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Re-evaluation of the Triassic sequence in the subsurface of the Little Plain Basin Hungary: A case study from the Győrszemere-2 well

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The Little Plain Basin is one of the largest units in the Pannonian Basin System. Its continuation in Slovakia is called the Danube Basin. The Little Plain Basin is one of the most underexplored areas in Hungary. Based on archival geologic and geophysical data the lithostratigraphic composition of the area is controversial. The significance of the area is increased by the known Neogene and the supposed basement (Paleozoic and Mesozoic) hydrocarbon systems in Hungary and in Slovakia.

The purpose of this study is to identify the exact age, facies, geologic formations and possible source rocks of the Triassic section penetrated by the Győrszemere-2 well in the Little Plain Basin.

Based on new facies and paleontological results it can be stated that two Triassic sequences are identified in the well, separated by fault breccia. A carbonate sequence was deposited between the Induan and Early Anisian and above that a homogeneous recrystallized dolomite appears, the age of which is unknown.

The following formations were encountered, from base upward:

Arács Marl Fm. (3,249.5–3,030 m), silty marl with ooids, bivalves, gastropods and ostracode shells. Occasionally layers of angular quartz grains in large quantities appear. *Postcladella kahlori* and *Spirobis phlyctaena* indicates Induan (Early Triassic) age.

Köveskál Dolomite Fm. (3,030–2,790 m), rich in ooids and also containing anhydrite. The *Glomospira* and *Glomospirella* dominance indicates an age interval between Olenekian and earliest Anisian age.

Fault breccia (2,790–2,690 m) separating the Köveskál and overlying dolomites.

Upper dolomite (2,690–2,200 m): homogeneous, saccharoidal, and totally recrystallized. The age is unknown.

The low TOC values of the supposed source rock interval (marl between 3,249.5 and 3,030 m) indicate poor hydrocarbon potential.

Key words: Lower Triassic (Induan), Kisalföld (Little Plain), sedimentology, paleontology, Arács Marl Formation, Köveskál Dolomite Formation, hydrocarbon exploration

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Introduction (problems, goals, methods)

Problems

The Little Plain Basin is one of the largest parts of the Pannonian Basin System. Its continuation in Slovakia is called the Danube Basin. It is one of the most under-explored areas in Hungary. An exact knowledge of the stratigraphic column of the Győrszemere-2 well is important (1) for the oil industry (2) for basic geologic research.

(1) The Győrszemere-2 well (Gysz-2; Fig. 1) was drilled by the OKGT (Hungarian Oil and Gas Trust) in 1972. The well was dry. According to the archival geologic and geophysical data the lithostratigraphic composition of the well is controversial. Based on a core and thin section study, a Ladinian-Norian age was determined for the Triassic marly rocks in the well report (Balázs et al. 1973). As opposed to this, in 1980 Bércziné Makk (Appendix in Balázs et al. 1973) determined the foraminifera from cores 29–31 as of Early Triassic (Late Scythian) age.

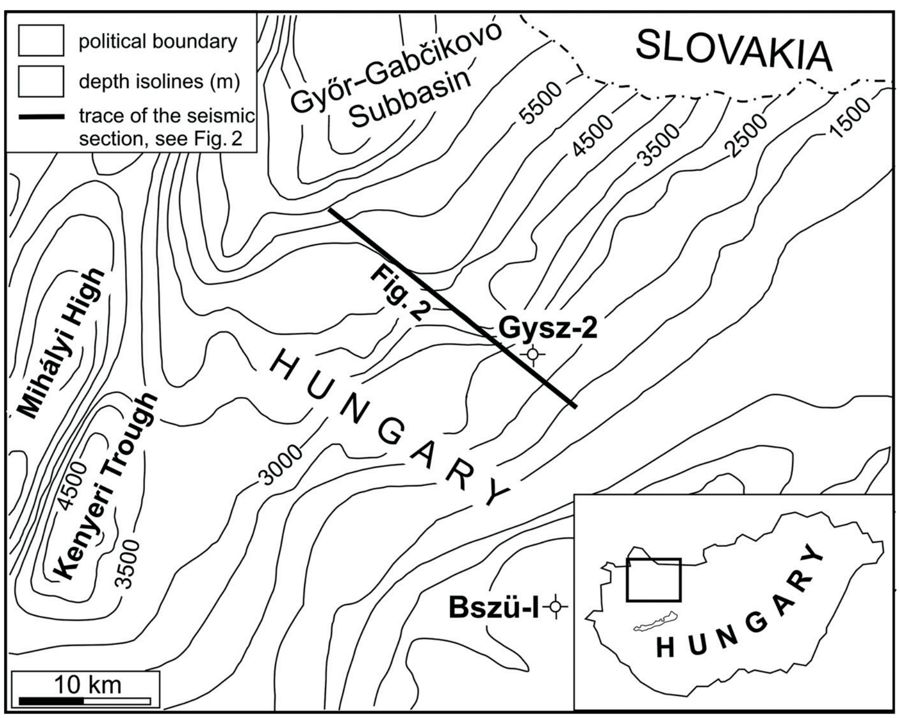


Fig. 1
Pre-Cenozoic depth map of the Little Plain Basin (after Horváth and Royden 1981 and Haas et al. 2010). The investigated Gysz-2 well is located on the southeastern margin of the Győr–Gabčikovo Subbasin. The Bszü-I well is located in a structurally high position, and could have penetrated a similar Induan-Olenekian succession

Among the Triassic formations of the Transdanubian Range two are considered as source rocks (Kókai and Pogácsás 1991a, b; Badics and Vető 2012): the Carnian Veszprém Marl Formation and the Upper Norian-Rhaetian Kössen Marl Formation. Consequently it was initially assumed that in the Gysz-2 well, and in the Little Plain Basin in general, Triassic source rock was present.

Several wells were drilled in the Little Plain Basin, but most of the discovered gas fields in Hungary and in Slovakia have high CO_2 and N_2 content, or are mixed N_2–CO_2–HC fields. Neogene and Paleozoic rocks represent the source rocks of these petroleum systems (Mattick et al. 1996; Hrušecký 1999; Vető et al. 2014).

Mesozoic source rocks were found only in the Transdanubian Range Unit, from a petroleum system known in the Zala Basin south of the Little Plain Basin (Kókai and Pogácsás 1991a, b; Clayton and Koncz 1994).

Re-evaluation of the available archival geologic and geophysical data is essential for the understanding of the hydrocarbon systems of the Little Plain Basin in Hungary and its continuation in Slovakia.

(2) The structure of the Little Plain Basin is very complicated, and there are only a few wells that reached the basement. The Gysz-2 well was situated in the sliver zone of the Transdanubian Range Unit; consequently, it provides information on its stratigraphy as well.

Goals

The main objectives of the study were: 1) to determine the age of the silty marl (cores 31–35) and dolomite (cores 30–14), 2) to obtain information on the facies of the Triassic rocks, 3) based on the age, facies and lithology of the well, to compare the succession of the well with the Triassic Formations of the Transdanubian Range Unit, and 4) to justify or reject the presence of Triassic source rocks in the well.

Methods

The existing cores and thin sections of the well were studied and evaluated. In addition to this, Hungarian Horizon Energy Ltd. had prepared 17 new thin sections. In order to distinguish the dolomite from the limestone, the new thin sections were stained with alizarin red. Paleontological investigations (of foraminifera) were carried out on the thin sections. The log signal of the gamma ray log was correlated with the different Triassic rock types. The gamma ray log, lithology, fossil content were correlated on the montage panel (Fig. 3).

Geologic background

The Little Plain Basin is an extensional basin in the background of the Eastern Alps and the Western Carpathians. It is one of the largest parts of the Pannonian Basin System and consists of a large, 7–8 km deep central basin (Győr–Gabčikovo Subbasin) connecting to two smaller troughs (Csapod and Kenyeri) of 4 km depth on the Hungarian side. The Transdanubian Range Unit forms its eastern boundary (Fig. 1).

The basin was bordered by NE-SW oriented low-angle normal/scissor faults during the Middle Miocene. The main tectonic contact zone is called the Rába Line, which separates the two Austroalpine Units from the Transdanubian Range Unit. The basement within the Austroalpine Units consists of metamorphic rock of Paleozoic age, while the Transdanubian Range Unit is composed of Paleozoic and Triassic rocks, which form nappe structures and are covered by the deposits of the Upper Cretaceous sedimentary cycle or by Neogene basin-fill sediments (Tari 1994; Hrušecký 1999; Haas et al. 2010; Tari and Horváth 2010). The Gysz-2 well was drilled on the north-

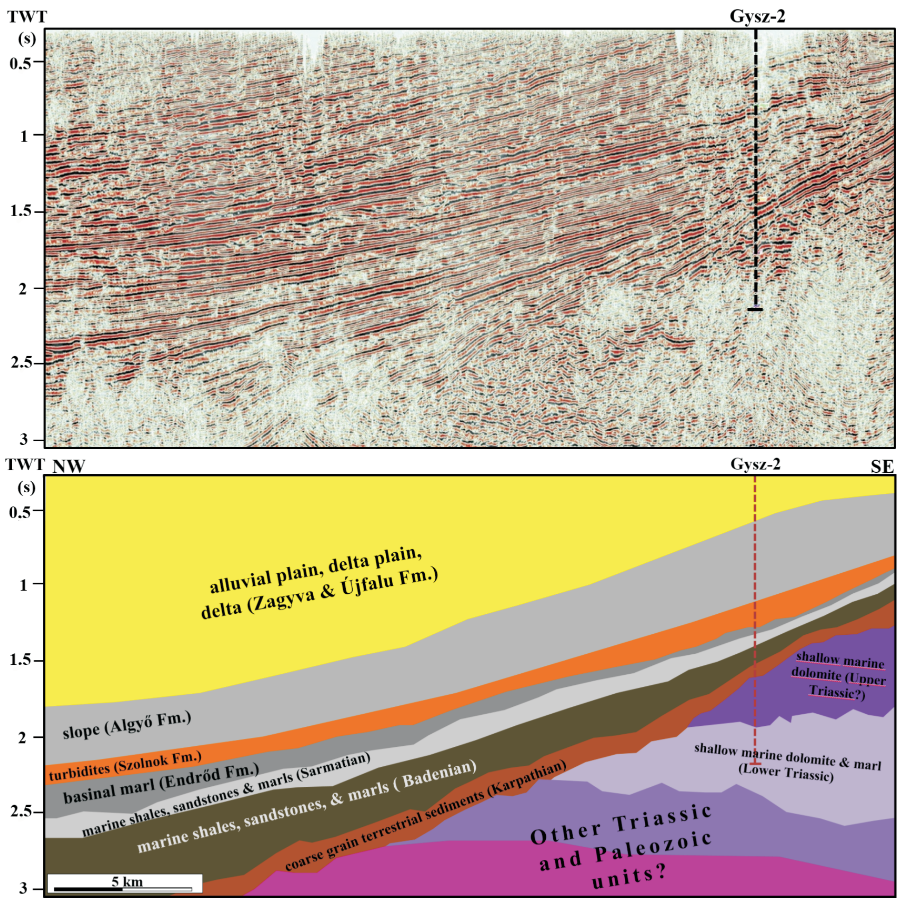


Fig. 2
Seismic section and interpretation through the Gysz-2 well location. Mesozoic carbonates of the NW flank of the Transdanubian Range syncline form the basement below the Neogene basin fill sediments. The position of the section is in Fig. 1

western flank of the synclinal structure of the Transdanubian Range Unit in the southeastern margin of the Neogene Győr–Gabčikovo Subbasin. Beside its hydrocarbon exploration purpose the well was drilled to understand the Neogene basin-fill sediments and the basement rocks between Gönyű and Tét (Mészáros et al. 1973). The Lower Triassic sequence of the Transdanubian Range Unit belongs to the initial transgressive phase of the Permian–Lower Cretaceous sedimentary cycle. The Permian alluvial plain had been covered by the sediments of the rising sea level of the Early Triassic. Sediments of a carbonate ramp were deposited until the end of the Middle Anisian. The ramp was differentiated in the Middle Anisian when carbonate platforms and basinal carbonates were developed (Budai and Vörös 1992; Haas 2004).

In the Karpathian, after a considerable hiatus, coarse-grained terrestrial sediments were deposited on the eroded surfaces of the Triassic rocks with an angular disconformity (Fig. 2). In the Badenian marine shale, sandstone and marl were deposited. Sarmatian sediments are represented by marine shale and marl.

The Little Plain Basin was among the first in the Pannonian Basin System to be filled up by the paleo-Danube during the Late Miocene (Pannonian). The shelf-margin slopes prograded across the basin from 10 to 9 My ago, from a NW–N direction. Delta, delta plain, and later sediments of the alluvial plain were deposited until the present (Juhász 1991, 1998; Uhrin and Sztanó 2011; Magyar et al. 2012).

Győrszemere-2 well (Figs 2 and 3)

Stratigraphic column of the Győrszemere-2 well

Between 0 and 2,220 m Miocene clay, claystone, sand, sandstone, marl, and calcareous marl, between 2,220 and 3,030 m Triassic dolomite, and between 3,030–3,249.5 m calcareous marl and marl with limestone intercalations, were penetrated. In the following the Triassic units are described, from the base upward.

Triassic sediments in the Győrszemere-2 well (Fig. 3)

3,249.5–3,030 m: ***Arács Marl Formation*** (Fig. 4), marl, silty with limestone intercalations

The lower part (cores 33–35) consists of grey and brownish-grey, homogeneous, silty marl.

Some levels are rich in ooids, bivalve, gastropod and ostracode shells (Fig. 4/7), occasionally bioturbated (Fig. 4/4). At a certain level idiomorphic quartz and calcite crystals appear in large quantities; mica also appears in the calcareous matrix and is rich in pyrite. The dip is 4–5°.

Three microfacies can be distinguished in its upper part (cores 31 and 32) from base to top:

1) The sediment consists of 8–20 mm fining-upward cycles (Fig. 4/1). The lower surface is uneven. The lower part consists of idiomorphic, subangular quartz grains showing a fining-upward trend (Fig. 4/1–3). The upper part consists of clayey calcite

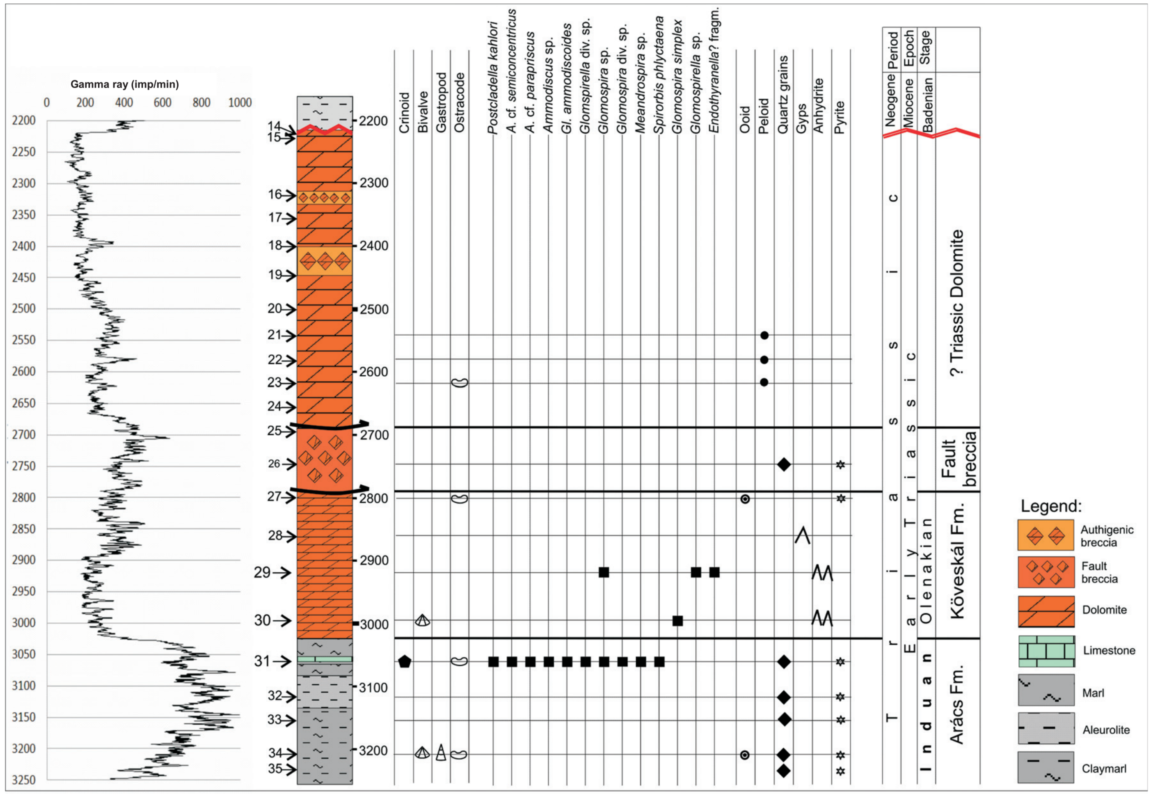


Fig. 3
The penetrated Triassic sequence of the Gysz-2 well. The Arács Marl Fm. is easily identifiable on the GR log as well. The dolomite series is visually variable, but from the core samples only the lower ooidal anhydritic part (Köveskál Dolomite) could be identified. *A.* cf. *semiconcentricus* = *Ammodiscus* cf. *semiconcentricus; A.* cf. *parapriscus* = *Ammodiscus* cf. *parapriscus*

layers containing abundant mica and pyrite in large quantities. These cycles probably represent storm deposits (tempestites), which are deposited below the storm wave base on the ramp where the tidal range is small and the prevailing winds are strong. The siliciclastic grains originate from the uplifted and eroded hinterland.

2) Grey, dark grey, homogeneous siltstone with mica. The microfacies is mudstone. In the micritic, microsparitic matrix angular quartz (less than 0.1 mm in diameter), pyrite and mica appear. In some samples, half of the matrix is dolomitized.

3) Crinoidal lime/dolostone (Fig. 4/6). The microfacies is crinoidal packstone. The stained thin section revealed that only the crinoidal fragments are calcitic, while the matrix is dolomite. Sporadically foraminifers, ostracodes and pyrite occur. There are concentrations of quartz grains in some thin layers.

The foraminifera *Postcladella kahlori* (Brönn. et al.) (Fig. 4/9), *Ammodiscus* cf. *semiconcentricus* Waters (Fig. 4/10), *Ammodiscus* cf. *parapriscus* Ho (Fig. 4/11), *Ammodiscus* sp., *Meandrospira* sp. (Fig. 4/8), *Glomospira* div. sp. (minimum two species, but not determinable at species level), *Glomospirella ammodiscoides* (Rauser), *Glomospirella* div. sp., and annelida: *Spirobis phlyctaena* Brönnimann et Zaninetti (Fig. 4/12) point to an Early Triassic (Scythian) Induan age (Krainer and Vachard 2011).

The sediment was deposited in the shallow subtidal part of the homoclinal ramp. The ooids were formed during permanently agitated water, the fossil rich layers in the subtidal zone, and the tempestites in the deeper part of the ramp. The fossils (foraminifera, crinoids, ostracodes and one worm *(Spirorbis phlyctaena)*) indicate that it was deposited in a normal saline, shallow, intertidal environment close to the coast.

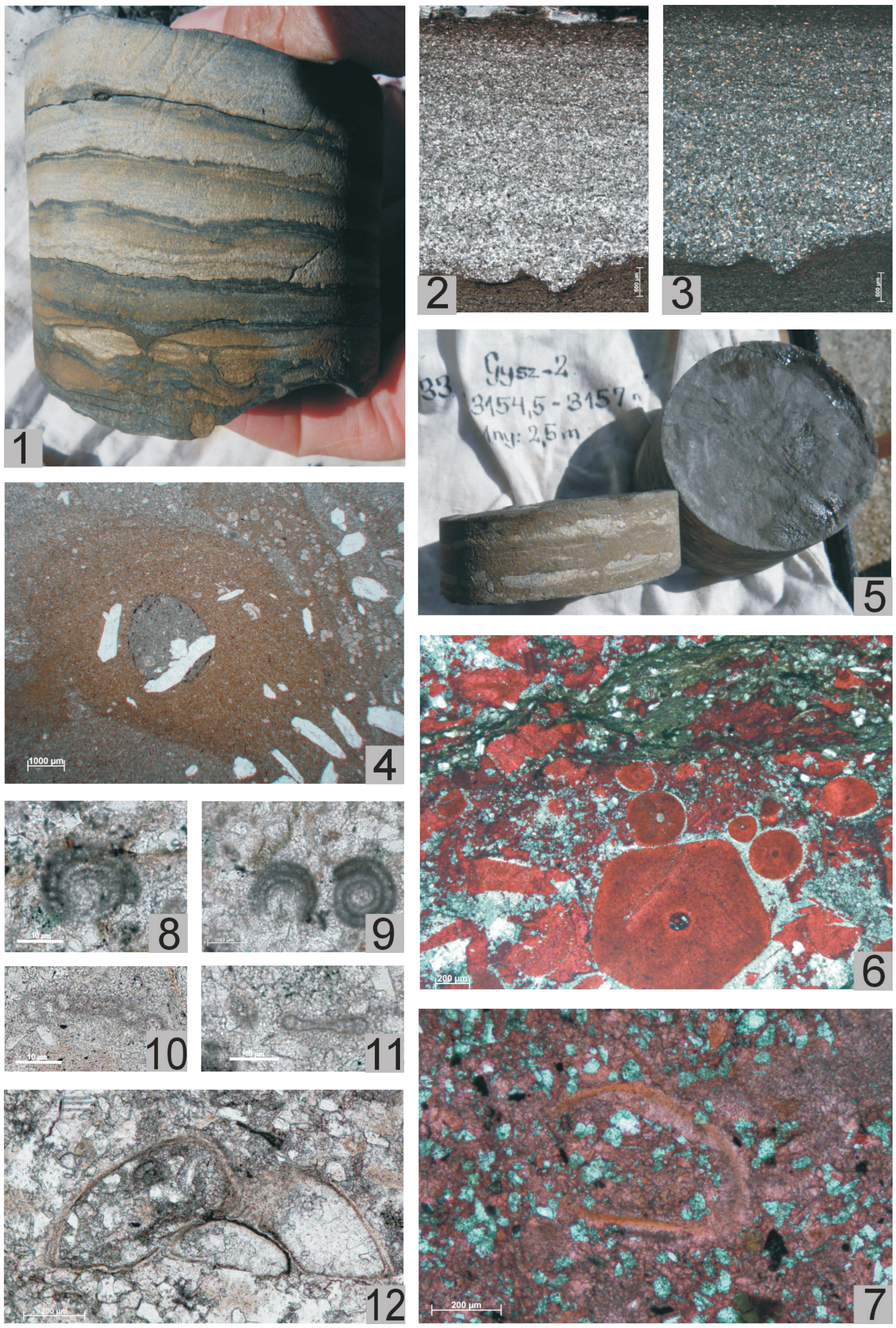
The Arács Marl Formation is clearly separated from the above dolomitic section on the gamma ray logs (Fig. 3).

3,030–2,790 m: ***Köveskál Dolomite Formation*** **(cores 27–30)**

The dolomite (cores 27–30) is rich in ooids, and also contains anhydrite (Fig. 5/5, 6). It is grey to brownish grey dolomite (Fig. 5/1, 2), sometimes with coffee-brown colored irregular patches. The rock is recrystallized. Four microfacies can be distinguished.

1) Ooid packstone (Fig. 5/3, 4): The majority of the rock, the matrix and the inner part of the ooids are dolomitized. The dolomite crystals are smaller (0.2 μm) within the ooids than in the matrix (2–4 μm). Occasionally the middle part of the ooids consist of larger dolomite crystals or pyrite concentrations. The dolomite crystals are very likely larger where the crystals were originally larger. Vugs appear in the matrix between the ooids, and are either filled with anhydrite, or are empty. Pyrite appears sporadically in the matrix as well.

2) Ostracode packstone (Fig. 5/7, 8): The matrix is partially dolomitized. Occasionally the inner part of the ostracodes is empty, but formation of the dolomite rhombs had already begun (Fig. 5/8). Pyrite occurs sporadically in the matrix.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3) Pelmicrite: Pelloids and pellets appear in the microsparitic matrix. In many cases the space between the pellets is dissolved and filled with anhydrite. Some poorly preserved foraminifera appear as well.

4) Stromatolite (originally microbial mat): Fenestral fabric appears in one thin section only.

The foraminifera are represented by *Glomospira* sp. (Fig. 5/9), *Glomospirella* sp. (Fig. 5/10), *Endothyranella*? fragment (Fig. 5/12), and *Glomospira simplex* Harlton (Fig. 5/11). Based on the *Glomospira* and *Glomospirella* dominance the dolomite is younger than the layer with *Postcladella kahlori* (core 31). The foraminifera assemblage indicates an age interval between Early Triassic and the earliest Anisian. It is noteworthy that the Olenekian *Meandrospira pusilla* biofacies, which is characteristic for the Csopak Marl Formation, and the *Meandrospira dinarica* association which is Anisian in age, are missing here. This can be explained by a different age, by sporadic core sampling, or by different environmental conditions.

The sediments between 3,030 and 2,790 m were deposited in shallow water. The ooidal packstone is typical for permanently agitated water. The algal mat formed in a

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Fig. 4
Lithology, microfacies, fossils from the Arács Marl Fm.

4.1–4.3: Tempestites from core 32

4.1: Macroscopic appearance of the tempestites. It is cyclic sediment. A single cycle is 8–20 mm thick. The lower surface is uneven. The lower part consists of idiomorphic, subangular quartz grains, showing a fining-upward trend. The upper part consists of clayey calcite layers containing abundant mica. These cycles most probably represent storm deposits (tempestites)

4.2–4.3: Boundary between two tempestite layers. The muddy surface of the lower cycle is followed by an erosion surface. The fining-upward trend of the resedimented quartz grains is also well visible. HOR thin section

4.3: The same as 4.2 with +N

4.4. Bioturbation in thin section. MOL thin section core 33

4.5. Macroscopic appearance of core 33. Brownish-grey siltstone with many tiny spots. 2–3 mm thick white, bluish-white intercalation, but the layer is not continuous

4.6. Microfacies of core 31/I. Crinoidal wacke-packstone. Stained thin section. The red patches are the calcitic crinoid fragments. The small bluish rhombus grains are the dolomite crystals, the sporadically appearing tiny white crystals are quartz grains. It is noticeable that the crinoid fragments consist of calcite, whereas the overgrowth edges around the crinoid fragments are already dolomitized. In the matrix calcite patches are present, which are the remnants of the original limestone. HOR thin section

4.7. Microfacies of core 34. Stained thin section. In calcareous matrix quartz grains appear in great quantity. HOR thin section

4.8–4.12. Fossils form the Arács Marl, core 31

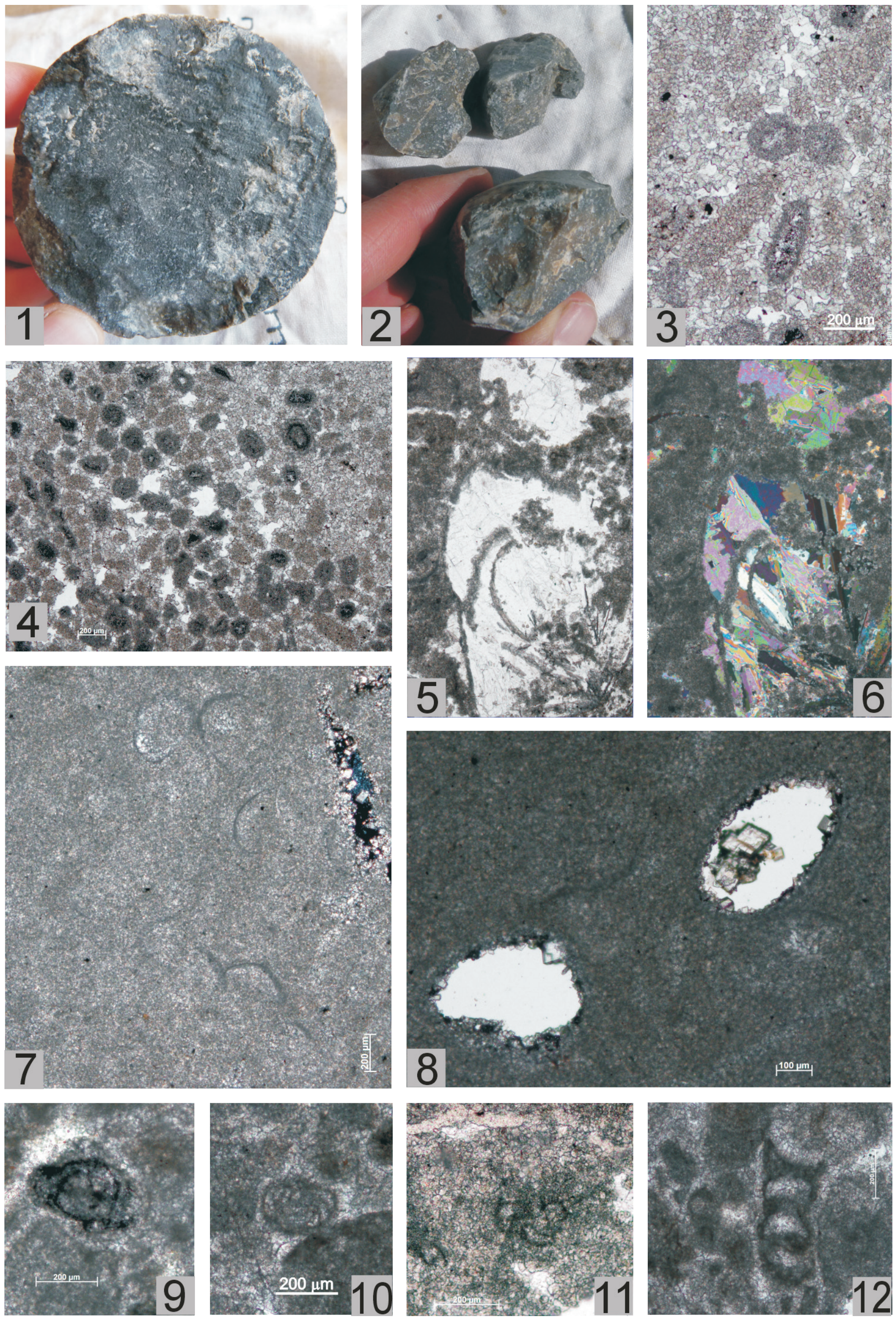
4.8. *Meandrospira* sp.

4.9. *Postcladella kahlori* (Brönn. et al.)

4.10. *Ammodiscus* cf. *semiconcentricus* Waters

4.11. *Ammodiscus* cf. *parapriscus* Ho

4.12. *Spirobis phlyctaena* Brönn. et Zaninetti. An annelid (worm)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peritidal environment, the ostracode-bearing packstone and the pelmicrite in subtidal environment. Salinity occasionally rose to hypersaline levels, when dolomitization and evaporite formation occurred.

The gamma ray peaks are much less than the values of the Arács Marl, but the upper section (2,790–2,900 m) has similarly high values as the fault breccia between 2,790 and 2,690 m.

2,790–2,690 m: **Fault breccia** (Mészáros et al. 1973)

Angular, light grey clasts occur in the dark matrix (core 25, 2,694–2,696 m). The diameter of the clasts varies between 0.8 and 4 cm (Fig. 6/1). The matrix consists of calcite crystals. The shape of the calcite crystals is partly elongated (20 × 100 μm), partly isometric (30 × 30 μm). The axes of the elongated calcite crystals run parallel to the outline of the clasts, which originate from the underlying layers. They represent:

1) Tempestite (Fig. 6/4), the same as in core 32,
2) Fine-grained dolomite (Fig. 6/2),
3) Coarse grained dolomite (Fig. 6/3), and
4) ? Oolitic limestone. It is difficult to determine the original texture.

Based on the interpretation of the seismic section the breccia could be connected to a Neogene normal fault and to a Mesozoic reverse fault as well.

2,690–2,220 m: **Dolomite:** white, brownish grey, homogeneous, saccharoidal, splintery dolomite without ooids, anhydrite and pyrite (Fig. 6/5)

The original structure can only seldom be seen because of the fabric-destructive dolomitization. Under the microscope, two different types can be distinguished:

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Fig. 5
Lithology, microfacies, and fossils from the Köveskál Dolomite Formation

5.1–5.2. The Köveskál Dolomite is brownish-grey. Under magnification many transparent spots (1–1.5 mm in diameter) appear. Core 29.

5.3–5.4. Ooidal dolomite. The ooids consist of fine-grained dolomite crystals, whereas the matrix also contains coarse-grained dolomite crystals. In the matrix empty vugs can be seen. MOL thin section core 27/b. Pyrite appears in the inner part of some ooids

5.5–5.6. The dissolved mold of a mollusk shell was filled with anhydrite. MOL thin section core 30.

5.6. +N

5.7. Ostracodal wackestone. MOL thin section core 27/a

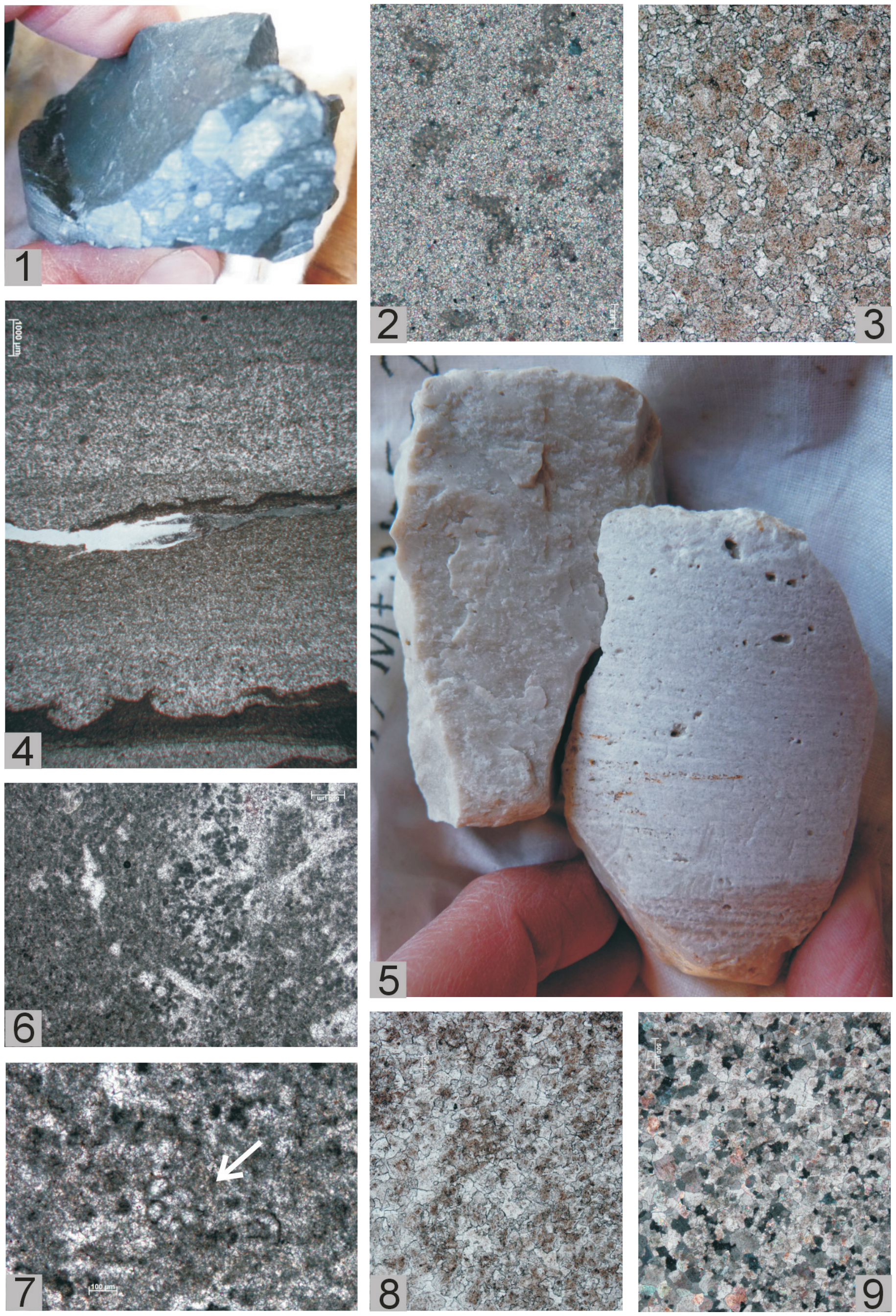
5.8. Well-developed, idiomorphic dolomite crystals grow partly on the edge of the dissolved ostracode molds, partly in the inner part of the ostracode molds

5.9. *Glomospira* sp. core 29

5.10. *Glomospirella* sp. core 29

5.11. *Glomospira simplex* Harlton core 30

5.12. *Endothyranella* ? fragments core 29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1) Coarsely-crystalline, totally dolomitized rock (Fig. 6/8, 9), where the diameter of the dolomite crystals varies between 200 and 500 μm. The dolomite content is high (93–100%).

2) Pelmicrite. Peloids and micritic nodules appear in a microsparitic matrix (Fig. 6/6). The ghosts of the original grains and matrix can still be seen but they are almost impossible to identify. The only recognizable fossils are ostracodes and foraminifera remnants (Fig. 6/7) and Tubiphytes-like fossils. Dolomite content is 100%.

In the middle part of the upper, homogeneous dolomite, between 2,447 and 2,402 m, an authigenic breccia appears. The clasts of the breccia show mosaic structure, which is characteristic of hydrobreccia.

Because only some ghosts of foraminifera appear, but no more precise identification is possible, the age of the dolomite between 2,690 and 2,220 m is unknown.

Nothing certain can be said about the original facies because the original structure of the rock is not preserved. The calcareous mud was most likely deposited on a shallow carbonate platform, and during sea-level lowstand the calcareous mud was dolomitized. The lack of ooids and anhydrite point to the fact that the original rock of the upper dolomite between 2,690 and 2,220 m was deposited under different conditions than the lower dolomite between 3,030 and 2,790 m.

The thickness of the upper dolomite (2,690–2,220 m) is considerable, totaling 470 m, but its dip is unknown; consequently it is not clear whether this is the real or the apparent thickness.

Fig. 6
Lithology and microfacies of the fault breccia and of the (?) Triassic Dolomite

6.1–6.4: Fault breccia

6.1. Matrix-supported breccia. In the dark matrix, subangular, light grey pebbles. Their diameter varies between 0.8 and 4 cm. Core 25

6.2–6.4. Different microfacies of the pebbles

6.2. Type I: fine-grained dolomite. The dark patches are remnants from the original rock, which were most probably micritic components, ooids, or micrite patches. Core 25 +N

6.3. Type II: the gravel is totally dolomitized; only the well-developed dolomite crystals can be seen. Core 25

6.4. Type III: tempestite. Two tempestites. The erosive base and the fining-upward trend are well visible. Core 25

6.5. White, homogeneous, slightly porous dolomite from core 17. This macroscopic appearance is typical for the uppermost dolomite type

6.6. Microfacies of the dolomite between 2,690–2,447 m. The rock is rich in peloids and micritic nodules. This microfacies is different from that between 3,030 and 2,790 m, which is rich in ooids; anhydrite is also present. Core 23

6.7. In the middle of the photo a badly preserved foraminifer appears. Core 23

6.8. Totally dolomitized rock. Core 20

6.9. Microfacies of core 20 with +N

On the gamma ray log (Fig. 3) there is a significant difference between the upper dolomite and the underlying fault breccia.

Organic geochemical investigation

The dark grey, black marl succession (3,249.5–3,030 m) was investigated with Rock Eval pyrolysis on seventeen samples from five cores, and vitrinite reflectance on one core sample, to obtain information on the source rock parameters (Table 1). It should be noted that the well was drilled in 1972–1973, and the core samples may have lost their original volatile organic matter content.

In every case TOC was lower than 0.5%, which means poor source rock quality. The HI (hydrogen index) indicates gas-prone source rock and the HI and OI (oxygen index) values show types III and IV kerogen. Based on the Tmax values the investigated section is close to the top of the oil window (Hunt 1995). Only one vitrinite reflectance measurement was made from the Gysz-2 well, on core 32 (3,116–3,118.5 m). Its mean value is 0.82%; the range of values is 0.75–0.85%, which points to the fact that the sample was from within the oil window, which fits with the interpretation of the Tmax values.

Table 1
Results of the Rock Eval pyrolysis from the core samples of the Arács Marl section

Core number	Depth from (m)	Depth to (m)	Tmax (ºC)	TOC (%)	HI (mg HC/g TOC)	OI (mg CO_2/g TOC)
31/I	3059.5	3062		0.07		443
31/II	3059.5	3062	429	0.13	31	338
31/II	3059.5	3062	431	0.14		300
31/II	3059.5	3062	431	0.22	9	223
31/III	3059.5	3062	422	0.22	32	223
31/III	3059.5	3062	430	0.21	14	214
32	3116	3118.5	432	0.18	33	228
32	3116	3118.5	431	0.21	19	133
33	3154.5	3157		0.09		400
33	3154.5	3157		0.13		308
34	3206.5	3208.5	432	0.14	14	186
34	3206.5	3208.5	433	0.19	53	158
34	3206.5	3208.5	432	0.13		292
35	3233.5	3236.5	434	0.28	54	100
35	3233.5	3236.5	436	0.32	147	94
35	3233.5	3236.5	436	0.39	115	54
35	3233.5	3236.5	432	0.19	37	153

Comparison of the Lower Triassic sedimentation of the Transdanubian Range with that of the Győrszemere-2 well (Fig. 7)

In the area of the Transdanubian Range a significant transgression took place at the P/T boundary (Haas 2001). Due to the transgression a facies shift of 100 km magnitude can be observed between the Late Permian and Early Triassic facies belt. The Late Permian alluvial plain was inundated and transformed into a homoclinal shallow marine ramp. Sedimentation was influenced by the eustatic sea-level fluctuation and by terrigenous input eroded from the uplifted hinterland. Around the Early/Middle Triassic boundary terrigenous input drastically decreased.

The following facies zones were formed on the homoclinal ramp during the earliest Triassic:

In the northeastern part of the Transdanubian Range the Triassic succession begins with grey limestone, calcareous marl, and silty marl with oolite, gastropod-oolite and crinoid or mollusk coquina interbeds **(Alcsútdoboz Limestone Fm.).** Representatives of *Claraia* (*C. wangi-griesbachi* fauna) and foraminifera appear about 40 m above the P/Tr boundary. The thickness of the formation is 150–200 m. This is a shallow subtidal

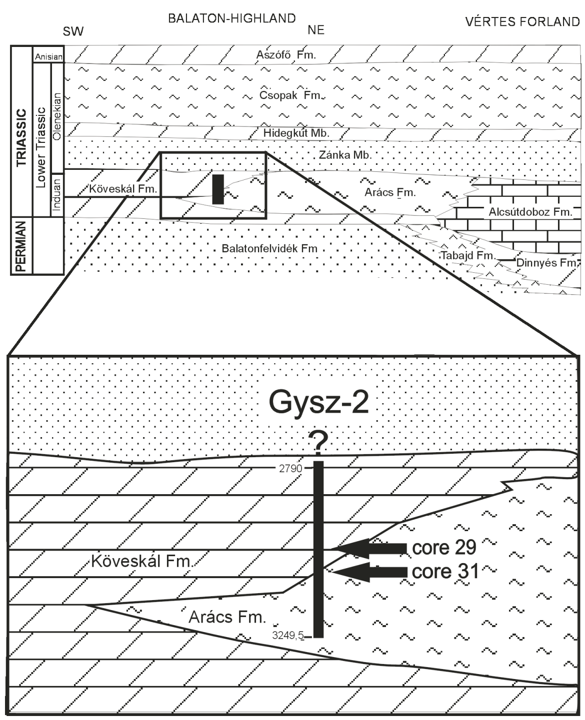

Fig. 7
Correlation between the Triassic Formations of the Transdanubian Range and the Lower Triassic succession penetrated in the Győrszemere-2 well between 2,790 and 3,249.5 m. After Haas 2001

facies formed partly in the high-energy outer shelf margin, partly in the protected inner shelf area. The coquinites represent storm deposits.

In the middle sector of the Balaton Highland, at the same stratigraphic level, greenish-grey and brownish-red limestone and calcareous marl, silty marl, marl, and subordinate dolomite with a characteristic *Claraia* fauna (**Arács Marl Fm.;** Haas 1993) appear. The Triassic sediments lie unconformably above the eroded surface of the Permian Balatonfelvidék Sandstone. The lowermost siliciclastic layers are followed by ooidal dolomite, in which bioturbation is common. A characteristic foraminifer is *Postcladella kahlori.* In some levels crinoidal calcarenite appears. The age is Induan. The thickness of the formation is 80–120 m. The depositional environment may have been in the shallow subtidal zone of the protected inner shelf.

The marl and silty marl encountered in the Győrszemere-2 well between 3,249.5 and 3,030 m shows similarity to the Arács Marl. It is rich in often bioturbated ooids, and crinoidal packstone also appears; *Postcladella kahlori* was found as well. Consequently, based on the similar lithology and the same age it can be considered as the **Arács Marl Fm.**

Southwest of the Balaton Highland the dolomite intercalations show a thickening trend; consequently the succession becomes more and more dolomitic **(Köveskál Dolomite Fm.).** The grey, cellular-porous dolomite and dolomitic marl contain considerable amount of fine, siliciclastic material, and red marl interlayers also occur. Relicts of ooids are common. The pores are often filled with gypsum and anhydrite crystals. *Claraia* specimens were found in some layers. The dolomitic sequences were formed in the restricted parts of the shallow ramp. The average thickness of the formation is 100 m.

Dolomite encountered in Győrszemere-2 well between *3030–2790 m* (cores 27–30) is also rich in ooids. The vugs and molds are filled with anhydrite. The *Glomospira* and *Glomospirella* dominance yields a time interval between Early Triassic – earliest Anisian age. Based on the age and lithology it can be interpreted as Köveskál Dolomite Fm.

Conclusions

The well encountered the following formations:

Arács Marl Fm. (3,249.5–3,030 m): silty, marl with limestone intercalations; Lower Triassic (Induan) age; the TOC values (<0.5%) of analyzed core samples indicate poor quality source rocks.

Köveskál Dolomite Fm. (3,030–2,790 m): its fossils point to an age interval between Early Triassic and the lowermost part of the Anisian stage.

Fault breccia (2,790–2,690 m): separates two different dolomite formations.

The upper dolomite (2,692–2,220 m) is white homogeneous dolomite without any fossils. Its age is unknown, but most probably it is not lower Triassic dolomite.

Our microfacies and paleontological investigations justified the age determination of Bérczinė Makk (1980). Cores 31, 30, and 29 contain Lower Triassic fossils.

The age of the marl penetrated in the Győrszemere-2 well is the same as the Lower Triassic Arács Marl, and not of the Upper Triassic source rock (the Carnian Veszprém Marl or the Norian-Rhaetian Kössen Marl). The source rock quality of the Arács Marl was investigated with Rock Eval pyrolysis and vitrinite reflectance. It oil mature but contains poor quality (<0.5% TOC) gas-prone kerogen.

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