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Lower Jurassic dolomite-limestone succession with coal in the Kočevski Rog and correlation with neighbouring areas (southeastern Slovenia)

Spodnjejursko dolomitno-apnenčevo zaporedje s premogom v Kočevskem Rogu in primerjava s sosednjimi območji

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Ključne besede: premog, karbonatne prikamenine, lias, Dinarska karbonatna platforma, Slovenija
Key-words: coal, adjacent carbonate rocks, Liassic, Dinaric carbonate platform, Slovenia

Abstract

The article deals with the Lower Jurassic shallow-water succession of carbonate rocks with lenses of coal in the area of the Dinaric carbonate platform east of Kočevje. The coal is of Middle Liassic age. The footwall of the coal is represented by the Lower Liassic grained bituminous dolomite and the hanging wall by the Upper Liassic spotted limestone. The coal was formed in a shallow lagoon and/or deeper marsh at paralic-limnic conditions. A correlation of developments of the Liassic beds in the Kočevski Rog, Suha krajina, Mala gora, Kočevska Mala gora and Bela krajina area has been performed in this paper as well.

Kratka vsebina

Članek opisuje spodnjejursko plitvovodno zaporedje karbonatnih kamenin z vložki premoga na območju Dinarske karbonatne platforme vzhodno od Kočevja. Premog je srednjeliasne starosti. Talnino premoga predstavlja spodnjeliasni zrnati in bituminozni dolomit, krovnino pa zgornjeliasni marogasti apnenec. Premog je nastajal v plitvi laguni in/ali globljem močvirju ob paralično-limničnih pogojih. V članku je opravljena primerjava razvojev liasnih plasti Kočevskega Roga, Suhe krajine, Male gore, Kočevske Male gore in Bele krajine.

Introduction

The Lower Jurassic carbonate rocks with coal in the Kočevski Rog area were discovered at stratimetric profiling (D o z e t, 1982). The considered coal occurrence lies 15 km east of Kočevje (Fig. 1) in the Kočevski Rog area. The coal-bearing succession

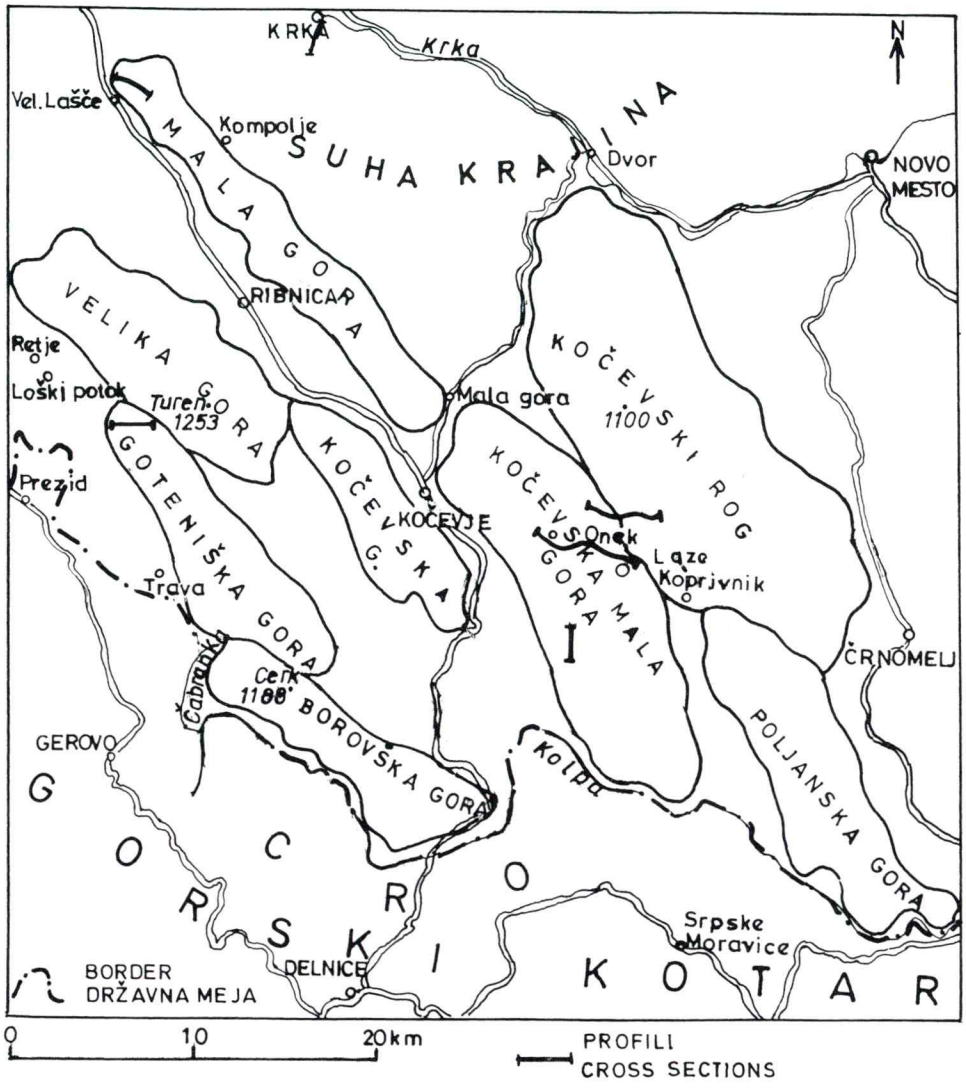


Fig. 1. Location sketch map
Sl. 1. Položajna shematska karta

lays open along the forest-road near the hunting hut north of the small village Laze. The dolomite-limestone succession of the Liassic contains at some levels of the middle part of the succession 8 thin seams and lenses of coal. The coal is of high quality.

The carbonate rocks are classified by F o l k 's (1959) petrographic classification of limestones and D u n h a m's (1962) classification of carbonate rocks according to depositional texture. The macrofossils are determined by I r e n a D e b e l j a k. Chemical analysis of the coal samples are performed in the laboratory of REK Trbovlje. The

colour of the rocks is defined according to Munsell's ROCK COLOR CHART, based upon the three dimensional comprehension of colours.

Previous Investigations

In the history of the Slovene coal exploration, The Kočevski Rog, Kočevje and Dolenjsko area on the whole with their Jurassic coal occurrences regarding the quantity of coal have never been of importance. In these areas the coal outcrops were in all cases small, consequently, their economic significance was small as well. Traces of abandoned research and miner's digging show that the Jurassic coal was discovered and locally exploited already before the second World war. After the War B u s e r (1965b, 1974) mentioned the coal in bituminous dark grey grained dolomite on the boundary between the Middle and Upper Liassic. During his field work he found two outcrops of this coal. The first outcrop lies southeast of the village Nova Vas surmounted the village Metulje in the Bloke plateau area. The coal outcrop can be seen above the surface of the ground in length of 3 metres with the thickness of the coal up to 0.5 metres. The local people dug this coal and sold it to neighbouring blacksmiths. The second outcrop of the Jurassic coal is situated west of the village Retje in the Loški Potok area. The coal occurs in five up to 5 centimetres thick seams, which are tectonically strongly interrupted. We can follow them in length of 5 metres.

It is true, the considered coal occurrences are of no economic importance, but they are of great scientific importance, especially for paleogeographic study of the Dinaric carbonate platform area and the reconstruction of environmental and geodinamic events during the time interval of the Lower Jurassic.

Rather numerous but economically unimportant coal occurrences in the lower part of the Jurassic carbonate sequence were discovered during the mapping for the Basic geologic map of SFRJ S 1:100 000 on the Map Sheet Delnice (D o z e t, 1983; S a v i ć & D o z e t, 1985a, b). The coal occurs in the Liassic stratified and platy brownish grey coarse-grained strongly bituminous dolomite and between plates and beds of dark grey to black micritic limestone. In the Kočevje and Gorski kotar area the Lower Jurassic coal occurs in the form of up to 0.75 metres thick and 8 metres long lenses. In most cases we can see rather thinner and shorter lenses. At some places there are just some centimetres thick seams of coal.

B u k o v a c et al. (1984) mentioned smaller findings of coal at Brezovica in the Bela krajina area WSW of Črnomelj. Nowadays, just a smaller trench as well as dumping-ground have been preserved. The lense of coal occurs within the Liassic dolomite with marly dolomite and dolomitic marl in the hanging wall. Both rocks contain impregnated bitumen, originated by bitumenization of coal.

Geology of the Coal Deposits

Stratigraphic position

The stratigraphic carbonate sequence with thin seams and lenses of coal in the Kočevski Rog area belongs to the Middle Liassic. Considering fauna and coal we can divide the Kočevski Rog succession into three parts (Fig. 2): 1)- the lower part, footwall respectively, 2)- the middle or coal-bearing part and 3)- the upper part represen-

ting the hanging wall. The lower part belongs to the Lower Liassic, the coal sedimentary sequence is of the Middle Liassic age, whereas the hanging wall with regard to the stratigraphic position and according to lithology is of the Upper Liassic age.

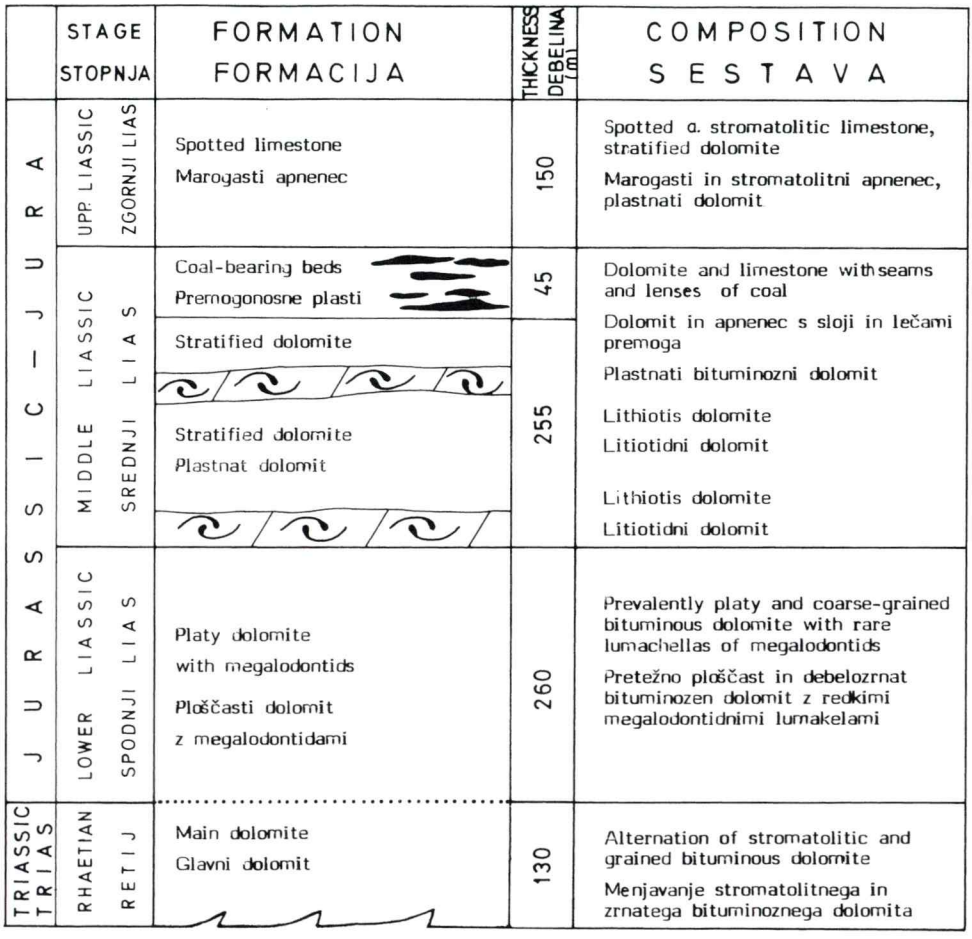


Fig. 2. Stratigraphic position of the coal-bearing beds
Sl. 2. Stratigrafska lega premogonosnih plasti

The footwall of the coal-bearing beds, which we ranged to the Lower Liassic, is composed of dark brownish grey and brownish grey platy (2-10 cm) and bedded bituminous dolomite, which at some places contains small organic remains. Occasionally, we can observe in the dolomite a thin lamination. According to structure the dolomite belongs to fine-grained, medium-grained and coarse-grained dolosparite. The age of the lowermost dolomite is defined with reference to its stratigraphic position and lithology. The considered dolomite succession lies conformly under the *Lithiotis* dolomite.

The coal occurs in the Middle Liassic brownish grey grained strongly bituminous

dolomite. The Middle Liassic dolomite is clearly stratified (15-35 cm). Rarely, it is platy (5-10 cm). Contacts between beds are sharp, surfaces of beds are even or wavy. The structure is fine-, medium- and coarse-grained. Besides prevalently coarse-grained dolosparite there is a horizon of *Lithiotis* dolomite which seperates the Lower and Middle Liassic beds. *Lithiotis* skeletons are mainly parallel to bedding and they lie so closely together that they form lumachellas. The Lower Liassic dolomite originated by late diagenetic dolomization of limestones. Its late diagenetic origin is proved, first of all, by his coarse-grained structure. In the Middle Liassic stratigraphic sequence besides dolosparites individual thin layers of fine-grained intraformational dolomitic breccia also occur. The thickness of the coal-bearing beds ammounts to 45 metres. The coal of the Kočevski Rog autcrop is followed in five levels of the Middle Liassic interval. It occurs in the form of thin seams and lenses. B u s e r (1965b, 1974) ranged the Liassic coals in the Dolenjska area to hard coals, but according to our data they chiefly belong to brown coals. Due to small thickness and extention the coal is not suitable for exploitation.

Conformly upon the coal-bearing beds lies the succession of the Upper Liassic limestones, which are considered to be an equivalent of the spotted limestone formation. The transition of the dolomite to limestone is graded. The limestone is platy or bedded (5-30 cm) and greyish black. It mostly belongs to micrite, rarely to stromatolite or laminated limestone. Very rarely the limestone is grained. At some places it decomposes into 2-5 cm thick plates. Frequently the limestone is more or less dolomitized. In the lowermost part the limestone is interbedded by two beds (20 cm, 30 cm) of clay. The lower interbed is composed of brownish grey clay, shaly marl and rare, 5-7 cm thick pebbles of grey micritic and stromatolitic limestone.

Tectonic Movements

On the boundary between the Triassic and Jurassic period in the Dinaric carbonate platform area there have never been any orogenic tectonic movements (D o z e t, 1989) because there can be found no folding, thrusting or nappe-tectonic traces, traces of volcanisms or metasomatic changes on sedimentary rocks of that time. There are nowhere to be seen tectonic discordant contacts; on the contrary, in all cases concordance of the Upper Triassic and Jurassic beds is in question. In the area investigated there are also not to be found any coarse-grained basal transgressive formations so that we are right in affirming that the continuity of sedimentation had only be disturbed by the periodical interruptions as a reflection of weak or stronger epeirogenic movements of the carbonate platform.

At the end of the Norian period the epeirogenic movements, which were present more or lesser all the Norian interval of sedimentation, when in the tidal area predominatly stromatolitic dolomites were formed, gradually increased so much that some local intertidal areas of the Dinaric carbonate platform raised and became for a shorter time a mainland. On the local dry land a karstification, weathering and erosion took place, which made possible the origin of Karst forms, dolomitic breccia and conglomerate as well as bauxitic clays. These phenomena testify for an increased epeirogenic activity and local discontinuity in that span of time.

To the new intensified epeirogenic movements it came on the boundary between the Lower and Middle Liassic. Namely, in the Middle Liassic stratigraphic sequence numerous but not so expressive events can be observed indicating intensified positive

epeirogenic movements. It is not difficult to find out that the Middle Liassic sedimentation in comparison to the monotonous Lower Liassic dolomite stack containing *Lithiotis* limestones and dolomites, micrites and various biomicrites as well as biosparitic limestones, is much more variegated. We should still mentione coarse-grained biointrasparitic limestones with orbitopsellas as well as interbeds of oosparitic, oointrasparitic and bioointrasparitic limestones with here and there hematitized ooids. The gay-coloured sedimentation point at unquiet Middle Liassic period in the Kočevje area. This picture can be completed by phenomena as lateral and vertical facies alternation, wedging out of the beds and the fact that lithiotids occur in dolomites and limestones, that the *Lithiotis* horizons have very unstable thickness wedging out at some places, further on, the occurrence of the limestone- dolomite breccias with calcitic cement and not at last the coal occurrences that speak for local shallow lagoons, marshes and dry land forming conditions for vegetation, and contributing to the origin of the coal-bearing sediments. The whole Liassic period was very probably a relatively cold and humid period, especially its middle part, when the coal was formed.

Kočevski Rog Cross Section

The shallow-marine Liassic carbonate succession with thin seams and lenses of coal (Figs. 3, and 4) are well-developed east of Kočevja in the Kočevski Rog area. They lay open along approximately 500 metres long forest road interval north of Laze. This cross-section is important for knowledge of geologic developments and especially for study of palaeogeographic conditions in the Kočevski Rog area, Dinaric carbonate platform respectively, in the Lower Jurassic span of time. The considered cross-section begins at pretty strong dinaric fault, which separates the south-lying Lower Malm and north-lying Liassic sedimentary succession with coal seams.

Cladocoropsis limestone

The limestones lying to the south of the dinaric fault are greyish black to black, in some intervals light gray to moderate light gray. From the structural point of view micritic, biomicritic and biosparitic limestones with algae, foraminifers, *Cladocoropsis* and molluscs occur. Here and there interbeds of biointrasparitic limestones with corals and molluscs as well as a biolithite with corals, bryozoans and *Cladocoropsis* occur. The thickness of the described beds carries together 150-200 metres. With regard to lithofacies and according to fossil contents we suppose, the described carbonate rocks belong to the Middle Malm.

Lower dolomite member

North of the dinaric fault lies about 75 metres thick stack of grey to dark grey platy and stratified (5-10 cm, 10-35 cm) moderate and coarse-grained strongly bituminous dolomite, which occasionally contains undeterminable organic remains. The dolomite is at some places laminated. In the laminae light grey, very fine-grained and dark grey coarse-grained dolosparite alternate. According to stratigraphic position and lithology the lower dolomite member is of the Middle Liassic age.

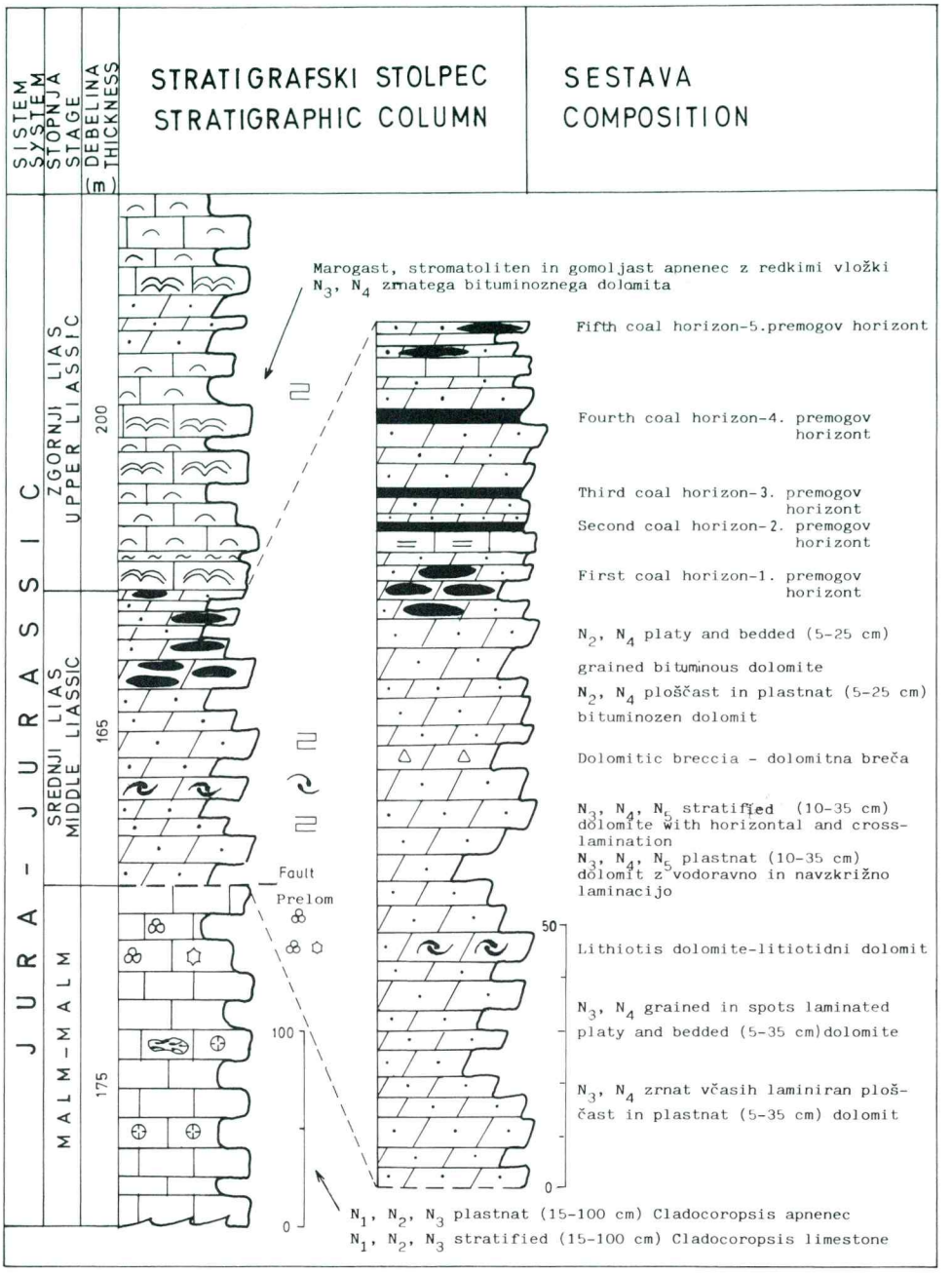


Fig. 3. Stratigraphic column of the Liassic beds with coal in the cross-section 1 in the Kočevski Rog

Sl. 3. Stratigrafski stolpec liasnih plasti s premogom v profilu 1 na območju Kočevskega Roga

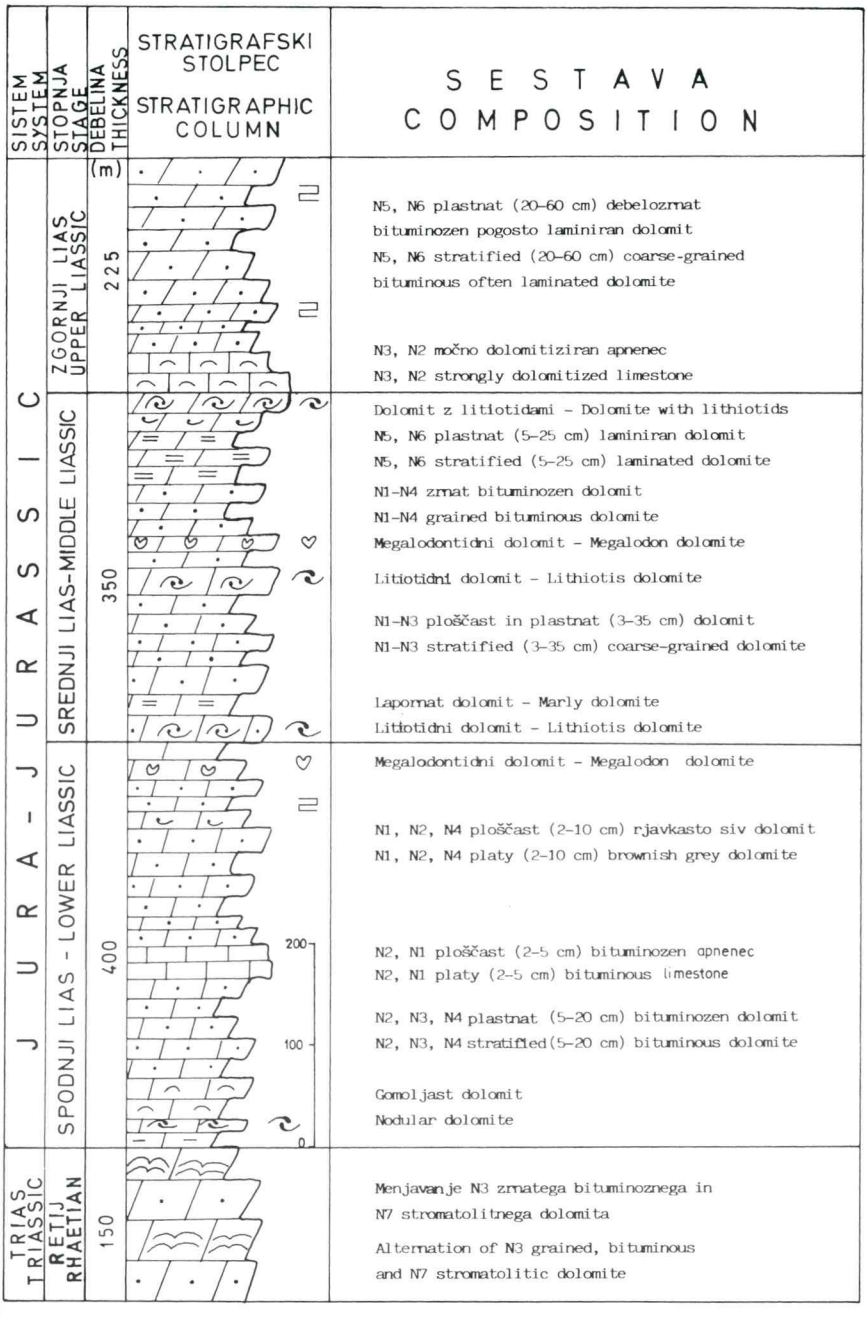


Fig. 4. Stratigraphic column of the Liassic beds in the cross-section Laze-Onek in the Kočevski Rog area

Sl. 4. Stratigrafski stolpec liasnih plasti v profilu Laze-Onek na območju Kočevskega Roga

Lithiotis dolosparite

Upon the lower dolomite member lies concordantly without interruption a grey stratified (20-60 cm) dolosparite of the coquina type. The sparitic dolomite contains very numerous lithiotid bivalves. In the Middle Liassic period these and some others pelecypods built submarine lawns, biostromes respectively. After the deposition and consolidation of the lime mud occurs a late diagenetic dolomitization that changed the lithified biosparitic limestone into a coarse-grained dolomite. The thickness of the dolomite bed with lithiotids is 2.5 metres. The contact betwen the lower dolomite and *Lithiotis* dolosparite represents the boundary between the Lower and Middle Liassic.

Coal-bearing beds

Upon the horizon of the *Lithiotis* dolomite follows, first, 75 metres thick stack of grey, moderate brownish grey and dark grey platy and stratified (5-10 cm, 10-60 cm), moderate-grained bituminous dolomite with very rare and thin (up to 0.5 m) interbeds of intraformational dolomitic breccia. The breccia is composed of very poorly rounded greyish black fragments of moderate grained dolomite in a very fine-grained dolomitic groundmass. In the dolomite fragments as well as in the groundmass, occasionally, an organic detritus can be seen. The lamination occurs due to various granularity and organic contents. White, brownish grey, dark brown and black laminae alternate. Besides horizontal lamination, occasionally, the cross-lamination can be observed. The coal-bearing beds originated in a shallow supratidal and intertidal sea, where the coal substance were brought.

The first coal horizon (Fig. 5) is about 8 metres thick. It consists of 3 interlayers, lenses respectively, of coal lying within dark brownish grey and dark grey strongly decomposed grained bituminous dolomite. The black coal substance is at some places in sharp even contact with the dolomite, but in other places it passes on very irregulary to adjacent rocks.

The first seam of the first coal horizon is 20-30 cm thick. In the lower part it contains some dark grey coal clay. The hanging wall of the coal seam is represented by greyish black, platy (3-5 cm), grained bituminous dolomite, which is in pretty clear contact with the coal. Downwards the coal passes first into a greyish yellow dolomitic marl, then into a platy and thin-bedded (5-15 cm) grained bituminous dolomite. The coal substance is pretty clayey; in the lowermost part with a yellow and in the topmost part with a grey and dark grey clay. The upper contact of the coal with the dolomite is even, the lower one even to slightly wavy.

The second coal seam (Fig. 5) is 20-25 cm thick. The coal substance is in the lower and upper part as well as laterally blended with a dark grey and greyish black clay. In the hanging wall there is a brownish grey, platy (5-15 cm), grained, bituminous dolomite, while its footwall is composed of platy and thin-bedded (5-15), grained bituminous dolomite. The upper contact of the coal and dolomite is wavy or irregular, the lower one is even to slightly wavy.

The third coal seam (Fig. 5) is 15 cm thick. In this seam a dark grey coal clay predominates. In the hanging wall of the coal seam there is a brownish grey platy (2-10 cm) fine and moderate-grained dolomite. In the footwall there is a brownish platy (5-15 cm) grained bituminous dolomite. Both contacts are wavy and irregular. The uppermost dolomite bed, which terminates the first coal horizon, is pinkish and 1.5 m

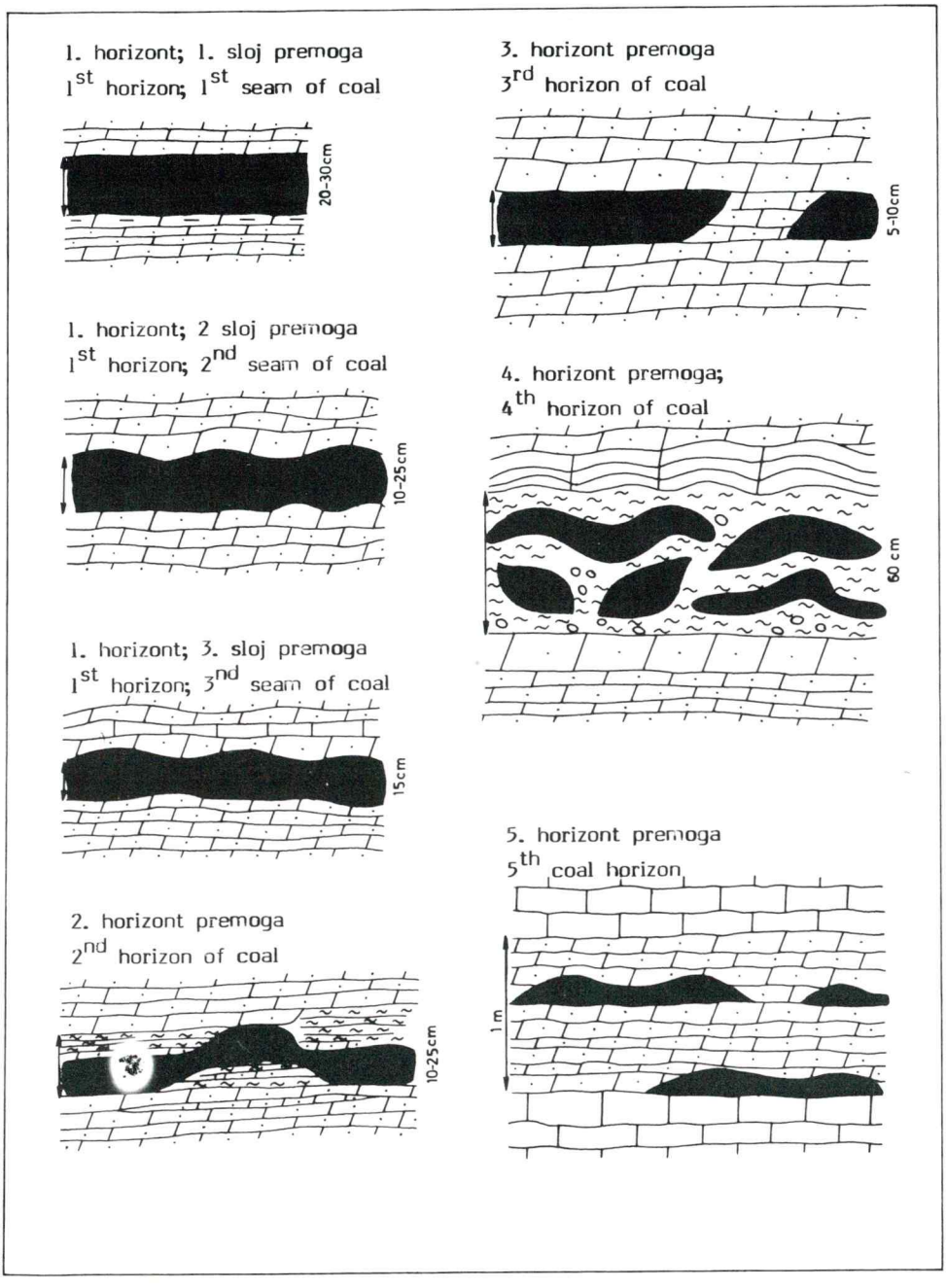


Fig. 5. Coal-bearing horizons and coal seams in the Kočevski Rog area
Sl. 5. Premogovi horizonti in sloji premoga na območju Kočevskega Roga

thick. It is overlain by 60 cm thick bed of the greyish black bituminous grained limestone, which is in its lowermost and uppermost part pinkish red.

The second coal horizon (Fig. 5) is 10-20 cm thick. It is characterized by lenslike occurrences of a yellowish grey poorly cemented dolomite in the black coal substance alternating with foliated (1-3 cm) black claystone. The hanging wall is composed of a platy and thin-bedded (5-15 cm) yellowish grey, dark grey and greyish black grained bituminous dolomite; in the footwall there is a yelowish grey platy (3-10 cm) grained bituminous dolomite.

The third coal horizon (Fig. 5), composed of black coal substance, is 5-15 centimetres thick. The coal seam is in one part interrupted with a grained bituminous dolomite. In the footwall of the coal there is a stratified (25-35 cm) olive grey fine-grained dolomite, whereas the hanging wall is composed of stratified (30-45 cm) grayish black moderate grain dolomite.

The fourth coal horizon (Fig. 5) consists of black coal substance, which is very irregularly arranged in bluish and greenish grey foliated coal clay. There is about 25 % of coal. Consequently, the clay is strongly predominant sediment in this horizon. The fourth horizon is 60 centimetres thick. In the coal clay up to 1.5 cm large, rather rounded pebbles of dark brown grained bituminous dolomite can be seen. Conformly and with a sharp irregular bed surface lies upon the coal and clay a brownish grey stromatolitic dolomite.

To the coal-bearing beds is also added 7.5 metres thick **transitional belt** between the Middle Liassic dolomite and Upper Liassic spotted limestone. The belt of transition begins with 0.5 metres thick grey platy (1-5 cm) stromatolitic limestone. The basal part of the stromatolitic limestone is here and there pinky to pinkish red and in spots strongly dolomitized. Upwards follows 1 metre thick bed of grey, in the basal part pinky, extraordinary strongly dolomitized laminated stromatolitic limestone. It is overlain by 25-50 cm thick bed of greyish black to black grained bituminous nodular dolomite with 1.5 cm large erosion holes. Upwards follow first 0.5 metre thick packet of greyish black fine-grained platy and stratified (2-30 cm) limestone, then 0.5 metres thick interval of greyish black stratified (10-30 cm) micritic limestone. The dolomite (3 m), which overlies the deseribed limestone, is olive grey to greyish black, platy and thin-bedded (5-20 cm) moderate-grained and strongly bituminous („saturated" dolomite) with up to 10 cm thick lenses of coal. This is the fifth and at the same time last horizon of coal in the considered stratigraphic sequence. The sediments in the transitional zone are conventionally, according to the principle that the transitional interval belongs to the formation, which is more variegated, ranged to the Middle Liassic succession.

The fifth and at the same time the last *coal* **horizon** (Fig. 5) consists of dark brownish grey to greyish black stratified (2-15) grained strongly bituminous dolomite with 10-25 cm thick lenses of coal. The horizon is 1 m thick. The coal lenses occur on the boundary between the limestone and dolomite as well as within the dolomite. The footwall of the fifth horizon is represented by 0.75 to 1 metres thick interbed of the greyish black stratified (10-25 cm) grained limestone. It is underlain by olive grey to greyish black stratified and platy (5-20 cm) grained bituminous dolomite. The hanging wall of the fifth horizon is represented by a thick-bedded dark grey and grey stromatolitic limestone. The both contacts, the lower and upper one, are sharp and even.

Spotted limestone

This is the formation of grey, dark grey and greyish black micritic fine-grained platy (5-10 cm) and stratified (10-35 cm, rarely 45-60 cm) limestone with more or less frequent yellowish clayey and marly spots. Some spots originated by late diagenetic dolomitization of primary limestone due to different mineralogical and chemical composition. In the topmost part of 120 metres thick stack of spotted limestone there is some 5-12 metres thick intervals of thick-bedded coarse-grained brown to moderate dark brown grained bituminous dolomite. In the limestone numerous horizontal parallel stylolites can be observed. Along the stylolites, which can be followed vertically every 5-10 cm, a late diagenetic dolomitization advanced loosening the rock to the measure that previously thick-bedded rock changed to a platy rock. In the formation of predominantly spotted limestone laminated and stromatolitic limestones are also frequent. The lamination occurs, first of all, due to different organic contents (white, light brown, dark brown, black laminae) and because of various grade and type of dolomitization (light and dark brown laminae). Quite important characteristic of the formation of the spotted limestones is also that it is extremly poor with fossils. In these limestones only undeterminable organic remains are preserved.

Sedimentary Environment

From the Tethys area in literature the Rhaeto-Liassic coal period with numerous coal occurrences is frequently mentioned. But in the Dinaric carbonate platform area in the Dolenjsko region in Rhaetian there were no conditions for forming the coal. It is true that epeirogenetic movements and shallowing of the sea in this connection are, intensified to this measure that some tidal areas became dry land for a while, where a karstification and erosion took place. But in the Dinaric carbonate platform area there were no all favourable conditions for origin of the coal. Not before the end of Rhaetian, at the begining of the Jurassic respectively, warm and humid climate occurred. The land and marsh flora expanded. Under favourable climate conditions and fast development of various flora on one side, and by existance of numerous shallow marine basins, lagoons respectively, it came to repeated accumulation of plant material in the lime mud and to origin of several seams of coal.

Consequently, the Liassic coal-bearing formation has a variegated composition. The oscillations of the sea level in the lagoon were a consequance of episodic changes in the hydrosphere and especially of intensified movements and processes in the lithosphere (subsidence). Marshy forest facies, as basic facies of origin of the coal beds, was bound for lithoral zone. Sedimentation in the lagoon depended on relation of three gradients: 1) plant material accumulation, 2) deposition of carbonate mud and 3) subsidence. In intervals, when the plant material accumulation was high, and the climate conditions enough favourable, it came to formation of coal seams. At the moment, when the gradient of the plant deposition was minor than the subsidence gradient, the deposition of the coal was interrupted. The coal seam was overlain by carbonate mud. After that, diagenetic and metamorphic processes in deposited sediments followed.

Correlation of the Liassic Beds in the Southeastern Slovenia

The coal-bearing Liassic beds of the Kočevski Rog are correlated with the Liassic beds of the Mala gora (Fig. 9), Kočevska Mala gora (Fig. 6 and 7), Suha krajina (Fig. 8) and Bela krajina t.i. of those areas of the Dinaric carbonate platform in the southeastern Slovenia, that lie in the close neighbourhood of the Kočevski Rog. The analogy of the Liassic stratigraphic columns in the enumerated areas is evident already at first sight. In the lower part of the Liassic interval a grained, prevalently platy and strongly bituminous dolomite is developed. In the middle part of the carbonate succession, upon the first lithiotid horizon, one or more horizons of coal, coal shale and clay can be seen. In the hanging wall of the coal-bearing beds there is a platy and stratified spotted limestone.

The stratigraphic column of the Liassic beds in the cross-section G. Retje-Bukovec at Poljane (Fig. 9) in the Mala gora area is very similar to the above-enumerated. This stands especially for the lower and upper part of the Liassic column, composed of grained bituminous dolomite, the spotted limestone respectively. The significant difference occurs in the middle part of the Mala gora Liassic succession, where in the lowermost, in the middle and especially in the topmost part the oolitic limestone appears. As limestone as dolomite are rich with micro- and macrofossils. The main difference is, the Liassic beds, which build the Mala gora Mts., do not contain the coal.

Probably the most special is the stratigraphic column of the Liassic beds in the Suha krajina area (Fig. 8), which is in the lowermost part represented by the so called Krka limestones (D o z e t, 1993). These are prevalently black, thick-bedded, biomicritic, oomicritic, intrasparitic and biointrasparitic limestone with interlayers of intraformational breccias and conglomerates, fenestral limestones, stromatolitic limestones and occasionally dolomites. The enumerated sediments show distinctive characteristics of shallow-water sedimentation originating in a subtidal, intertidal and supratidal environment. These sediments contain the Lower Liassic fauna and flora. However, the most frequent between the fossils are algae and foraminifers. In the Lower Liassic limestones are determined among others the algae *Palaeodasycladus mediterraneus* Pia, *Palaeodasycladus elongatus* Praturlon and *Linoporella lucasi* Gros & Lemoine. The Middle Liassic sedimentation in the cross-section Podbukovje (Krka) - M. Korinj (Fig. 8) is much more variegated than the Lower Liassic one. The sedimentary succession of the Middle Liassic interval consists of dark and medium dark grey, grained, bituminous dolomites, intraformational dolomitic breccias, biopelmicritic, oosparitic, oointrasparitic as well as lithiotid and megalodontid limestones. In the lowermost part of the considered sedimentary succession there are pure and calcareous dolomites with interbeds of intraformational dolomitic breccias. Dolomites are coarse-grained, consequently, late diagenetic by origin. Occasionally, they contain more or less numerous fine organic remains. The megalodontid limestones are pretty rare. The lithiotid limestones occur in the upper part of the Middle Liassic carbonate succession. From the structural point of view, the lithiotid limestones belong to biomicrites, where in the dark grey to greyish black limy mud numerous lithiotids are accumulated. In spots, the lithiotids are accompanied by megalodontids and foraminifers. In the lithiotid facies biostromal and reef type of sedimentation occurs. On the other hand, the grained limestones and dolomites were formed in the subtidal, intertidal and supratidal environment. The Upper Liassic interval (Fig. 9) is represented by the formation of the spotted limestones, which is in the Suha krajina area characterized by a small thickness of only some ten metres. However, it consists of

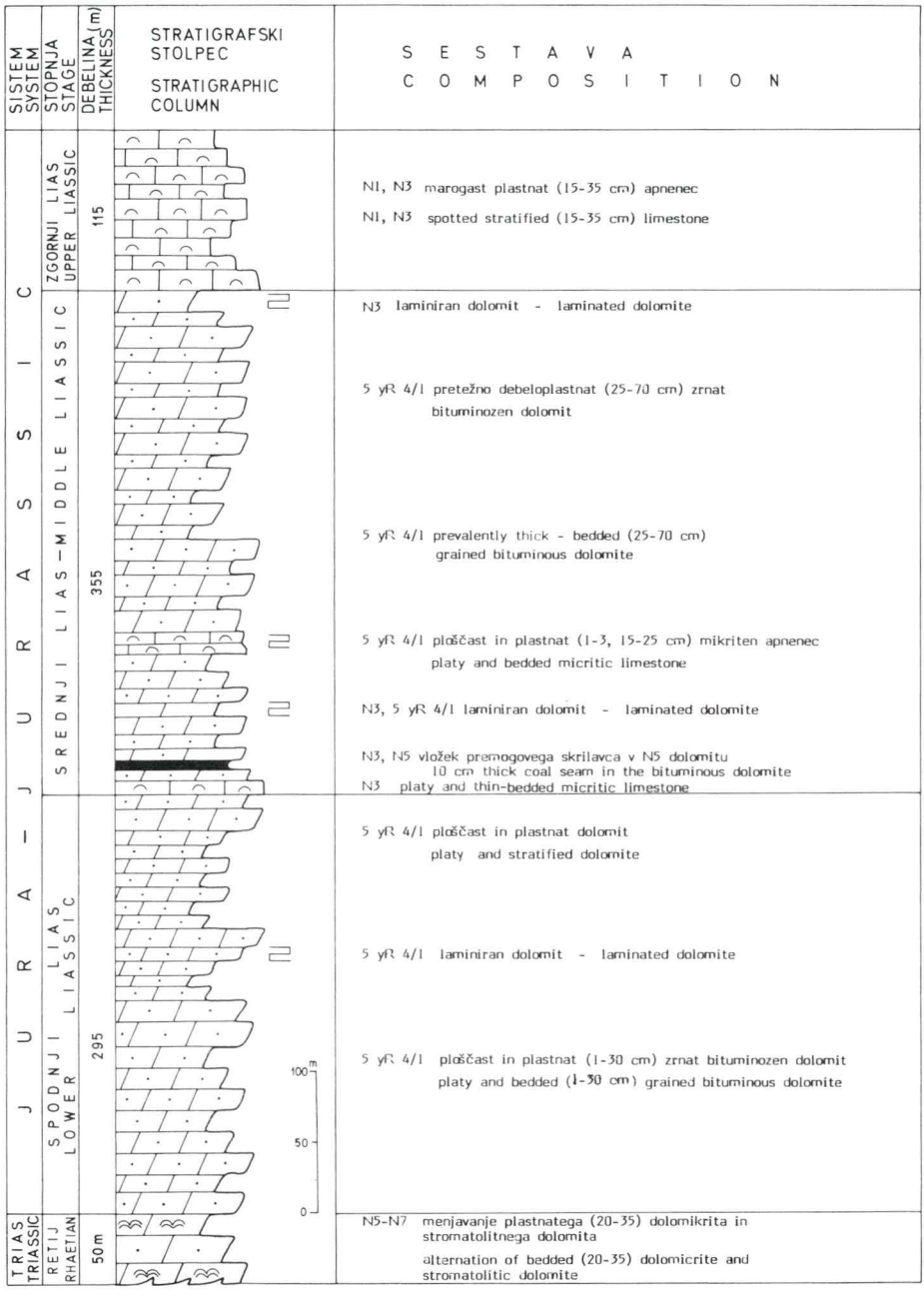
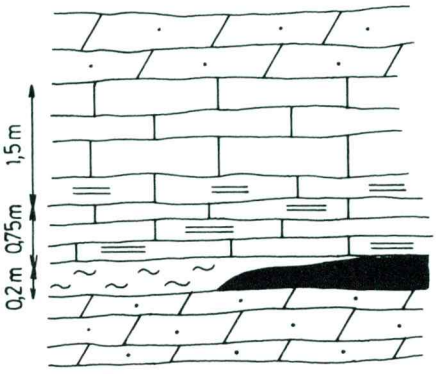


Fig. 6. Stratigraphic column of the Liassic beds in the cross-section Pekel-Lapinje in the Kočevska Mala gora area

Sl. 6. Stratigrafski stolpec liasnih plasti v profilu Pekel-Lapinje na območju Kočevske Male gore



N_4, N_3 ploščast in plastnat zrnat bituminozen dolomit

N_3 plastnat (20-50 cm) mikriten apnenec

N_3 ploščast (3-5 cm) pasnat apnenec

N_4 premogov skrilavec in glina

N_1, N_3 ploščast in plastnat bituminozen zrnat dolomit

Fig. 7. The detail of the Middle Liassic succession of carbonate rocks with coal in the cross-section Pekel - Lapinje in the southern part of Kočevska Mala Gora

Sl. 7. Detajl srednjeliasnega zaporedja karbonatnih kamenin s premogom v profilu Pekel -Lapinje v južnem delu Kočevske Male gore

platy (3-10 cm) and stratified (15-45 cm) dark grey, greyish black and black, prevalently micritic, spotted, frequently nodular limestone as well. The limestones are at some places somewhat dolomitizied containing rare, some metres thick interbeds of brownish grey grained dolomite. From the structural point of view they mostly belong to a micrite or pelmicrite. Occasionally, they contain intraclasts as well as limonitized ooids and oncoids. The spotted limestones are very poor with fossils indicating that they were formed in an environment, which was unfavourable for living organisms. The described sedimentary succession is according to the stratigraphic position of the Upper Liassic age. Namely, it lies between the lithiotid limestones, which are in the Dinaric carbonate platform area of the Middle Liassic age, and oolitic limestones containing the Dogger fauna.

Conclusions

The stratigraphic sequence of the Middle Liassic carbonate rocks, which were formed in the Kočevski Rog region in the Dinaric carbonate platform area, includes in several levels thin seams and lenses of coal. The basic characteristic of the seams and coal lenses is a small and unstable thickness, which changes from 60 cm to complete wedging out.

The material for formation of the coal originates from marsh and land vegetation. Regarding the number of exposed coal outcrops we conclude that for the development of the marsh vegetation the best conditions were given in the Middle Liassic. If we compare the Jurassic and Tertiary conditions or vegetation, it is not difficult to find out that the latter were much more favourable. At formation of the Lower Jurassic coal it went for an accumulation of plant material. The transport of this material have been carried out by means of water streams. The finer and more resistant constituents were transported (blown) and laid down into basins by atmospheric currents. The Middle Liassic occurrences are small. Locally, they were exploited, but nowadays, they

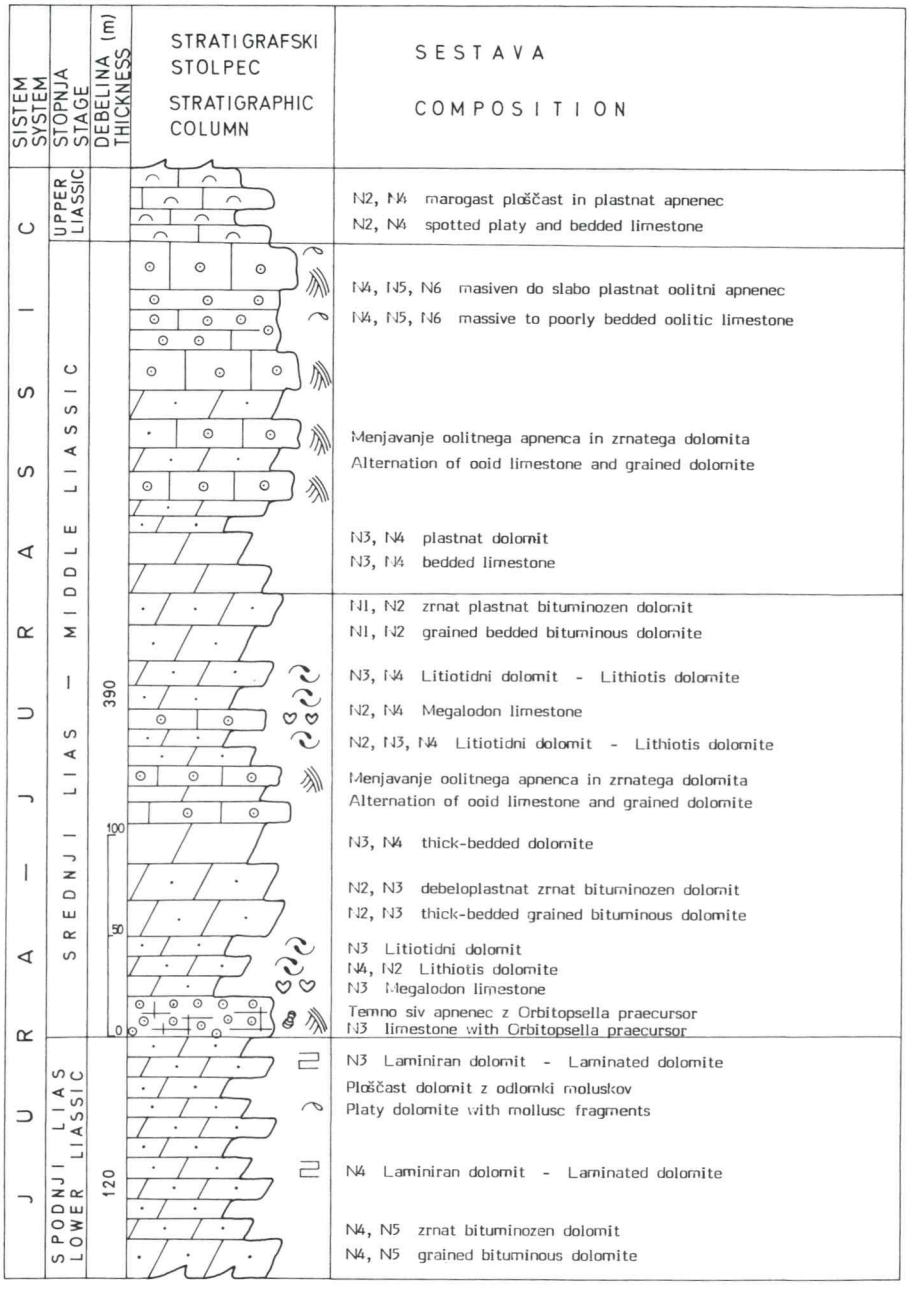


Fig. 8. Stratigraphic column of the Liassic beds in the cross-section Podbukovje (Krka) - M. Korinj in the Suha krajina area

Sl. 8. Stratigrafski stolpec liasnih plasti v profilu Podbukovje (Krka)-M. Korinj na območju Suhe krajine

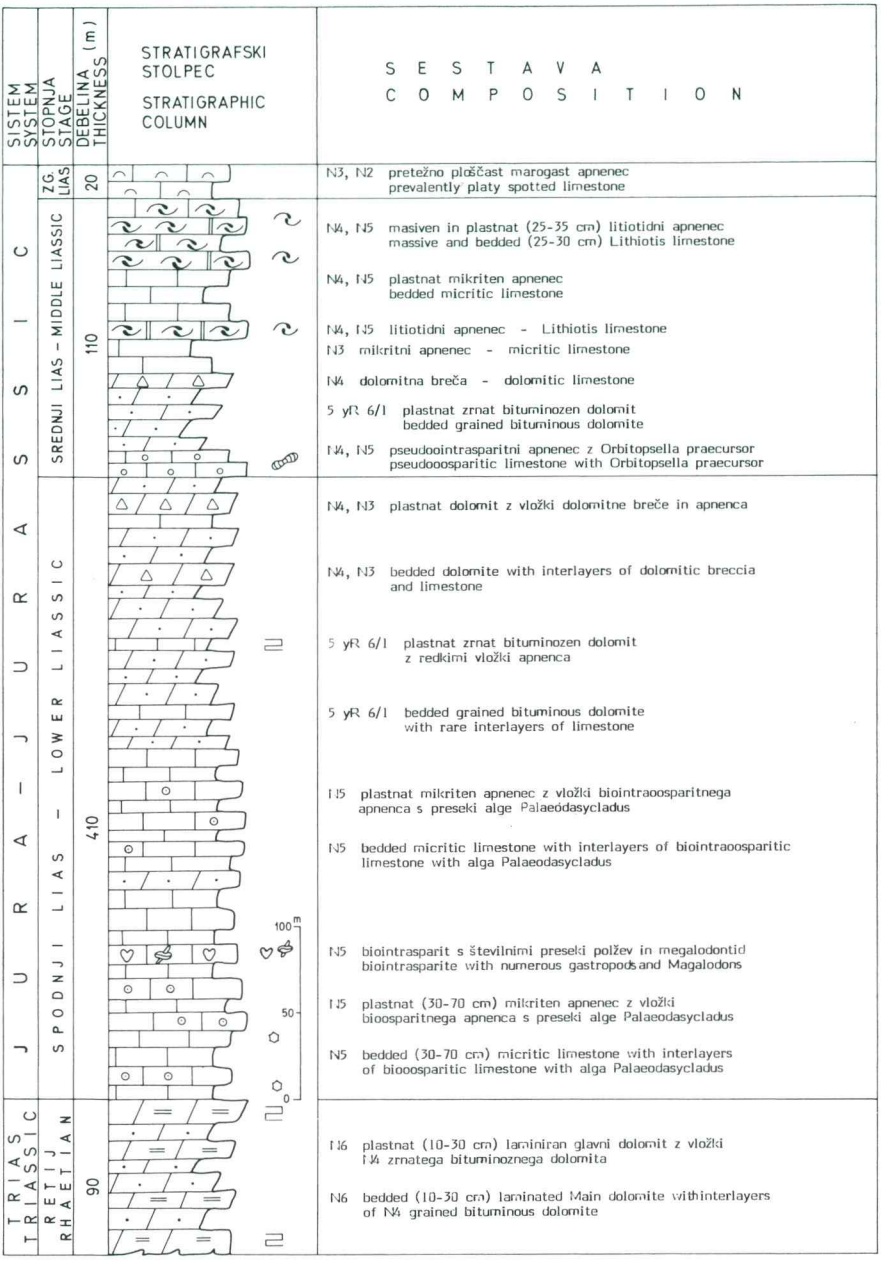


Fig. 9. Stratigraphic column of the Liassic beds in the cross-section G. Retje-Bukovec at Poljane in the Mala Gora area

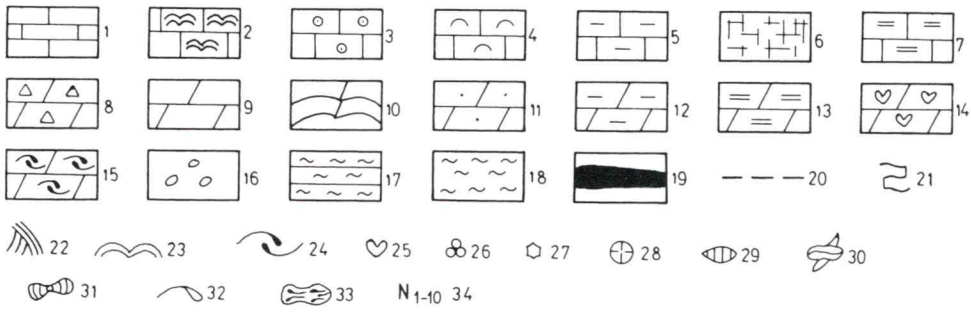
Sl. 9. Stratigrafski stolpec liasnih plasti v profilu G. Retje-Bukovec pri Poljanah na območju Male gore

have no economic significance. The small thickness of the coal horizons speaks for the fact, that there was no exuberant autochtonous flora and that it was transported into basins by river streams. The Middle Liassic coal occurrences are small. Locally, they were exploited in the past, but nowadays, they are of no economic importance.

Acknowledgements

For the determination of lithiotid bivalves the author expresses gratitude to M. Sc. Irena Debeljak.

LEGENDA - LEGEND



LEGENDA - LEGEND

1 - Ploščast in plastnat apnenec, 2 - stromatolitni apnenec, 3 - oolitni apnenec, 4 - marogasti apnenec, 5 - lapornati apnenec, 6 - masivni apnenec, 7 - laminirani apnenec, 8 - dolomitna breča, 9 - plastnat dolomit, 10 - stromatolitni dolomit, 11 - zrnati bituminozni dolomit, 12 - lapornati dolomit, 13 - laminirani dolomit, 14 - megalodontidni dolomit (lumakela), 15 - litiotidni dolomit (lumakela), 16 - prodniki, 17 - glinovec, 18 - glina, 19 - premog, 20 - prelom, 21 - vodoravna lamininranost, 22 - navzkrižna lamininranost, 23 - stromatolit, 24 - litiotide, 25 - megalodontide, 26 - mikro favna, 27 - mikroflora, 28 - korale, 29 - hidrozoji, 30 - polži, 31 - orbitopsele, 32 - odlomki moluskov

1 - Platy and stratified limestone, 2 - stromatolitic limestone, 3 - oolitic limestone, 4 - spotted limestone, 5 - marly limestone, 6 - massive limestone, 7 - laminated limestone, 8 - dolomitic breccia, 9 - stratified dolomite, 10 - stromatolitic dolomite, 11 - grained bituminous dolomite, 12 - marly dolomite, 13 - laminated dolomite, 14 - megalodontid dolomite (lumachelle), 15 - lithiotid dolomite (lumachelle), 16 - gravel, 17 - claystone, 18 - clay, 19 - coal, 20 - fault, 21 - horizontal lamination, 22 - cross-lamination, 23 - stromatolite, 24 - lithiotids, 25 - megalodontids, 26 - microfauna, 27 - microflora, 28 - corals, 29 - hydrozoans, 30 - gastropods, 31 - orbitopsellas, 32 - mollusc fragments

Spodnjejursko dolomitno-apnenčevo zaporedje s premogom v Kočevskem Rogu in primerjava s sosednjimi območji

Uvod

Spodnjejurske karbonatne kamenine s premogom so bile odkrite pri stratimetrijskem profiliranju (D o z e t, 1982). Izdanek teh plasti leži okoli 15 km vzhodno od Kočevja (sl. 1) v Kočevskem Rogu. Premogonosne plasti so razgaljene ob gozdni cesti pri lovski koči severno od vasi Laze. Liasno dolomitno-apnenčevo zaporedje vsebuje v nekaj nivojih srednjega dela zaporedja 8 tankih slojev in leč premoga. Tovrstna premogišča na Kočevskem so majhna. Lokalno so jih izkoriščali v preteklosti, danes pa so brez pomena. Starostna pripadnost tega dela mezozojske skladovnice karbonatnih kamenin s tankimi plastmi premoga je bila različno obravnavana. Naše raziskave kažejo, da so premogonosne plasti v Kočevskem Rogu srednjeliasne starosti.

Karbonatne kamenine so določene po F o l k o v i (1959) klasifikaciji apnencev in D u n h a m-ovi (1962) klasifikaciji karbonatnih kamenin glede na sedimentne teksture. Makrofosile je določila I r e n a D e b e l j a k. Kemične analize vzorcev premoga so opravljene v laboratorijih REK Trbovlje. Barvo kamenin sem označeval po Munsell-ovem ROCK COLOR CHART, ki bazira na trodimenzionalnem pojmovanju barv.

Dosedanje raziskave

Kočevski Rog, Kočevska in Dolenjska nasploh s svojimi jurskimi premogišči v zgodovini slovenskega premogovništva po količini premoga niso nikoli bili pomembni. Na teh območjih so jurska premogišča majhna, zato je bil njihov ekonomski pomen le lokalen. Sledovi opuščenih raziskovalnih in rudarskih del kažejo, da so jurski premog odkrili in lokalno izkoriščali že pred drugo svetovno vojno. Po vojni omenja B u s e r (1965b, 1974) premog v bituminoznem temno sivem zrnatem dolomitu med srednjim in zgornjim liasom. Pri terenskem delu je zasledil dva izdanka tega premoga. Prvi izdanek leži jugovzhodno od Nove vasi nad vasjo Metulje na Bloški planoti. Premogov sloj izdanja na dolžini treh metrov in je debel do 0,5 m. Domačini so ta premog kopali in ga prodajali kovačem. Drugi izdanek jurskega premoga leži zahodno od vasi Retje v Loškem potoku. Premog se pojavlja v petih do 5 cm debelih slojih, ki so tektonsko precej prekinjene in jih sledimo na dolžini 5 metrov. Opisani nahajališči premoga sta sicer gospodarsko nepomembni, imata pa znanstveni pomen še zlasti pri paleogeografski študiji območja Dinarske karbonatne platforme in rekonstrukciji sedimentacijskih in geodinamičnih dogajanj v časovnem intervalu spodnje jure.

Dokaj številne, vendar gospodarsko nepomembne pojave premoga je pri kartiranju za Osnovno geološko karto SFRJ 1:100 000 na listu Delnice v spodnjem delu jurske karbonatne skladovnice odkril avtor (D o z e t, 1983; S a v i ć & D o z e t, 1989). Premog nastopa v rjavkasto sivem liasnem močno bituminoznem dolomitu in med polami in plastmi temno sivega do črnega mikritnega apnenca. Spodnjejurski premog se na Kočevskem in v Gorskem kotarju najpogosteje pojavlja v obliki največ do 0,75 m debelih in do 8 m dolgih leč. V večini primerov gre za precej tanjše in krajše leče, ponekod pa sledimo le nekaj cm debele sloje premoga.

B u k o v a c et al. (1984 a, b) omenjajo manjše ležišče premoga pri Brezovici v Beli krajini. Premogišče je bilo nekoč izkoriščano. Danes sta ohranjena le manjši rov in jalovišče. Premogova leča je ležala v liasnem dolomitu z laporastim dolomitom in do-

lomitnim laporjem v krovnini. Obe kameninі krovnine vsebujeta impregnirani bitumen, ki je po bitumenoloških analizah nastal z bitumenizacijo premoga. Lignohumit je razpršen v mineralni osnovi dolomita. Potemtakem imamo tu opravka s subbituminoznim premogom in subbituminoznim dolomitom.

Stratigrafske razmere spodnjejurskega intervala mezozojske skladovnice Dinarske karbonatne platforme na območju Kočevskega Roga, Kočevske, Dolenjske, Notranjske in Gorskega kotarja so opisane v delih B u s e r j a (1965 a, b; 1974), D o z e t a (1980, 1982, 1983, 1989, 1992 a, b, 1996), S a v i ć a in D o z e t a (1985 b) ter B u k o v c a in sodelavcev (1984). Spodnjejurske plasti z litiotidami in megalodonti sta nadrobno obdelala B u s e r in D e b e l j a k o v a (1994/95) ter D e b e l j a k o v a in B u s e r (1998). Biostratigrafija in biostratigrafska razčlenitev jurskih plasti sta podana v delih D o z e t a in Š r i b a r j e v e (1981) ter D o z e t a (1990). Tektonska zgradba obravnavanega ozemlja je prikazana v delih B u s e r j a (1965 b, 1974), D o z e t a (1983) ter S a v i ć a in D o z e t a (1985 a, b). Tektonska premikanja na Kočevskem v mezozoiku so opisana v delu D o z e t a (1985 b).

Geologija premogišča

Stratigrafska lega

Karbonatna skladovnica s tankimi sloji in lečami premoga v Kočevskem Rogu (sl. 3, sl. 4) pripada spodnji juri. Spodnjejursko sedimentno zaporedje Kočevskega Roga lahko glede na favno in premog razdelimo v tri dele (sl. 2): spodnji ali talninski del, srednji ali premogonosni in zgornji ali krovninski del. Talninski del pripada spodnjemu liasu, premogonosno sedimentno zaporedje je srednjeliasne starosti, krovninski del pa je glede na stratigrafsko lego in po litologiji zgornjeliasni.

Talnina premogonosnih plasti, ki smo jo prišteli k spodnjemu liasu, je sestavljena iz temno rjavkasto sivega in rjavkasto sivega ploščastega (2-10 cm) in plastnatega bituminoznega dolomita. Ponekod vsebuje drobne organske ostanke. V dolomitu mestoma opazujemo tanko pasnatost. Po strukturi pripada dolomit drobno, srednje in debelozrnatemu dolosparitu. Starost spodnjeliasnega dolomita je določena na podlagi njegove stratigrafske lege in po litologiji. Opisano dolomitno zaporedje leži konkordantno pod litiotidnim dolomitom.

Premog nastopa v srednjeliasnem rjavkasto sivem zrnatem in močno bituminoznem dolomitu. Srednjeliasni dolomit je jasno plastnat (25-35 cm). Redko je ploščast (5-10 cm). Kontakti med plastmi so ostri, površine ploskev pa ravne ali valovite. Struktura je drobno- srednje- in debelozrnata. Poleg prevladujočega debelozrnatega dolosparita se pojavlja tudi horizont litiotidnega dolomita, ki loči spodnji in srednji lias. Skeleti litiotid so v glavnem vzporedni s plastnatostjo in so tako tesno skupaj, da tvorijo lumakele. Spodnjejurski dolomit je nastal pri poznodiagenetski dolomitizaciji apnencev. Za njegov poznodiagenetski nastanek govori predvsem njegova kristalna struktura. V srednjeliasni skladovnici se poleg dolosparitov pojavljajo tudi posamične tanke plasti drobnozrnate intraformacijske dolomitne breče. Debelina premogonosnih plasti znaša okoli 45 m.

V nahajališču Kočevski Rog sledimo premog v petih nivojih srednjeliasnega intervala. Pojavlja se v obliki tankih slojev, vložkov in leč. B u s e r (1965 b, 1974) je uvrstil liasne premoge na Dolenjskem med črne premoge, po naših podatkih pa v glav-

nem pripadajo rjavim premogom. Zaradi majhne debeline in razprostranjenosti liasni premog ni primeren za izkoriščanje.

Konkordantno na premogonosnih plasteh leži zaporedje zgornjeliasnih apnencev, ki jih imamo za ekvivalent formacije **marogastih apnencev**. Prehod dolomita, v apnenec je postopen. Apnenec je ploščast, plastnat (5-30 cm) in sivkasto črn. Najpogosteje pripada mikritu, redkeje stromatolitu in pasovcu. Le redko ima zrnato strukturo. Mestoma razpada v 2-5 cm debele plošče. Pogosto je bolj ali manj dolomitiziran. V najspodnjejšem delu vsebuje dva vložka (20 cm in 30 cm) gline. Spodnji vložek sestavljata rjavkasto siva glina in skrilav lapor z redkimi 5-7 cm debelimi prodniki sivega mikritnega in stromatolitnega apnenca. Apnenec je pri poznodiagenetski dolomitizaciji ponekod spremenjen v debelokristalasti dolomit.

Tektonska premikanja

Proti koncu norijske dobe so se epirogenetska premikanja, ki so bila več ali manj prisotna skoraj ves čas norijske sedimentacije, ko so se v območju plime in oseke usedali pretežno stromatolitni dolomiti, postopoma tako povečala, da so nekatera intertidalna področja Dinarske karbonatne platforme postala za krajši čas kopno. Na lokalnem kopnem so se vršili zakrasevanje, preperevanje in erozija, ki so omogočili nastanek zakraselih oblik, dolomitne breče in konglomerata ter boksitne gline.

Na območju Dinarske karbonatne platforme na meji med triasno in jursko periodo ni bilo orogenetskih premikanj (D o z e t, 1989). Manjši epirogenetski sunki starokimerijskega dviganja so na tej časovni prelomnici pogojevali sedimentacijo postopnega značaja; triasne in jurske plasti pa so povsod konkordantne.

Do novih močnejših epirogenetskih premikanj je prišlo na meji med spodnjim in srednjim liasom. V srednjeliasni skladovnici Kočevske opazujemo namreč številne vendar ne tako izrazite dogodke, ki kažejo na močnejša pozitivna epirogenetska premikanja. Ni težko ugotoviti, da je srednjeliasna sedimentacija v primerjavi z monotono spodnjeliasno dolomitno skladovnico zelo pestra, sestoji pa iz litiotidnih apnencev in dolomitov, mikritnih in biomikritnih apnencev, dolosparitov, megalodontnih apnencev in dolomitov ter biosparitnih apnencev. Posebej naj omenimo še debelozrnate biointrasparitne apnence z orbitopselami in vložke oosparitnih apnencev s tu in tam hematitiziranimi ooidi. Pestra sedimentacija kaže na dokaj nemirno srednjeliasno obdobje na Kočevskem. To sliko dopolnjujejo še pojavi kot so: bočno in vertikalno menjavanje facij, izklinjevanje plasti in dejstvo, da se litiotide pojavljajo zdaj v apnencih zdaj v dolomitih, da imajo litiotidni horizonti zelo nestalno debelino in se včasih celo izklinjajo, nadalje pojav apnenčevo-dolomitnih breč s kalcitnim vezivom in ne nazadnje pojavi premoga, ki govorijo za lokalne plitve lagune, močvirja, okopnitve in ustvarjanje pogojev za vegetacijo, ki je sodelovala pri nastanku sedimentov s premogom. Lias je bil verjetno v celoti sorazmerno hladno in vlažno obdobje, zlasti pa njegov srednji del, ko je nastajal premog.

Profil Kočevski Rog

Liasne karbonatne plasti v plitvovodnem razvoju s tankimi vložki in lečami premoga so lepo razvite vzhodno od Kočevja na območju Kočevskega Roga. Odkrite so ob približno 500 m dolgi gozdni makadamski poti (sl. 3 in 4). Profil je pomemben za

poznavanje geoloških razvojev in zlasti študij paleogeografskih razmer na ozemlju Kočevskega Roga oziroma območja Dinarske karbonatne platforme v spodnji juri.

Profil pričenja ob precej močni, približno dinarsko usmerjeni prelomnici, ki loči južno ležeče spodnjemalmske in severno ležeče liasno zaporedje sedimentov s plastmi premoga.

Apnenec s cladocoropsisi

Južno od preloma ležeči apnenec je sivkasto črn do črn, v določenih intervalih svetlo siv do srednje svetlo siv. V strukturnem pregledu prevladujejo mikritni, biomikritni in biosparitni apnenec z algami, foraminiferami, cladocoropsisi in moluski. Tu in tam naletimo na vložke biointraoosparitnega apnenca s koralami, cladocoropsisi, briozoji in moluski. Debelina opisanih plasti znaša 150 do 200 metrov. Glede na litofacies in na fosilno vsebino sklepamo, da pripadajo opisane kamenine srednjemu malmu.

Spodnji dolomitni člen

Severno od dinarskega preloma leži okoli 75 metrov debela skladovnica srednje temno sivega do temno sivega ploščastega in plastnatega (5-10 cm, 10-35 cm) srednje in debelozrnatega močno bituminoznega dolomita, ki tu in tam vsebuje nedoločljiv organski detritus. Dolomit je včasih laminiran, oziroma pasnat. V pasovih se menjavata svetlo sivi zelo drobnozrnati in temno sivi debelozrnati dolosparit. Krojitev kamenine je debelo paralelepipedska, redkeje nepravilna. Spodnji dolomitni člen je glede na litologijo, stratigrafsko lego in debelino srednjeliasne starosti.

Litiotidni dolosparit

Nad spodnjim dolomitnim členom leži konkordantno brez prekinitve sivi plastnati (20-60 m) dolosparitni dolomit lumakelnega tipa. Sparitni dolomit vsebuje izredno številne litiotidne školjke. Školjke so na območju Dinarske karbonatne platforme v srednjeliasni dobi sestavljale podmorske trate ali biostrome. Po odložitvi apnenca je nastopila poznodiagenetska dolomitizacija, ki je že litificirani biosparitni apnenec spremenila v debelozrnati dolomit. Debelino horizonta dolomita z litiotidami je 2,5 m. Kontakt med spodnjim dolomitom in litiotidnim dolosparitom predstavlja mejo med spodnjim in srednjim liasom.

Premogonosne plasti

Nad horizontom litiotidnega dolomita sledi najprej 75 m debela skladovnica sivega, srednje rjavo sivega in temno sivega, ploščastega in plastnatega (5 - 10 cm, 10 - 60 cm) srednjezrnatega bituminoznega dolomita z zelo redkimi in tankimi (do 0,5 m) vložki intraformacijske dolomitne breče. Dolomitna breča je sestavljena iz zelo slabo zaobljenih sivkasto črnih drobcev srednjezrnatega dolomita v sivi zelo drobnozrnati dolomitni osnovi. V dolomitnih drobcih in tudi v osnovi opazujemo tu in tam organ-

ske ostanke. Dolomit je včasih laminiran. Laminiranost nastopa zaradi različne zrnavosti in vsebnosti organske komponente. Menjavajo se bele, rjavkasto sive, temno rjave in črne lamine. Poleg vodoravne opazujemo mestoma tudi navzkrižno laminiranost. Premogonosni skladi so nastajali v plitvem nadplimskem in medplimskem okolju, kamor je bila prinašana tudi premogova substanca.

Prvi horizont premoga: Prvi horizont premoga (Sl. 5) je debel 8 metrov. Sestoji iz treh slojev oziroma leč premoga, ki leže v temno rjavo sivem in temno sivem močno razkrojenem oziroma razpadlem zrnatem bituminoznem dolomitu. Črna premogova substanca je ponekod v ostrem ravnem kontaktu z dolomitom, drugod pa zelo nepravilno prehaja v prikamenino.

Prvi sloj premoga (Sl. 5) prvega horizonta je debel 20-30 cm. V spodnjem delu vsebuje tudi nekaj temno sive premogove gline. Krovnino premoga tvori sivkasto črn ploščast (3-5 cm) zrnat bituminozen dolomit, ki je v ravnem in jasnem kontaktu s premogom. Navzdol prehaja premog najprej v sivkasto rumen dolomitni lapor nato v ploščast in tanko plastnat (5-15 cm) zrnat bituminozni dolomit. Premogova substanca je močno zaglinjena; v bazalnem delu z rumeno, v vrhnjem delu pa s sivo in temno sivo glino. Zgornji kontakt premoga z dolomitom je raven spodnji pa raven do rahlo valovit.

Drugi sloj premoga (Sl. 5) je debel 10-25 cm. Premogova substanca je v spodnjem in zgornjem delu in tudi lateralno pomešana s temno sivo in sivkasto črno glino. V krovnini premoga je rjavkasto siv ploščast (5-15 cm) zrnat bituminozen dolomit, njegovo talnino pa sestavlja črn ploščast in tankoplastnat (5-15 cm) zrnat bituminozen dolomit. Zgornji kontakt premoga in dolomita je valovit do nepravilen spodnji pa raven do rahlo valovit.

Tretji sloj premoga (Sl. 5) je debel 15 cm. V tretjem sloju prevladuje temno siva premogova glina. V krovnini premoga je rjavo siv ploščast (2-10 cm) drobno in srednje zrnat dolomit v talnini pa je rjavkast ploščast (5-15 cm) zrnat bituminozen dolomit. Oba kontakta sta valovita do nepravilna. Vrhnja plast dolomita, ki zaključuje prvi horizont, je debela 1,5 m in je rožnato obarvana. Na njej leži 60 cm debela plast sivkasto črnega zrnatega bituminoznega apnenca, ki je v najspodnjejšem in vrhnjem delu rožnato rdeč.

Drugi horizont premoga (Sl. 5) je debel 10-25 cm. Zanj je značilno lečasto pojavljanje rumenkasto sivega prhkega dolomita v črni premogovi substanci, ki se menjava z lističastim (1-3 mm) črnim glinovcem. Krovnino premoga predstavlja ploščast in tanko plastnat (5-15 cm) rumenkasto siv, temno siv in sivkasto črn zrnat bituminozen dolomit v talnini pa je rumenkasto siv ploščast (3-10 cm) zrnat bituminozen dolomit.

Tretji horizont premoga (Sl. 5), ki ga sestavlja sivkasto črna premogova substanca, je debel 5 do 15 centimetrov. Plast premoga je na enem mestu prekinjena z zrnatim bituminoznim dolomitom. V talnini premoga je plastnat (25-35 cm) olivno sivo drobnozrnat dolomit, v krovnini pa plastnat (30-45 cm) sivkasto črn srednjezrnat dolomit.

Četrti horizont (sl. 5) je sestavljen iz črne premogove substance, ki je zelo nepravilno razporejena v modrikasto in zelenkasto sivi skrilavi premogovi glini. Debel je 60 centimetrov. Premoga je okoli 25 %. V premogovi glini so redki do 1,5 cm debeli dokaj zaobljeni prodniki zrnatega bituminoznega dolomita in glinovca. Konkordantno in z ostro nepravilno ploskvijo na premogu leži rjavo siv stromatolitni dolomit.

Med premogonosne plasti štejemo tudi 7,5 m debel **pas postopnega prehoda** med srednjeliasnim dolomitom in zgornjeliasnim marogastim apnencem. Pas postopnega prehoda pričenja z 0,5 m debelim sivim ploščastim (1-5 cm) stromatolitnim apnencem. Bazalni del stromatolitnega apnenca, je mestoma rožnat do rožnatordeč in ponekod močno dolomitiziran. Navzgor sledi v debelini 1 m debeloplastnat, siv, v bazalnem delu rožnat, izredno močno dolomitiziran pasnat in stromatoliten apnenec. Na njem leži 25-50 cm debela plast sivkasto črnega do črnega zrnatega bituminoznega gomoljastega dolomita z do 1,5 cm velikimi korozijskimi votlinami. Navzgor sledi najprej 0,5 m debel paket sivkasto črnega drobnozrnatega ploščastega in plastnatega (2-30 cm) apnenca, nato pa 0,5 m debel interval sivkasto črnega plastnatega 10-30 cm mikritnega apnenca. Dolomit (3 m), ki leži nad opisanim apnencem, je olivno siv do sivkasto črn, ploščast in tanko plastnat (5-20 cm) srednjezrnat in močno bituminozen. Premogonosne plasti se zaključujejo z 1 m debelim paketom temno rjavega in sivkasto črnega ploščastega in plastnatega (2-25 cm) zrnatega močno bituminoznega „satastega" dolomita z do 10 cm debelimi lečami premoga. Gre za peti in zadnji horizont premoga (Sl. 5) v obravnavanem sedimentnem zaporedju.

Kamenine v pasu postopnega prehoda uvrščamo dogovorno k srednjeliasnemu zaporedju po načelu, da spada pas postopnega prehoda k tisti formaciji, ki je bolj pestra.

Marogasti apnenec

Gre za formacijo sivega temno sivega in sivkasto črnega mikritnega in drobnozrnatega ploščastega (5-10 cm) in plastnatega (10-35 cm, redko 45-60 cm) mikritnega apnenca z bolj ali manj pogostnimi rumenkastimi glinastimi in laporastimi lisami. Nekatere lise so nastale pri poznodiagenetski dolomitizaciji prvotnega apnenca zaradi različne mineraloške in kemične sestave. V vrhnjem delu 120 m debele skladovnice marogastega apnenca je nekaj 5 do 12 metrov debelih vložkov debeloplastnatega debelozrnatega (40-60 cm) rjavo do srednje temno rjavega zrnatega bituminoznega dolomita. V apnencu opazujemo številne vodoravne stilolitne šive. Po šivih, ki jih sledimo vertikalno v plasteh na vsakih 5 do 10 cm, je napredovala poznodiagenetska dolomitizacija, kar je zrahljalo kamenino do te mere, da je prvotno plastnata kamenina razpadla na plošče. V formaciji pretežno mikritnega marogastega apnenca sta v obravnavanem profilu precej pogostna tudi pasnati in stromatolitni apnenec. Pasnatost v kamenini nastopa predvsem zaradi različne vsebnosti organskih snovi (beli, svetlo do temno rjavi, črni pasovi) in zaradi razlik v zrnavosti posameznih pasov ter zaradi različne stopnje in vrste diageneze (svetlo in temno rjavi pasovi). Značilnost formacije marogastih apnencev je tudi, da je izredno revna s fosili. V teh apnencih zasledimo ponekod nedoločljive organske ostanke.

Tabela 1. Kemična sestava premoga v profilu Pekel-Lapinje (Kočevska Mala gora, južno od Oneka) in na območju Belih vod (Goteniška gora, sl. 1)

Table 1. Chemical composition of the coal in the cross-section Pekel-Lapinje (Kočevska Mala gora, S of Onek) and at Bele vode (Goteniška gora, fig. 1)

Koordinate x = 5057,999 y = 5471,710 Coordinates		x = 5045,260 y = 5498,370		
Nahajališče Locality	Bele vode	Južno od Pekla South of Pekel		
Vzorec Sample	737/4, 8, 11	6334/2	6334/5	6334/7
Vlaga celotna % Total moisture	17,75	8,82	15,28	7,15
Pepel - Ash %	30,09	80,30	66,82	84,25
Gorljive snovi % Combustible matters	52,17	10,88	17,90	8,60
Žveplo celotno % S total	1,37	0,19	0,50	0,27
Žveplo v pepelu % S in ash	1,08	0,06	0,19	0,16
Žveplo gorljivo % S combustible	0,29	0,13	0,31	0,11
Zgornja kal. vrednost Upp. calorific value kcal/kg	3402 = 13,24 MJ/kg			
Spodnja kal. vrednost Lower cal. value kcal/kg	3116 = 13,04 MJ/kg			

Opomba: Kalorične vrednosti so določene kalorimetrično, razen pri tistih vzorcih, ki v kalorimeterski bombi ne zgorevajo.

The calorific values are defined calorimetric, except those samples, which do not burn out in the calorimetric bomb.

Kemična sestava premoga

V geološkem profilu Pekel-Lapinje v južnozahodnem delu Kočevske Male gore je zaporedje kamnin (sl. 6), ki po stratigrafski legi in litološki sestavi pripadajo srednjemu liasu.

Na tej lokaciji je v dolomitu okrog 2,25 m debel vložek zgoraj plastnatega spodaj

ploščastega apnenca. Na kontaktu med apnencem in dolomitom je okoli 20 cm debel vložek temno sivega premogovega skrilavca in gline s sledečo kemično sestavo, ki je prikazana na tabeli 1.

Sedimentacijsko okolje

V literaturi se z območja Tetide pogosto omenja reto-liasno premogovo obdobje s številnimi pojavi in ležišči premoga. Vendar na območju Dinarske karbonatne platforme v retiju ni bilo pogojev za nastajanje premoga. Epirogenetska premikanja in s tem v zvezi plitvenje morja sta se sicer povečala do te mere, da so nekatera medplimska področja postala za krajši čas kopno, na katerem sta se vršila le zakrasevanje in erozija. Šele koncem retija oziroma na začetku jure je prišlo do pojavov vlažne klime in z njo tudi do pospešnega razvoja kopenske in močvirne flore ter nastajanja premoga. V ugodnih klimatskih pogojih in naglemu razvoju rastlin na eni strani in obstoju številnih plitvovodnih bazenov oziroma lagun na drugi strani, je prišlo do večkratne akumulacije rastlinskega materala v karbonatno blato in do nastajanja premogišč. Kolebanja nivoja vode v laguni so bila posledica epizodičnih sprememb v hidrosferi in zlasti pojačanih premikanj in procesov v litosferi (subsidenca). Močvirna gozdna facija, kot matična facija za nastanek premogovih slojev, je bila vezana za priobalno zono. Sedimentacija v laguni je bila odvisna od razmerja treh gradientov: (1) nanosa rastlinskega materiala, (2) nastajanja karbonatov in (3) subsidence. V intervalih, ko je bil gradient donosa rastlinskega materiala visok in klimatski pogoji ugodni, je prihajalo do nastajanja slojev premoga. V trenutku ko je gradient donosa rastlinskega materiala bil manjši od gradienta subsidence je nastajanje premogovih slojev bilo prekinjeno. Na premogove sloje se je odložilo karbonatno blato. Nato so sledili diagenetski in metamorfni procesi v odloženih sedimentih.

Korelacija liasnih plasti južnovzhodne Slovenije

Premogonosne liasne plasti Kočevskega Roga primerjamo z liasnimi plastmi Male gore (sl. 9), Kočevske Male gore (sl. 6 in 7), Suhe krajine (sl. 8) in Bele krajine, to je tistih predelov Dinarske karbonatne platforme v južnovzhodni Sloveniji, ki ležijo v neposredni bližini Kočevskega Roga, oziroma ga obdajajo. Že na prvi pogled opazimo veliko sorodnost liasnih profilov naštetih lokalnosti. V spodnjem delu liasnega intervala je razvit zrnat, pretežno ploščast in močno bituminozen dolomit. V srednjem delu karbonatne skladovnice je nad prvim litiotidnim horizontom en ali več horizontov premoga, premogovega skrilavca in gline. V krovnini premogonosnih plasti je ploščast in plastnat zgornjeliasni marogasti apnenec.

Stratigrafski stolpec liasnih plasti v profilu G. Retje - Bukovec pri Poljanah na Mali gori (sl. 9) je dokaj enak zgoraj naštetim. To velja zlasti za njegov spodnji in zgornji del, ki ga sestavljata zrnat bituminozni dolomit oziroma marogasti apnenec. Opazna razlika nastopa v srednjem delu liasnega zaporedja Male gore, kjer se v najspodnjejšem, srednjem in zlasti vrhnjem delu pojavlja oolitni apnenec. Tako apnenec kot dolomit sta bogata z makro in mikrofosili. Glavna razlika je v tem, da liasne plasti, ki gradijo Malo goro, ne vsebujejo premoga.

Še najbolj drugačen je stratigrafski stolpec liasnih plasti Suhe krajine (sl. 8), ki ga v spodnjem delu predstavljajo Krkini apnenci (D o z e t, 1993). Tu pretežno gre za de-

beloplastnate, črne, biomikritne, oomikritne, intrasparitne in biointrasparitne apnence z vložki intraformacijskih breč in konglomeratov, fenestralnih apnencev, stromatolitnih apnencev ter tu in tam dolomitov. Našteti sedimenti kažejo izrazite značilnosti plitvomorske sedimentacije in so nastajali v podplimskem, medplimskem in nadplimskem pasu. Vsebujejo spodnjeliasno favno in floro, najbolj pogostne v njih pa so alge in foraminifere. V spodnjeliasnih apnencih so med drugim določene alge *Palaeodasycladus mediterraneus* Pia, *Palaeodasycladus elongatus* Praturlon in *Linoporella lucasi* Gros & Lemoine. Srednjeliasna sedimentacija v profilu Podbukovje (Krka) - M. Korinj (sl. 8) je precej bolj pestra kot spodnjeliasna. Sedimentno zaporedje srednjeliasnega intervala sestoji iz temno in srednje temno sivih, zrnatih, bituminoznih dolomitov, intraformacijskih dolomitnih breč, biopelmikritnih, oosparitnih, oointrasparitnih ter litiotidnih in megalodontidnih apnencev. V najspodnjejšem delu obravnavanega zaporedja sedimentov so čisti in apnenčevi dolomiti z vložki intraformacijskih dolomitinih breč. Dolomiti so debelokristalasti, torej poznodiagenetski. Včasih vsebujejo precej drobnih organskih ostankov. Megalodontidni apnenci so redki. Litiotidni apnenci se pojavljajo v zgornjem delu srednjeliasne skladovnice. V strukturnem pogledu pripadajo biomikritom, kjer so v temno sivem do sivkastočrnem apnenem mulju nakopičene številne litiotide, ki jih tu in tam spremljajo megalodontide in foraminifere. V litiotidni faciji se pojavljata biostromalni in grebenski tip sedimentacije, zrnati apnenci in dolomiti pa so se odlagali v podplimskem, medplimskem in nadplimskem okolju. Zgornjeliasni interval (sl. 8) predstavlja formacija marogastih apnencev za katero je v Suhi krajini značilno, da je debela le nekaj deset metrov. Sestoji iz ploščastih (3-10 cm) in plastnatih (15-45 cm) temno sivih, sivkasto črnih in črnih pretežno mikritnih, lisastih, pogosto tudi gomoljastih apnencev. Apnenci so tu in tam nekoliko dolomitizirani in vsebujejo redke, nekaj metrov debele vložke rjavkasto sivega zrnatega dolomita. V strukturnem pogledu pripadajo najpogosteje mikritu in pelmikritu. Ponekod vsebujejo intraklaste ter limonitizirane ooide in onkoide. S fosili so zelo revni, kar kaže na to, da so se tvorili v okolju, ki je bilo neugodno za žive organizme. Opisano zaporedje sedimentov je po stratigrafski legi sodeč zgornjeliasne starosti. Leži namreč med litiotidnimi apnenci, ki so srednjeliasne starosti, in oolitnimi apnenci z doggersko favno.

Zaključek

Zaporedje srednjeliasnih karbonatnih kamenin v Kočevskem Rogu, ki pripada Dinarski karbonatni platformi, vključuje v več nivojih tudi tanke sloje in leče premoga. Osnovna značilnost slojev in leč premoga je majhna in nestalna debelina, ki se giblje od 60 cm do popolne izklinitve. Material za premog poteka od kopenske in močvirske vegetacije. Glede na število odkritih pojavov premoga sklepamo, da so za razvoj močvirske vegetacije bili dani najboljši pogoji v srednjem liasu. Pri spodnjejurskih premogih je šlo predvsem za alohtono kopičenje oziroma akumulacijo rastlinskega materiala. Transport materiala se je vršil s pomočjo vodnih tokov, drobnejši in odpornejši material (polen, spore) pa z vetrom. Majhne debeline slojev premoga govore, da ni bilo bujnega avtohtonega rastlinstva temveč da je le-ta prihajal v bazen z rečnimi tokovi. Srednjeliasna premogišča so majhna. Lokalno so jih izkoriščali v preteklosti, dandanes pa nimajo nobenega pomena za gospodarstvo.

Zahvala

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Plate 1 - Tabla 1

1, 2 Selektivna poznodiagenetska dolomitizacija premogonosnega ploščastega in plastnatega mikritnega apnenca z intrasparitnimi ter stromalitnimi pasovi in redkimi stiloliti.

Selective late diagenetic dolomitization of the coal-bearing platy and stratified micritic limestone with intrasparitic and stromatolitic laminae and rare stylolites.

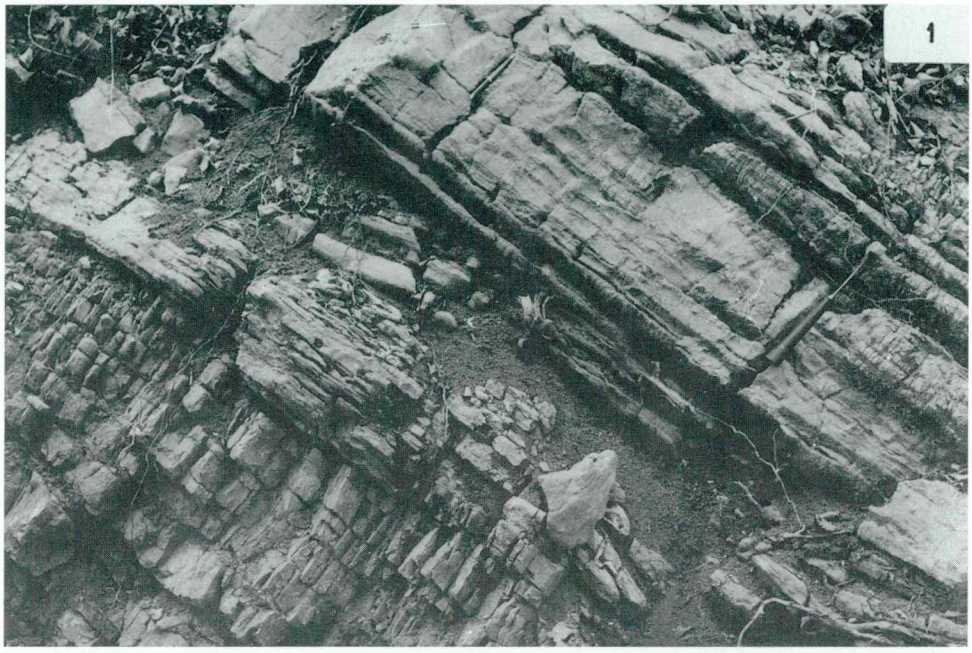
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Plate 2 - Table 2

1 Litiotidne školjke ? *Lithioperna* sp. in *Cochlearites* sp. v srednjeliasnem zrnatem bituminoznem dolomitu
Lithiotid bivalves ? *Lithioperna* sp. and *Cochlearites* sp. in the Middle Liassic grained bituminous dolomite

2 Prvi horizont s tremi sloji premoga v srednjeliasnem ploščastem in plastnatem zrnatem bituminoznem dolomitu
The first horizon with three coal seams in the Middle Liassic platy and stratified grained bituminous dolomite

3, 4 Drugi horizont premoga v poznodiagenetskem ploščastem in plastnatem zrnatem bituminoznem dolomitu
The second horizon of coal in the late diagenetic platy and stratified grained bituminous dolomite

5 Tretji horizont premoga v debeloplastnatem zrnatem bituminoznem dolomitu
The third horizon of coal in the thick-bedded grained bituminous dolomite

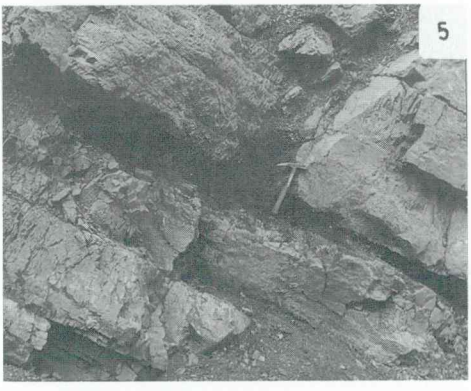
6 Premog med spodaj ležečim plastnatim zrnatim bituminoznim dolomitom in zgoraj ležečim pasnatim mikritnim apnencem
The coal between underlying stratified grained bituminous dolomite and overlying laminated micritic limestone


1


2


3


4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