Šentjur, Planina, Trobni Dol and Loka at Žusem were carried out in 1985 and 1986. In the investigation programme for the underground gas storage in 1985 and 1986 (Dozet & Stojanovič, 1985/86 a, b) one of the planned localities was also the area of the Rudnica Anticline. On the basis of geological and geophysical explorations in the wider Rudnica Anticline area Dozet et al. (1994 a) came to draw the conclusion, the feasibility of the reservoir in the Pre-Tertiary basement (dolomite) was problematic. Dozet and Rijavec (1994 b) described the geological relationships in the area between Šentjur, Planina, Trobni Dol and Loka at Žusem. On the basis of results of the previous geological mapping Petrica et al. (1995) stratigrafically dismembered the Tertiary sediments in the Trobni Dol area and wider surroundings. Dozet et al. (1996) discussed the geological relationships of the Laško Synclinorium in the area between Grahovše and Lahomno. Rijavec and Dozet (1996) presented the lithostratigraphy and biostratigraphy of the Egerian, Eggenburgian, Badenian and Sarmatian beds in the Kozjansko area between the Trobni Dol in the west and Rudnica Mt. in the east. The sedimentary succession with coal and pyroclastic rocks in the Trobni Dol area were studied by Grad et al. (1996). Every attention was given to the stratigraphic problems of the Egerian succession as well as to the coal, its stratigraphic position and age. Dozet et al. (1998) gave a summarized description of results of detailed and regional geological investigations in the Krško-Brežice Plain and its wider surroundings. Kralj (1998) examined the volcanoclastic rocks in the borehole Tdp-1/84 Trobni Dol. She established, that the uppermost 160 metres in the cored borehole mainly consist of volcanoclastic rocks, deposited entirely in a marine environment. Two phases of volcanic activity have been recognized. Dozet et al. (1999) gave a lithologic description and biostratigraphic subdivision of the Tertiary sediments on the basis of data resulting from geological mappings in the area between the Savinja River and Pojerje. Placer (1999 a, b) considered the Sava Folds as a triangle between the Periadriatic, Idrija and Central Hungarian tectonic zones. According to him the Southern Alps are thrusted on the External Dinarides and the Adriatic or Apulian foreland. Dozet and Aničić (2000) as well as Aničić and Dozet (2000) discussed the Pre-Tertiary basement of the Krško depression. The authors arrive at a decision that the Pre-Tertiary basement of the Krško depression is built of the Carboniferous, Permian, Triassic, Jurassic, and Cretaceous rocks. Ramovš et al. (2001) made a comparision of the Lower Triassic developments in the Eastern Sava Folds and the Northern Julian Alps. On the basis of own geological mappings Rijavec and Dozet (2002) gave a lithological description and biostrati-graphical subdivision of the Oligocene and Miocene sediments in the about 50 km^2 area

between the Savinja River in the west, Pojerje in the east, Laško, Ojstro, Breze in the north and Gračnica Valley in the south. The Tertiary biostratigraphy of adjacent areas and the considered area has been correlated as well. ANIČIĆ ET AL. (2002) described lithological characteristics of the Tertiary beds in the Kozjansko area. The Tertiary stratigraphic sequence consists of Oligocene and Miocene beds, and two emersion phases developed in the time span ranging from Kiscellian to Pannonian; the first in Ottnangian, Karpatian and partially Badenian, and the second in Badenian and Sarmatian.

GEOLOGICAL AND GEOGRAPHYCAL SETTING

The above-mentioned investigations comprise the terrains of the western and central part of Kozjansko. The western boundary of the investigated area is represented by the Savinja River on the section between Celje and Rimske Toplice. Furtheron, the investigated area borders to the south on the rivulet Gračnica, to the north on Šentjur and to the east on the Rudnica Mountain.

Generally speaking, the geological structure of the terrains between the Savinja River and the Rudnica Mountain consists of two parts: the bellow-lying Pre-Tertiary basement and the above-lying Tertiary stratigraphic sequence. Far most extended are the Tertiary sediments building except a minor area at Grahovše the Tertiary synclines. On the other hand, the Younger Paleozoic and Mesozoic rocks compose the marginal parts of the considered synclines. The Quaternary deposits are preserved only in minor areas in larger valleys and on slopes. Although the geologic structure of the Pre-Tertiary basement was influenced by the Pre-Tertiary tectonics, the study area was mostly affected by the Tertiary tectonic forces. Consequently, the Tertiary succession, which discordantly overlies the Pre-Tertiary basement, consists of strongly folded Upper Oligocene and Miocene beds. From the geotectonic point of view the study area belongs to the Sava Folds.

STRATIGRAPHY

In the study area the Younger Paleozoic rocks are composed of shaly, sandy and conglomeratic clastic rocks originated prevalently in the river delta area. The Mesozoic rocks were formed on the Slovenian (prevalently), Julian and Dinaric Carbonate Platforms as well as in the Slovenian Basin. They are composed of rocks of sedimentary and volcanic origin. The Tertiary rocks originated in the Pannonian Sea. The most common and characteristic feature of the Tertiary deposits occurring in the investigated area is, that the oldest sediments are pretty shaly and afterwards more and more sandy. Upon that, marly and limy sedimentation predominated. The younger deposits, containing clayey and marly interlayers, grow again and again sandy passing finally into a gravel. Generally speaking, the larger the size of grains, the younger the sediments are.

Carboniferous and Lower Permian

The Younger Paleozoic rocks crop out chiefly along the northern edge of the eastern part of the Tertiary Laško Syncline area, but they

are visible above the surface of the ground at Grahovše east of St. Lenart (Vrh nad Laškim) and at Trobni Dol as well. These rocks occur still in outcrops at Svetina and Kanjuce.

The dark Younger Paleozoic succession of clastic rocks is composed of shale, claystone, micaceous quartz sandstone, siltstone and conglomerate (subordinate). The above-enumerated non-oxidized sediments are dark grey, greyish black and black, but at weathering they become firstly olive grey, then brown and finally even reddish brown. Generally, these sediments contain a relatively large ammount of mica. In the considered sedimentary succession the quartz sandstone prevail. The sandstone consists of about 70 % of quartz, 10 % of mica (muscovite, biotite), 5 % of feldspars and 15 % of contact cement. The conglomerate is rare cropping out in the Trobni Dol and V. Grahovše area. At some places, claystone, shale, siltstone and quartz sandstone alternate in the same proportion. Within the clastic rocks at Brezlovšek southeast of Svetina 0.5 metre thick lense of black crinoidal limestone with numerous white calcitic veinlets occurs (Buser, 1979a). The thickness of the dark grey clastic rocks, we added to Carboniferous and Permian, is more than 500 metres, but their real thickness is very probably much bigger. The Carboniferous-Permian sedimentary succession in the M. Grahovše area is separable in three lithostratigraphic units. In the lowermost part of the succession there is a brownish grey to dark grey, thick-platy, very compact, fine-pebbled, micaceous quartz conglomerate passing at some places into a conglomeratic and coarse-grained, micaceous, quartz sandstone. In the middle part of the succession lies brownish grey to dark grey, platy (5-10 cm), medium – and coarse-grained, very micaceous quartz sandstone, whereas in the uppermost part of the succession dark grey and black, platy claystone and shale alternate. In the Younger Paleozoic stratigraphic sequence from the area between Laško and Svetina prevails a dark grey to silver grey, bedded (10-50 cm), platy (2-5 cm), very shaly (decomposing in more and more thin plates and leaves), rather metamorphized and thin-folded, phyllite-like, strongly micaceous, pretty compact, fine- to coarse-grained quartz sandstone with more or lesser shale and claystone intercalations. The described sandstone grades upwards into the brownish grey, top inky brown, very micaceous, platy (0,5-2 cm) shale and still upwards into a dark, bluish, silver and olive grey, platy (1- 5 cm) or shaly claystone with a dark brown to dark reddish brown oxide cover.

In the block of coarse-grained micaceous quartz sandstone east of Trbovlje Bittner (1884) found plant remains of the genus *Calamites* sp. In the limestone pebbles northeast of Podlipoglav fossil remains of corals, pelecypods, gastropods, cephalopods and brachiopods have been found (Ramovš, 1954). In the pebbles of light grey limestone with numerous corals and crinoids the following corals and stromatopores have been determined (Flügel, 1958): *Macyeea (Thamnophyllum) stachei*, *Favistella (Dendrostella)* sp., *Favosites (Favosites) alpinus ottiliae*, and *Clathrodictyon* sp. The above-enumerated fossils indicate Upper Emsian and probably Middle Devonian. Ramovš (1965) came to the conclusion that the clastic-developed Paleozoic rocks in the Sava Folds belong to the Trogkofelian stage. Since the above-described sedimentary suc-

cession passes upwards gradually into the Val Gardena formation BUSER (1979 a) concluded, that the uppermost part of the dark sedimentary succession belongs in fact to the Ratendorfian and Trogkofelian stage. Extra large thickness of these rocks speaks against the supposition, they belong to Permian only. Namely, they envolve still the whole Upper Carboniferous or even a part of the Lower Carboniferous. However, at Ortnek it was proved (ŠLEBINGER, 1955; RAMOVŠ, 1962), that lithologically equally developed beds in the Sava Folds belong to Permian and not to Carboniferous. Consequently, it is most probable, that a pretty considerable part of the Carboniferous beds in the Sava Folds is of the Permian age. In the dark shaly beds, occasionally, lenses of limestone breccias and sandstones as well as limestones occur, in which RAMOVŠ (1965) mentioned at Lanišče and Podlipoglav the fusulinids *Quasifusulina* ex. aff. l*ongissima* and *Rugosofusulina alpina* as well as algae *Antracoporella spectabilis* and *Tubiphytes* sp., which were extended in the Upper Carboniferous and Permian sediments. In the limestone breccias at Podlipoglav and Lanišče the corals *Cyataxonia cornu* and numerous crinoids still have been found. The Trogkofelian quartz conglomerate in the Sava Folds comprises at Lipoglav pebbles and blocks of limestone as well (RAMOVŠ & JURKOVŠEK, 1976). Beside crinoid remains, molluscs and problematical fossils (bryozoan) the fusulinid *Pseudostaffella* sp. and foraminifer *Bradyina* sp. are very important there, proving that a part of conglomerate material was brought from the limestone of the Moscovian stage (Middle Carboniferous). In the pebbles of the Lower Permian conglomerate RAMOVŠ (1988/89) discovered the Lower Devonian and Lower Carboniferous conodonts, namely: *Belodella* sp., *Panderodus* cf. *unicostatus, Polygnathus* sp., *Pseudoneotodus beckmanni*, *Roundya* sp., *Gnathodus* cf. *symmutatus* as well as *G. praebilineates* and *Spathognathodus campbelli*. Accordingly, in the Lower Permian conglomerate northeast of Podlipoglav the blocks and pebbles of the Upper Silurian, Lower Devonian and Middle Carboniferous limestones have been evidenced so far. KOLAR-JURKOVŠEK AND JURKOVŠEK (1985, 1986, 1990) found numerous new finds of plant fossils in the Ljubljana–Polšnik area proving the Upper Carboniferous age. In two localities along the motorway between Bizovik and northern Golovec tunnel entrance a rich plant fossils have been collected and determined (KOLAR-JURKOVŠEK AND JURKOVŠEK, 2002). Considering the entire assemblage composition and the presence of some calamite-like forms, a lower part of the Westphalian is indicated.

Gröden

Into the Middle Permian are ranged the red and greenish grey clastic sediments, which are in our opinion an equivalent in age of the Gröden beds, Val Gardena Formation in the Southern Tyrol respectively. In the study area these rocks build the Sava Folds between Rečica, Tremerje and Svetina, north of Kum at Laško, in the Lipni Dol and at Vrabčeva peč. These beds of the Middle Permian lie concordantly without any signs of interrupted sedimentation upon the dark clastic sediments, we ranged to Carboniferous and the Lower Permian. The Gröden sedimentary succession is composed of red claystone, shale, siltstone, sandstone and conglomerate alternating rhythmically between themselves. In the considered succession of red sediments, here and there, rare

interbeds of greyish and greenish grey clastic sediments of the same mineral composition occur. In the mineral composition of the above-enumerated medium- and coarse-grained sediments quartz and quarzite predominate. Micas (muscovite and biotite) occur in pretty quantity, while plagioclase, ortoclase and clay minerals are rather subordinate. The cement consists of fine-grained quartz, sericite and limonite. The red and greenish grey sediments are massive to poorly bedded. In coarse-grained sediments more or less expressive cross-lamination and rare gradation could be seen. The thickness of the described red sediments ranges commonly from 200 to 400 metres. Actually, in the Sava Folds the thickness of the Gröden beds varies considerably. In the investigated area the thickness of the desribed rocks varies from 50 m to 400 m, whereas towards the south in the Pleše area they are wedging out (Buser, 1974, 1979b; Dozet, 1985). In the study area the desribed sediments do not contain fossil remains. They are referred to the Middle Permian according to the stratigraphic position, lithological composition, sediment properties and analogy with similar red sediments in the Sava Folds and wider surroundings.

In the Kozjansko area the Upper Permian beds are commonly absent. They are found only in the 10 m wide belt west of Zgornja Rečica at Laško (Buser, 1979b).

Mesozoic

In the Upper Permian period the Sava Fold area was in greater part a dry land, whereas the Mesozoic deposits originated on the Slovenian Carbonate Platform. In Ladinian (Buser, 1989) this platform was disintegrated on several blocks. The Central Slovenia block was sank and Slovenian Basin originated. At the beginning of Carnian, Cordevolian respectively, north of the Slovenian Basin the Julian Carbonate Platform originated, while south of the mentioned basin the Dinaric Carbonate Platform was formed. Accordingly, the Triassic, Jurassic and Cretaceous sediments of the studied part of the Sava Folds were deposited on the carbonate platforms of Outer Dinarides and in the Slovenian Basin (Inner Dinarides).

Triassic

The Triassic stratigraphic sequence is built of clastic, carbonate and volcanic rocks. Carbonate rocks compose the Lower Triassic, Upper Triassic and Jurassic prevalently shallow marine rock column. In the pelagic development Middle Triassic, Upper Triassic, Upper Jurassic and Lower Cretaceous beds occur.

Lower Triassic

Scythian

The Scythian rocks crop out at several places along the southern borderland of the eastern part of the Laško Syncline. As a rule, they lie discordantly upon the Younger Paleozoic clastic rocks passing upwards continually into the Anisian dolomite.

At Mišji Dol in the Kozjansko area the lowermost part of the Scythian beds is most probably cut off by a fault, so that the Lower Triassic beds border with underlying platy and very micaceous marlstone and marly limestone tectonically. Reddish, greenish and

greyish sandy marlstones, shales and sandstones with poorly preserved indeterminable pelecypods belong most probably to the Seis Beds. In the lowermost part occurs a medium grey to medium dark grey and yellowish, bedded (10-50 cm), poorly sandy, fine-grained lower dolomite. The lower dolomite contains up to 1 cm thick intercalations of brownish, bluish and greenish grey micaceous marlstone with Fe and Mn dendrites. At some places it may be even oolitic. Over the described dolomite lie yellowish, bluish, greenish, pink, orange and reddish grey, bedded (20-70 cm), platy and shaly, commonly laminated and banded limy dolomite, oolitic dolomite and strongly dolomitized and recrystallized oolitic limestone with mollusc imprints. Upwards alternate greenish grey to yellowish grey, sometimes very micaceous dolomites and shaly dolomitic marlstones (predominant). Still higher in the lithologic column occurs a yellowish grey and greyish yellow, platy (3-10 cm), micaceous dolomite as well as a bedded (10-35 cm), rarely platy (5-10 cm), medium grey to grey, in spots very micaceous dolomite. Over these beds lies without any signs of interruption of sedimentation a greenish grey to dark grey and greyish black, bedded (10-40 cm), platy (2-10 cm) and shaly, micritic and fine-grained limestone with white calcitic veinlets. The Scythian lithologic column in the Mišji Dol cross-section is terminated by a dark grey and greyish black, platy, rarely bedded, fine-grained micritic limestone and limy shale (predominant). Upon the beds, we ranged in the Scythian series, lies an about 15 m thick succession of a dark grey to moderate dark grey and extremely stromatolitic and loferitic, platy (3-10 cm) sparitic dolomite; we beleive it is an equivalent in age of the Lušnica Member (Anisian). In the micaceous-marly-sandy Scythian beds the pelecypod *Anadontophora fassaensis* and the gastropod *Holopella gracilior* have been collected. In the uppermost beds of the Scythian sedimentary succession in the Mišji Dol at Jurklošter the gastropods *Natira costata* and at Svetina the foraminifer *Meandrospira pusilla* have been found (BUSER, 1979 a). The previously mentioned foraminifer has been determined in the uppermost part of the Mišji Dol Scythian sedimentary succession by RAMOVŠ AND ANIČIĆ (1995) as well. According to these two authors the lower dolomite succession with oolitic dolomite and the gastropod *Coelostylina werfensis* corresponds to the Gastropod Oolite Member, whereas the topmost limestone sequence with the foraminifer *Meandrospira pusilla* corresponds to the Cencenighe Member in the dolomites.

With reference to the lithologic composition and according to superpositional members the described sedimentary succession with the determined fauna corresponds to the Southern Tyrol Dolomites Werfen Formation.

Middle Triassic

Anisian

In the study area the Anisian stage is characterized by a monotonous dolomite development with scarse fossil contents. The dolomite, which according to its clear stratigraphic position between the Scythian and Ladinian beds we range in Anisian, lies concordantly upon the Scythian beds. As a rule, it is pretty darker than other Triassic dolomites, especially in the lower part. But this rule is not reliable everywhere. The colour of the dolomite could be tolerably changed

from place to place as vertically as horizontally rendering more difficult the ascertaining of its stratigraphic appartenance. The Anisian dolomite column can be lithostratigraphically divided into four members, namely: 1) – lower platy dolomite, 2) – bedded dolomite, 3) – massive dolomite and 4) – upper platy dolomite.

*The **lower platy dolomite*** is dark grey, a little clayey, and prevalently microsparitic and pelsparitic. In the lower part of the dark sparitic dolomite in the Žusem area up to 7,5 meters thick interlayers of a greyish black and black, platy (1-7,5 cm) dolomitic marlstone occur.

*The **bedded dolomite*** is dark bluish grey, very dark grey, fine-grained and chiefly thick-bedded (15-60 cm). In the bedded dolomite sedimentary structures occur, which are characteristic for origin in a neritic environment of shelf sea. Occasionally, the bedded dolomite is characteristically fine-laminated and thin-bedded containing algal stromatolites, dessication pores, and corosion cavities just like the Main Dolomite or the Dachstein Limestone. The beds with the structures enumerated above originated in a supratidal environment. A dolomite with intraclasts and very fine-grained dolomite, originated in intertidal and subtidal environments, occur there as well.

*The **massive dolomite*** is bluish grey carbonate rock with an absence of layering. Here and there, a poorly defined bedding can be observed. An indistinct stratification in the dolomite also occur at some places, where stromatolites are present. The massive dolomite is pretty porous. Oval and roundish cavities, usually fulfilled by fine dolomite crystals, are most probably remains of alga *Diplopora annulatissima*. The massive dolomite is mostly pretty recrystallized. The recrystallization destroys usually the structures and textures of the previous sediment. The entirely recrystallized dolomite has a "saharoid" texture. However, at several places in the Sava Folds you can observe clearly thick-bedding (100-250 cm) of the Upper Anisian dolomite as well.

*The **upper platy dolomite*** does not represent a continual horizon. Laterally, it may wedge out. In the uppermost part of the Anisian carbonate succession there is a dark grey platy dolomite with intercalations of clayey dolomite and dolomitic marl at some places. In the study area the upper platy dolomite is up to 20 metres thick.

The Anisian dolomite is usually poor in fossils. In the dolomitized limestone of the basal lithostratigraphic unit, the lower platy dolomite respectively, at the road Rečica-Šmohor Buser (1979a) quoted the following microfossils: *Meandrospira dinarica, Glomospira senensis, Earlandinita* sp. and *Aeolisaccus duningtoni*. The thickness of the considered carbonate succession ranges in the study area from 200 to 300 metres.

Ladinian

The rocks of the Ladinian stage crop out in the area between Celje and Štore, at Svetina and between Resevna and Rifnik. The main characteristics of the Ladinian beds in the considered area are great variety of sedimentation as well as rapid, lateral and vertical changes of lithological composition already at short distances, what is in close connection with vivacious volcanic and tectonic

activity in that period. **In the Žusem area** the Ladinian beds are composed of a dark grey to greyish black, prevalently dark olive grey claystone with rare intercalations of black marly limestone, fine-grained silicified limestone and platy limestone with chert. **On the Resevna Mt.** the Ladinian succession consists in the lower part of the succession of greenish grey, grass-grey and dark greenish grey, if wheathered brown and dark reddish brown tuff with several ten metres thick interbeds of a dark grey to black, platy, rather compact marlstone and pretty thinner interbeds of a dark grey to black micritic and sparitic limestone. In the upper part of the considered succession appears greenish grey, more or less compact, prevalently massive and only here and there platy and bedded keratophyre tuff with an up to 50 m thick greenish and olive grey, rarely dark grey and black claystone, which is lithologically similar to the Carboniferous one.

Pseudo-Zilian Beds. On the northern borderland of the eastern part of the Laško Syncline lie concordantly upon the Anisian dolomite the so-called Pseudo-Zilian rocks. In the region east of the Sava River the Pseudo-Zilian Beds can be followed in a narrow belt from Laško towards the east on the slopes of Hum (585 m) and Brdo as far as Slatna. In the Pseudo-Zilian Beds several centimetres to several metres thick intercalations of claystone, shale, siltstone, sandstone, conglomerate, tuff, micritic limestone with chert and keratophyre alternate. The sandstone is a little more extended in the Žikovica area. In the sandstone and conglomerate quarz grains prevail, while mica and plagioclase are pretty subordinate. However, the granularity of the clastic Pseudo-Zilian rocks changes relatively fastly especially in vertical direction. The Ladinian beds contain various magmatic rocks as well. They are keratophyre, quartz kerathophyre, spilitized diabase and their tuffs. The Pseudo-Zilian Beds were denominated by TELLER (1889). In the grey slate of the Celje castle hill he found the lamellibranch *Daonella lommeli* proving the Langobardian age of the slate succession. On the Celje castle hill JURKOVŠEK (1984) found 10 m bellow the slate with *D. lommeli* and towards the reef limestone, within the light grey tuff and tuff slate, another 10 cm thick layer containing exclusively juvenile specimens of the species *D. lommeli*. From 3 m to 10 m bellow the lower layer with daonellas there is a 3 m thick bed of brown grey massive limestone with corrosion vugs underlain by a grey limestone containing porifera and corals of the species *Craspedophyllia cristata, Omphalophyllia recondita* and *Dictyocoelia manon*.

Keratophyre, quartz keratophyre, tuff. These rocks are extended in the area between Celje and Štore, south of Svetina, on the Resevna Mountain, in the Tremerje area, south of Šentjur, as well as in the Gorice and Laško area. The volcanic rocks of the Middle Triassic age belong in the investigated area to a kerathophyre-porphyre-spilite magma. They were examined and described in detail by Nikitin (MUNDA, 1953), HAMRLA (1954), as well as M. Dimič and A. Hinterlechner-Ravnik (BUSER, 1979a). These rocks are brownish, greenish, greenish grey, dark greenish grey and spotted reddish. They consist of quartz and plagioclase phenochrists as well as microchrystal and fine-grained groundmass. In rare minor flakes occur a biotite as well. Feldspars are generally fresh and replaced by calcite. Beside keratophyre

in the volcanic rock complex light grey and bluish, very compact, fine- and medium-grained tuffs and tuffites also occur. Tuff breccia, where fragments of a greenish quartz rock are bounded by tuff groundmass, occurs very rarely. Characteristical volcanic breccias crop out in an abandoned quarry east of Štore (Buser, 1979 a). Tuffs of the above-enumerated rocks belong to lithoclastic and lithoclastic-crystalloclastic tuffs. In their compositon prevail microchrystal silicate, mostly very kaolinizied and sericitized rock fragments, however, quartz and plagioclase fragments are pretty numerous as well.

Pilitized diabase and tuff. Both rocks crop out in the area south of Svetina. However, the spilitized diabase and tuff are most extended in the Koprivnik area. Generally speaking, the diabase rocks are less extended than the keratophyre ones. The ***diabase*** rock is normally of distinctively dark green colour. Non-weathered it is very compact and it is characterized by an intersertal and ophitic texture. Hamrla (1954) described the spilitized diabase immediately at Laško as ***augite porphyrite***. The macroscopically grey-blue rock is fine-grained and nearly without any phenochrysts. In spots, the white and greenish amygdales can be observed. Among the mafic minerals augite strongly prevails. Olivine is an accessory mineral. The quartz grains are very rare as well. In such variegated groundmass rare bigger plagiclase-phenocrysts occur. The mineral composition of the plagioclase phenocrysts and plagioclases in matrix is the same. The amygdales in the rocks are fulfilled by calcite (white) and spherolitic chlorite (dark), and they are up to several milimetres in size. ***Spilitized diabase tuff*** is grenish grey and fine-grained consisting of more or less altered and changed phenochrysts of feldspars and mafic minerals, calcite, chlorite and clay minerals. The rock is most commonly strongly calcified, chloritized and sericitized. On the basis of own microscopic examinations, quantitative chemical analysis of several keratophyre and augite-porphyrite specimens Hamrla (1954) confirmed the view of some previous geologists, that in the district of eastern Slovenia there were at least two stages of eruptions in the Wengen period. The features of contact metamorphism in adjacent rocks are not observed. The gently silification and pyritisation of some carbonate blocks in the Ladinian slates might be effected by post-volcanic hydrotermal activity.

Upper Triassic

Carnian

The Carnian stage comprises three substages, namely: Cordevolian, Julian and Tuvalian. The common characteristic of the beds of all three substages is, they are poor in fossils.

Cordevolian

The Cordevolian beds are exposed especially along the southern border of the Tertiary complex of the Laško Syncline; but minor outcrops of the Cordevolian carbonate rocks are preserved along the northern border of the Laško Syncline in the Žusem and Rudnica Mt. region as well. The northern belt of the Cordevolian rocks extends in the area from Tremerje towards Pečovnik, from where it can be traced at the surface still forward as far as Svetina.

The Cordevolian dolomite, lying at Žusem concordantly upon the Ladinian beds, is light grey, very light grey, white and bluish grey.

It is most characterized by a "saharoid" texture. Normally, it is massive and rarely poorly bedded. Within the dolomite irregular patches of very strong dolomitized intrasparitic and micritic limestones are preserved. It is obvious, that the described dolomite originated at late diagenetic dolomitization of previously deposited limestones. The Cordevolian dolomite is always more or less porous. Oval and roundish holes are fulfilled by fine dolomite crystals and strongly recrystallized organic remains, belonging most probably to the alga *Diplopora annulata*. In the dolomite beds at Šmarjeta near Rimske Toplice small megalodontids indicate, that the upper part of the considered dolomite belongs to Julian and Tuvalian (BUSER, 1979a). In the area between Lipoglav and Pance in the extremely southern edge of the Sava Folds DOZET (1966, 1985) found in the Cordevolian dolomite well-preserved algae of the species *Diplopora annulata* Schafhäutl with two subspecies, namely: *trichopora* Pia and *vesiculifera* Pia.

The Cordevolian limestone is medium grey, pink, massive and rarely thick-bedded. In the Cordevolian belt between the Pečovnik and Svetina the basal Cordevolian carbonate rocks lie without any sign of interruption of sedimentation over the Ladinian keratophyre. Only at Zaroviše the Cordevolian limestone breccia lies directly upon the keratophyre pointing at a short-lived local dry land and an interruption of sedimentation. The mentioned limestone was occasionally late diagenetically dolomitized, so that in these places a more or less dolomitized limestone and coarse-grained dolomite could be observed. The limestone is generally rather recrystallized. Diagenetic processes and tectonical changes destroyed organic structures in the rock to that extent that only poorly recognizable fossil remains of alga *Diplopora annulata* are preserved. The thickness of the Cordevolian beds varies from 200 to 300 meters.

Julian and Tuvalian

Since in the beds of the considered interval of the Triassic stratigraphic sequence there are no fossils for separation of the Julian from the Tuvalian substage, these beds are presented together. They are exposed in most complete development in the Voluš area, where the Julian-Tuvalian beds lie concordantly upon the Cordevolian bluish grey, medium-grained, massive, commonly more or less porous dolomite. The Julian-Tuvalian sedimentary succession begins there with a medium dark grey to greyish black, platy (1-5 cm), fine-nodular limestone with one interbed of a greyish black, if weathered dark olive grey claystone. Upwards follows a medium grey to greyish black (1-5 cm), fine-nodular limestone with interlayers of bedded (10-35 cm), fine-grained, black limestone and marlstone. Here and there the limestone contains chert. In the upper part of the considered succession there is a greyish black to black, platy claystone disintegrating in thin plates and leaves and passing upwards continually into the Bača Dolomite. The described sedimentary succession indicates characteristics of a pelagic development. North of Henina as well as at Jurklošter and Šentjanž a very extended conodont species *Gondolella polygnatiformis* has been determined in the limestone. Furtheron, in the limestone that alternates in the uppermost part with the Bača Dolomite north of Henina and at Šentjanž, beside the earlier mentioned species still another species *Epigondella nodosa* occurs. The latter ranges these beds

into the Tuvalian substage showing in fact (Buser, 1979a), that the higher lying dolomite with chert ("Bača Dolomite") belongs to the Norian and Rhaetian stage. The middle and upper part of the Carnian beds in the investigated area is still developed on the Špica Mt. south of Globoko. There is a platy and bedded, dark grey to greyish black, micritic limestone with interbeds of calcarenite and marly claystone and shale, which are thrusted over the older Anisian and Scythian sediments. The described rocks pass upwards gradually into the Upper Triassic dolomite with chert (Bača Dolomite). Buser (1979a) beleived that the Anisian, Ladinian and Carnian beds in the Central Sava Folds were developed as a dolomite with some rare passages into a limestone. Between Tremerje and Pečovnik a shallow marine development of the Julian and Tuvalian beds is well exposed. In the limestone the algae *Poikiloporella duplicata* and *Clypeina besici* (Poljak, 1973) occur, proving the Middle and Upper Carnian age of the succession. These fossils proved, that in the middle and upper part of the Carnian period in the Kozjansko area shallow water carbonate sedimentation continued from Cordevolian (Buser, 1979a). The thickness of the described pelagic development range from 115 to 150 metres; on the other hand, the shallow water carbonate sediments are up to 200 metres thick.

Norian and Rhaetian

In the investigated area of Kozjansko the Norian and Rhetian stages occur, first of all, in a pelagic development, represented by a grey, very fine-grained and sparitic dolomite containing up to several centimetres thick plates and beds of a grey, dark grey and black chert. According to the lithological composition these beds are an equivalent in age of the Bača Dolomite. The Norian and Rhaetian rocks occur at the surface in the form of some square kilometres large complex between the Vel. Kozje and Voluš Mt. The bedded dolomite with chert in the Voluš Mt. area lies concordantly upon the pelagic Carnian sediments. The thickness of the pelagic Norian-Rhaetian rocks varies there from a 100 to 150 metres. In the wider Jurklošter area a platy and bedded sparitic dolomite intercalated with 5 to 25 centimetres thick beds of dark grey, greyish black and black chert crops out. The dolomite, which is with reference to the stratigraphic position and lithological composition pretty similar to the Bača Dolomite, passes downwards gradually into the platy Tuvalian limestone. In the beds of the platy limestone within the dolomite along the road Rečica-Šmohor (Buser, 1979a) the conodonts *Paragondolella navicula* and *Neogondolella mombergensis* have been determined.

In the Šibenik quarry at Rifnik, the light grey to very light grey, dark bluish grey, micritic, intrasparitic, here and there pretty dolomitized Dachstein Limestone with numerous corosion cavities fulfilled with calcite is exploited. With reference to the stratigraphic position and sedimentary properties this limestone belongs to the uppermost part of the Dachstein Formation. In the quarry of the Main Dolomite (Hauptdolomit) at Lanišče southeast of Ljubljana at the Sava Folds/Dolenjsko Karst contact Sedlar, Petrov and Čadež found fossils determined by Ivan Rakovec as *Megalodus* cf. *triqueter* var. *dolomitica*, *Megalodus gümbeli* and others. In the same quarry Berce (1955) and Buser (1974) found the pelecypod *Neomegalodon gümbeli*, *Dicerocardium curionii* respectively. At the detailed geological mapping of

the Lanišče-Polica area, lying on the passage of the Sava Folds into the Dolenjsko Karst, DOZET (1966, 1985) ascertained that the Main Dolomite (Hauptdolomit) was overlain by 250 to 300 metres thick lithostratigraphic sequence of the Dachstein Limestone, in which megalodontids occur as well. The dolomite and the limestone show typical properties of the Lofer development (stromatolites, lamination, megalodontids, intraformational breccias and conglomerates, corosion cavities).

Jurassic and Cretaceous

Upper Tithonian and Berriasian

The rocks of the Upper Tithonian, Berriasian and probably Valanginian age are preserved in the form of erosional patches upon the light grey Triassic dolomite in the Loka at Žusem surroundings. Along the contact breccias with limonitic groundmass and Mn traces occur. In the pelagic succession platy and thin-bedded (2-20 cm), yellowish and light grey micritic limestones prevail; however, greyish, greenish and pinkish micrites with thin plates, lenses and nodules of a dark grey to greyish black chert as well as shaly claystones, marlstones and limy marlstones of erlier enumerated colours occur as well. For the considered sedimentary succession rare intercalations of more or less silicified fine-grained limestones with chert as well as calcarenites are also characteristic. In the calcarenites a gradation, as well as parallel and cross-bedding can be sporadically observed. The outcrops of the rocks in the Rudnica Mt. area were described by HAMRLA (1955). He beleived they are of Carnian age.

Later, the same outcrops were worked out in detail by BABIĆ (1979), describing the facies and defining the age of these sediments. The greater part of sediments is represented by thin-bedded, fine-grained pelagic limestones with chert nodules and bands comparable to the Biancone and other similar Mediterranean formations of the same age. The micrite is partly recrystallized to microsparite. In the pelagic limestone succession the calcarenites occur as rare intercalations. The grains of the calcarenites and rudites are prevalently echinoderm calcite grains and molluscan fragments. In the fine-grained, brecciated and conglomeratic limestones beside echinoderm and molluscan fragments as well as calpionellid, radiolarian, foraminifer, aptychi, echinoid, ostracod, bryozoan and algal remains ooids and various lithoclasts are present. Among calpionellids the following species have been determined so far (BABIĆ, 1979)*: Calpionella alpina, C. elliptica, C. alpina-elliptica, Calpionellopsis simplex, Cps. oblonga, Tintinopsella carpatica, Remaniella cadischiana* and *Calpionella* sp. The determined fossils prove the Upper Tithonian, Berriasian and very probably Valanginian age of described sediments. In the groundmass there are numerous radiolarians, as well as "sphares" *Cadosina lapidosa* and *Stomiosphaera* sp. Among foraminifers the species *Protopeneroplis striata* and *Nautiloculina* sp. occur. The mixed fauna testifies, that pretty part of fragments are resedimented from a shallow marine into deeper marine environment. The conglomeratic limestone consists of pebbles, pelagic limestones with radiolarians and calpionellids, as well as shallow water carbonate particles. ŠRIBAR (1981) devided biostratigrafically the succession of platy, porcelain-like limestones with chert into two biozones. The lower part of the limestone succession comprising numerous

calpionellids is referred to the biozone with calpionellids. The biozone evidenced by calpionellids is transitional in character and its stratigraphic range is the Upper Tithonian to Valanginian. In the uppermost part of the platy limestone succession there are nothing but radiolarians, calcisphaeras and sponge spicules. Calpionellids disappear totally. This part of the platy limestones is assigned to the biozone with radiolarians, corresponding in her opinion mostly to the Hauterivian stage.

South of Sevnica at Sava between Boštanj and Telče, along the road Konjsko-Križ Ogorelec and Dozet (1997) researched the deeper water pelagic sedimentary succcession of the Upper Triassic, Jurassic and Lower Cretaceous age in detail. The authors came to the following conclusions: The lower part of the stratigraphic sequence, composed of thick-bedded dolomites with chert, conodonts *Neogondolella steinbergensis* and elements of *Misikella hernsteini*, comparable with the Bača Dolomite, is of Upper Triassic age. This dolomite is overlain by several beds of limestone breccias, silicified limestones and shales all belonging to the lower and Middle Jurassic. Upwards follows a radiolarite interval, intercalated with marly limestone and overlain by the upper limestone breccia. The described succession is ended by almost white, porcelain-like, thin-bedded and platy limestones with chert and calpionellids, known under the name Biancone and Maiolica, which are in that area of the Upper Tithonian, Berriasian and probably Valanginian age.

Aptian and Albian

The Lower Cretaceous beds are exposed in the Sevnična Valley south of Planina, southeast of Jurklošter at Njivice and at Henina. South of Planina and at Henina the Lower Cretaceous sediments lie discordantly upon the "Bača" Dolomite. The sedimentary succession, we ranged to the Aptian and Albian, consists of claystone, marlstone, marly limestone, calcarenite, limestone breccia and chert. The breccia consists of the Jurassic and Lower Ceretaceous rocks. In the breccia and calcarenite orbitolinids and other foraminifers have been found. Furthermore, a gradation, parallel, convolute and cross-stratification can be observed in the breccia and calcarenite indicating a turbiditic deeperwater sedimentation. The Jurassic and Cretaceous beds in the Sava Folds were previously researched by Grad (1960, 1961). Lapajne and Šribar (1973) ranged the beds at Njivice southeast of Jurklošter into the Upper Cretaceous. In the limestone breccia southeast of Jurklošter orbitolinids, trocholinas as well as crinoid and echinod remains have been found. Between Sevnica and Brestanica Buser and Pavšič (1978) discovered in similar sediments a nannoplankton association ranging the above-described pelagic sedimentary succession into the Lower Cretaceous. The index-species *Parhabdolithus angustus* ranges the discovered nannoplankton association into the uppermost part of the Lower Cretaceous, whereas the species *Nannoconus colomi,* showing at somewhat older part of Aptian, has also been found in these sediments. The species *Rucinolithus irregularis* occurs only in Aptian and Albian. With reference to the whole fossil association and the fossils enumerated above, the mentioned authors came to the conclusion, that the examined samples of the marl belong to the span of time from the Lower Aptian to Albian.

SUMMARY

The oldest beds of the area between the Savinja River and the Rudnica Mountain belong to the Carboniferous and Permian system, the Younger Paleozoic respectively, composed exclusively of clastic rocks (clayey shale, claystone, quartz siltstone, sandstone and conglomerate). Generally speaking, the Younger Paleozoic complex could be divided in two lithostratigraphic units: the dark Carboniferous and Lower Permian beds and the overlying red and greenish continental and lagoonal Gröden beds. Sedimentary structures and other characteristics indicate that the underlying dark formation, which is in the M. Grahovše area separable in three lithostratigraphical units, has been deposited in a rather shallow-water environment. In the Upper Permian period the considered area was in greater part a dry land.

The Mesozoic stratigraphic sequence of the study area has been formed on the carbonate platforms of Outer Dinarides and in the Slovenian Basin. The Triassic lithological column is composed of clastic, carbonate and volcanic rocks. Carbonate rocks compose the Lower and Upper Triassic as well as Jurassic prevalently shallow-marine rock column. The Middle and Upper Triassic, Upper Jurassic and Lower Cretaceous beds occur in a pelagic environment. The Scythian series in the considered area can be compared with the Werfen Beds in the Southern Tyrol Dolomites. The Anisian stage is characterized by a monotonous dolomite development with scarce fossil contents. The lower part of the Middle Triassic lithological column is divided in four members. The Anisian dolomite is conformly overlain by the Ladinian beds. The main characteristics of the Ladinian beds in the considered area are a great variety of sedimentation as well as rapid lateral and vertical changes of lithological composition already at short distances, what is in close connection with vivacious volcanic and tectonic activity in that period. The volcanic rocks of the Middle Triassic age belong to a kerathophyre-porphyre-spilite magma. The Cordevolian carbonate rocks lie without any sign of interruption concordantly over the Ladinian rocks. The Julian and Tuvalian succession indicate characteristics of pelagic development. Occasionally, a shallow-marine development of the Julian and Tuvalian beds can be seen. In the considered area the Norian and Rhaetian occur in a pelagic and shallow-marine development. According to lithology the dolomite is an equivalent of the Bača Dolomite and the limestone of the Dachstein Limestone. The rocks of the Upper Tithonian, Berriasian and probably Valanginian age are preserved in the form of erosional patches upon the light gray Triassic dolomite. The greater part of the Tithonian-Valanginian succession belongs to the so-called Biancone Limestone; a porcelainlike, thin-bedded and occasionally laminated carbonate sediment containing pelagic fossils as well as numerous nodules and thin layers of chert. Discordantly upon the Biancone sediments and older rocks lie the beds composed of claystone, marlstone, marly limestone, calcarenite, limestone breccia and chert forming the so-called Lower Cretaceous carbonate flysch. Sedimentary structures and textures as well as lithologic composition of the carbonate flysch point at turbidity's current origin. The Aptian-Albian age of the described sedimentary succession is defined by nannoplankton and foraminifers.

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