Middle Liassic-Lower Malm Stratigraphic Gap in Suha krajina

Stratigrafska vrzel srednji lias-spodnji malm na območju Suhe krajine

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Received: April 23, 2003 **Accepted:** September 15, 2003

Abstract: The Upper Triassic and Jurassic stratigraphy as well as the Middle Liassic-Lower Malm stratigraphic gap in the Suha krajina area have been studied in this article. In the cross-section Valična vas-Sela to the northwest of Žužemberk the Upper Triassic, the Lower and Middle Liassic as well as the Lower and Upper Malm sediments have been recognized. The field and laboratory studies showed that in that part of Slovenia the Upper Liassic and Dogger beds were not deposited. That significant interruption of sedimentary continuity has been caused by intensified epeirogenic movements between the Middle Liassic and the Lower Malm.

Izvleček: V tem članku so podane zgornjetriasne in jurske stratigrafske razmere ter stratigrafska vrzel srednji lias-spodnji malm na ozemlju Suhe krajine. V profilu Valična vas-Sela severozahodno od Žužemberka so ugotovljeni zgornjetriasni, spodnje- in srednjeliasni ter spodnje- in zgornjemalmski sedimenti. Terensko in laboratorijsko proučevanje je pokazalo, da zgornjeliasne in doggerske plasti v tem delu Slovenije niso bile odložene. To pomembno prekinitev sedimentacije so povzročila pojačana epirogenetska premikanja med srednjim liasom in spodnjim malmom.

Key words: Stratigraphy, unconformity, Upper Triassic, Jurassic, Suha krajina, Outer Dinarides

Ključne besede: stratigrafija, stratigrafska vrzel, zgornji trias, jura, Suha krajina, Zunanji Dinaridi

Introduction

The study area (Figure 1) lies about 45 kilometres to the southeast of Ljubljana. It belongs to the region known under the name of Suha krajina. The geological composition and structure of the Suha krajina region has been systematically investigated in the framework of the regional field mapping for the Geologic Map of Slovenia on the scale of 1:50.000. Its lithological composition indicates that it belongs to the large paleogeographic Mesozoic unit named the Dinaric Carbonate Platform. From the geotectonic point of view the investigated area belongs to the Outer Dinarides. The unit of the Outer Dinarides was originally a relatively large and morphologically uniform area of predominantly shallow water carbonate deposits ranging from subtidal to supratidal environment. In the Middle Triassic the Outer Dinarides underwent a dif-

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ferentiation due to the formation of the Slovene trench, and soon the originally uniform area was dissected into two minor platforms, the Julian and the Dinaric one (BUSER, 1989; RADOIČIĆ, 1989). Carbonate rocks were continuously deposited there from the Upper Triassic to the Lower Tertiary. The platform consisted of a very thick carbonate succession with an average thickness of about 4000 m to 5000 m.

Generally speaking, the syngenetic paleotectonic events have controlled the paleogeographic evolution of the Dinaric Carbonate Platform. The neotectonic processes uplifting the study area, dictate the present position of the Suha krajina region.

PREVIOUS INVESTIGATIONS

Suha krajina was one of the least explored areas of Slovenia. The oldest data on geological structure of this region can be found in the articles of M.V. LIPOLD (1858). ŽURGA (1938) was among first who described the geological structure of the Dolenjska district. In the notice on geological mapping of the Map Sheet Novo Mesto, GERMOVŠEK (1953, 1956) mentioned among others the transgres-

Figure 1. Location sketch map of the Valična vas – Sela at Šumberk cross-section
Slika 1. Položajna skica profila Valična vas – Sela pri Šumberku

sion of the Tithonian limestones upon the Liassic limestone in the area between Temenica and the upper stream of Krka. The transgressive Malm limestones contain the typical Tithonian pseudooolitic-brecciated horizon.

In the Trnovski gozd area the Liassic is represented by oolitic limestones with dolomite and micritic limestone interbeds. The upper part of the oolitic succession belongs most probably already to Dogger. The oolitic limestone is transgressively overlain by the Tithonian coral and hydrozoan limestones.

The Jurassic biostratigraphy of the area was dealt by Germovšek (1954), Šribar (1966) and Turnšek (1966, 1969, 1972). Buser (1968, 1974) reported that the Upper Liassic and Dogger beds are not developed at Smrekova draga in the Trnovski gozd area, as well as in the area among Ivančna gorica, Radohova vas and Trebnje.

Pleničar (1968) reported that in the Dolenjsko district in the area between Stična, Šentvid, Radohova vas and Vel. Gaber the Malm beds lie transgressively upon the Middle Liassic ones.

Šribar (1966) described the Jurassic sediments between Zagradec and Randol in the Suha krajina region. On the basis of microfossils and the stratigraphic position she divided the Jurassic succession into the Lower and Middle Liassic, Upper Liassic-Dogger, Lower Malm, and Upper Malm.

In the comparatively small region of southern Slovenia Turnšek (1969) distinguished three types of hydrozoan fauna formed during the Lower Malm that are connected with three separated areas. These are the hydrozoan *Cladocoropsis* in the southern faunistic area, the parastromatoporidian Hydrozoa, corals and Chaetetidae in the central faunistic area, and the actinostromaridian Hydrozoa in the northern faunistic area.

The results of systematic regional geologic mapping on the map sheet Ribnica that comprises the study area as well, are presented in the geological map on the scale of 100 000 and its explanatory text by Buser (1969, 1974).

Pleničar and Premru (1977) found that the limestone at Trebnje with the foraminifer *Lituosepta recoarensis* (Cati) was overlaid discordantly by the Lower Malm sediments and that the Dogger rocks were absent.

Buser (1979) studied the geological circumstances on the Map Sheet Ribnica 1:100 000 and divided the Jurassic succession in the lower (Oxfordian and Lower Kimmeridgian) and upper part (Upper Kimmeridgian and Tithonian).

Describing the geological structure of the Ribnica Map Sheet area Buser (1974, 1979) mentioned the Jurassic ($J_3 - J_1$) transgressional boundary as well.

Bukovac et al. (1984) presented a sedimentary and erosional reduction of the Liassic, Dogger and Lower Malm lithologic succession in the Črnomelj Map Sheet area.

The results of field and laboratory investigations in the study area were published in the following papers: Strohmenger, Dozet & Koch (1987 a, b), Strohmenger (1988), Strohmenger & Dozet (1991) and Strohmenger, Deville & Fookes (1991)

studying the oolitic facies, stratigraphy, diagenesis, facies developments, the Malm eustacy and geochemistry of the Jurassic carbonate rocks in Suha krajina. DOZET AND STROHMENGER (1996) described the Late Malm carbonate breccias at Korinj discussing their significance for eustacy and tectonics. Shallow water deposits, breccias and subaerial exposures, evidenced by bauxite at some places in the Suha krajina region, are considered to be connected with eustatic sea-level variations as well as syn-sedimentary fracturing and block-faulting. DOZET (1995b) described various types of the Malm algal nodules (oncolites) from the Suha krajina region in the central Slovenia.

In his dissertation STROHMENGER (1988) discussed microfacies and diagenetic development of the Jurassic carbonate rocks from the section Kompolje-Ogorelec at the Mala gora mountain and the section Krka-Mali Korinj in the Suha krajina region.

STROHMENGER AND DOZET (1991) studied the stratigraphy, facies developments and geochemistry of the Jurassic carbonate rocks in Suha krajina. The field studies showed that at least the uppermost part of Dogger was not deposited there.

STROHMENGER ET AL. (1991) compared the Upper Jurassic stratigraphy and the facies development of the Dinaric Carbonate Platform of Slovenia with the Jurassic Carbonate Platform of southern Jura (southeastern France). The Malm discontinuity is interpreted as representing a large-scale sequence boundary, probably of type 1, (black pebble conglomerate: France; reef breccia: Switzerland; karst breccia: Slovenia).

DOZET (1993) detected the complete Lofer cyclothems in the Lower Liassic beds from the Slovenian part of the Outer Dinarides.

BUSER AND DEBELJAK (1996) studied the distribution of lithiotids in the Jurassic beds of south Slovenia. The horizon with bivalves (lithiotid horizon) is attributed to Pleinsbachian (Domerian). The most interesting are three large bivalve species: *Lithiotis problematica* Gümbel, *Cochlearites loppianus* (Tausch) and *Lithiopedalion scutatus* (Dubar). In addition, the following genera can be found: *Gervilleioperna, Mytilus, Opisoma* and *Pachyrisma* (with subgenera *Pachymegalodon* and *Durga).*

DEBELJAK AND BUSER (1998) ranged the horizon containing the Middle Liassic bivalves, the so called "lithiotid horizon", into the Pliensbachian or Domerian.

DOZET AND ŠRIBAR (1998) lithologically described and biostratigraphically subdivided the shallow marine Jurassic beds in the southeastern Slovenia.

METHODS

This study is based on the systematic regional geological mapping for the Geological Map of Slovenia on the scale of 1:50 000 as well as several detailed field surveys including stratimetric measuring and profiling as well as a precise sedimentological and facies study of the Jurassic rocks in the considered area. Moreover, the whole area is docu-

mented by rock samples, numerous thin-sections and geochemical analyses. The stratigraphic relationships have been established by means of micro- and macrofossils as well as lithological and biostratigraphical correlations. The carbonate rocks are classified according to FOLK's (1959) practical petrographic classification of limestones and DUNHAM's (1962) classification of carbonate rocks according to depositional texture. The microfauna and microflora are determined by Ljudmila Šribar and Rajka Radoičić. Hydrozoans, sponges and corals are determined by Dragica Turnšek. The colour determinations of the rocks are based on the Munsell Rock Colour Chart.

STRATIGRAPHY

The study area is built of the Triassic and Jurassic rocks, which are at many places covered with a couple of metres of the Pliocene and Quaternary deposits. The Triassic system is represented by the Main Dolomite, which is overlain by the Rhaetian-Liassic carbonate succession. The Jurassic beds are not completely developed. The up to the present gathered data show the lack of the Upper Liassic and the Dogger beds. The above-mentioned Triassic and Jurassic beds are the result of more or less continuous sedimentation on the Dinaric Carbonate Platform.

STRATIGRAPHY OF THE SEDIMENTARY SUCCESSION UNDERLYING THE MIDDLE LIASSIC-LOWER MALM UNCONFORMITY

The sedimentary succession exposed at the surface in the Suha krajina area and lying under the Middle Liassic-Lower Malm unconformity range in age from the Upper Triassic to the Middle Liassic belonging to two pretty widely exposed formations, namely: the Main Dolomite and the Rhaetian and Liassic Beds (Fig. 2, Fig. 3).

Main Dolomite Formation

About 2000 metres thick Triassic rock succession in Southern Slovenia lies transgressively upon the Permo-Carboniferous and Permian beds (BUSER, 1974; DOZET, 1985; SAVIĆ ET AL., 1982).

The Upper Triassic beds are developed as 800 to 1000 metres thick succession of carbonate rocks, known as the Main Dolomite or Hauptdolomit, deposited on the vast stable carbonate platform of the Outer Dinarides showing the Lofer development. Sedimentary structures, geochemical data and fossils indicate a sedimentation in a quiet restricted shelf with numerous signs of littoral conditions. Mineralogical and chemical analyses show that the dolomite is very pure with stechiometric composition. Stromatolitic and loferitic layers were subjected to an early dolomitization with capilary processes. Other layers were dolomitized after deposition.

In spite of monotonous outer aspect the Main Dolomite shows a pretty heterogeneous microfacial composition. Being formed in changeable littoral and sublittoral conditions the Main Dolomite shows numerous lithological varieties, which are characteristic for intertidal and supratidal environments. These are stromatolitic layers, loferites, laminated carbonate rocks as well as tidal conglomerates in different varieties and interweavings.

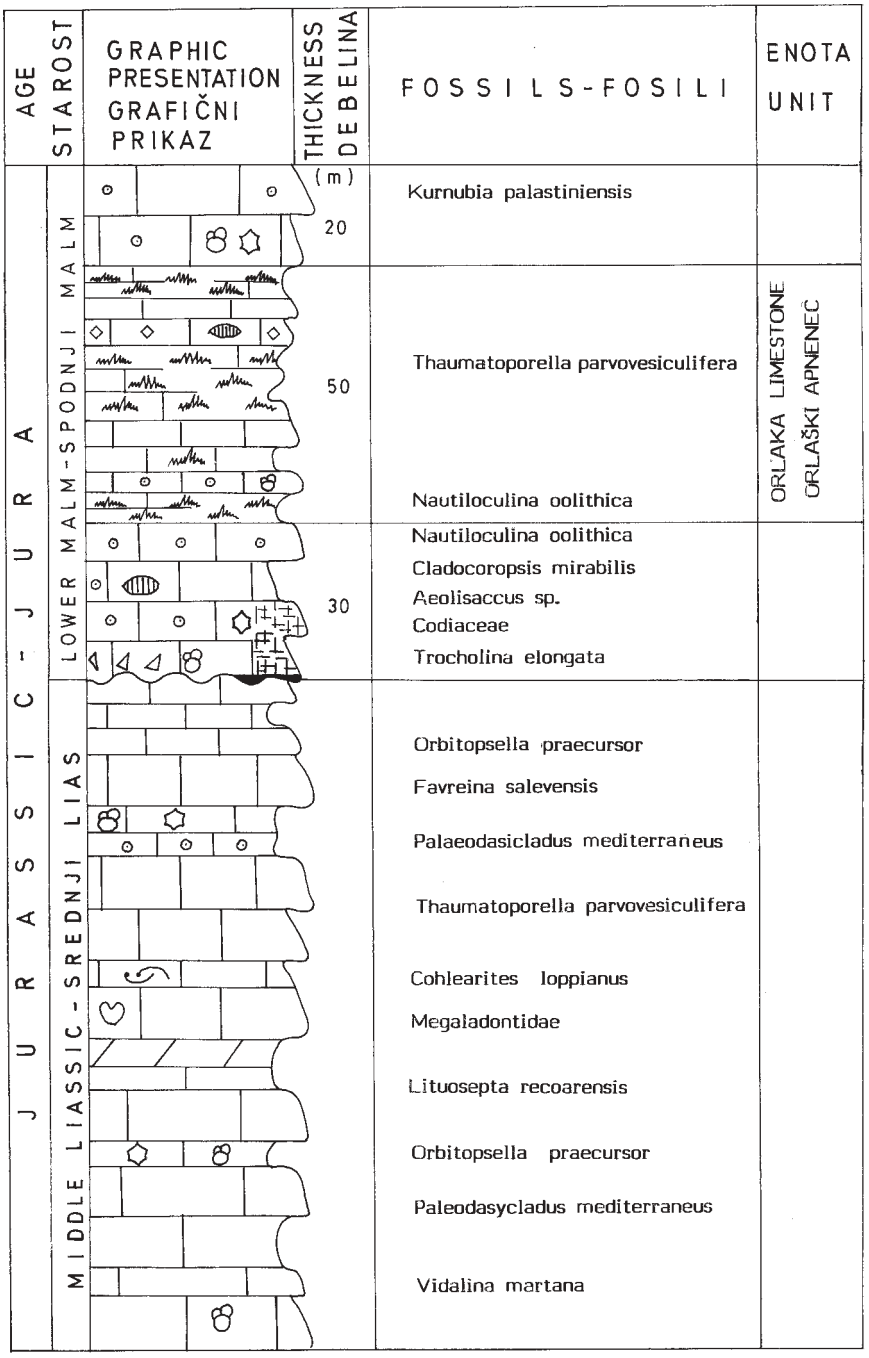
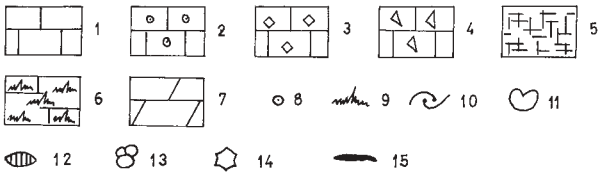


Figure 2. Shematic geological column in the level of the Jurassic stratigraphic gap, the underlying Middle Liassic and the overlying Lower Malm beds
Slika 2. Shematski geološki stolpec v predelu jurske stratigrafske vrzeli ter spodaj ležečih srednjeliasnih in zgoraj ležečih spodnjemalmskih plasti



LEGEND

1 - micritic limestone, 2 - oolitic limestone, 3 - sparitic limestone, 4 - brecciated limestone, 5 - massive limestone, 6 - micritic limestone and cherts, 7 - bedded dolomite, 8 - ooid, 9 - chert, 10 - lithiotids, 11 - megalodontids, 12 - reef fossils, 13 - foraminifers, 14 - algae, 15 - red clay

LEGENDA

1 - mikritni apnenec, 2 - oolitni apnenec, 3 - sparitni apnenec, 4 - brečasti apnenec, 5 - masivni apnenec, 6 - mikritni apnenec in roženci, 7 - plastnati dolomit, 8 - ooid, 9 - roženec, 10 - litiotide, 11 - megalodontide, 12 - grebenski fosili, 13 - foraminifere, 14 alge, 15 - rdeča glina

Figure 3. Legend
Slika 3. Legenda

Rhaetian and Liassic Beds

The Main Dolomite being most extended in the Valična vas-Sela area passes upwards into pretty heterogeneous carbonate succession ranging in age from the Uppermost Triassic to the Middle Liassic.

The Rhaetian-Liassic carbonate succession has a heterogeneous composition, being composed of laminated dolomite and limestone, micritic and biomicritic limestone, dolomitized limestone as well as dolomitic and dolomitic-calcareous breccias. In the lower and middle part of the described sedimentary succession dolomites prevail, whereas in the upper part limestones are most common.

The dolomites are well-stratified (10-35 cm) or platy (5 cm), fine and coarse-grained, very light grey, light grey, and occasionally very light brownish grey. In the lower part of the succession intercalations of grey and dark grey middle to coarse-grained dolomite appear. Laminated and stromatolitic dolomites are often observed in the lower and middle part of the Rhaetian-Liassic lithological column.

The limestones are thick-bedded (35-150 cm) belonging to the light brownish grey micrite, rarely biomicrite. At some places very light grey, light grey and medium grey, thick-bedded, laminated, micritic limestone occurs with some centimetres solution cavities filled with white calcite. Among the de-

scribed limestones there are very light grey, platy (5 cm) and stratified (10-35 cm) more or less dolomitized limestones. Occasionally, red and pink strongly dolomitized limestones with some mm to some cm large cavities filled with calcite occur in the considered sedimentary succession.

Dolomitic and dolomitic-calcareous breccias are very light grey, light grey and moderate light grey, having heterogeneous composition. They are composed of 3 cm to 4 cm, rarely up to 15 cm big angular fragments of moderate grey, micritic to fine-grained dolomite, brownish and somewhat bituminous dolomite, light grey laminated dolomite as well as stromatolitic dolomite with frequent shrinkage pores and fissures.

The age of the described dolomite column is defined according to micro and macro fossils as well as its stratigraphic position.

In the carbonate rocks of the lower part of the Rhaetian and Liassic lithologic sequence the algae *Palaeoedasycladus* sp., foraminifers Lagenidae, Lituolidae, Textulariidae and Verneuilinidae as well as gastropod and brahiopod remains have been ascertained. In the similar beds in the quarry St. Ana at Mirna Peč the foraminifer *Haurania deserta* Henson has been recognized. The above-enumerated fauna point at the Lower Liassic age of sediments.

More rich in fossils are the sediments of upper part of the Rhaetian-Liassic carbonate succession in the cross-section Valična vas-Sela containing *algae Palaeodasycladus mediterraneus* Pia, *Thaumatoporella parvovesiculifera* (Raineri), *Aeolissaccus* sp., and nonskeletal blue-green algae, foraminifers *Oribtopsella praecursor* (Gümbel), *Lituosepta recoarensis* (Cati), *Vidalina martana* Farinacci, *Glomospira* sp., Opthalmidiidae, Textulariidae and Lagenidae. Rare sections of *Favreina salevensis* (Paréjas) can also be seen. In the Rhaetian-Liassic lithologic sequence rare megalodontid lumachelles occur as well. The lithiotid horizon with the thickness of 5 metres is poorly developed.

Middle Liassic-Lower Malm unconformity

The paleontological data clearly indicate that the Middle Liassic-Lower Malm contact represent in fact an unconformity. However, along the contact there are no signs of angle discordance or larger transgression. Only a thin layer of a red clay can be seen upon the contact surface at some places. The red clay and fossils indicate a substantial break or gap in the geologic record resulting from a change that caused the deposition to cease for a considerable span of time implying an uplift and erosion with loss of the previously formed sediments.

Stratigraphy of the sedimentary succession overlying the Middle Liassic-Lower Malm unconformity

The considered sedimentary succession (Figure 2, Figure 3) starts with beds of breccoid limestone, limestone and calcareous breccia; upwards follow oolitic, bioclastic and reef

limestones. In the lower part of the oolitic limestone an horizon of predominantly micritic limestone with chert occur.

The sedimentary succession overlying the Middle Liassic-Lower Malm unconformity ranges in age from the Lower to the Upper Malm involving the Orlaka Limestone with chert and in the preface mentioned oolitic, bioclastic, reef as well as *Tintinnina* and *Clypeina* carbonate rocks.

Orlaka Limestone with chert

The Orlaka Limestone with chert rests with great unconformity upon the Middle Liassic carbonate rocks.

Limestone with chert is usually grey and moderate dark grey. From the textural point of view it belongs to intrasparitic, biointrasparitic, micritic, pelmicritic, oointrasparitic and bioclastic limestones containing fragments and detritus of hydrozoans and molluscs. The treated limestone show clear stratification (25-50 cm) being commonly platy and thin- bedded (2-20 cm) and containing lenses and thin layers of grey, yellowish grey and moderate dark grey dotted chert.

The limestones with chert at Orlaka is underlain by several metres thick biohermal reef limestone with hydrozoans and echinoids. According to Buser (1974) the limestone with chert at Orlaka is, taking into account its stratigraphical position and lithological composition, an equivalent of the limestone with chert at Trnovo forest, which also underlies the reef limestones. In the limestone with chert at Trnovo forest Radoičić (Buser, 1978) determined the following fossil association: *Protopeneroplis striata* Weynschenk, *Nautiloculina oolithica* Mohler, *Textularia* cf. *agglutinans, Discorbis acutuliformis, Thaumatoporella parvovesiculifera* (Raineri), *Bacinella* sp. as well as algal and to algae similar structures. The variegated microfossil association indicates that the limestone with chert from Trnovo forest belongs to the lower part of Malm, Oxfordian respectively.

Shelf and reef carbonate rocks

In the Malm period a differentiation of formerly uniform shallow shelf area progressively continued. In the Dolenjska district already at the beginning of Malm barrier reef, back-reef and restricted shelf with lagoon were formed. Turnšek (1966, 1969) came to the conclusion, that three areas and hydrozoan types were formed in a comparatively small region of the southern Slovenia, namely: the hydrozoan *Cladocoropsis* in the southern faunistic area, parastromatoporidian hydrozoans, corals and chaetetids in the middle faunistic area and actinostromaridian hydrozoans in the northern faunistic area. Different hydrozoan types had developed because of somewhat different ecologic conditions prevalent in each of these areas. The areas with individual faunistic types follow each other in narrow and long belts extending from the southeast to northwest, a fact, which leads us to supposition that they followed either a former direction of shore or a course of some submarine shelf.

The Lower Malm beds, exposed among Radohova vas, Muljava and Orlaka are composed of light grey moderate grey, light

brownish grey, grey, and rarely moderate dark grey micritic, biomicritic, biolithitic, coarse-grained bioclastic, biointrasparitic and oolitic limestones, limestones with chert, bioclastic limestones as well as reef breccias.

The **oolitic limestones** are made of radial, micritic and tangential ooids, fossil remains and detritus bound together with a sparitic carbonate cement. They are massive or thick-bedded, moderate grey and commonly cross-bedded. From the structural point of view the at first sight monotonous carbonate succession is composed of oosparites, ointrasaprites and bioosparites. The oolitic limestones originated from the transport of the ooid sand and fossil detritus, carried by tidal streams and waves, deposited on a tidal sand bar.

The reef limestones are sediments consisting of remains of the Jurassic reef-building organisms such as hydrozoans, corals, sponges, bryozoans, chaetetids, echinoids, gastropods, pelecypods, and of sediment-binding organic constituents such as calcareous algae. Since the treated limestones are made up in large part of skeletons of hydrozoans they are called hydrozoan reefs. Relatively frequent occurrences of biolithite of biohermal type, the mode of occurrences and distribution of the reef limestones in the Dolenjska district and broader in the Outer Dinarides indicate large reefs of barrier type (BUSER, 1974).

Hydrozoan fauna was the most important reef builder and belongs to the north faunistic area (TURNŠEK, 1969). Among hydrozoans Sphaeractinidae with genera *Sphaeractinia* and *Ellipsactinia* prevail; however, pretty numerous were also another hydrozoans from the group of Actinostromariicae. For this reason TURNŠEK (1969) named the hydrozoans of the northern area the actionostromariid type. According to TURNŠEK, (1966, 1969) the northern area was in the early Jura a long, relatively narrow reef, extending from Nemci and Ojstrovec across Trnovski gozd and Ljubljansko barje to Mačkovec and Bela krajina. Since the Jurassic rocks with hydrozoans were recently exposed only in the Trnovski gozd (Trnovo forest) and Dolenjsko district as well as at Ivančna gorica towards the south and south-east, and because of the similar fauna in both areas she concluded, there was a uniform hydrozoan reef, which was later interrupted by late tectonic movements and at some places partly elevated or partly sunk. At Dob and Stična gora from the Dolenjsko district the following hydrozoan species were determined by Turnšek: *Astrostylopsis tubulata,* A. *trnovica, Actinostromina germovsheki, Desmopora listigonorum, Cylopsis florida, C. lata, Cylopsis* sp., *Coenostella thomasi* and Sphaeractinidae.

Beside enumerated macrofauna the reef limestones contain the following microfossils, determined by Lj. Šribar: *Nautiloculina oolithica* Mohler, *Glomospira* sp., *Trocholina* sp., *Nodobacularia* sp., *Aeolisaccus* sp., *Chitinoidella* sp., *Tubiphytes* sp., Codiaceae, Ophthalmidiidae and Textulariidae as well as the sponge *Cladocoropsis* sp. The whole association proves the Lower Malm age.

The basic building and lithologic element of the whole reef complex was light, moderate light grey, grey, rarely dark grey and strati-

fied, usually massive, biolithitic limestone composed of skeleton of different reef building organisms among which sphaeractinids, actinostromariids, hydrozoans and blue green algae prevail.

Relatively very extended rocks in the study area are ***bioclastic carbonate rocks***, composed of extremely strong recrystallized fragments of fossils of ruditic size and partly recrystallized dark grey and greyish black prevalently micritic, biomicritic and dismicritic intraclasts as well as numerous round and oval pellets. Among fossil fragments ruditic fragments of echinoderms strongly prevail. The groundmass of these rocks consists of coarse-grained sparry calcite, rarely of matrix. Among noncarbonate rocks clay admixture is predominant. Bioclastic carbonate rocks originated by destruction of smaller and larger very extended reef bodies. The most important reef building organisms were hydrozoans, sponges, corals, algae, echinoderms and pelecypods.

After consolidation biointrasparuditic limestones were submitted to extremely strong latediagenetic changes such as recrystallization, cementation and dolomitization. Selective late dolomitization, was present in different levels of the reef complex. Consequently, smaller and larger patches of coarse-grained latediagenetic dolomite occur in the reef complex. Biointrasparuditic limestone is usually massive. Clear stratification with 5-65 cm thick beds can rarely be seen. In these sediments a cross-stratification can also be observed.

Reef breccias appear in the fore-reef area. They are composed of fragments and blocks of biolithitic and biointrasparuditic limestones with sections and fragments of hydrozoan colonies. The fragments were broken from the reef by action of waves and tides.

On the basis of up to this time collected data we can say, the considered Lower Malm sedimentary succession was formed on an elongated reef pretty far from the shore. The basic reef building element was the biolithitic limestone. The biointracalcirudites and biocalcarenites were deposited in the back-reef shallow sea, whereas the reef breccias were accumulated in the fore-reef area.

Clypeina and *Tintinnina* limestones

The Lower Malm reef and perireef limestones in the Sela-Šumberk-Dobrnič area pass towards northeast and north into the Upper Malm sedimentary succession, which comprises the Upper Kimmeridgian and Portlandian *Clypeina* and *Tintinnina* limestones. The Lower Malm succession is overlain there by laminated, stromatolitic, oncolitic, micritic and biointrasparitic limestones, patch reefs as well as early and latediagenetic dolomites and carbonate breccias. The treated beds are characterized by a rhythmic sedimentation. The color of the beds is mostly grey and light grey. From the structural point of view calcarenites and calcirudites prevail. The considered sedimentary succession is massive or stratified. The limestones and calcareous dolomites contain a fossil fauna and flora. The most numerous fossils are clypeinas and tintinnins. However, hydrozoans, sponges, gastropods, pelecypods as well as other molluscs also occur. The age of the treated lithological column is determined by the following microfossils:

Clypeina jurassica Favre and the tintinnin *Campbelliella milesi milesi* Radoičić. Beside these two fossils still *Kurnubia palastiniensis* Henson, *Salpingoporella annulata* Carozzi, *Favreina salevensis* Paréjas, *Quinqueloculina* sp., *Faveloides.* sp., Trochaminidae, Textulariidae, Verneuilinidae, Ophthalmidiidae, Codiaceae, echinoderms as well as echinoid, gastropod and other mollusc remains have been found.

DISCUSSION

Whereas on the Dinaric Carbonate Platform in the Jurassic period a shallow water sedimentation was carried out, with the exception of short-lived interruption at the transition from the Lower to the Upper Malm, when during the short-lasting emersion thinner lenses of bauxite were formed, in the transition area (Suha krajina) between the Slovenian trough and the Dinaric Carbonate Platform the epeirogenic activity was intensified, which caused an uplifting of marginal areas of the Dinaric Carbonate Platform, being completely elevated above the sea-water level at the end of the Middle Liassic. With origin of dry land the sedimentation in the carbonate margin area was interrupted. Such conditions lasted untill the Lower Malm. The stratigraphic gap Middle Liassic-Lower Malm in the marginal area is marked by absence of the Upper Liassic and the Dogger sedimentation and fossils. The stratigraphic gap is a sufficient evidence for relatively long-lived emersion, after the deposition of the Middle Liassic beds, lasting as far as the Lower Malm transgression. Since it appeared in several parts of Slovenian, Croatian and Bosnian Dinarides as well as in Italy, the mentioned emersion was a regional phenomenon.

Accordingly, in the time interval Middle Liassic-Lower Malm some areas of the Dinaric Carbonate Platform were partly or completely without any sedimentation, considered by many authors as a bar (BUKOVAC ET AL, 1974) with larger and smaller elevations, which could be presented like a part of an uniform island arc, a chain of islands respectively, raising from the deep sea floor near to the dry land, passing from Bosanska krajina across Kordun, Banija, Žumberak, Bela krajina, Suha krajina and Trnovski gozd still forward to northeast and Italy. This, morphologically well-expressed belt, a narrow elongated bar respectively, was relatively closely connected with a differentiation in until that time uniform sedimentary area of the Dinaric Carbonate Platform. In that place the Malm hydrozoan-coral reefs were also formed. The mentioned bar separated in this way in the uniform sedimentary area of Outer Dinarides an expressively shallow-water area of the carbonate shelf from the tectonic trench with a deep sea-water sedimentation.

In BUSER's opinion, in the Middle Liassic-Lower Malm span of time in our territory the dry land was not so spread, occurring only in rare isolated places in the Southern Slovenia.

It is necessary to emphasize that in the Jurassic period, inside the Dinaric Carbonate Platform, in the lagoon area respectively, there were no mountain-forming tectonic events, because traces of folding, thrusting or napping as well as traces of volcanic and

metasomatic changes of rocks nowhere have been ascertained. Equally, tectonic discordant contacts and thick basal coarse-grained formations are also nowhere to be found, so it seems correct to consider that in the Jurassic period a continuous sedimentation occurred there, interrupted only with periodic, short-lived local interruptions, as a consequence of intensified epeirogenic movements of the carbonate platform. The treated movements caused periodic landforms especially on the border between the Lower and the Upper Kimmeridgian. On the other hand, these movements caused the sedimentary differentiation of the area, and at the same time had a great influence on sedimentation (Dozet, 1989). Continuous sedimentation, but of other type, was also performed through the whole Jurassic period in those parts of the Dinaric Carbonate Platform, which were near to the back and restricted reef.

On the Dinaric Carbonate Platform significant epeirogenic movements and other changes occurred in the Middle Liassic, manifested first of all in a variegated sedimentation. The continuous sedimentation in the Upper Triassic and the Lower Liassic sedimentary column indicates there were no larger tectonic movements at that time. Intensified epeirogenic movements of the Late Kimmerian provoked the Lofer sedimentation, manifested in rhythmic deposition of carbonate sediments like dolomites, breccias, conglomerates as well as fenestral, laminated, micritic and biomicritic limestones.

Strictly speaking, on the very Liassic-Malm contact in the investigated area there are no clear signs proving a transgression, erosion or angle discordance. Between the Middle Liassic and Lower Malm limestones occurs nothing but a red silty clay indicating an important interruption of sedimentation.

After the Middle Liassic a ridge was formed on the Dinaric Carbonate Platform. The ridge area was characterized by an absence of Upper Liassic and Dogger deposits. The more or less continuous upraised relief or positive structure can be followed from Northern Italy across Slovenia and Croatia to Bosnia. The described ridge was in close connection with the outer hydrozoan belt of Turnšek (1969).

At Orlaka in the Suha krajina region the lithiotid horizon is only some metres thick. By all means, the thickness of the Middle Liassic beds at Orlaka, correlating it with the thickness of the Middle Liassic beds in other part of Slovenia, is unusually small, what points at Middle Liassic tectonic movements, which hindered the deposition and finally caused a lack of sedimentation and erosion of the deposited beds. In the upper part of the Middle Liassic sedimentary succession interlayers of marly limestone appear here and there.

Conclusion

In the cross-section Valična vas-Sela at Šumberk the beds of the Main Dolomite, Rhaetian and Liassic carbonate rocks, Orlaka Limestone with chert, shelf and reef carbonate rocks as well as *Clypeina and Tintinnina* limestones have been ascertained.

Detailed facies analyses show that after the

Middle Liassic in the study area significant changes happened causing an absence of the Upper Liassic and Dogger sediments. In spite of relatively large stratigraphic gap, the Middle Liassic-Lower Malm contact is not erosively, tectonically or clearly transgressively marked in the investigated area. It is represented only by a relatively thin red clay layer lying apparently concordantly between the lithiotid and reef limestones.

In the last twenty years the geologic investigations in the Suha krajina region showed that the Jurassic sedimentation was provoked and controlled by sea-level oscillations as well as fault tectonic activity. In fact, the Jurassic movements did not have any particular influence on the tectonic structure of this part of Slovenia. But, they had a very strong influence on the sedimentation during that time (DOZET, 1989). We may state that in the study area no orogenic movements in the Jurassic period occurred, since no folding can be found there, nor were there any traces of thrusting or nappe tectonic movements, volcanism or metasomatic changes of sedimentary rocks. There are nowhere any greater tectonic discordant contacts. Furthermore, in the area investigated no thicker coarse-grained basal transgressive formations can be found, so that we may be correct in affirming that the continuity of sedimentation had only been disturbed by periodical interruptions as a reflection of weaker or stronger epeirogenic movements of the carbonate platform.

Acknowledgements

The author gratefully acknowledges Ljudmila Šribar and Rajka Radoičić for determination of microfossils as well as Dragica Turnšek for determination of hydrozoans, corals and sponges. On the other hand, the author is much obliged to the Ministry of Schools, Science and Sports as well as to the Geological Survey of Slovenia for financial support of his investigations in the field.

POVZETEK

Stratigrafska vrzel srednji lias-spodnji malm na območju Suhe krajine

V profilu Valična vas-Sela severozahodno od Žužemberka (Slika 1) je z detajlno biostratigrafsko analizo, po litologiji, stratigrafski legi in po analogiji s podobnimi razvoji v okolici opisana stratigrafska vrzel srednji lias-spodnji malm. Litološko pestro zgrajeno ozemlje leži na prehodu med Dolenjsko-Notranjskimi mezozojskimi grudami in Posavskimi gubami. GERMOVŠEK (1955) je menil, da si alpsko-dinarske meje med Posavskimi gubami in kraškimi Dinaridi ne moremo predstavljati kot tektonsko linijo, temveč kot prehoden pas manjšega tektonskega pomena. DOZET (1966, 1985) je na območju Pleš pri Ljubljani ugotovil, da so Posavske gube v tem delu Slovenije narinjene na dolenjski kras pod kotom 15 do 20°. Če izvzamemo le nekaj metrov debela ilovnata pliokvartarna prekritja je raziskano ozemlje zgrajeno iz karbonatnih kamnin t.j. različnih apnencev dolomitov ter karbonatnih breč. Našteti sedimenti

pripadajo glavnemu dolomitu, dolomitu in brečam retija in liasa, oolitnemu apnencu, grebenskemu apfnencu in brečam, orlaškemu apnencu, ter klipeinskemu in tintininskemu apnencu in dolomitu (Slika 2, Slika 3).

Obravnavana stratigrafska vrzel je posledica občutnih tektonskih in paleogeografskih sprememb, ki so se po naših podatkih pričele že koncem srednjega liasa in so se končale nekje v spodnjem malmu. V karbonatnih kamninah pod obravnavanim kontaktom je ugotovljena sledeča favna in flora: foraminifere *Triasina hantkeni* Majzon, *Vidalina martana* Farinacci, *Orbitopsella praecursor* (Gümbel), *Lituosepta recoarensis* (Cati) ter alge *Palaeodasycladus mediterraneus* Pia, *Thaumatoporella parvovesiculifera* (Raineri), *Aeolisaccus* sp. in favreina *Fravreina salevensis* (Paréjas). V spodnjem delu liasne skladovnice se pojavljajo tudi drobne megalodontidne lumakele ter odlomki gastropodov in brahiopodov, v srednjem delu pa litiotide. Litiotidni horizont je neizrazit in je debel vsega nekaj metrov. V tem horizontu litiotidnih školjk se pojavlja (Buser, 1974) vrsta *Cohlearites loppianus* (Tausch).

Odsotnost zgornjeliasnih in doggerskih sedimentov v sicer kontinuirani skladovnici karbonatnih kamnin nam kaže na kopno, ki je obstajalo v časovnem intervalu med srednjim liasom in spodnjim malmom. Kljub sorazmerno veliki sedimentni vrzeli pa sam kontakt med talninskimi in krovninskimi sedimenti ni izrazit, saj niso ohranjeni tipični erozijsko-transgresivni sedimenti, niti ni opaziti karstifikacije oziroma "hard ground"površin. Na meji med talnino in krovnino obravnavanega kontakta se ponekod pojavlja samo tanka plast rdeče gline, ki je edina sled sicer pomembne jurske prekinitve sedimentacije v tem delu Slovenije. Naj omenimo še, da je bazalna plast spodnjemalmskih plasti tu in tam nekoliko bračasta. Tipični sedimenti zaporedja nad kontaktom so: plastnati orlaški mikritni apnenec s tankimi plastmi, lečami in gomolji roženca, predgrebenski oolitni in bioklastični grebenski apnenci, apnenci ter apnenci in dolomiti s klipeinami in tintininami.

Naj poudarimo, da leže karbonatne kamnine s klipeinami in tintininami superpozicijsko nad grebenskimi apnenci razen v neptunskih klastičnih dajkih (Dozet, 1965 a).

V spodnjem delu malmskega sedimentnega zaporedja so ugotovljene foraminifere *Nautiloculina oolithica* Mohler, *Kurnubia palastiniensis* Henson in *Trocholina* sp., ter spongija *Cladocoropsis mirabilis* Favre v zgornjem delu pa algi *Clypeina jurassica* Favre in *Salpingoporella annulata* Carozzi, tintinine *Campbelliella milesi milesi* Radoičić, favreina *Favreina salevensis* Paréjas in foraminifera *Kurnubia palastiniensis* Henson.

V tem članku opisani sedimenti so nastajali v glavnem na robu karbonatne platforme med karbonatnim šelfom in Slovenskim bazenom. Pripadajo litoralnemu (mikritni, biomikritni in intraklastični apnenci, dolomiti), zagrebenskemu (oolitni in bioklastični apnenci), grebenskemu (koralni, hidrozojski in spongijski biolititi) in predgrebenskemu okolju (predgrebenske karbonatne breče). V

tej smeri so opazne precejšnje spremembe ne samo v sedimentaciji temveč tudi biofaciesu.

Opisani sedimenti ter favna in flora kažejo, da leži obravano ozemlje na severnem robu karbonatnega šelfa, ki je obstajal v zgornjem triasu ter spodnji in zgornji juri. Očitno je, da so bili v časovnem intervalu med srednjim liasom in spodnjim malmom robni deli karbonatnega šelfa vsled pojačanih epirogenetskih sil dvignjeni do te mere, da je nastalo zgornjeliasno-doggersko kopno in sorazmerno dolgotrajna prekinitev sedimentacije. Na takratnem kopnem so na raziskanem območju nastajale samo tanke plasti rdeče gline.

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