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THE TRIASSIC AND JURASSIC SEDIMENTS IN EASTERN STARA PLANINA MTS. (BULGARIA) — AN EXAMPLE OF CLASSIFICATION OF GEOSITES IN SEDIMENTARY ROCKS

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Abstract. Two types (basin and shelf) of Triassic and Jurassic Tethyan sediments participate in the structure of eastern Stara Planina Mts. (eastern Bulgaria). A parautochtonous position is assumed for the basin type rocks. The shelf sediments are allochtonous and can be observed as olistolites included in the Lower Jurassic Sini Vir Formation and in the Middle Jurassic Kotel Formation. The parautochtonous sediments take part in the composition of the probable overthrust structures refolded in antiformal and synformal structures, and intensely eroded before Late Cretaceous times. From the geological heritage point of view, the Triassic and Jurassic sediments of the region are included in a large unit — geosites framework — composed of 19 geosites: 10 in the parautochtonous and 9 in the allochtonous sediments. They exhibit different geological (tectonical, stratigraphical, palaeontological, etc.) features.

Key words: geosites framework, geosites, Triassic, Jurassic, eastern Stara Planina Mountains, eastern Bulgaria.

Abstrakt. W strukturze wschodniej Starej Planiny (wschodnia Bułgaria) występują dwa typy triasowych i jurajskich osadów Tetydy: basenowe i szelfowe. Skały pochodzenia basenowego uważane są za parautochtoniczne. Osady szelfowe są allochtoniczne. Występują one w dolnojurajskiej formacji Sini Vir oraz w środkowojurajskiej formacji Kotel, w formie olistolitów. Osady parautochtoniczne uczestniczą w prawdopodobnej strukturze płaszczowinowej, przefałdowanej w struktury antyklinalne i synklinalne, intensywnie zerodowanej przed górną kredą. Z punktu widzenia dziedzictwa geologicznego, osady triasowe i jurajskie omawianego regionu tworzą dużą zbiorczą jednostkę geotopową, obejmującą 19 geotopów: 10 w osadach parautochtonicznych, 9 w osadach allochtonicznych. Posiadają one różnorodne cechy geologiczne (tektoniczne, stratygraficzne, paleontologiczne itp.).

Słowa kluczowe: jednostka geotopowa, geostanowiska, trias, jura, wschodnia Stara Planina, wschodnia Bułgaria.

INTRODUCTION

A lively discussion on the units of geological heritage nomenclature (geosites frameworks and geosites) has been lately initiated in the Working Group 1 of ProGEO for south-eastern Europe. Triassic and Jurassic Tethyan formations in the eastern Stara Planina Mountains, eastern Bulgaria, are suitable subjects to expose and illustrate the point of view on this problem. The geosites framework represents rocks deposited in a part of a basin, limited in time, in which the sedimentation, distribution of fauna, depositional sequences, etc. are predestined by the palaeotectonics and the palaeogeography of this basin. In this sense, the Triassic and the Jurassic rocks in the Matoride Basin of eastern Stara Planina Mts. represent an example of geosite framework. These deposits are of Tethyan type in contrast to most of the other deposits of the same age in Bulgaria that posses a Peri-Tethyan character.

The lower boundary of this geosite framework is unknown because the lower boundary of the oldest rocks — the Lower Triassic Mayadere Fm. is not exposed. The upper boundary coincides with the upper boundary of the Kotel Fm. — the youngest age proven in it is the Middle Bathonian (Mid Jurassic).

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However, these rocks have suffered erosion, and this boundary coincides probably in time with the Early Callovian when the region was tectonically compressed and the marine sediments were exhumed to the surface.

The type area of the geosites framework is situated in the valley of the Luda Kamchia River (Fig. 2). The aim of the individualisation of the geosites framework is to have the possibility to conform the contemporaneous geosites frameworks from the different parts of one or many sedimentary basins. The geosites framework consists of numerous single geosites that display one or more characteristic features of the exposed sediments. One geosite may demonstrate several features as, e.g. palaeontological (occurrence of fossils), stratigraphical (e.g. the type sections of one stage/substage, or of some lithostratigraphical or biostratigraphical units, etc.), historical (e.g. the locality where a stage/substage has been introduced for the first time in the world or in the country, etc. or the locality where a stratigraphical or tectonical hypothesis was created, etc.), lithological (when a geosite posses some very particular features), geomorphological, etc.

HISTORY OF THE RESEARCH

The study of the Triassic and Jurassic rocks in eastern Stara Planina Mts. started very actively at the beginning of the 20th century. The pioneering work of Bakalov (1910, 1942, etc.), Kockel (1927, 1929) and Berndt (1934) solved successfully some stratigraphical problems. Sachariewa-Kowatchewa (1962, 1967, 1969) described in a more modern way the macrofossils of the Upper Triassic. Ganev (1961), Kanchev and Entcheva (1967), Kanchev and Ivanova-Panayotova (1972) and Kanchev (1993–1995) contributed substantially to the knowledge of the Triassic and Jurassic stratigraphy. In 1967, Nachev *et al*. (1967) introduced for the first time in the region the formational analysis of the rocks and launched the hypothesis that all Triassic and Jurassic rocks in eastern Stara Planina Mts. represented olistolites in the Upper Cretaceous black shales of the Kotel Fm.

The study of the Triassic conodonts (Budurov, 1960; Budurov, Stefanov, 1965) and foraminifers (Budurov, Trifonova, 1974, etc.), the Jurassic brachiopods (Tchoumatchenco, 1989, 1990), ichnofossils (Tchoumatchenco, Uchman, 1999) etc. brought to a new level the knowledge of the Triassic and Jurassic fauna. Tchoumatchenco (1988) made an effort to reconstruct the primary position of the allochtonous Jurassic blocks included into the Middle Jurassic Kotel Formation. Tchoumatchenco, Černjavska (1989–1990) and Tchoumatchenco *et al*. (1992) developed the new stratigraphy and palaeotectonics of the Lower and Middle Jurassic in eastern Stara Planina Mts. creating the new turbidite lithostratigraphical units Sini Vir Fm., Balaban Fm. and returning to the Kotel Fm. of a Mid Jurassic age. Budurov *et al*. (1997) have drawn up a formal lithostratigraphy of parautochtonous Triassic rocks, identifying the Mayadere, Gyurgenliya and Glogova formal lithostratigraphical formations.

The Eastern Balkan Triassic and Jurassic sediments were deposited in a trough (rift) formed in the southern margin of the Moesian Platform (Zagorchev, 1996, Fig. 1). In the eastern direction, it was probably connected with the North-Dobrogean Tulcea zone of the North Dobrogean orogen and the South Crimea zone. One of authors (Tchoumatchenco, 2002) suggested also the extension to the west, through the Izrimetz palaeograben towards the Sinaia rift in the southern and eastern Carpathians.

Triassic and Jurassic sediments of two types, namely coarse siliciclastic turbidites and shelf sediments participate in the geological structure of the territory of eastern Stara Planina Mountains. Their outcrops are: (a) parautochtonous, and (b) allochtonous. The parautochtonous Triassic and Jurassic rocks are of basin type. The Jurassic sediments build up the limbs, and the Triassic — the core of a complicated Late Mid-Jurassic

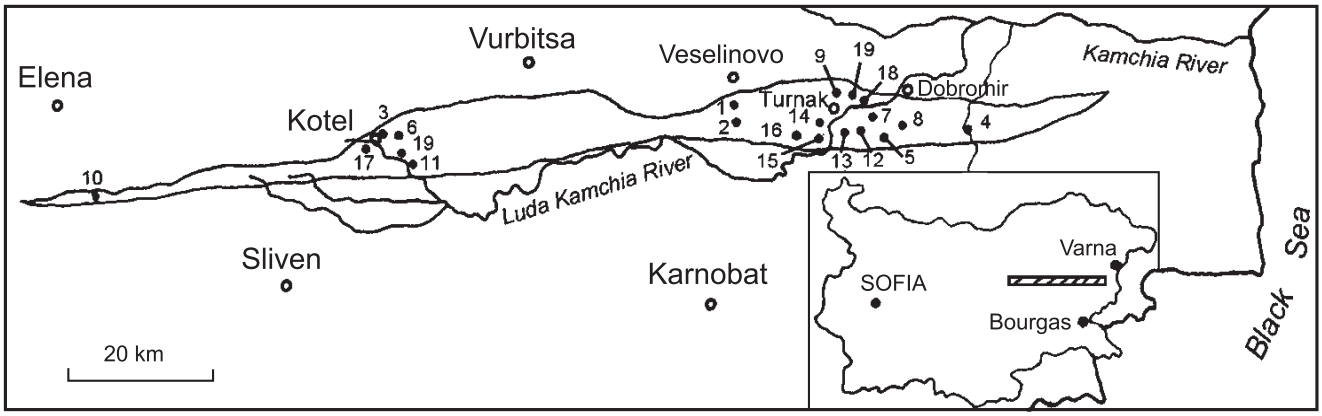

Fig. 1. Map showing the position of the Matoride Geosites Framework and the geosites in the parautochtonous (No. 1–10) and allochtonous (No. 11–19) Triassic and Jurassic sediments

Numbers consistent with the text

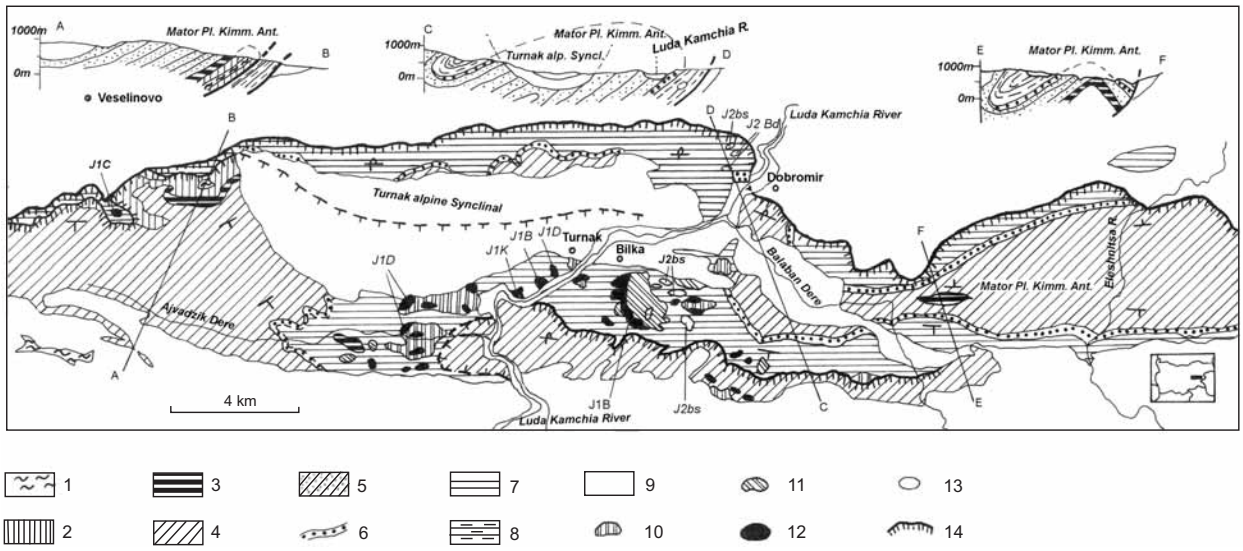

Fig. 2. Geological map of the Triassic and Jurassic sediments in the region of Luda Kamchia River Valley (reinterpreted after Kanchev, 1993; type area of the Matoride Geosites Framework)

Parautochtonous sediments: *1* — Mayadere Fm. (Spathian), *2* — Gyurgenliya Fm. (Lower Anisian–Lower Carnian), *3* — Glogova Fm. (Upper Carnian–Norian to Rhaetian), *4* — Sini Vir Fm. (?Norian–Toarcian), *5* — Balaban Fm. (Toarcian), *6* — Kotel Fm. (Aalenian–?Middle Bathonian), *7* — younger sediments (Lower and Upper Cretaceous and Palaeogene); **allochtonous sediments (in olistolites)**: *8* — Triassic and Jurassic rocks, *9* — Middle Jurassic sediments, *10* — overthrust; **geosites in allochtonous sediments** (noted on the map): Tr_3 n–r (Orta Kaya type limestones); J_1B — Bilka type; J_1K — Karaveljovo type; Tr_{1-2} Lower Triassic marls and limestones + J_1D — Djula type, Ajvadzik Dere; J_1C — Cerkoviste type in the locality Ramadan Chair; J_2bs — Black shales with Bossitra alpine in the Kotel Fm.; J_2Ba — sandstones of Balaban Fm. in the Kotel Fm.

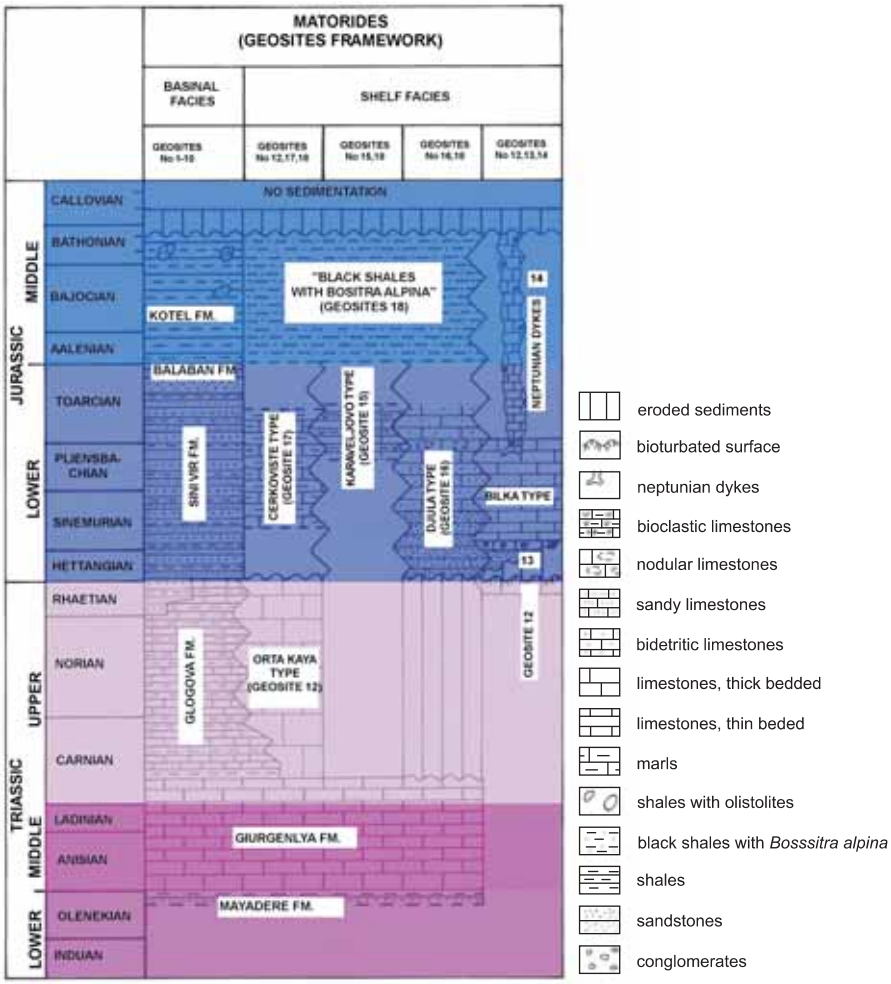

Fig. 3. Correlation of Triassic and Jurassic sections in eastern Stara Planina Mts. and the Matoride Geosites Framework and Geosites in them

anticline: the Mator–Planina anticline. The allochtonous sediments are exposed as olistolites included in the black shales of the Mid Jurassic Kotel Formation. The olistolites are formed of shelf carbonate Triassic and Jurassic sediments, as well as of smaller blocks coming from the Matoride rifted basin, partly destroyed during the Mid-Jurassic. These sediments take part in the composition of supposed overthrust structures, subject to an intense erosion before the Late Cretaceous and covered transgressively by Upper Cretaceous sediments

GEOSITES FRAMEWORK AND GEOSITES IN THE TRIASSIC AND JURASSIC ROCKS IN EASTERN STARA PLANINA MTS.

Ten geosites are identified in the parautochtonous Triassic and Jurassic basin rocks. The geosites are of different types: stratigraphical, palaeontological, palaeotectonical, etc. The stratigraphical geosites are represented by the stratotypes of the local lithostratigraphical units and/or some outcrops which show some characteristic features. The palaeontological geosites contain many fossils, and the tectonical geosites exhibit some elements of the Cimmerian and the Alpine structures in the region. In the allochtonous rocks, included into the Jurassic rocks as olistolites, 9 geosites are distinguished.

GEOSITES IN THE PARAUTOCHTONOUS ROCKS

STRATIGRAPHICAL GEOSITES

The Triassic rocks are subdivided (Budurov *et al*., 1997) in the following formal lithostratigraphical units: Mayadere Fm. (Lower Triassic), Gyurgenliya Fm. (Lower Anisian–Lower Carnian), Glogova Fm. (Upper Carnian–Norian–Rhaetian – p.p.), and the Jurassic rocks (Tchoumatchenco, Černjavska, 1989) are grouped into the Luda Kamchia group and subdivided into Sini Vir Fm. (Rhaetian (p.p.)–Toarcian (p.p.), Balaban Fm. (Toarcian) and Kotel Fm. (Aalenian–Middle Bathonian). The stratotypes of this lithostratigraphical units are designed as stratigraphical geosites.

Geosite 1. (Fig. 1–4). It represents the stratotype of Mayadere Fm. (93.5 m) located parallel to the Maya Dere River, near the village of Vesselinovo, Shumen District (42°57’25’’ N and 27°05’20’’E) (Budurov *et al*., 1997). It is build (Fig. 4) of an irregular, flysch-like alternation of marls, shales, siltstones, sandstones and limestones. The relative volume of shales and siltstones is greater in the basal parts of the section, and is gradually replaced upwards by marls with limestones interbeds. The age corresponds to the upper parts of the Olenekian Stage (Spatian) — conodont zones *Neospathodus triangularis–N. homeri,* foraminifer zone *Meandrospira pusilla,* and the palynozones *Densoisporites nejburgii* and *Cycloverrutriletes presselensis.*

Geosite 2. (Fig. 1, 2, 3, 5). This geosite is the stratotype of Gyurgenliya Fm. (29.7 m), located parallel to the Maya Dere River near the village of Vesselinovo (42°57’25’’ N and 27°05’20’’ E) (Budurov *et al*., 1997).

Fig. 4. Geosite 1. Mayadere Fm., holostratotype

MayaDere valley, South of village Vesselinovo, Shumen District; scale bar — 1 m

Fig. 5. Geosite 2. Gyurgenliya Formation, holostratotype

South of village Vesselinovo, Shumen District; scale bar — 1 m

It is situated above the stratotype of the Mayadere Fm. and is built up (Fig. 5) of grey, grey-greenish, reddish or yellowish limestones, in the lower part inter-bedded with marls, and locally, with silicates (radiolarites?). The age is determined as Lower Anisian–Lower Carnian, based on rich conodont and foraminifer fauna: conodont zone *Paragondollela timorensis* and lower parts of the foraminifer zone *Pilammina densa* Zone (Aegean Substage), *Paragondolella bulgarica* Zone and parts of *Pilammina densa* Zone (Pelsonian Substage), *Pridaella constricta* Zone (Illyrian — lower parts of Fassanian Substage), *Paragondolella foliata* Zone and part of *Turriglomina mesotriassica* Zone (upper parts of Fassanian–Longobardian Substage), *Paragondolella polygnathiformis* Zone and parts of *Paraophtalmidium carpathicum* Zone (Cordevolian–Julian Substage).

Geosite 3. (Fig. 1, 2). The geosite — stratotype of Glogova Fm. (*c.* 30 m), is situated along the road Kotel–Omourtag, parallel to the Glogova River (Budurov *et al*., 1997, Pl. I) (42°53'35'' N and 26°27'20'' E).

The formation is a calciturbidite — irregular alternation of marls (dominating in the lower parts) with thin-bedded limestones, silty limestones, calcareous siltstones and clayey limestones (mainly in the upper parts).The age is determined as Late Carnian–Norian–Rhaetian (?), based on rich macro-fauna as well as on foraminifers — *Paraophthalmidium carpathicum* and parts of *Miliopora cuvillieri* Zone and newly-found palynomorphs corresponding to *Vallasporites ignacii–Corollina meyeriana* Zone, thus pointing at Norian age for a part of the section.

Geosite 4. (Fig. 1, 2). It is the holostratotype of Sini Vir Fm.(*c.* 500–800 m.), situated in the valley of Eleshnitsa River. It was described by Tchoumatchenco and Černjavska (1989, Pl. I, Figs. 1–3) and re-described in Tchoumatchenco *et al*. (1992) (42°56'11''N and 27°24'25''E).

The unit is characterised by a turbidite silicoclastic alternation — sandstones to calcareous sandstones, aleurolites and shales to marls, containing many siderite concretions. The Sini Vir Fm. is formed of coarser — proximal, and finer — distal sediments, structuring fan-deltas and their surrounding of finer sediments. The problems of this formation age are very complicated. Tchoumatchenco and Černjavska (1989), Černjavska (1990), Peybernès *et al*. (1989a, b) determined by spores and pollens a Pliensbachian–Toarcian age of the uppermost parts of the unit. In the outcrop called Izvorite near the town of Kotel Lachkar, Peybernčs *et al.* (1989a) determines cysts of dinoflagellates of the Rhaetian–Hettangian species *Rgaetogonyaulax rhaetica*. In some sediments, described by Kockel (1927, 1929) as "Schwarzflysch serie" (regarded here as lower parts of the Sini Vir Fm), Kanchev, Encheva (1967) and Kanchev (1993, 1995) indicated the presence of Upper Triassic Halobia. On the base of the idea to unify the "black flysch" and the Sini Vir Fm. in one lithostratigraphical unit, it is regarded here the age of the Sini Vir Fm. as Late Triassic (?Norian–Rhaetian)–Early Jurassic (Hettangian–Toarcian) — the boundary Triassic/Jurassic appears there.

Geosite 5. (Fig. 1, 3). The holostratotype of Balaban Fm. (*c.* 60 m) is described by Tchoumatchenco and Černjavska (1989, Pl. II, Fig. 2) and by Tchoumatchenco *et al*. (1992). It is located in the Balaban Dere Valley, South of the Dobromir Village (42°56'30'' N and 27°18'00'' E).

As Balaban Fm. is separated from the upper part (*c.* 60 m) of the siliciclastic turbidite sequence, started by the Sini Vir Fm. The Balaban Fm. is characterised by thick beds of turbidite sandstones. The collected palynomorphs *Lycopodiumsporites austroclavatidites*, *Chasmatosporites major*, *Classopolis* sp. represent a large Early and Middle Jurassic section, and the age is attributed to the Toarcian, due to its stratigraphical position.

Geosite 6. (Fig. 1, 3). The stratotype of the Kotel formation (*c.* 1000 m) is situated near the town of Kotel and has an Aalenian–Middle Bathonian section (Tchoumatchenco, Černjavska, 1989) (42°53'35'' N and 26°27'25'' E).

The Kotel Fm. was introduced into the Bulgarian literature by Nachev *et al*. (1967) as an Upper Cretaceous lithostratigraphical unit. Later, Tchoumatchenco and Černjavska (1989) returned its Middle Jurassic age, assumed by Černjavska (1962). The Kotel Fm. is build of dark to black shales with rare and thin intercalation of turbidite sandstones; black shales contain many Triassic and Jurassic olistolites. Some of these olistolites crowned the heights as Kodzha Kaya, Ouch Kaya, Orta Kaya, Orlitsite etc. They add to the formation the aspect of "Wild flysch". From the Kotel Fm., pollens, spores and dinoflagelata cysts were described (Černjavska, 1962; Tchoumatchenco, Černjavska, 1989, 1990; PeybernPs *et al*., 1989a, b; Dodekova, Tchoumatchenco, 1989) which characterised the Aalenian, the Bajocian and the Middle Bathonian. Probably the younger parts of the Kotel Fm. were subsequently eroded.

PALAEONTOLOGICAL GEOSITE

Geosite 7. (Fig. 1, 2). The outcrop of Sini Vir Fm., from vicinity of the former village Emirovo (near the village Dobromir), (42°56'25'' N and 27°16'05'' E) provided Tchoumatchenco and Uchman (1999) with a rich collection of ichnofossils and made an important contribution to the knowledge of the evolution of Mesozoic ichnodiversity.

TECTONICAL GEOSITES

Geosite 8. (Fig. 1, 2, 6, 7). The outcrop situated along the forest road in the region of Cheshme Bair Hill (in the upper valley of Balaban Dere River) represents a palaeotectonical geosite in which two limbs and the core of the Late Cimmerian Mator–Planina anticline are preserved (Tchoumatchenco, Černjavska, 1990). The core (Fig. 2, cross-section E–F) is represented by the calciturbidites of the Glogova Fm. (Fig. 5) in the topmost parts of Cheshme Bair Hill; the southern anticlinal limb is build up by the rocks of the Sini Vir Fm., Balaban Fm. and Kotel Fm. and crops out in the Balaban Dere Valley. The Glogova Fm. (Fig. 6) is build up of alternation of clastic limestones and marls — represented calcareous turbidites, in which

Fig. 6. Geosite 8. Glogova Formation

Northern limb of Mator Planina anticline, Cheshme Bair, Balaban Dere valley, Varna District

Fig. 7. Geosite 8. Sini Vir Formation

Southern limb of Mator Planina anticline, Cheshme Bair, Balaban Dere valley, Varna District

Fig. 8. Geosite 10. Balaban Formation

The mountain pass Vratnik, near the village of Dobrevtsi, Sliven District

the Bouma rhythms Ta, Tb, Tc, and Td can often be observed; the Sinivir Fm (Fig. 7) is structured predominantly by siliciclastic turbidite. The lower boundary coincides with the first siliciclastic turbidite bed situated over the calciturbidite of the Glogova Fm. The basal part of the Sini Vir Fm. is build of alternation of marls to calcareous shales, and aleurolites and sandstones. This is a section with a progressive transition from aleuritic and aleuritic-sandy limestones (Glogova Fm.) up to sandy, two components hyposediments (sandy limestones up to limy sandstones (Sini Vir Fm.). In the lower part of the section predominate calcareous rocks with aleuritic admixture (the Glogova Fm.), and upwards increases progressively the quantity and dimension of the terrigenous component (the Sini Vir Fm.). The terrigenous component is formed in the basal part predominantly of rock pieces and micas, which diminish upwards and are replaced by quartz particles. All these features show that there is common source of the two lithostratigraphical formations alimentation, and they differ by deepening of the rocks erosion, only.

Geosite 9. (Fig. 2, section A–B). The northern limb of the Late Cimmerian Mator Planina anticline is overturned (Fig. 3, cross-section C–D) and crops out in the vicinities of the former Emirovo Village (Sini Vir Fm.), and in the area of the railway station and the village Strouya (27°28’25’’ E and 42°57’30’’ N).

The anticlinal core was eroded there during the Late Jurassic and the Early Cretaceous, and is filled by Upper Cretaceous sediments, structuring the superimposed Turnak alpine synclinal. To the West, in the valley of Maya Dere, the core of the Late Cimmerian Matore Planina Anticline is thrusted over its northern limb, represented by shales of the Mid Jurassic Kotel Fm.

Geosite 10. (Fig. 1, 3, 8). This geosite represents the outcrops of the Luda Kamchia Group on the Vratnik Pass, at the road to village Dobrevtsi (26°08’40’’ E and 42°54’50’’ N) (Tchoumatchenco, Černjavska, 1989).

The siliciclastic turbidites of the Sini Vir Fm. from the southern limb of the Mator Planina anticline are thrusted over the Lower Cretaceous siliciclastic turbidites of the Cherni Osum Fm. Also sandstones of the Balaban Fm. well crop out (Fig. 8).

GEOSITES IN THE ALLOCHTONOUS TRIASSIC AND JURASSIC SEDIMENTS

The allochtonous Triassic and Jurassic sediments, within the Lower and Middle Jurassic rocks, are selected as 8 geosites. They are derived from the destructed southern palaeoshelf of the Exotic Range of Zlatarski (Tchoumatchenco, 1988; Tchoumatchenco and Černjavska, 1990; Tchoumatchenco *et al*., 1992), as well as of parts of the southern slope of the Matoride (Tethyan) basin. Enormous Triassic olistolites build up the tops of Kayite Heights in the Luda Kamchia

Gorge, the Orlitsite Hills, etc. The Lower Jurassic blocks are subdivided into 4 types, to which Tchoumatchenco (1988) gave different local names; they reflect their primary sedimentation position on the palaeoshelf.

Geosite 11. (Fig. 1). This geosite crops out south of the Kotel town and represents an allochtonous block, build up of alternation of limestones and marls, regarded as the Upper Triassic Glogova Fm., included into the black shales of the Mid Jurassic Kotel Fm.

Geosite 12. (Fig. 1, 2, 3, 9).The geosite represents the summits of Kodzha Kaya, Orta Kaya, Ouch Kaya heights (Fig. 9) (42°55'10'' N and 27°14'35'' E).

They are build of the Upper Triassic platform bioclastic limestones (rudstones). The bioclasts are of crinoids, fragments of corals, etc. The limestones form beds of 10–50 cm, some time thicker, in which corals form irregular stocks (patch reefs). Berndt (1934) compared these limestones with the German Dachstein limestones. The limestones contain foraminifers *Tolypammina discoidea*, *Trochammina balcanica*, *Trochammina* sp., *Variostoma* sp., *Glomospirella* sp., *Miliolipora cuvilieri*, *Variostoma/Diplotremina*, *Tubyphytes* sp.; Ganev (1961) collected also *Cyrtina uncinata*, *Rhaetina gregaria*, "*Rhynchonella*" aff. *fissicostata*, *Nautilus* sp. nov.; Budurov *et al*. (1997) described these limestones as Orta Kaya type Upper Triassic limestones. They are included into the Middle Jurassic Kotel Fm.

Geosite 13. (Fig. 1, 2, 10). The geosite is situated south of Bilka Village and demonstrate the transgressive contact of the Lower Jurassic sediment, described as Bilka type (Tchoumatchenco, 1988), overlaying the Orta Kaya type Upper Triassic limestones (Fig. 10) (42°55'09'' N and 27°14'36'' E).

Jurassic sediments begin with sandstones or with calcareous breccia (built predominantly of Ostreids and brachiopods (*Lobothyris* sp. indet.) fragments, corals and rare ammonites (*Coroniceras* sp. indet.). They pass into reddish micritic limestones, from which brachiopods *Spiriferina alpina alpina*, *Cirpa* cf. *langi*, *C. borissiaki*, *Capillirostra* sp., *Lobothyris subpunctata*, *Zeilleria waterhousii*, as well as rare corals were collected along the road between Aytos and Provadia, near the bridge on the Koru Dere. Tchoumatchenco (1988) and J. Stephanov (in collection) determined ammonites *Amaltheus evolutus* and *A. subnodosus*; on the upper surface of the Triassic limestones, below the Jurassic sediments, there are many *Trypanites* type borings.

Geosite 14. (Fig. 1, 2, 3, 11). It is situated up to 1 km SW of the railway station Turnak, within the railway cutting in the locality Kazaldza Kaya (Fig. 11) (42°55'50'' N and 27°13'55'' E).

It is built up of reddish micritic limestones (with Pliensbachian brachiopods as *Lobothyris subpunctata* and *Cirpa langi*). In these limestones intercalations of irregular shapes exist, interpreted as neptunian dykes with brachiopods of Toarcian to Bathonian age: *Homoeorhynchia cynocephala* (Toarcian), *Aulacothyris blakei*, *Dundrothyris perovalis*, *Kallirhynchia platiloba* (Mid Jurassic), etc. (Tchoumatchenco, 1988, 1989, 1990). These dykes filled palaeokarstic forms and are build up of oolithic limestones and/or conglomerates.

Fig. 9. Geosite 12. General view of Ouch, Orta and Kodzha Kaya heights — olistolite of Ortha Kaya type in the Kotel Formation

Near the village of Bilka, Luda Kamchia valley, Burgas District

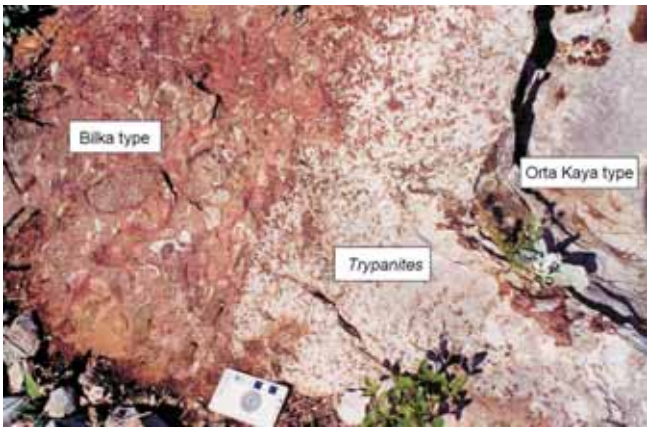

Fig. 10. Geosite 13. Transgressive contact between Bilka type Lower Jurassic and the Upper Triassic Orta Kaya type near the Bilka Village

Burgas District (on the southern slope of the Kodzha Kaya height)

Fig. 11. Geosite 14. Neptunian dyke

Toarcian to Lower Bathonian in the Bilka type sediment, in the vicinity of Kazaldza Kaya, near the village of Turnak, Burgas District

Fig.12. Geosite 17 — Cerkoviste type Lower Jurassic sediments — olistolite included into the Kotel Fm. in the locality Kominceto

East of the Kotel town, Burgas District

Geosite 15. (Fig. 1, 2, 3). The geosite is situated on the railway cutting, North of Karaveljovo railway station (42°55'45'' N and 27°10'35'' E).

It contains the Karaveljovo type Lower Jurassic (Domerian — the lowest parts of Toarcian) sediments (Tchoumatchenco, 1988, 1989, 1990); the outcrop is build up of grey-greenish marls in alternation with thin beds of grey-pinkish limestones; they are bioclastic, made of numerous fragments of crinoids, echinids, belemnites and brachiopods: *Spiriferina alpina falloti*, *S. alpina alpina*, *S. haueri*, *Homoeorhynchia almaensis*, *Zeilleria quadrifida*, indicating the lower part of the Domerian Substage.

Geosite 16. (Fig. 1, 2). The rocks of this geosite crop out in the Ajvadjik Dere valley, confluence of the Luda Kamchia River (Tchoumatchenco, 1988, Pl. II, Fig. 2) (42°54'40'' N and 27°09'20'' E).

It consists of Triassic and Lower Jurassic sediments. The Triassic is represented by the Olenekian Mayadere Fm. and the Mid Triassic Gyurgenliya Fm. The Mayadere Fm. is built up of thinly bedded limestones (4–10 cm thick), grey, in alternation with marls. The marly intercalations upwards became thinner; the limestones are with irregular bedding surfaces, compared by Berndt (1934) with the German Wellenkalk. Ganev (1961) collected from them "*Terebratula" margaritovi*, *Eumorphotis iwanovi*, *E. telleri*, *Hoernesia socialis*, *Gervillia incurvata*, *Anodontophora* (*Myacites*) *fassaensis*, *Pleurotomaria sansonii*, *Naticella costata*, *Tirolites* cf. *spinosus*, *Dinarites dalmatinus*, *Arianites* (*Meropella*) *plejanae*. The sediments of the Mayadere Fm. are connected upwards, in a progressive transition, with limestones of the Gyurgenliya Fm. At the base, they contain (1) a packet of thinly bedded (8–12 cm thick) grey limestones, up to 20 m thick, with numerous small Spiriferinids; (2) above them the section continues with thickly bedded (30–60 cm), dark-grey limestones, thick up to 8–10 m; (3) alternation between grey limestones and grey-greenish marls — thickness *c*. 15 m. Ganev (1961) collected from them *Tetractinella trigonella* and *Aulacothyris angusta*; (4) the Triassic part of the section ends with thickly bedded (1–2 m) grey and reddish limestones — *c*. 20–25 m thick. These Triassic rocks were described by Berndt (1934) as "grey limestones of Ajvadjikdere".

Different parts of the Triassic rocks are transgressively covered by the Djula type Sinemurian–Carixian (Lower Jurassic) sediments (Tchoumatchenco, 1988). The Djula type sediments begin with (5) 4–8m thick sandstones, over which the section continues with (6) *c.* 17 m thick, predominantly bioclastic, reddish to greenish, thinly bedded (5–10 cm) limestones, with many fragments of crinoids and Ostreids; (7) limestones, reddish to violet, lithoclastic; the lithoclasts are represented by reddish micritic limestones with irregular rounded shapes of up to 5–7 cm in diameter; the matrix is formed by fragments of crinoids and bivalves. *Lobothyris subovoides* and the Upper Sinemurian ammonite *Xipheroceras* cf. *Ziphus* were collected from the packet; (8) limestones (2.0 m) grey-greenish, micritic, with *Aegoceras* sp. indet.; (9) lithoclastic limestones (1.40 m) grey-greenish; the clasts are of micritic grey-beige limestones (2x6 cm up to 10x10 cm), and the matrix is of aleuritic limestones, grey-greenish; (10) limestones (0.50 m) red-violet, granular, with many large Belemnites; (11) limestones (0.50 m) grey-greenish, granular, biodetritic, with many foraminifers: *Involutina liassica*, *I. turgida*, *Cornuspira orbiculare*, *Ophtalmidium carinatum*, *Lenticulina polygirata*, etc.

Geosite 17. (Fig. 1, 12). The geosite represents the Cerkoviste type Lower Jurassic, in the locality Cerkoviste (42°53'00'' N and 26°26'30'' E), town Kotel (Tchoumatchenco, 1988, Pl. II, Fig. 1).

The Cerkoviste type is build of isolated blocs of red, ferriferous, clayey limestones, with crinoid bioclasts, to red marls (Sinemurian in age), included into the black shales of the Kotel Fm. (Fig. 12). Many geologists have collected rich ammonite and brachiopod fauna from these blocks; ammonites: *Sulciferites* sp. (Lower Sinemurian), *Coroniceras* sp.indet. (upper parts of the Lower Sinemurian), *Oxynoticeras* sp. (Upper Sinemurian), *Charmasseiceras* sp. (Upper Sinemurian); brachiopods: *Spiriferina haueri*, *Gibbirhynchia amalthei*, *Piarorhynchia juvenis*, *Prionorhynchia greppini*, *Nucleata bodrakensis*, *Lobothyris subovoides*, *Zeilleria numismalis*, *Z. subdigona*, etc. (Tchoumatchenco, 1988). Limestones of these blocks are used for the building decorative walls in some houses in Kotel.

Geosite 18. (Fig. 1). Geosite of "Black shales with *Bositra alpina",* near Strouya Village, Varna district (42°57'10'' N and 27°8'30'' E).

It is build of black aleuritic shales, sometime rich in ammonites (facies common in other parts of Bulgaria and known as Etropole Fm.). This block is of shelf genesis and is included in the black shales of the Kotel Fm. as olistolite. The same rocks can be observed also in the Bedzene Dere, East of Orta Kaya Hill.

Fig. 13. Geosite 19. Olistolite of Toarcian Balaban Fm. (coarse siliciclastic turbidite) included into the Mid Jurassic Kotel Fm.

Near the railway station Strouya, District Varna

Geosite 19. (Fig. 1, 13). The geosite is located near the railway station Strouya, Varna District (42°57'30'' N and 27°28'25'' E).

It represents exposures of sandstones blocks (3–5 m) — coarse siliciclastic turbidite of the basinal Balaban Fm. (Toarcian), included as olistolites in the black shales of the Middle Jurassic Kotel Fm. (Fig. 13).

CONCLUSIONS

The list of the Triassic and the Jurassic geosites in eastern Stara Planina Mts., presented above, is not closed and will be continuously improved during future work within the project NZ-1310/03 of the Bulgarian NCSR.

The biggest problem, connected with the Triassic and Jurassic sediments in eastern Stara Planina Mts., concerns connections with the contemporaneous rocks: in the eastern direction — with the North Dobrogean Tulcea Zone and southern Crimea (?), and in the western direction — with the areas of Kazanluk, Teteven, and the Izdrimets Palaeograben and, probably, with the Sinaia Rift in the southern and eastern Carpathians, etc.

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