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Lithofacies and age data of Jurassic foreslope and basin sediments of Rudabánya Hills (NE Hungary) and their tectonic interpretation

SZILVIA KÖVÉR[1], JÁNOS HAAS[1], PÉTER OZSVÁRT[2], ÁGNES GÖRÖG[3], ANNETTE E. GÖTZ[4] and SÁNDOR JÓZSA[5]

[1]Geological, Geophysical and Space Science Research Group of the Hungarian Academy of Sciences, Pázmány Péter str. 1/C, H-1117 Budapest, Hungary; koversz@yahoo.com; haas@ludens.elte.hu
[2]Hungarian Academy of Sciences — Hungarian Natural History Museum, Research Group for Paleontology, P.O. Box 137, H-1431 Budapest, Hungary
[3]Eötvös University, Department of Paleontology, Pázmány Péter str. 1/C, H-1117 Budapest, Hungary
[4]Institut für Angewandte Geowissenschaften, Technische Universität Darmstadt, Schnittspahnstraße 9, D-64287 Darmstadt, Germany
[5]Eötvös University, Department of Petrology and Geochemistry, Pázmány Péter str. 1/C, H-1117 Budapest, Hungary

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Abstract: Jurassic sedimentary rocks of the Telekesvölgy Complex (Bódva Series), Telekesoldal Complex (Telekesoldal Nappe) and the Csipkés Hill olistostrome in Rudabánya Hills (NE Hungary) were sampled for microfacies studies and interpretation of the depositional environments. The Telekesvölgy Complex is made up of reddish to greenish marl, occasionally containing limestone olistoliths — gradually progresses from the Norian Hallstatt Limestone of the Bódva Series — then grey marl, which may correspond to the latest Triassic Zlambach Formation. This variegated marl progresses into grey marl and calcareous marl, containing crinoid fragments. It may be interpreted as a hemipelagic facies, relatively close to submarine highs. Bajocian to Lower Bathonian black shales, rich in radiolarians and sponge spicules representing typical deep pelagic facies, are also assigned to the Telekesvölgy Complex. The Telekesoldal Complex represents a mélange-like subduction-related complex that consists of black shales, sandstone turbidites and olistostrome beds, and deposited by gravity mass flows. A relatively deep marine basin in the proximity of a submarine slope is likely to be the depositional environment of this unit. The clasts of the olistostromes are predominantly Middle to Upper Triassic pelagic limestones, rhyolite and basalt. Subduction related nappe stacking of the ocean margin during the Middle to Late Jurassic may have created suitable conditions for this sedimentation pattern. Bajocian–Callovian age of the complex was proved by the revision of the radiolarian fauna and new palynological data, the first from the Jurassic of the Aggtelek-Rudabánya Hills. The Csipkés Hill olistostrome consists of carbonate turbidite beds containing Jurassic platform derived foraminiferal and olistostrome horizons with Middle–Upper Triassic limestone clasts of red Hallstatt facies.

Key words: Jurassic, Neotethys, subduction-related complex, mass-flows, microfacies, Foraminifera, Radiolaria, palynomorphs.

Introduction

The last geological mapping project in the early eighties resulted in a new geological and tectonic map of the Aggtelek-Rudabánya Hills (Less et al. 1988; Szentpétery & Less 2006). Recognition of nappes can be considered the most important result of this project. However, the definition and accordingly the number of the structural units, the superposition of the nappes, the sedimentary features and ages of the sequences have not been clarified. The previous investigators pointed out, that there are metamorphic and non-metamorphic structural units forming a complex nappe stack (Grill et al. 1984; Árkai & Kovács 1986; Less et al. 1988; Less 2000; Szentpétery & Less 2006). According to their concept, this nappe stack is composed of three main tectonic units, and characterized by different kind of rocks and subjected to different degrees of metamorphism.

In the last years a new project should obtain new structural and metamorphic data for a better understanding of the structural position, the deformation history and the metamorphic conditions of the nappes of Aggtelek-Rudabánya Hills (Fodor & Koroknai 2000, 2003; Kövér et al. 2005, 2006, 2007).

In the course of these investigations new stratigraphical and sedimentological questions came up concerning the Jurassic sequences. These sequences have been studied since the middle of the 19th century (Foetterle 1869). Until the 1980-ies the whole Mesozoic succession was assigned to the Triassic. As a result of the works of Grill & Kozur (1986), Grill (1988) and (Dosztály 1994) the Jurassic age of these formations became generally accepted about 20 years ago. However, our knowledge of the structural position, depositional environment and exact age of the Jurassic formations, their relations with the underlying Triassic basement, and the correct order of the formations has not been clarified, until now.

On the basis of lithological and paleontological data, the previous researchers subdivided the uppermost Triassic-Jurassic sequences into two lithostratigraphic units: the Telekesvölgy Complex (TVC) and Telekesoldal Complex (TC) although the same units were also referred as formations and groups, respectively (Grill & Kozur 1986; Grill 1988; Dosztály 1994; Dosztá-

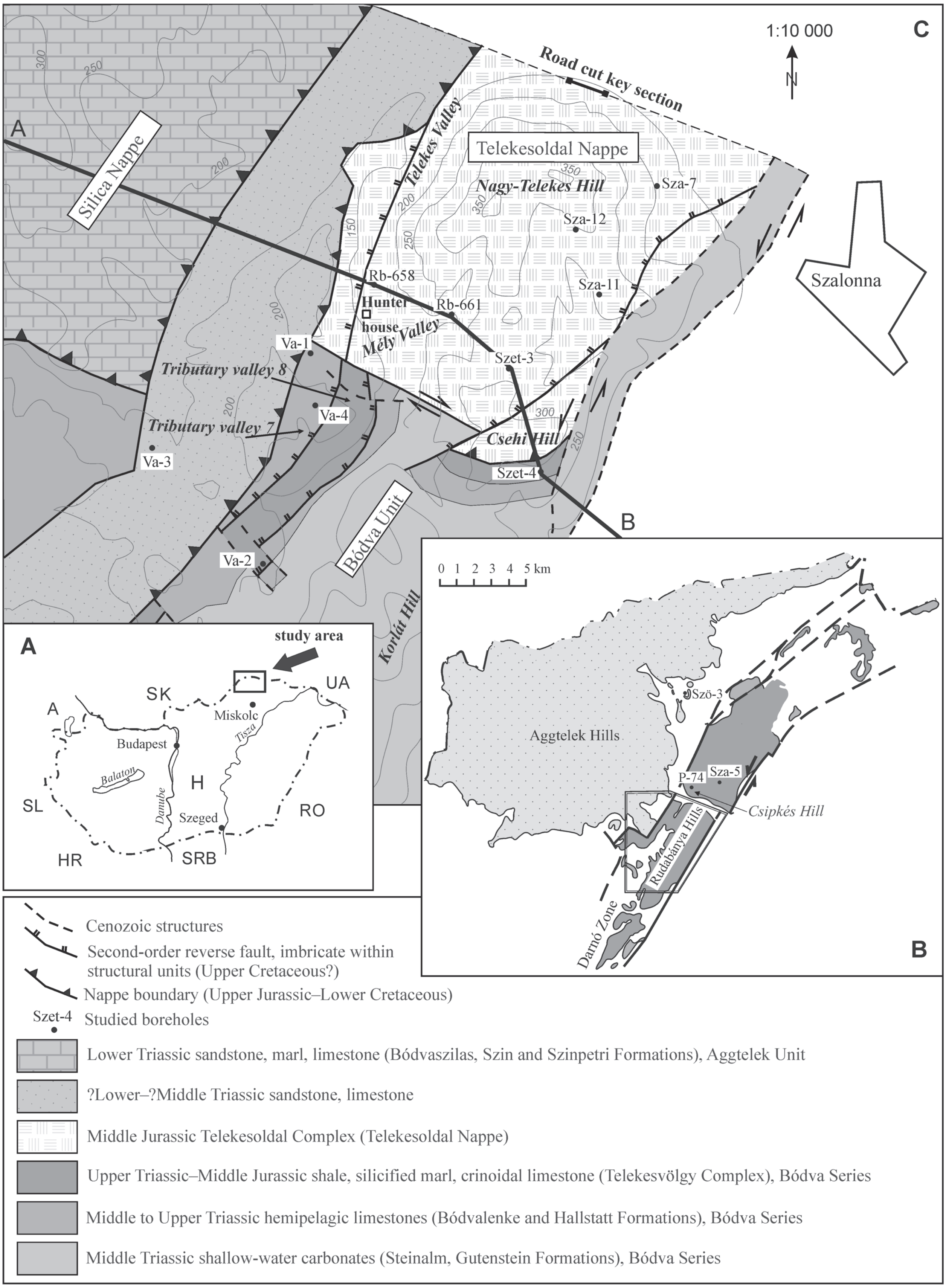


Fig. 1. Location of the study area with simplified structural elements (after Kövér et al. 2008), geographical names and locations of the boreholes. Line A–B indicates the course of the cross-section (Fig. 2).

ly et al. 1998). Grill (1988) subdivided the TVC into three subunits: a) variegated (reddish-greenish) claymarl sequence of Late Triassic age. It was regarded by Dosztály et al. (1998) as an atypical development of the latest Triassic Zlambach Marl on the basis of lithological comparison; b) a siliceous crinoidal limestone and marl unit that was called "spotty marl" by Dosztály et al. (1998); and c) black claystone. Grill (1988) subdivided the TC into the following lithofacies types: a) siliceous marl unit; b) rhyolite; c) shale with sandstone olistoliths and d) shale with conglomerate and limestone olistoliths. Slightly modifying this subdivision, Dosztály et al. (1998) distinguished two units: a) grey claystone–siliceous marl with subvolcanic rhyolite bodies and b) olistostromal unit containing a sandstone olistolithic and a limestone-rhyolite olistostrome interval.

The Jurassic parts of both complexes were interpreted as the products of slope and basin environments, most likely in a Jurassic back arc basin (Grill 1988).

Geological mapping revealed some other occurrences, which are supposed to be uppermost Triassic or Jurassic as well, and could not be classed among the previously mentioned complexes.

1. Olistostrome at Hidvégardó contains redeposited clasts of a whole Bódva-type ("Hallstatt facies") Anisian-Norian sequence: early Middle Triassic grey platform carbonates (Steinalm Formation), Middle and Upper Triassic red cherty limestones (Bódvalenke Formation), and Upper Triassic pink and grey limestones (Hallstatt Formation) (Szentpétery & Less 2006).

2. A small, previously unmentioned sequence was recently encountered on the southeastern slope of Csipkés Hill (Fig. 1b) (Csipkés Hill was also called Bizó-tető Hill in some references) (Kövér 2005). It consists of alternating beds of carbonate turbidites and silicified marls that are overlain by fine-grained, and followed by coarse-grained olistostrome beds.

These uppermost Triassic(?)–Middle Jurassic formations have a great importance for understanding the Jurassic evolution of the Neotethys Ocean. However, no detailed report on the sedimentological characteristics and component analysis of the redeposited clasts has been published so far (except from the Szalonna-Perkupa road cut key section of TC (Kovács 1988)).

The aim of the present paper is to define lithofacies units, to summarize the facies characteristics of the defined units, to provide interpretation for the provenance of the redeposited clasts and depositional environments, and last but not at least to revise the existing radiolarian data, and provide new age data by foraminiferal and palynomorph investigations.

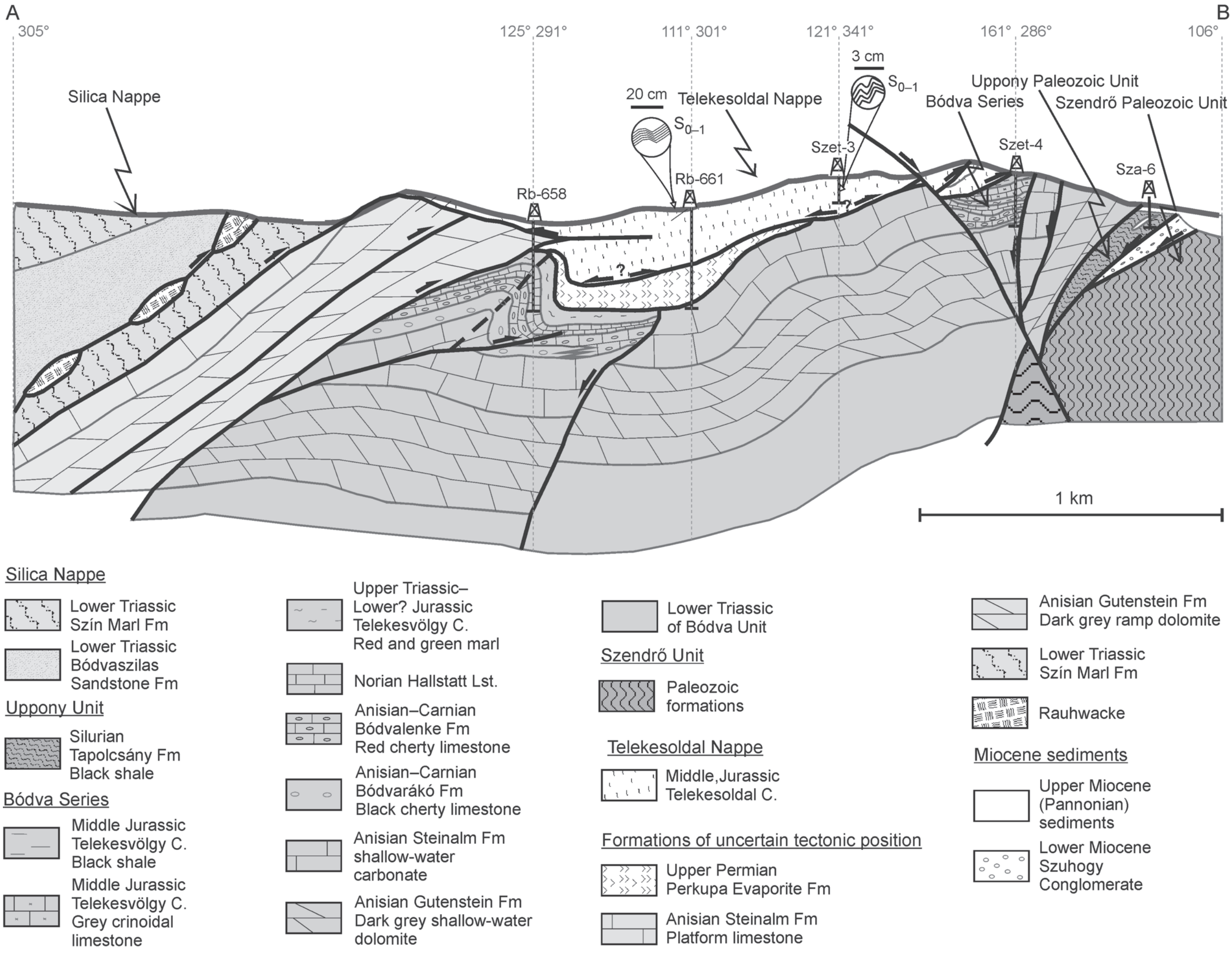


Fig. 2. Cross-section of the area after Kövér et al. (2008).

Geologic setting

The Rudabánya Hills are located in NE Hungary (Fig. 1a), and built up by a nappe stack of Upper Permian–Middle Jurassic sediments. They are located within the Cretaceous–Tertiary Darnó Fault Zone bounded by major faults to the NW and SE (Fig. 1c). The Darnó Zone is an important NNE-SSW structural element, located in NE Hungary reaching the southernmost part of the Slovak Republic. Earlier works considered both boundary faults as a Miocene sinistral structure (Less & Szentpétery 2006; Szentpétery 1997), but the newest review of Fodor et al. (2005) — on the basis of fault slip data — challenged this hypothesis. They pointed out, that the Darnó Line does not represent a first-order nappe/terrain boundary during the Late Jurassic-Cretaceous orogeny.

The northwestern segment of this fault zone is actually the boundary between the Aggtelek Hills containing only Upper Permian and Triassic formations and the Rudabánya Hills containing uncertain Paleozoic rocks (Less et al. 1988), and Upper Permian–Middle Jurassic formations (Less et al. 1988). Jurassic rocks occur in two structural units. The Upper Triassic(?)–Middle Jurassic Telekesvölgy Complex is part of the Bódva Unit (Kövér et al. 2006, 2007, 2008), which is made up of Upper Permian to Middle Jurassic formations (Figs. 1a, 2). The Telekesoldal Complex represents an individual nappe (Figs. 1a, 2) overlaying the Bódva Nappe (Kövér et al. 2006, 2007, 2008). The TC was subject to ductile deformation in three phases and a higher anchizonal–lower epizonal metamorphism during the Cretaceous (Árkai & Kovács 1986; Kövér et al. 2007). From the sedimentary rocks, the only available age was Bajocian by means of the radiolarian fauna of the lowermost shale-marl member (Grill & Kozur 1986; Dosztály 1994).

Successions

Telekesvölgy Complex

On the basis of macroscopic observations and microfacies studies performed on cores Rudabánya Rb-658, Szalonna Sza-5, Szendrő Szet-4, Varbóc Va-2 cores (Fig. 1b,c), trenches in the Telekes Valley (Tributary Valley 7 and 8) and outcrops on Csipkés Hill (Fig. 1c) various lithofacies units could be distinguished. However, continuous sections exposing the whole formation are not available, the relevant biostratigraphic data are very limited and the stratigraphic superposition of the lithofacies units is ambiguous. Figure 3 shows the most probable lithofacies succession referring to the relevant cores and surface exposures and the discussion below follows this pattern.

Variegated and grey marl

Szalonna Sza-5 core. In Szalonna Sza-5 core Upper Triassic red, locally cherty limestones (Hallstatt Limestone) are concordantly overlain by red, green and grey marl 23 m in thickness, that was assigned to the Zlambach Formation (Szentpétery & Less 2006). It is followed by grey marl with slump structures in a thickness of 30 m.

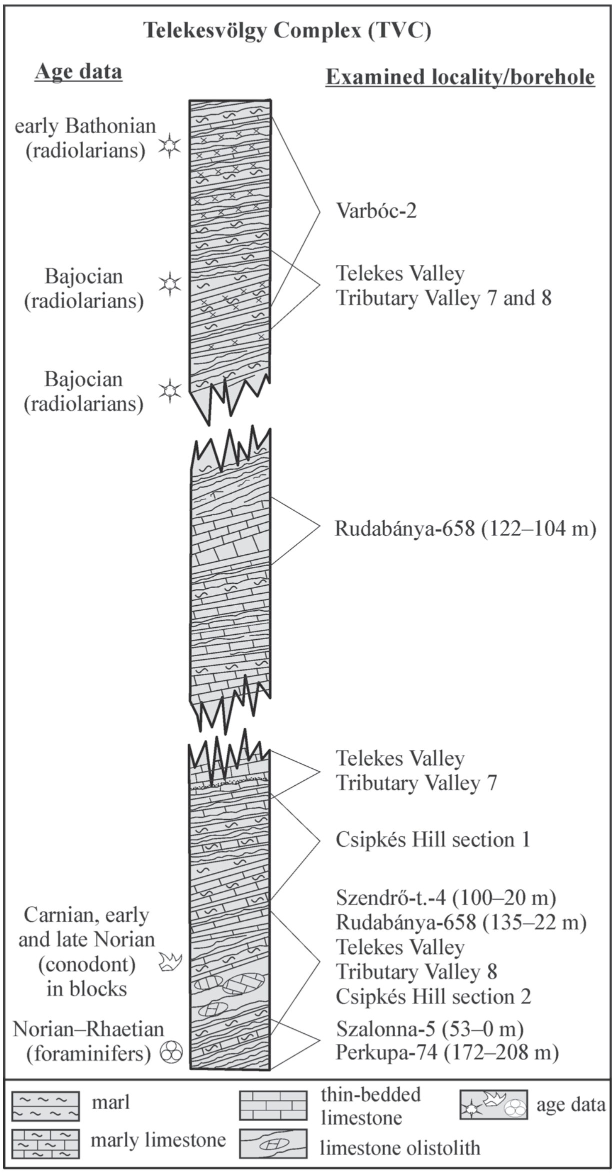


Fig. 3. Simplified reconstructed stratigraphic column of the Telekesvölgy Complex. The positions of the age data, the studied boreholes and outcrops are approximately indicated.

Perkupa P-74 core. In Perkupa P-74 core, brown to grey marls occur above the Hallstatt Formation with tectonic contact and the marls are tectonically overlain by Upper Triassic hemipelagic carbonates. This ~30 m thick interval may also be assigned to the Zlambach Formation. Texture of these rocks is rather unspecific; mudstone–wackestone containing small bioclasts, silt-sized quartz and in one thin section poorly preserved foraminifers, ostracodes, fragments of bivalves, echinoderms and radiolarian moulds (Fig. 4). From this thin section the following foraminiferal taxa could be determined: *Aulotortus friedli* (Kristan-Tollmann), *A. parallelus* (Kristan-Tollmann), *Semiinvoluta clari* Kristan, *Turrispirillina minima* Pantić, *Lamelliconus* sp., *Meandrospira* sp., *Frondicularia* sp., *Lingulina* sp. The dominance of the Involutinidae (*Aulotortus*, *Semiinvoluta*, *Lamelliconus*) and Spir-

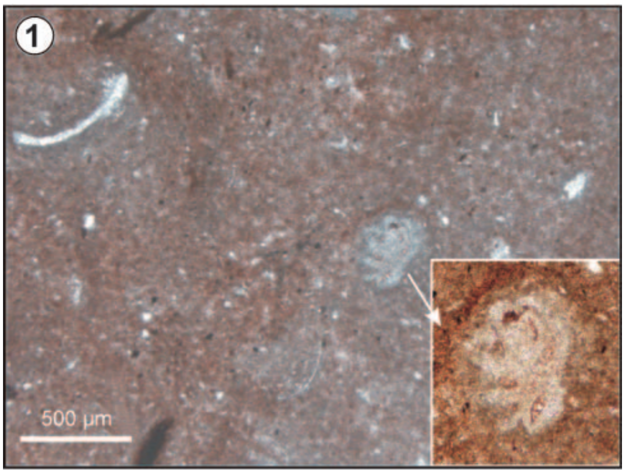


Fig. 4. Thin section of core P-74, 170.9–171 m interval, showing wackestone texture with foraminifers and fragments of bivalves. The foraminifer indicated by a white arrow is enlarged on the smaller photo.

illinidae (*Turrispirillina*) indicate a warm, well-ventillated, shallow-water environment, like the habitat for these forms.

The co-occurence of these genera is characteristic in the Late Triassic. Except *A. friedli* (Kristan-Tollmann) — which appeared already in the lowermost Carnian — all species determined only in the Norian–Rhaetian (Kristan 1957; Kristan-Tollmann 1962, 1964; Zaninetti 1976; Salaj et al. 1983, 1988; Trifonova 1993). According to Salaj et al. (1983), the age range of the species *T. minima* Pantić is Norian-Rhaetian, although it was mostly reported from the Norian (e.g. Oravecz-Scheffer 1987).

Telekes Valley, Tributary Valley 8 section. Brownish grey marl, alternating with grey calcareous marl and greenish grey shale exposed in the Telekes Valley, Tributary Valley 8 section may also belong to this lithofacies unit but it is poorly constrained. It contains pink limestone olistoliths which yielded Late Norian conodonts (Balogh & Kovács 1977).

Csipkés Hill section 1. In the sample taken form the Csipkés Hill section 1, alternating red and yellow laminae are visible. The yellow layers consist of fine sand to silt-sized clasts that might be silicified carbonate particles while the red layers are radiolarian wackestones. Metre-sized limestone olistoliths containing Middle Triassic Foraminifera (det.: Bérczi-Makk) were reported by Grill (1988) from Csipkés Hill sections 1 and 2.

Rudabánya Rb-658 core. In Rudabánya Rb-658 core (Fig. 5), red and green claystones alternating with grey marls and calcareous marls were encountered above Hallstatt-type (Kovács in Szentpétery I. & Less Gy. (Eds.) 2006) red, locally cherty limestones with tectonic contact between them.

The lowermost, about 13 m thick part of this succession is made up of red and green claystone intercalating with grey marl. The texture of the samples studied is strongly sheared, and altered. However, the original radiolarian wackestone texture could be recognized (Fig. 6.1). Calcite moulds of radiolarians are usually deformed showing lenticular shape. Sponge spicules and other bioclasts can also be recognized in a few cases. The rocks were commonly affected by dolomitization and subsequent selective silicification. Under a microscope the texture is seemingly silty shale containing disseminated silt-sized quartz. However, in a lot of cases the quartz occurs in biomoulds (Fig. 6.2) or substitutes rhombic dolomite crystals. Accordingly, the majority of the quartz particles are probably not terrigenous grains but they formed by diagenetic alteration and structural deformation processes.

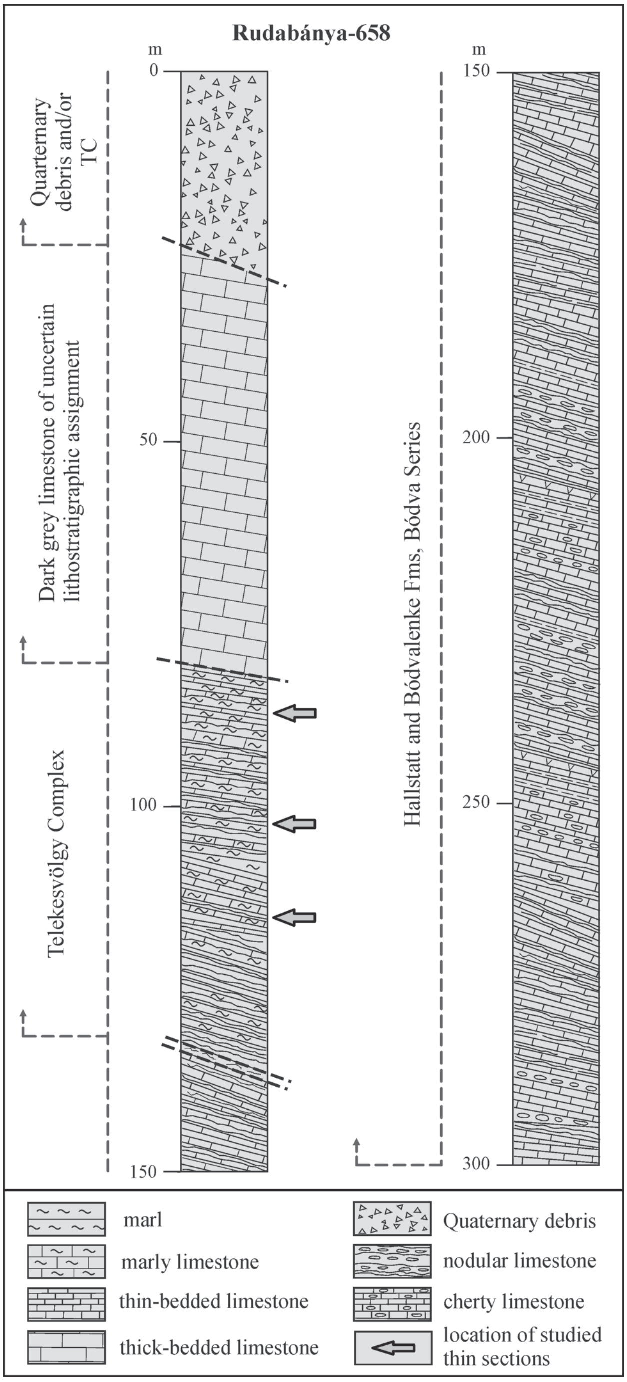


Fig. 5. Lithological and stratigraphic features of the Rudabánya Rb-658 borehole with new interpretations (Kövér et al. 2008).

Going upwards in the section, the proportion of the grey marl and calcareous marl increases, while the ratio of red and green claystone interlayers decreases. In this ~20 m thick

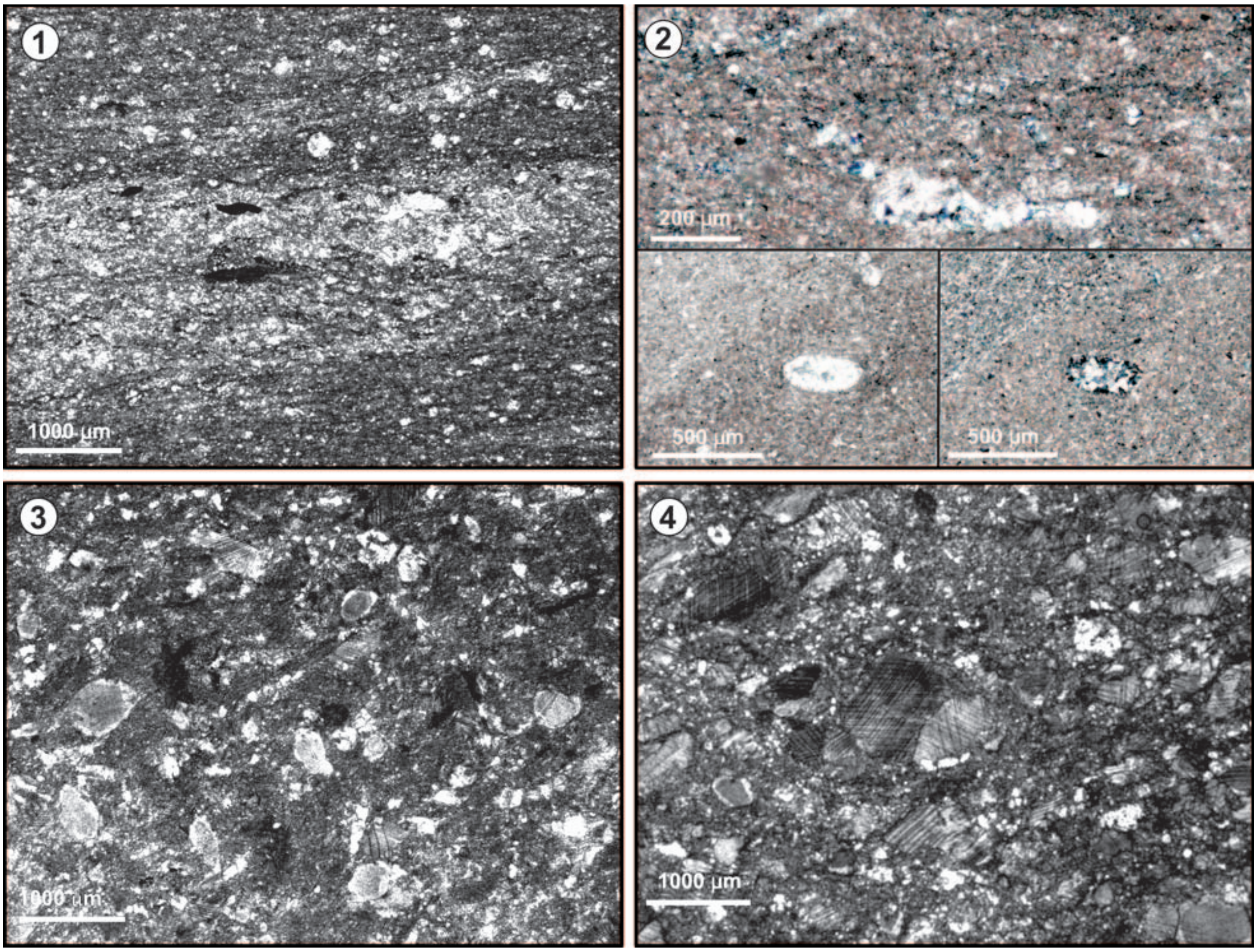


Fig. 6. **1** — Radiolarian rich layer in radiolarian marl. Rb-658, 119.9 m. **2** — Quartz substitutes rhombic dolomite crystals or occurs in biomoulds. Rb-658, 126 m (bottom left and right), 131 m (top). (Bottom right and top crossed polars). **3** — Fine-grained crinoidal wackestone. Rb-658, 104.6 m. **4** — Medium-grained crinoidal wackestone. Rb-658, 86.7 m.

interval fine to medium sand-sized crinoid ossicles are common in a micritic–microsparitic matrix and thin crinoidal packstone to grainstone interlayers also occur (Fig. 6.3–4). The matrix is often, crinoids are rarely silicified. Grey siliceous crinoidal marls and limestones akin to those in Rb-658 core (104–122 m) were reported by Grill (1988) from the Telekes Valley Tributary Valley 7 section and Csipkés Hill section 1.

The next ~20 m thick segment is made up of green and pinkish marl and calcareous marl progressing upward into grey marl; with the calcareous marl having a uniformly barren mudstone texture.

It is tectonically overlain by dark grey limestone, showing microsparitic texture with no sign of any diagnostic microstructure or fossil, which can refer either to the depositional environment or to the age of sedimentation. On basis of its macroscopic features, this limestone was assigned to the Gutenstein Formation (G. Less. pers. com).

Black siliceous shale

Varbóc Va-2 borehole. In Varbóc Va-2 borehole the Norian Hallstatt Limestone is tectonically overlain by black shale about 80 m thick. The locally silicified shale contains large amounts of radiolarians and sponge spicules.

Telekes Tributary Valley 7 and 8 sections. In the western part of the section exposed on the top of valley side of Telekes Tributary Valley 8, beside a steeply dipping Upper Triassic succession, black shale and siliceous shale were found. Radiolarian wackestone, radiolarian-sponge spicule wackestone and packstone (Fig. 7.1,3), sponge spicule packstone (Fig. 7.4), and radiolarite are typical textures of this lithofacies unit. In some samples sharp, erosional boundaries are visible between the radiolarian shale and the crinoidal calcarenite layer (Fig. 7.5,6), the latter is formed via turbiditic redeposition. The same texture types were found in the samples taken from black shale in the Telekes Valley Tributary Valley 7 section.

Revision of the radiolarian fauna in Telekesvölgy Complex

The first studies of radiolarians of the Rudabánya Hills, NE Hungary were conducted by Grill & Kozur (1986). Their samples were collected from the Varbóc-2 borehole and from several different outcrops in the Rudabánya Hills (i.e. Csehi-

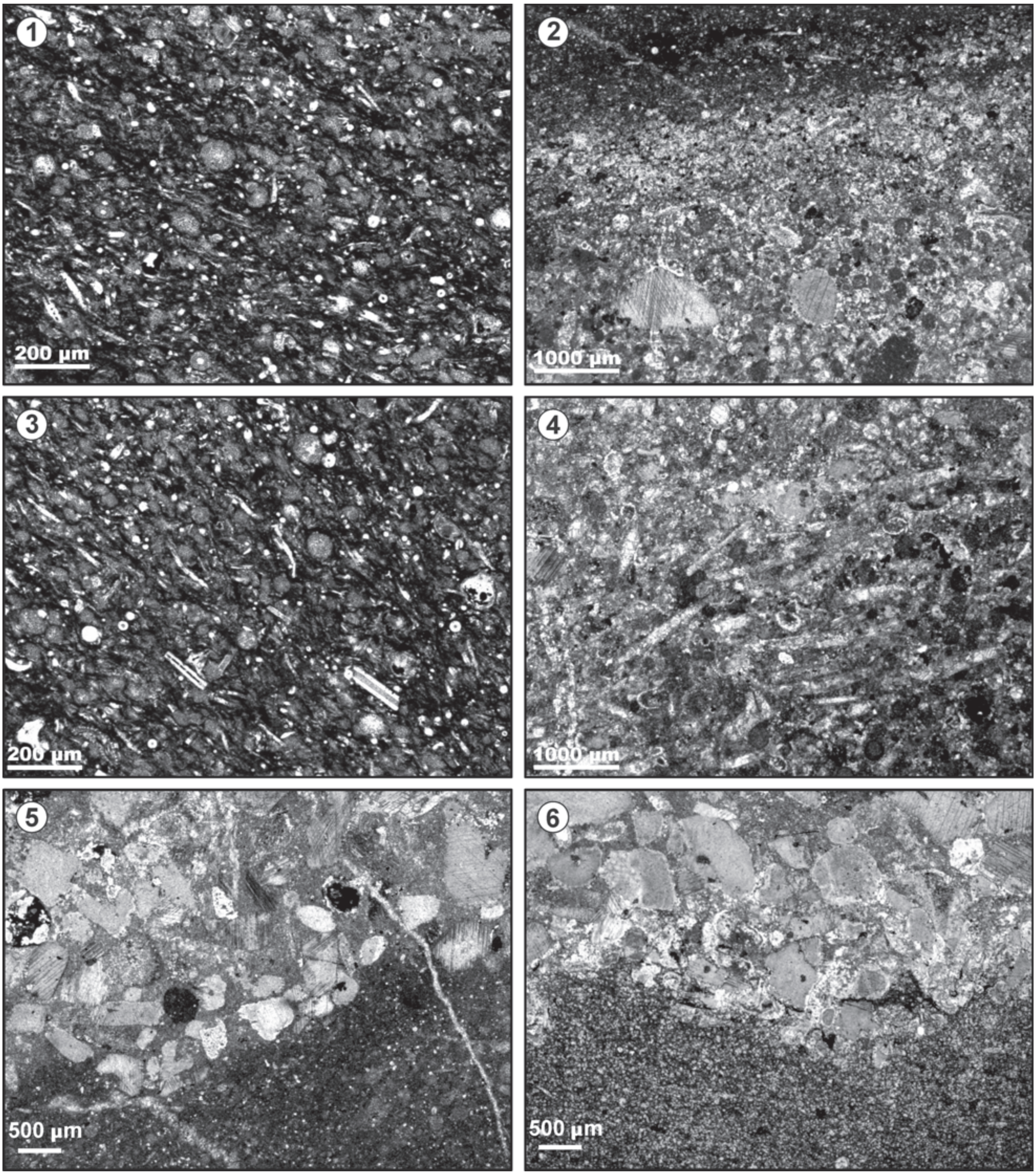


Fig. 7. 1, 3 — Radiolarian-sponge spicule packstone, Telekes Valley. **2, 4–6** — Details of a calciturbidite layer, Telekes Valley: above an uneven erosion surface a mudstone layer is overlain by coarse-grained crinoidal packstone that is the basal part of a carbonate turbidite (5, 6). Sponge spicula and crinoid packstone in the higher part of the turbidite layer (4). The topmost part of the turbidite layer showing gradual transition to pelagites of wackestone–mudstone texture (2).

hegy, Telekes Valley–Tributary Valley 7 and 8). Radiolarians were always found in the sequence of monotonous black to dark grey shales, mudstones, siliceous shales, manganese shales and dark shales (Grill & Kozur 1986). Previous biostratigraphic data of radiolarian investigation presumed Aalenian to the middle Bajocian ages in different sequences studied in the Rudabánya Hills. According to the re-assessment of the Varbóc-2 borehole (Dosztály 1994), the biostratigraphic age assigned the lower part to the Aalenian, and the upper part to the Bajocian or Bathonian. Our latest re-assessment of the radiolarian biozonation of the studied samples in the Rudabánya Hills is based on the Unitary Association Zones (UAZ95) proposed by Baumgartner et al. (1995). The occurrence and the stratigraphical distribution of the radiolarians in the examined samples are shown in Table 1.

Varbóc-2 borehole. The Varbóc-2 borehole penetrated the 87 m thick Jurassic monotonous black to dark grey shales, with thin siliceous shales and cherts, and crinoidal limestones intercalated with grey marl and mudstone. The 16 samples yielded abundant and moderately well preserved radiolarian assemblages.

Base of the borehole: samples come from 80.9 m, 79.1 m, 77.6 m, 73.9 m, 73.0 m and from 69.7 m. The following stratigraphically important radiolarian taxa were identified from these samples (Figs. 8, 9): *Hsuum mirabundum* Pessagno & Whalen, *H. belliatulum* Pessagno & Whalen, *H. matsuokai* (Isozaki & Matsuda), *Transhsuum maxwelli* (Pessagno), *Parahsuum officerense* Pessagno & Whalen, *P. snowshoense* (Pessagno & Whalen), *Semihsuum inexploratum* (Blome), *Pseudodictyomitrella spinosa* Grill & Kozur, *Archaeodictyomitra rigida* Pessagno, *Laxtorum*(?) *hichisoense* Isozaki & Matsuda, *Canoptum hungaricum* Grill & Kozur, *Tetratrabs zealis* (Ožvoldová). The co-occurrence of *H. mirabundum* Pessagno & Whalen (UAZ 3–6), *L.*(?) *hichisoense* Isozaki & Matsuda (UAZ 1–4) and *T. zealis* (Ožvoldová) (UAZ 4–13) indicates the UAZ 4 (Late Bajocian). However, presence of *H. belliatulum* Pessagno & Whalen and *H. snowshoense* (Pessagno & Whalen) is presumable the lower part of middle Bajocian age for this sequence as well, because these taxa co-occur in that close range in North America (Pessagno & Whalen 1982).

Samples from 64.1 m to 3.4 m yielded the following stratigraphically important radiolarian taxa (Figs. 8, 9): *Hsuum mirabundum* Pessagno & Whalen, *H. rosebudense* Pessagno & Whalen, *H. matsuokai* Isozaki & Matsuda, *Parahsuum stanleyense* (Pessagno), *Transhsuum hisuikyoense* (Isozaki & Matsuda), *T. maxwelli* (Pessagno), *Semihsuum inexploratum* (Blome), *Pseudocyrtis buekkensis* Grill & Kozur, *Eucyrtidiellum nodosum* Wakita, *Eucyrtidellum* cf. *E. unumaense* (Yao), *Stichocapsa robusta* Matsuoka, *Stichocapsa* sp. E. Baumgartner, *Archaeodictyomitra rigida* Pessagno, *A. exigua* Blome, *A. cellulata* O'Dogherty, Goričan & Dumitrica, *A. prisca* Kozur & Mostler, *Pseudodictyomitrella hexagonata* (Heitzer), *Protunuma turbo* Matsuoka, *Canoptum hungaricum* Grill & Kozur, *Dictyomitrella* (?) *kamoensis* Mizutani & Kido. The co-occurrence of *H. mirabundum* Pessagno & Whalen (UAZ 3–6) and *Stichocapsa robusta* Matsuoka (UAZ 5–7) indicates the UAZ 5–6 (latest Bajocian to Early Bathonian), furthermore the presence of *Stichocapsa* sp. E. Baumgartner (UAZ 5) presumably indicates the UAZ 5 (latest Bajocian to Early Bathonian).

Telekes Valley–Tributary Valley 8. In this section seven samples collected from the black and siliceous shale are re-assessed. The samples yielded the following, relatively well preserved and stratigraphically important radiolarian taxa (Figs. 8, 9): *Pseudodictyomitrella spinosa* Grill & Kozur, *Canoptum hungaricum* Grill & Kozur, *Unuma* cf. *U. typicus* Yao, *Parahsuum izeense* (Pessagno & Whalen), *Transhsuum hisuikyoense* (Isozaki & Matsuda), *T. maxwelli* (Pessagno), *T. brevicostatum* (Ožvoldová), *Eucyrtidiellum nodosum* Wakita, *E.* (?) *quinatum* Takemura. The co-occurrence of *P. izeense* (Pessagno & Whalen) (UAZ 1–3) and *T. maxwelli* (Pessagno) (UAZ 3–10) idicates the UAZ 3 (Early–middle Bajocian). Contrary to Dosztály's previous data (1994) we could not recognize any difference in biostratigraphic age between the lower and upper part of the investigated sequence. The occurrence and the stratigraphic distribution of the radiolarians in the examined samples are shown in Table 1.

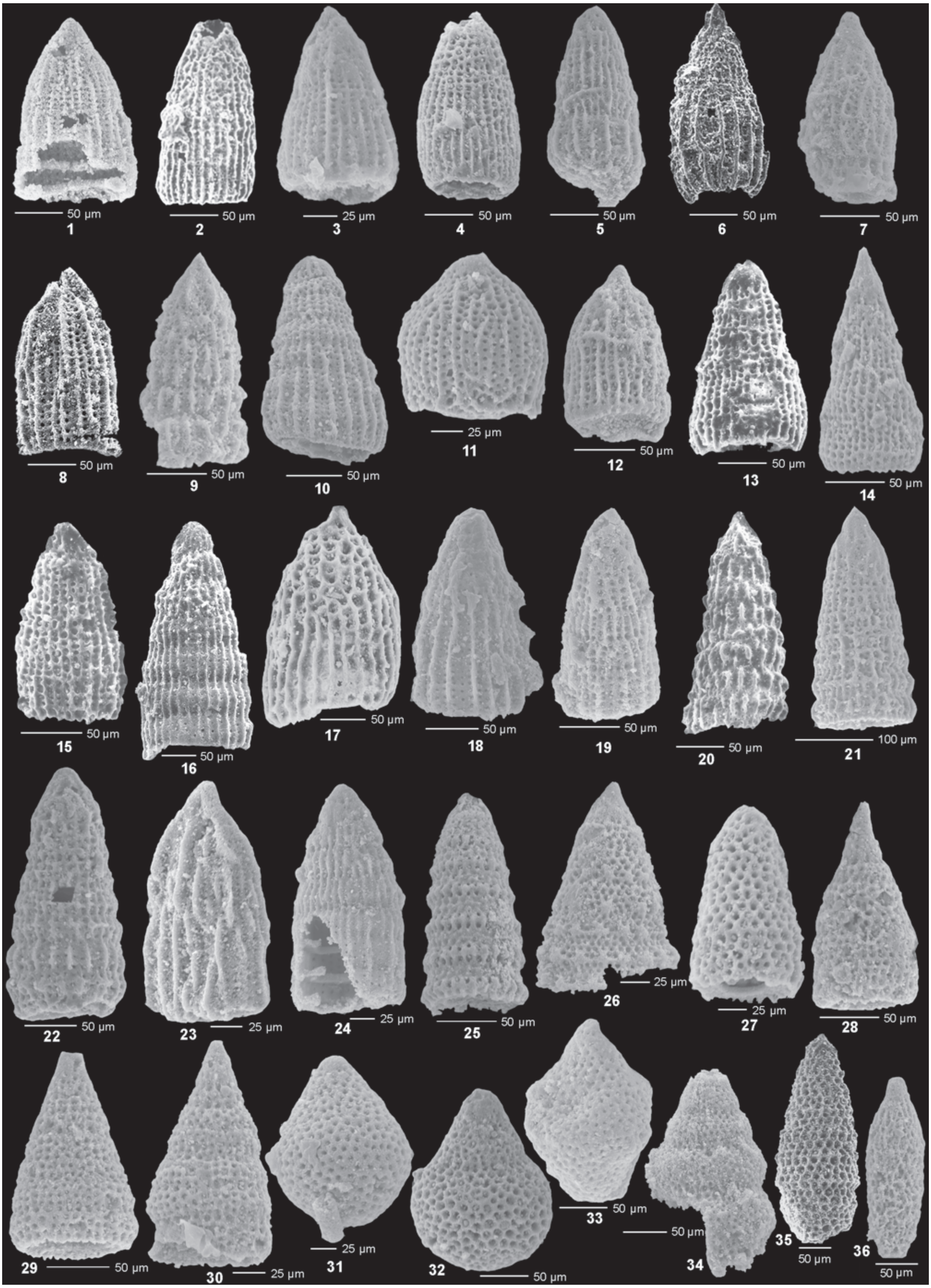
Telekesoldal Complex

The TC is made up of shale and marl, sandstone and olistrostrome lithofacies. However, their stratigraphic relations are poorly constrained due to the scarcity of age diagnostic fossils and continuous successions (Fig. 10). Szalonna Sza-4, -7, -10, -11, -12, Szendrő Szet-3 and Rudabánya Rb-661 cores and outcrops on Csehi Hill and the road cut type section at Telekesoldal provided important data on certain parts of the complex.

Black shale and clay marl with sandstone layers

One of the typical lithofacies of the TC is made up of dark grey to black shale and sandstone. Outcrops of this unit oc-

Fig. 8. Determined radiolarian fauna. **1** — *Archaeodictyomitra cellulata* O'Dogherty, Goričan & Dumitrică; Va-2 borehole: 49.3 m. **2** — *Archaeodictyomitra exigua* Blome; Telekes Valley–Tributary Valley 8: 8–43a. **3** — *Archaeodictyomitra patricki* Kocher; Va-2 borehole: 3.4 m. **4** — *Archaeodictyomitra rigida* Pessagno; Va-2 borehole: 64.1 m. **5** — *Hsuum baloghi* Grill & Kozur; Va-2 borehole: 48.5 m. **6** — *Hsuum matsuokai* Isozaki & Matsuda; Va-2 borehole: 73.0 m. **7** — *Hsuum mirabundum* Pessagno & Whalen; Va-2 borehole: 3.4 m. **8** — *Hsuum rosebudense* Pessagno & Whalen; Va-2 borehole: 49.3 m. **9** — *Hsuum* sp. E in Hull; Va-2 borehole: 58.5 m. **10** — *Hsuum* cf. *cuestaense* Pessagno; Telekes Valley–Tributary Valley 8: 8–47a. **11** — *Hsuum* cf. sp. 1 O'Dogherty et al.; Telekes Valley–Tributary Valley 8: 8–43a. **12** — *Parahsuum carpathicum* Widz & De Wever; Va-2 borehole: 30.2 m. **13** — *Parahsuum indomitum* (Pessagno & Whalen); Telekes Valley–Tributary Valley 8: 8–55a. **14** — *Parahsuum officerense* (Pessagno & Whalen); Va-2 borehole: 79.1 m. **15** — *Parahsuum izeense* (Pessagno & Whalen); Telekes Valley–Tributary Valley 8: 8–47. **16** — *Parahsuum snowshoense* (Pessagno & Whalen); Va-2 borehole: 64.1 m. **17** — *Parahsuum stanleyense* (Pessagno); Va-2 borehole: 3.4 m. **18** — *Semishuum inexploratum* (Blome); Va-2 borehole: 3.4 m. **19** — *Semishuum* sp.; Va-2 borehole: 30.2 m. **20** — *Transhsuum brevicostatum* (Ožvoldová); Telekes Valley–Tributary Valley 8: 8–47a. **21** — *Transhsuum hisuikyoense* (Isozaki & Matsuda); Va-2 borehole: 69.7 m. **22** — *Transhsuum maxwelli* (Pessagno); Va-2 borehole: 64.1 m. **23** — *Transhsuum* sp. 1; Va-2 borehole: 48.5 m. **24** — *Transhsuum* sp. 2; Va-2 borehole: 49.3 m. **25** — *Dictyomitrella* (?) *kamoensis* Mizutani & Kido; Va-2 borehole: 45.4 m. **26** — *Parvicingula* sp.; Va-2 borehole: 49.3 m. **27** — *Pseudodictyomitrella hexagonata* Grill & Kozur; Va-2 borehole: 64.1 m. **28** — *Pseudodictyomitrella spinosa* Grill & Kozur; Va-2 borehole: 77.6 m. **29** — *Pseudodictyomitrella* cf. *spinos*a Grill & Kozur; Va-2 borehole: 77.6 m. **30** — *Pseudodictyomitrella wallacheri* Grill & Kozur; Va-2 borehole: 77.6 m. **31** — *Stichocapsa robusta* Matsuoka; Va-2 borehole: 13.1 m. **32** — *Stichocapsa* sp.; Va-2 borehole: 64.1 m. **33** — *Stichocapsa* sp. E in Baumgartner; Va-2 borehole: 3.4 m. **34** — *Stichomitra* sp.; Va-2 borehole: 49.3 m. **35** — *Pseudoeucyrtis elongata* Grill & Kozur; Va-2 borehole: 30. 2 m. **36** — *Pseudoeucyrtis* sp.; Va-2 borehole: 69.7 m.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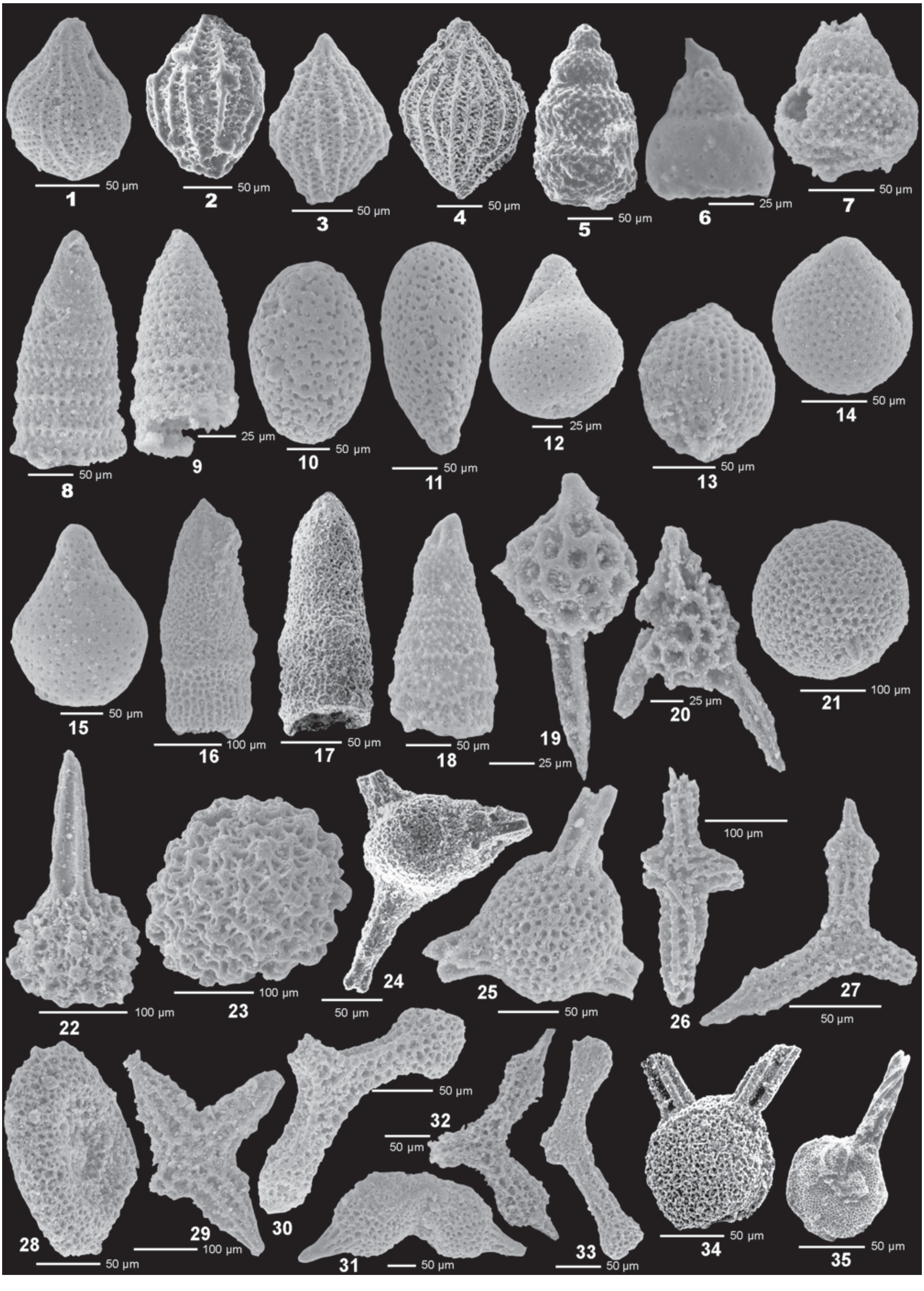
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cur S of the Nagy-Telekes Hill, in the Mély Valley, Balázstető Hill, Csehi Hill (Fig. 1a) and it was also exposed by the Szalonna Sza-12 core.

The dark shales are actually claymarls and claystones which contain quartz silt or fine-grained sand scattered in the clay or forming thin laminae. Erosional bases of the sandstone layers are common (Fig. 11.2). Graded bedding (Fig. 11.1,2) and cross-lamination can also be observed within some of the sandstone beds. Alternation of fine- to medium-sized sandstone and sandy siltstone laminae (Fig. 11.2) were also observed in thin sections. In some samples taken from the Mély Valley alternation of mm-thick sandstone laminae and thicker silty claystone layers were found. The sandstones consist predominantly of quartz, but the amount of feldspars (plagioclases) is usually significant and muscovites also occur in varying quantity (Fig. 11.3). The size of the grains varies from silt to medium-sized sand. The contacts of the grains are mostly pressure solution surfaces. Some evidence of intracrystalline deformation is present. Undulose extinction of the quartz grains is common. In some grains the recovery reached the last phase: subgrain boundaries separate the neighbour crystal fragments, which are slightly misoriented with respect to each other (Fig. 11.3).

Slump folds are commonly visible in the sandstone-bearing successions. Lens shaped sandstone bodies in the shale are also common. They may have formed either by early post-diagenetic disintegration of sandstone beds and gravitational redeposition of the sandstone blocks or by subsequent tectonic deformation processes leading to boudin formation.

Szalonna Sza-12 core. The Szalonna Sza-12 core exposed dark grey shale and marl with varying amounts of radiolarian moulds (calcite and quartz) in its lower part. It is overlain by a few metre thick interval containing 0.3–20 mm sized grey clasts with subordinate shale matrix or without any matrix but microstylolitic grain contacts (olistostrome beds). The typical components are as follows: “filament” wackestone, “filament” packstone (coquina), crinoidal wackstone, crinoidal packstone, dolosparite, siltstone, sandy shale, and highly altered volcanoclasts with quartz and feldspar phenocrystals. The boundaries between the matrix and the clasts are usually pressure solution surfaces; dark solution seams of insoluble material commonly occur around the clasts (Fig. 11.4). The upper segment of the core section is made up of alternation of fine-grained siliciclastic sandstone to siltstone and dark grey shale that can be interpreted as a very distal turbidite sequence. Since the original bedding is clearly visible in this alternating sandstone-shale section, the relationship of the S_{0-1} foliation and the occurrent fold related axial-plane clevage can be studied (Fig. 11.5,6). In the sample taken from 37.5 m the original S_{0-1} foliation and the later axial-plane clevage (S_2) intersect each other at about 70°. This S_2 foliation is spaced, and defined by anastomosing opaque mineral rich planes.

Dark grey shale and marl with olistostrome layers

Rudabánya Rb-661 core. In the Rudabánya Rb-661 core (Fig. 12) the Upper Permian Perkupa Evaporite Formation and a more than 10 m thick tectonic breccia zone (anhydrite, black shale, “rauhwacke”) form the basal shear horizon of the Telekesoldal Nappe (built up by the TC). In this core altered vitrophyric rhyolite, rhyolite tuff and ignimbrite occur in the lowermost part of the TC. Under the microscope fragments of volcanic glass and pumiceous texture — the characteristic features of ignimbrite — are clearly visible. Thin laminae of sericite-chlorite are predominant in the matrix. The porphyritic components are pertitic orthoclase, idiomorphic quartz with resorbed margin, fractured quartz with undulatory extinction, commonly partly melted, and few large sericitic plagioclases or plagioclase-orthoclase composite grains, and few biotites. The boundary of the large rhyolite-ignimbrite body (19 m apparent thickness) is sharp. Small (mm to 1 cm-sized) rhyolite clasts (Fig. 13) were encountered in “spotty” shale (usually silty claymarl, marl, calcareous marl) in several horizons in a 40 m thick interval above the large body. There are clasts consisting of large quartz and feldspar crystals in a calcified matrix. Composite grains also occur together with resorbed quartz and orthoclase crystal fragments. There are lithoclasts consisting of resorbed quartz and sheared, fractured perthitic orthoclase in a squeezed chloritic, calcitized and silicified matrix. Along with the rhyolite clasts a few carbonate clasts of similar size were also found. In the sample taken from 101.7 m, radiolarian wackestone (3 cm) (Fig. 14.1), “filament” wackestone (2 cm) clasts and an altered rhyolite clast (2 mm) were observed (Fig. 14.2). The typical texture of this interval is bioclastic wackestone containing large number of

Fig. 9. Determined radiolarian fauna. **1** — *Protunuma turbo* Matsuoka; Va-2 borehole: 64.1 m. **2** — *Unuma ochiensis* (Matsuoka); Va-2 borehole: 3.4 m. **3** — *Unuma typicus* Yao; Va-2 borehole: 64.1 m. **4** — *Unuma* cf. *typicus* Yao; Telekes Valley–Tributary Valley 8: 8–43. **5** — *Eucyrtidiellum* (?) *quinatum* Takemura; Telekes Valley–Tributary Valley 8: 8–53. **6** — *Eucyrtidiellum* cf. *unumaense* (Yao); Va-2 borehole: 64.1 m. **7** — *Eucyrtidiellum* sp. 1; Va-2 borehole: 51.5 m. **8** — *Canoptum hungaricum* Grill & Kozur; Va-2 borehole: 69.7 m. **9** — *Canoptum rudabanyaense* Grill & Kozur; Va-2 borehole: 48.5 m. **10** — *Archicapsa* sp. 1, Va-2 borehole: 64.1 m. **11** — *Archicapsa* sp. 2, Telekes Valley–Tributary Valley 8: 8–47. **12** — *Williriedellum* sp.; Va-2 borehole: 13.1 m. **13** — *Striatojaponocapsa synconexa* O’Dogherty, Goričan & Dumitrică; Va-2 borehole: 13.1 m. **14** — *Praewilliriedellum convexum* (Yao); Va-2 borehole: 30.2 m. **15** — *Praewilliriedellum* sp.; Va-2 borehole: 58.5 m. **16** — *Laxtorum* (?) *hichisoense* Isozaki & Matsuda; Va-2 borehole: 73.0 m. **17** — *Laxtorum* (?) *jurassicum* Isozaki & Matsuda; Va-2 borehole: 80.9 m. **18** — *Spongocapsula palmerae* Pessagno; Va-2 borehole: 58.5 m. **19** — *Pantanellium* sp. 1; Szet-3: 52.0–53.0 m. **20** — *Gorgansium* sp.; Szet-3: 52.0–53.0 m. **21** — *Cenosphaera* sp. X Yao; Szet-3: 69.8–70.6 m. **22** — *Acaeniotylopsis* (?) sp.; Szet-3: 69.8–70.6 m. **23** — *Praeconocaryomma* sp.; Va-2 borehole: 69.7 m. **24** — *Triactoma* cf. *jonesi* (Pessagno); Szet-3: 52.0–53.0 m. **25** — *Triactoma* sp. 1; Szet-3: 69.8–70.6 m. **26** — *Tetratrabs zealis* (Ožvoldová); Va-2 borehole: 73.9 m. **27** — *Tritrabs simplex* Kito & De Wever; Szet-3: 52.0–53.0 m. **28** — *Orbiculiforma* sp. X in Baumgartner; Szet-3: 69.8–70.6 m. **29** — *Emiluvia lombardensis* Baumgartner; Szet-3: 69.8–70.6 m. **30** — *Angulobracchia* sp.; Va-2 borehole: 69.7 m. **31** — *Paronaella* sp.; Va-2 borehole: 69.7 m. **32** — *Homoeoparonaella elegans* (Pessagno); Szet-3: 52.0–53.0 m. **33** — *Homoeoparonaella argolidensis* Baumgartner; Szet-3: 52.0–53.0 m. **34** — *Bernoullius rectispinus* Kito et al.; Va-2 borehole: 48.5 m. **35** — *Bernoullius* sp., Telekes Valley–Tributary Valley 8: 8–52.

Table 1: Presence/absence of radiolarian species in Varbóc-2 borehole, in Telekes Valley–Tributary Valley 8 section and in Szet-3 borehole. (gr9 = 52.0 m–53.0 m sample and gr11 = 69.8 m–70.6 m sample).

UAZ	Taxa	Varbóc-2 (Va-2) borehole (m)																	Szet-3 bh		Telekes Valley — Tributary valley 8							
		3.4	9.7	13.1	30.2	34.1	45.4	48.5	49.3	51.5	58.5	64.1	69.7	73	73.9	77.6	79.1	80.9	gr9	gr11	8-43	8-43a	8-47	8-47A	8-51	8-52	8-53	8-55a
	Acaeniotylopsis (?) sp.																			+					+			
	Acanthocircus (?) sp.																		+	+							+	
3–10	*Angulobracchia digitata* Baumgartner																		+									
	Angulobracchia sp.												+							+								
	Archaeodictyomitra cellulata O'Dogherty, Goričan & Dumitrică						+		+																			
	Archaeodictyomitra exigua Blome										+								+		+	+						
	Archaeodictyomitra patricki Kocher	+																										
	Archaeodictyomitra prisca Kozur & Mostler							+																				
	Archaeodictyomitra rigida Pessagno											+				+												
	Archaeodictyomitra sp. 1							+																+				
	Archaeodictyomitra sp. 2											+																
	Archaeodictyomitra sp. 3				+																							
	Archicapsa sp. 1	+									+	+											+					
	Archicapsa sp. 2													+														
	Archicapsa sp. 3																								+			
	Bagotum sp.														+													
1–9	*Bernoullius rectispinus* Kito et al.							+																				
	Bernoullius sp.																									+		
	Canoptum hungaricum Grill & Kozur							+			+	+	+				+							+	+			
	Canoptum cf. *hungaricum* Grill & Kozur																	+										
	Canoptum rudabanyaense Grill & Kozur							+																				
	Canoptum sp.																+											
	Canoptum (?) sp.																		+									
1–4	*Cenosphaera* sp. X Yao																			+								
	Cyrtocapsa sp.						+																					
3–7	*Dictyomitrella* (?) *kamoensis* Mizutani & Kido	+					+																					
1–4	*Emiluvia lombardensis* Baumgartner																		+	+								
1–4	*Emiluvia* cf. *lombardensis* Baumgartner																			+								
	Emiluvia sp.																			+								
	Emiluvia (?) sp.														+					+	+							
3–10	*Eucyrtidiellum nodosum* Wakita										+	+									+							
	Eucyrtidiellum (?) *quinatum* Takemura																								+		+	
	Eucyrtidiellum cf. *unumaense* (Yao)											+																
	Eucyrtidiellum sp. 1	+		+						+	+																	
	Eucyrtidiellum sp. 2																	+										
5–8	*Eucyrtidiellum* cf. *unumaense pustulatum* Baumgartner														+													
	Gorgansium sp.																		+									
4–11	*Homoeoparonaella argolidensis* Baumgartner																		+	+								
4–10	*Homoeoparonaella elegans* (Pessagno)																		+									
	Homoeoparonaella ? sp.																		+		+							
	Hsuum baloghi Grill & Kozur							+																				
	Hsuum belliatulum Pessagno & Whalen																+											
	Hsuum cf. *belliatulum* Pessagno & Whalen																+											
1–5	*Hsuum matsuokai* Isozaki & Matsuda								+			+		+	+													
	Hsuum cf. *matsuokai* Isozaki & Matsuda														+													

Table 1: *Continued.*

UAZ	Taxa	Varbóc-2 (Va-2) borehole (m)																	Szet-3 bh		Telekes Valley — Tributary valley 8							
		3.4	9.7	13.1	30.2	34.1	45.4	48.5	49.3	51.5	58.5	64.1	69.7	73	73.9	77.6	79.1	80.9	gr9	gr11	8-43	8-43a	8-47	8-47A	8-51	8-52	8-53	8-55a
3–6	*Hsuum mirabundum* Pessagno & Whalen	+			+			+			+						+											
	Hsuum cf. *mirabundum* Pessagno & Whalen										+																	
	Hsuum rosebudense Pessagno & Whalen								+																			
	Hsuum sp. E sensu Hull										+																	
	Hsuum cf. sp. 1 sensu O'Dogherty et al.																				+	+						
	Hsuum cf. *cuestaense* Pessagno																							+				
	Hsuum cf. *robustum* Pessagno & Whalen															+												
	Hsuum sp. 1													+		+	+											
	Hsuum sp. 2		+																									
	Hsuum (?) sp.				+																							
1–4	*Laxtorum* (?) *hichisoense* Isozaki & Matsuda													+	+							+					+	
	Laxtorum (?) cf. *hichisoense* Isozaki & Matsuda														+		+	+										
2–3	*Laxtorum* (?) *jurassicum* Isozaki & Matsuda																	+		+								
	Laxtorum (?) sp.														+	+												
1–6	*Orbiculiforma* sp. X sensu Baumgartner																		+	+								
	Orbiculiforma sp.																			+								
	Pantanellium sp. 1																		+									
	Pantanellium sp. 2																		+									
	Paronaella sp. B sensu Hull												+															
	Parahsuum carpathicum Widz & De Wever				+																							
	Parahsuum indomitum (Pessagno & Whalen)																											+
1–3	*Parahsuum izeense* (Pessagno & Whalen)																						+					
1–7	*Parahsuum officerense* (Pessagno & Whalen)																+											
	Parahsuum cf. *officerense* (Pessagno & Whalen)																	+										
	Parahsuum snowshoense (Pessagno & Whalen)											+	+															
3–8	*Parahsuum stanleyense* (Pessagno)	+																										
	Parahsuum sp.																						+					
	Paronaella mulleri Pessagno												+															
1–2	*Paronaella* cf. *corpulenta* De Wever												+						+									
	Paronaella sp.																			+								
	Paronaella (?) sp.											+																
	Parvicingula cf. *elegans* Pessagno & Whalen								+																			
	Parvicingula sp.	+									+																	
	Praeconocaryomma sp.												+															
1–11	*Praewilliriedellum convexum* (Yao)				+										+									+				
	Praewilliriedellum sp.										+																	
	Protunuma costata (Heitzer)						+																					
4–7	*Protunuma turbo* Matsuoka	+								+	+	+				+												
	Protunuma sp.											+				+												
	Protunuma (?) sp.														+													
	Pseudocrucella (?) sp.																		+									
	Pseudoeucyrtis buekkensis Grill & Kozur										+																	
	Pseudoeucyrtis elongata Grill & Kozur				+																							
	Pseudoeucyrtis sp.												+						+	+								
	Pseudodictyomitrella hexagonata (Heitzer)											+																
	Pseudodictyomitrella spinosa Grill & Kozur									+					+	+			+					+				
	Pseudodictyomitrella cf. *spinosa* Grill & Kozur										+	+																
	Pseudodictyomitrella wallacheri Grill & Kozur										+					+												
	Semihsuum fuchsi (Grill & Kozur)				+														+									

Table 1: *Continued.*

UAZ	Taxa	Varbóc-2 (Va-2) borehole (m)																	Szet-3 bh		Telekes Valley — Tributary valley 8							
		3.4	9.7	13.1	30.2	34.1	45.4	48.5	49.3	51.5	58.5	64.1	69.7	73	73.9	77.6	79.1	80.9	gr9	gr11	8-43	8-43a	8-47	8-47A	8-51	8-52	8-53	8-55a
4–7	*Semihsuum inexploratum* (Blome)	+															+											
	Semihsuum cf. *inexploratum* (Blome)	+																										
	Semihsuum cf. *brokencotense* Pessagno, Blome & Hull				+																							
	Semihsuum sp.			+	+																							
	Semihsuum (?) sp.	+																										
6–13	*Spongocapsula palmerae* Pessagno										+																	
5–7	*Stichocapsa robusta* Matsuoka	+		+	+		+	+		+		+																
5–5	*Stichocapsa* sp. E sensu Baumgartner	+																										
	Stichocapsa sp.					+																				+		
	Stichomitra sp.								+																			
	Striatojaponocapsa synconexa O'Dogherty, Goričan & Dumitrică	+		+																								
4–13	*Tetratrabs zealis* (Ožvoldová)														+													
3–11	*Transhsuum brevicostatum* (Ožvoldová)											+												+				
	Transhsuum cf. *brevicostatum* (Ožvoldová)												+															
2–7	*Transhsuum hisuikyoense* (Isozaki & Matsuda)	+										+	+								+							
3–10	*Transhsuum maxwelli* (Pessagno)	+			+						+	+	+	+											+			
	Transhsuum cf. *maxwelli* (Pessagno)										+								+									
	Transhsuum sp. 1								+																			
	Transhsuum sp. 2							+																				
	Transhsuum sp. 3							+			+			+	+	+	+											
	Triactoma cf. *jakobse* Carter																		+	+								
	Triactoma cf. *jonesi* (Pessagno)											+																
	Triactoma sp. 1										+	+																
	Triactoma sp. 2																			+	+							
	Triactoma (?) sp.																		+	+								
4–5	*Tricolocapsa plicarum* (Yao)				+																							
	Tricolocapsa cf. *fusiformis* Yao								+																			
	Tricolocapsa cf. *plicarum* (Yao)								+																			
	Tricolocapsa sp.									+							+											
	Trillus sp. 1											+																
	Trillus sp. 2											+																
	Trillus (?) sp.													+														
1–6	*Tritrabs simplex* Kito & De Wever																		+									
	Tritrabs cf. *ewingi* (Pessagno)																		+									
3–4	*Unuma typicus* Ichikawa & Yao											+												+				
	Unuma cf. *typicus* Ichikawa & Yao																			+	+							
	Unuma ochiensis (Matsuoka)	+																										
	Unuma sp. F sensu Yao																		+									
	Unuma cf. *echinatus* Ichikawa & Yao				+								+															
	Unuma sp.					+			+			+																
	Williriedellum sp.			+																								

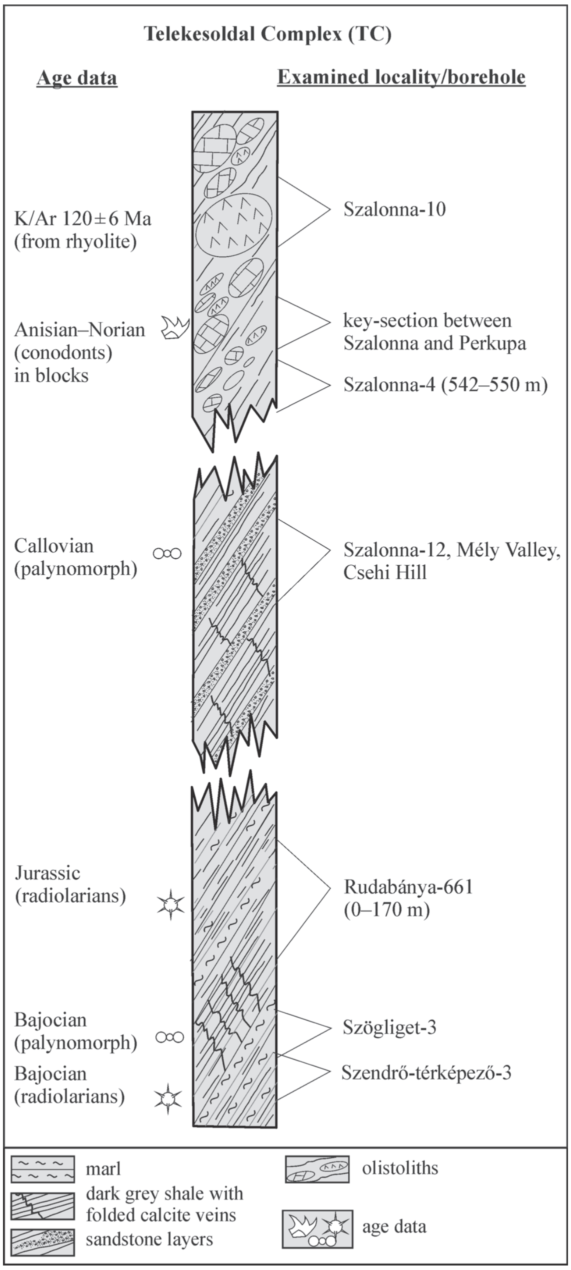

Fig. 10. Simplified *reconstructed* stratigraphic column of the Telekesoldal Complex. The stratigraphic positions of the age data, the studied boreholes and outcrops are approximately indicated.

radiolarians recrystallized to calcite, probably also sponge spicules and small fragments of thin-shalled bivalves ("filaments") locally. Darker bioturbation patches rich in organic matter and pyrite are common.

The shale is commonly strongly squeezed and deformed. Pressure solution seams are common in this interval (Fig. 14.5). The original sedimentary texture is punctuated by pressure solution seams which are commonly rich in opaque solution residual material. The contact between the shaly matrix and the occasionally present clasts are usually pressure solution surfaces, too. They are rich in insoluble material. The layer-perpendicular shortening is clearly visible in the case of the presence of originally subround shaped bioclasts (radiolarians) (Fig. 14.4). Signs of at least two phases of ductile deformation could be recognized in the thin sections. The sample from 96.1 m contains very tight, almost isoclinal folds, formed by the original radiolarian layers (Fig. 15.1). An incipient axial plane clevage (S_2) is connected to this folding phase. At 19.5 m a few mm scale kink fold (F_3) bends the original bedding or previous foliation (Fig. 15.2). The fold has angular hinge, the limbs meet each other at a sharp line. Tension joints syndeformationally filled with calcite are frequent in the hinge zone, while the bedding or previous foliaton planes worked as sliding surfaces. This deformation took place at the transition of ductile and brittle deformation fields.

In spite of the later deformation the original sedimentary texture can be recognized. It may have been radiolarian wackestone originally, but calcite moulds are more or less deformed, the globular moulds became lens shaped, and the bioturbation patches also got flattened. Only slightly squeezed and deformed shale also occur in several horizons, rarely. In the upper part of the sequence (above 100 m) the spotty shale (marl, silty marl) lithology and the radiolarian wackestone texture continues but the clasts are missing, whereas in the uppermost ~40 m of the core section the barren mudstone texture is prevailing. In a single sample at 25.0 m, probably representing a larger clast, well preserved thin-shalled bivalve fragments (Fig. 14.3) were found in silicified marl matrix ("filament" wackestone).

Hunter House section. In the neighbourhood of the Hunter House in the Telekes Valley slightly melted plagioclase free granite cataclasite was found within the rhyolite (Fig. 16.1).

Szalonna Sza-10 core. Rhyolites within a marl and claystone succession were also encountered in the Szalonna Sza-10 core (Grill 1988). An olistostrome layer containing predominantly radiolarian wackestone (Fig. 16.2), radiolarian–"filament" wackestone and a single, probably platform-derived clast (Fig. 16.3,5) was found in the 95.4–95.5 m interval. These platform facies carbonate clasts are very rare in the olistostrome of the TC. In core Sza-11 36.5–57.25 m along with the radiolarian "filament" wackstone, coarsely crystalline dolosparite and shale lithoclasts, an oolitic-crinoidal packstone clast was found in a shale matrix (Fig. 16.4,6).

Szalonna-Perkupa road cut key-section. The road cut key-section along the road between Szalonna and Perkupa is the best exposure of the typical olistotrome lithofacies (Kovács 1988). In the exposed succession 1–5 m thick dark greenish-grey bioturbated marl beds alternate with 0.1–5 m thick olistostrome beds. Centimeter- to tens of centimeters-sized clasts (mostly grey limestone and green rhyolite clasts) occur in the olistostrome beds (Fig. 17.1). The original shapes of the limestone and rhyolite clasts are rarely visible due to pressure solutional grain contacts and tectonic deformation. Angular brownish shale clasts, 0.5–2 cm in size, also commonly occur. The thickest beds contain the coarsest grains where size of rhyolite clasts may reach 0.5 m in diameter (Kovács 1988). Grain supported texture is typical but mud-supported debris flow deposits are also present, rarely. In the grain-supported beds the matrix is usually missing or subordinate, the microstylolitic grain contacts are typical.

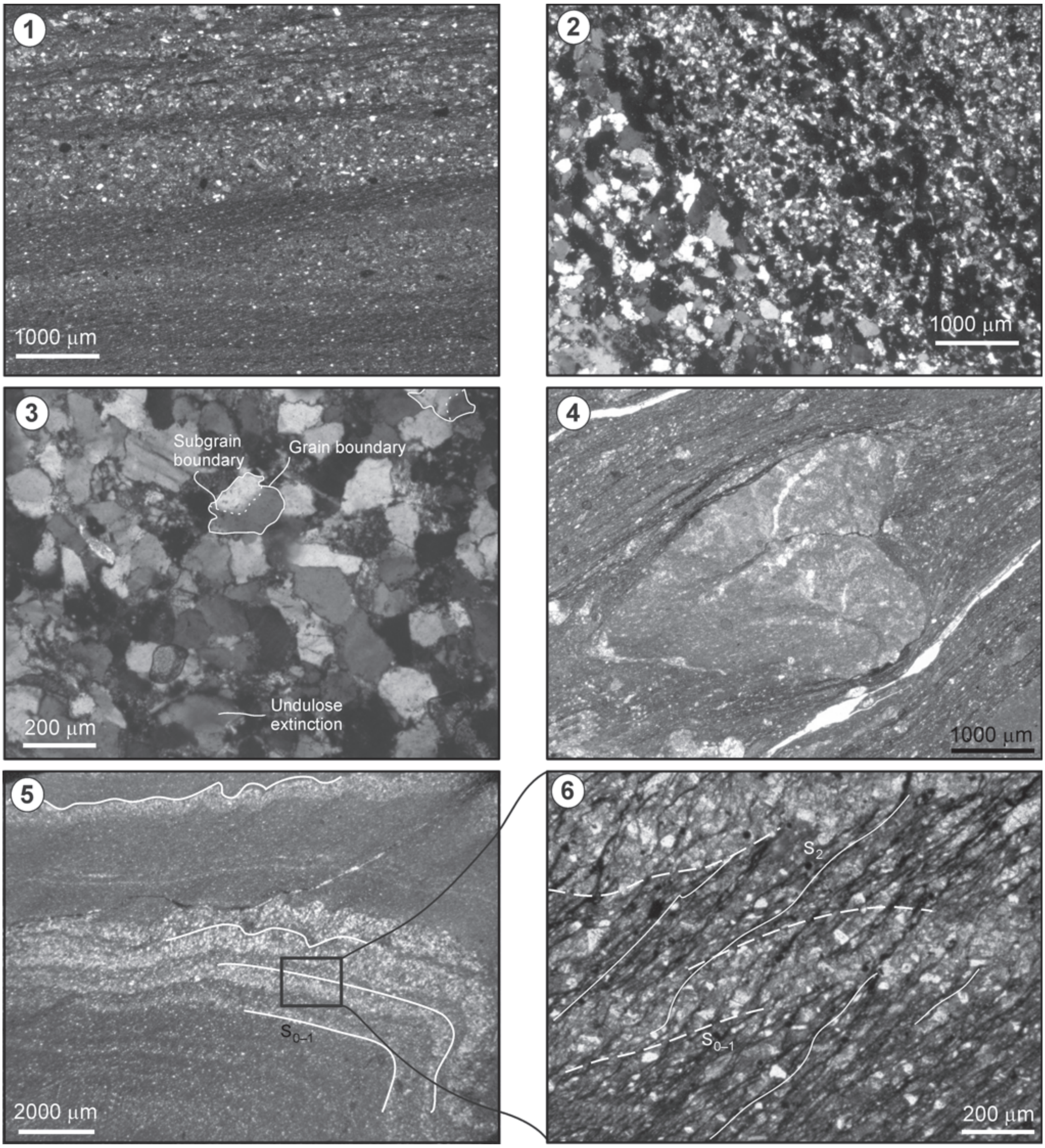

Fig. 11. **1** — Radiolarian turbidites. **2** — Erosional base and normal gradation of the sandstone and siltstone beds. **3** — Signs of intracrystalline deformation: undulose extinction of the quartz grains, subgrain boundaries separate the neighbouring crystal fragments. **4** — Carbonate lithoclast with shale matrix. At the rim of the clast dark seams consisting of insoluble material concentrated during dissolution are visible. **5, 6** — Presence of F_2 fold in the alternating sandstone-shale section. The original S_{0-1} foliation (subvertical on photo) and the later axial-plane clevage (S_2) intersect each other at about 70°. This S_2 foliation is spaced, and defined by anastomosing opaque mineral rich planes. Sza-12, 37.5 m.

The other characteristic feature for pressure solution here is the displacement of layering on certain planes (Fig. 17.2). In the matrix supported olistostromes the matrix is dark shale, marl with organic material and pyrite or fine siliciclastics with altered volcanogenic components.

In the olistostrome beds the carbonate clasts are predominant, their typical texture types are as follows: thin-shelled bivalve (“filament”) wackestone, radiolarian and “filament” wackestone, bioclastic (crinoidal), peloidal wackestone, peloidal grainstone, crinoidal wackestone, radiolarian wackestone, micritic mudstone (partially dolomitized or silicified in some cases), oolitic crinoidal packstone, dolomicrosparite and dolosparite, sparry calcite, and pervasively silicified rock. Some platform derived carbonate clasts were also de-

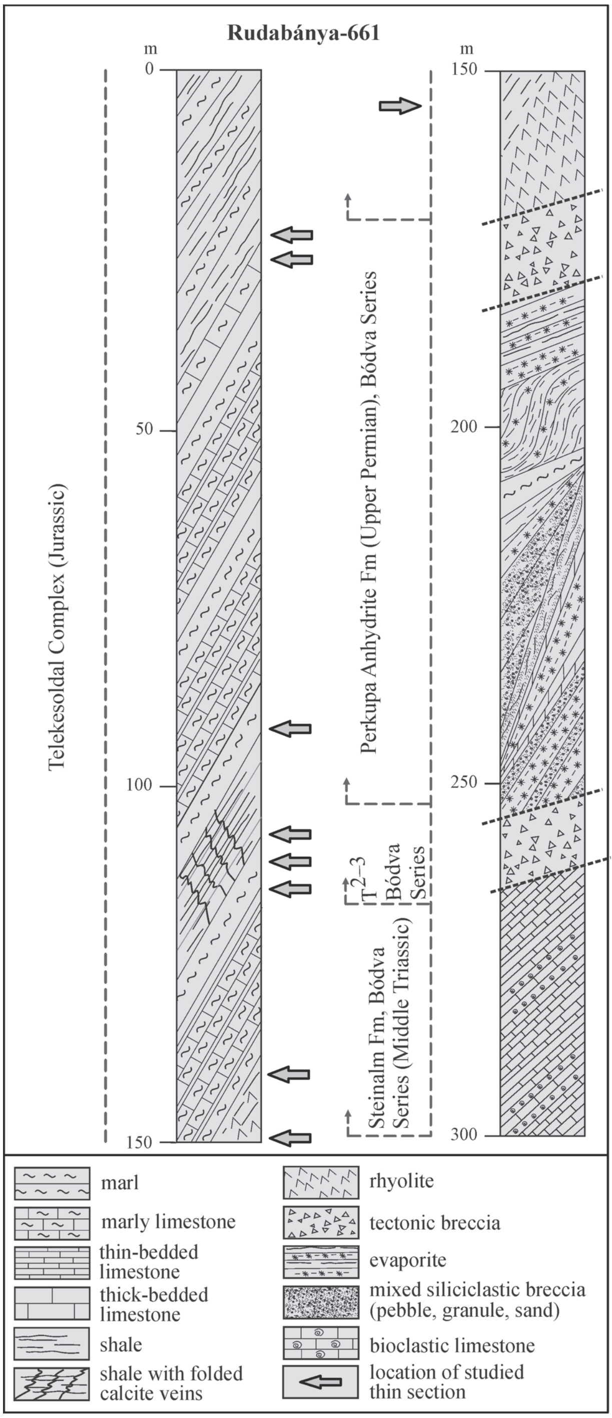

Fig. 12. Reconstructed lithological and stratigraphic features of the Rudabánya Rb-661 borehole. Note tectonically reduced pelagic Bódva Triassic below the evaporite, underlain by (Bódva?) platform carbonate.

tected. Early Ladinian to Late Norian conodonts were found in some grey limestone clasts (Balogh & Kovács 1977). The predominant part of the carbonate clasts is probably Triassic in age, and represents hemipelagic facies.

The sample presented on Fig. 17.3,5 is a succession, starting with greenish grey silty claystone basin facies. Above an uneven erosional surface, it is overlain by a 2 cm thick lithoclastic, bioclastic packstone layer with subordinate microsparitic matrix (Fig. 17.3). The typical grain size is between 1–5 mm, no grading is visible. The bioclasts are coarse sand-sized crinoid ossicles. The types of lithoclasts are as follows: bioclastic wackestone, peloidal wackestone, peloidal microsparite with a few "filaments", dolosparite and silty claystone (yellow). This layer is overlain by a 1 cm thick sponge spicule packstone (partially silicified) (Fig. 17.4) that is followed by a turbidite layer with an erosional contact. The ~1 cm thick allodapic layer is lithoclastic crinoidal packstone showing definite grading (Fig. 17.5).

Along with carbonate clasts highly altered volcanoclasts are usually common. Holocrystalline locally spherulitic, porphyritic rhyolites are typical (Fig. 18.1). They contain perthitic orthoclase, quartz of undularory extinction and idiomorhic resorbed quartz (Fig. 18.2), commonly surrounded by a siliceous ring. Strongly altered intersertal-intergranular basalt-dolerite clasts with slightly bent plagioclase lathes were also encountered rarely (Fig. 18.3–4). Individual idiomorphic resorbed quartz grains, mosaic like quartz crystals or crystal stacks, sericitic orthoclase and rarely plagioclase (oligoclase) derived from volcanites, together with coarse sand-sized crinoid ossicles also occur in some samples.

Range between the Telekes and Henc Valleys. Partially silicified carbonates containing carbonate lithoclasts were found in some samples taken from outcrops on the range between the Telekes Valley and Henc Valley. The texture is lithoclastic grainstone. Along with the 1–2 mm sized, medium to well rounded lithoclasts coarse sand-size bioclasts (bivalve and echinoderm fragments) also occur, rarely. The composition of the lithoclasts is as follows: micritic and microsparitic mudstone, "filament" wackestone, radiolarian wackestone and totally silicified clasts.

Revision of the radiolarian fauna in Telekesoldal Complex

Szet-3 borehole. Two samples (sample at 52.0 m–53.0 m and sample at 69.8 m–70.6 m) from the borehole yielded moderately well preserved and relatively abundant radiolarian assemblages, mainly characterized by spumellarians. The following stratigraphically important radiolarians were identified from the sample at 69.8 m–70.6 m (Fig. 9): *Emiluvia lombardensis* Baumgartner, *Emiluvia* spp., *Unuma* cf. *typicus* Ichikawa & Yao, *Laxtorum* (?) *jurassicum* Isozaki & Matsuda, *Triactoma* spp., *Pseudoeucyrtis* sp., *Orbiculiforma* sp. X sensu Baumgartner et al. The biostratigraphic range of *E. lombardensis* Baumgartner indicates UAZ 1–4 and *L.* (?) *jurassicum* Isozaki & Matsuda indicates UAZ 2–3. Co-occurrence of these species and the presence *Unuma* cf. *typicus* Ichikawa & Yao (UAZ 3–4) indicates that this sample can be assigned to UAZ 3 (Early–middle Bajocian).

The sample from 52.0 m–53.0 m yielded moderately well preserved and diversified radiolarian fauna (Fig. 9) including *Pseudodictyomitrella spinosa* Grill & Kozur, *Transhsuum* cf. *maxwelli* (Pessago), *Homoeoparonaella argolidensis* Baumgartner, *Homoeoparonaella elegans* (Pessagno), *Homoeoparonaella* cf. *elegans* (Pessagno), *Unuma* sp. F sensu Yao, *Gorgansium* sp., *Pantanellium* sp., *Tritrabs simplex* Kito & De Wever, *Tritrabs* cf. *ewingi* (Pessagno), *Emiluvia*

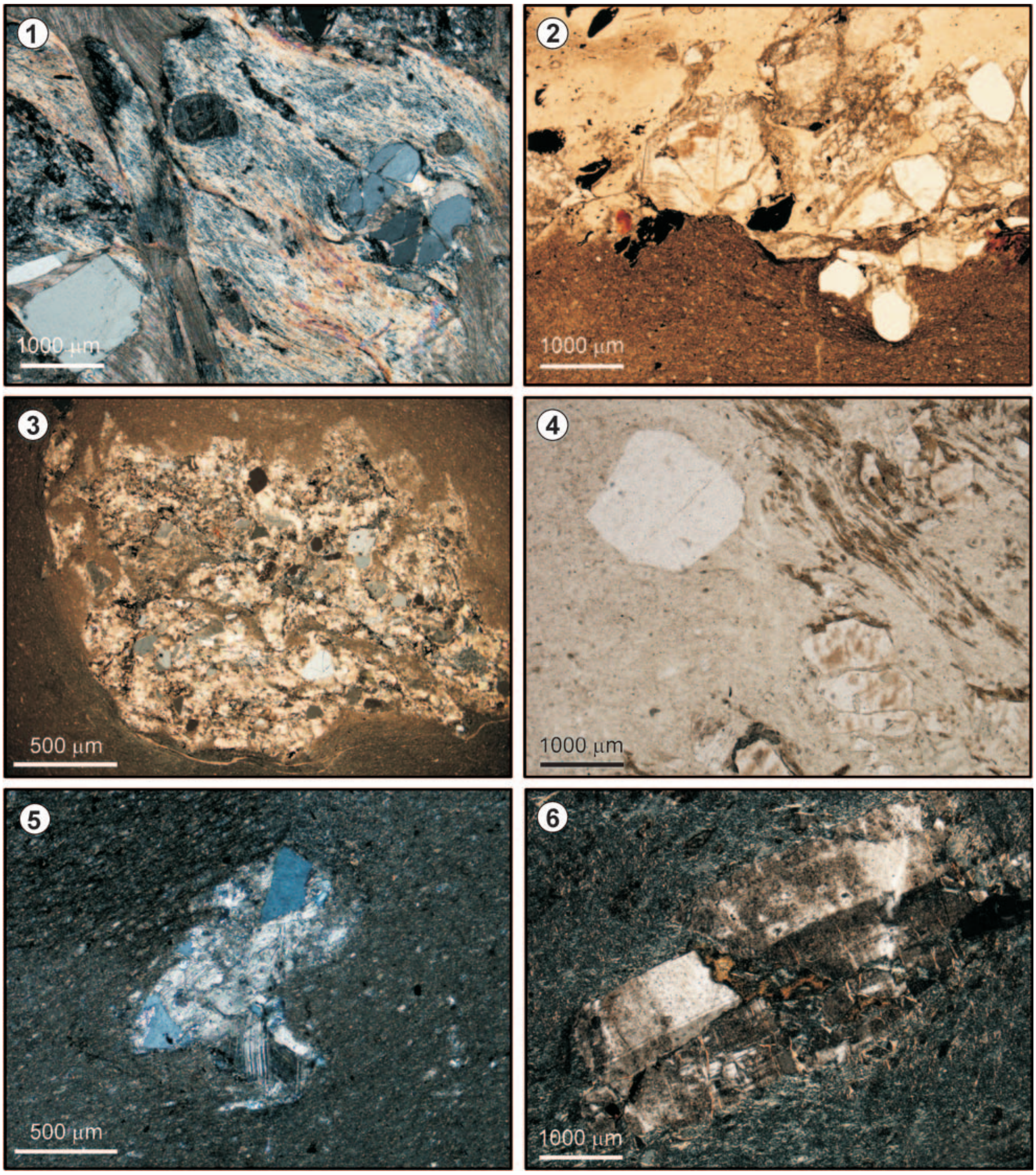

Fig. 13. **1** — Rock fragment surrounded by fibrous calcitic cement and containing large, fragmented quartz and smaller K-feldspar crystals in a sheared fine-grained, mostly sericitized matrix. Crossed polars, Rb-661, 116.1 m. **2** — Boundary of siltstone and sheared carbonatized rock fragment, in which large quartz, K-feldspar opaque minerals and few biotite crystals are surrounded by totally chloritized, sericitized glassy matrix. 1 polar, Rb-661, 149.0–149.1 m. **3** — Sheared, carbonatized rock fragment containing large quartz and K-feldspar crystals with diffuse boundary in siltstone. Crossed polars, Rb-661, 132.6 m. **4** — K-feldspar, quartz and biotite in glassy groundmass with characteristic texture of pumice bearing rhyolite tuff (ignimbrite). 1 polar, Rb-661, 153.3 m. **5** — Irregular shaped rock fragment with angular quartz crystals and sparitic matrix in siltstone. Crossed polar, Rb-661, 108.8 m. **6** — Large, slightly deformed and altered plagioclase (most probably albite) crystal in glassy groundmass, + polar, Rb-661, 153.3 m.

lombardensis Baumgartner, *Triactoma* cf. *jakobse* Carter, *Pseudocrucella*? sp., *Paronaella* cf. *corpulenta* De Wever, *Angulobracchia digitata* Baumgartner, *Hsuum fuchsi* Kozur. The biostratigraphic range of *E. lombardensis* Baumgartner indicates UAZ 1–4, while *H. argolidensis* Baumgartner, *H. elegans* (Pessagno) indicate UAZ 4–11. It follows that co-occurrence of them indicate the UAZ 4 (Late Bajocian).

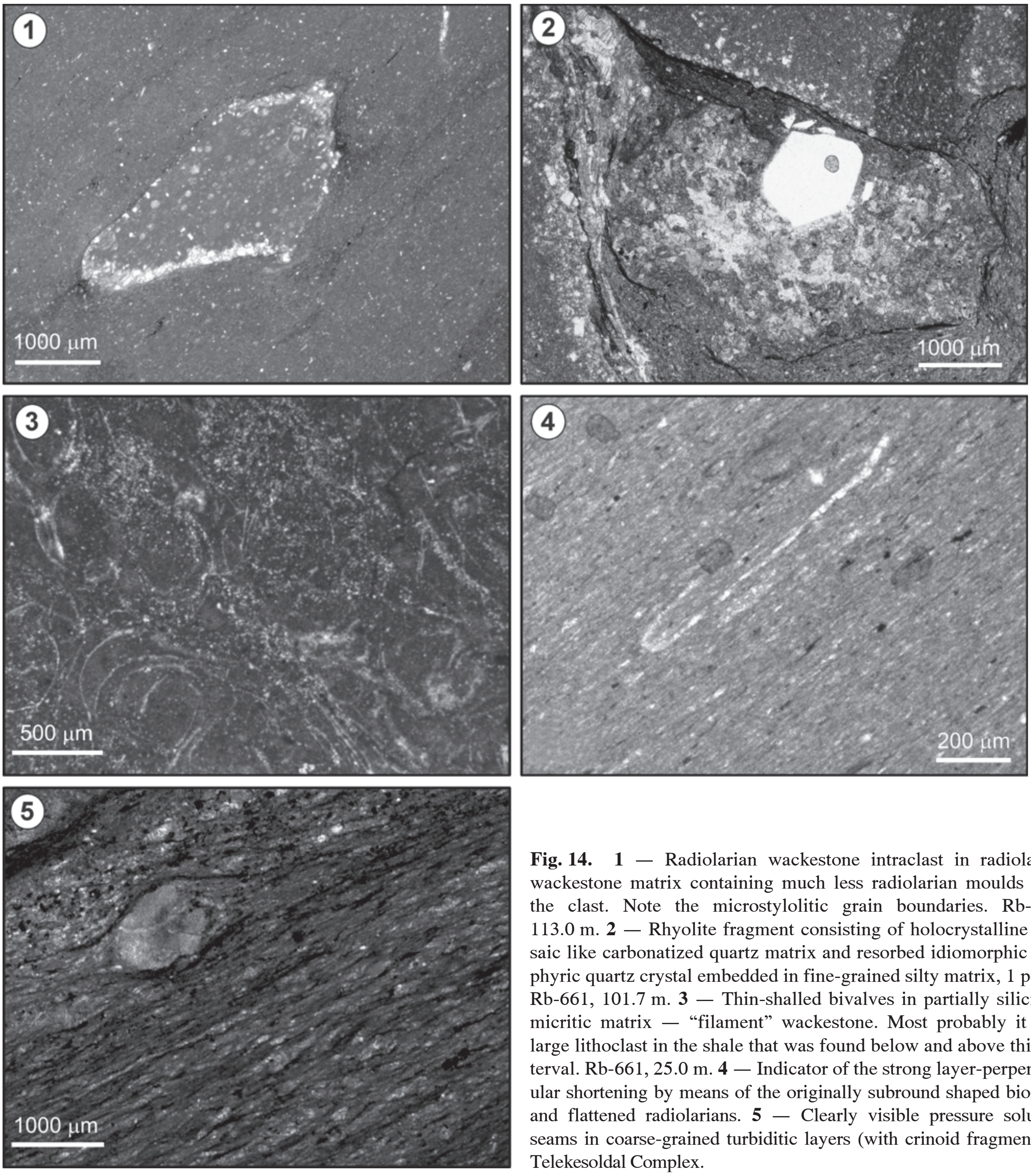

Fig. 14. **1** — Radiolarian wackestone intraclast in radiolarian wackestone matrix containing much less radiolarian moulds than the clast. Note the microstylolitic grain boundaries. Rb-661, 113.0 m. **2** — Rhyolite fragment consisting of holocrystalline mosaic like carbonatized quartz matrix and resorbed idiomorphic porphyric quartz crystal embedded in fine-grained silty matrix, 1 polar. Rb-661, 101.7 m. **3** — Thin-shalled bivalves in partially silicified micritic matrix — "filament" wackestone. Most probably it is a large lithoclast in the shale that was found below and above this interval. Rb-661, 25.0 m. **4** — Indicator of the strong layer-perpendicular shortening by means of the originally subround shaped bioclast and flattened radiolarians. **5** — Clearly visible pressure solution seams in coarse-grained turbiditic layers (with crinoid fragment) of Telekesoldal Complex.

Palynological age determination

Three wells (Sza-10, Sza-12, Szö-3) (Fig. 1) were sampled to analyse the sedimentary organic matter content. The Bajocian age of the dark shales of the TC based on the radiolarian fauna is confirmed by first findings of marine palynomorphs within this member. Sample 76.0 m from well Szö-3 yielded poorly to moderately preserved sedimentary organic particles. Poorly preserved specimens of the dinoflagellate cyst *Nannoceratopsis gracilis* Alberti were identified. This finding confirmed not only the Bajocian age, but also the structural position of this sample, because it proved that the dark shale of Szö-3 belongs to the TC. Other evidence (style of deformation, metamorphic temperature and pressure data) will be presented in a later paper.

Age-diagnostic dinoflagellate cysts (*Wanaea* sp., *Ctenidodinium* sp.) were also detected in sample 50.3 m from well Sza-12, indicating a Callovian age. Sample 74.0 m from well Sza-10 is characterized by opaque phytoclasts only; no palynomorphs are preserved.

Csipkés Hill olistostrome

Olistostrome, graded calcarenite and mixed siliciclastic–carbonate sandstone beds crop out on the southern slope of

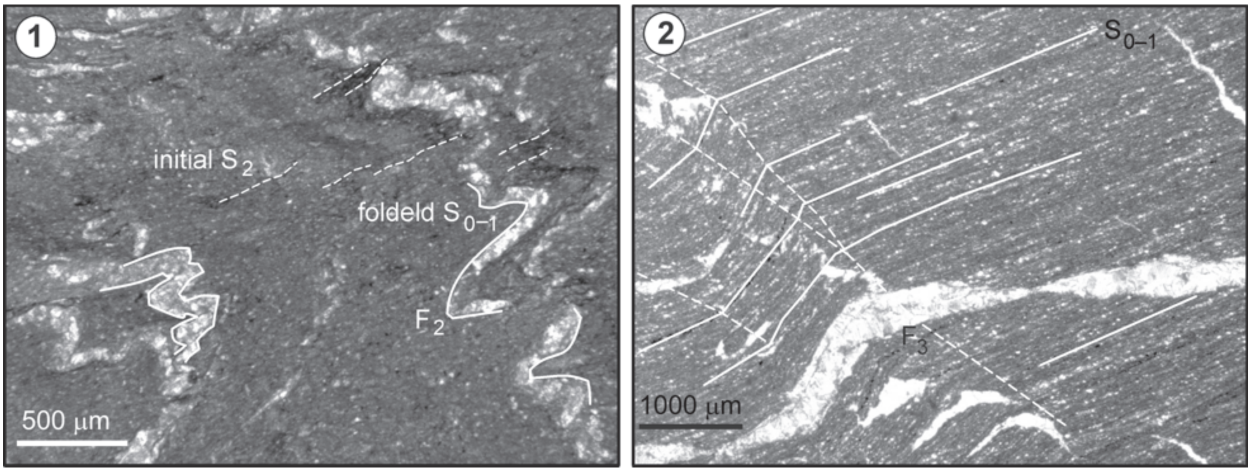

Fig. 15. **1** — Very tight, almost isoclinal folds, formed by the corser-grained layers in Rb-661 core, 96.1 m. **6** — A few mm scale kink fold (F_3) bends the original bedding or previous foliation. The original texture may have been radiolarian wackestone. Rb-661, 19.5 m.

Csipkés Hill. The section starts with alternating marl and coarse-grained carbonate sandstone beds, which are followed by upward coarsening bundles of olistostrome beds.

Macroscopically the calcarenite beds show normal gradation. The contacts between the marl and carbonate sandstone layers are usually undulate erosional surfaces.

Microscopically these graded carbonate turbidites are made up of mm-thick microlayers. Lithoclastic, bioclastic packstone of medium arenite grain size alternates with fine-grained lithoclastic peloidal grainstone. "Filament" wackestone and packstone, radiolarian wackestone and dark brown limonitic sparites are the typical lithoclast types. Crinoid ossicles and foraminifers occur in the interparticle micritic or microsparitic to fine sparitic material (Fig. 19). The following foraminiferal assemblage was encountered: *Planiinvoluta* sp., *Trochammina* sp., *Siphovalvulina* sp., *Valvulina* sp., *Tubinella*? sp., *Eoguttulina* sp. and *Nodosaria* sp., *Callorbis minor* Wernli & Metzger, *Protopeneroplis striata* Weynschenk (Fig. 20). In case of the latter two species due to strong recrystallization and partial dissolution of the calcite wall of the foraminifers the sections do not show the characteristic features. *Callorbis minor* has been known exclusively from the Bajocian but it was reported only from a few places (Wernli & Metzger 1990; Bassoullet 1997; Piuz 2004). It was also encountered in the Bükkzsérc Limestone in core Bükkzsérc Bzs-5 (Haas et al. 2006). The stratigraphic range of the *Protopeneroplis striata* is Late Aalenian–Late Tithonian (Schlagintweit & Ebli 1999; Schlagintweit et al. 2008). The range of *Siphovalvulina* is Hettangian to Early Cretaceous (Kaminski 2004). Consequently the Jurassic depositional age of the beds is proven and a Middle Jurassic (Bajocian?) age for the exposed beds is highly probable.

The upper part of the section contains olistostrome horizons. Macroscopically the olistostromes are grain supported, containing clasts from 1–2 mm to 4–5 cm in size. They are poorly sorted; the size of the clasts may vary in the same layer between a few mm-s and a few cm-s. The visible clasts are usually well-rounded. The following components could be distinguished by the naked eye: pink, red, light grey and black limestones, grey and green marl, red and light grey cherts.

In microscopic view the investigated olistostrome sample contains a large amount of lithoclasts, 1–3 cm in size. The following lithoclasts could be recognized: thin-shelled bivalve ("filament") coquina, radiolarian–"filament" wackestone, calcitized radiolarite, silicified "filament" wackestone, peloidal wackestone–packstone, clotted micrite with shrinkage pores that contains foraminifers and, brown carbonate grains with limonite staining. Lithoclastic, crinoidal packstone with fine arenite-sized grains that is either a layer or larger lithoclast was also observed (Fig. 19).

Lithoclastic packstone containing 1–3 mm sized lithoclasts in a microsparitic matrix (micro-olistostrome) is another typical texture of the exposed succession. The lithoclasts are slightly rounded to well-rounded. "Filament" wackestone and packstone, radiolarian wackestone, micritic mudstone, silicified "filament" packstone and chert are the typical components.

Discussion

Interpretation of the lithofacies units of the Telekesvölgy Complex

Based on data discussed above our summarizing conclusions are as follows:

- The Norian Hallstatt Limestone — well dated by conodonts — gets more argillaceous upward and gradually progresses into reddish to greenish and then grey marl that may correspond to the latest Triassic Zlambach Formation. Middle to Late Triassic pelagic limestone olistoliths — that is, slided blocks lithologically similar to the underlying strata — occur in the variegated marl unit, locally. These blocks could break down from the footwall of normal faults, connecting to the ongoing tectonic processes. The presence of shallow-water foraminifers (Perkupa-74 core) in this base-of-slope environment most probably refers to turbiditic currents, transporting platform derived material into the basin. The age of this variegated marl is Norian–Rhaetian (?).
- The stratigraphic relationship between the previously described formation and the pelagic basin facies radiolarian

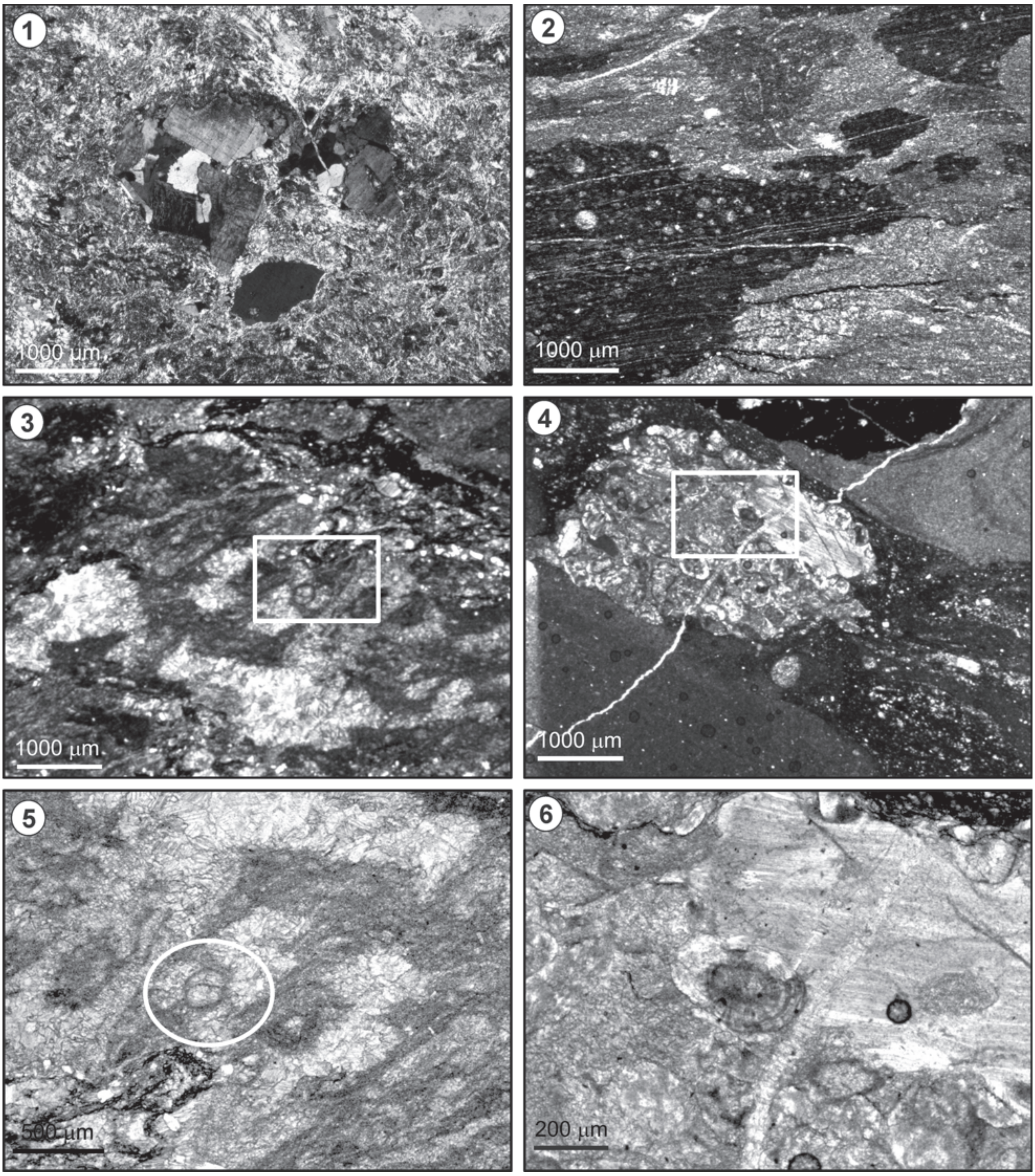

Fig. 16. **1** — Slightly melted plagioclase free granite cataclasite within the rhyolite of Telekesoldal Complex (TC) from the neighbourhood of the Hounter House in the Telekes Valley. **2** — Radiolarian wackestone and radiolarian "filament" wackestone components of the TC olistostrome. Sza-10, 95.4 m. **3, 5** — A rare platform-derived clast containing a foraminifers (in the white circle) and moulds, filled with coarsely crystalline sparite. Sza-10, 95.4 m. **4, 6** — A unique ooidal-crinoidal packstone texture clast from the TC olistostrome. Sza-11, 36.5 m. The white boxes on 3 and 4 indicate the enlarged areas (5, 6).

wackestones (unknown age) of similar lithological composition and colour — explored in Rb-658 core — is not evidenced.

- The variegated marl gradually progresses into grey marl and calcareous marl, containing significant amount of redeposited crinoid fragments. Accordingly it may be interpreted as a hemipelagic facies, relatively close to submarine highs. The age of this lithofacies unit is also unknown.

- The black shale, rich in radiolarians and sponge spicules is a typical deep pelagic basin facies, Bajocian to Early Ba-

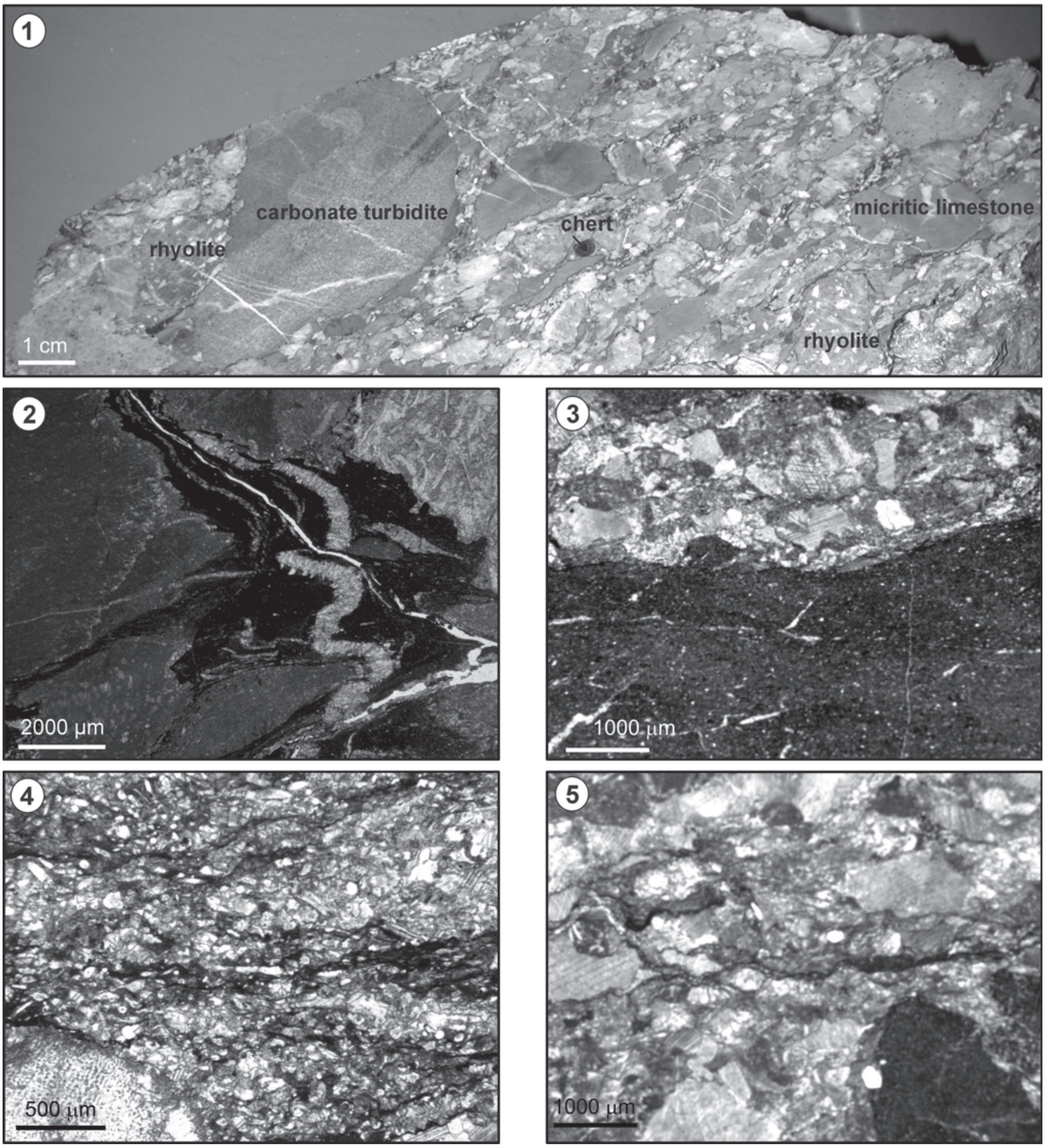

Fig. 17. **1** — Olistostrome from the road cut key-section along the road between Szalonna and Perkupa. The olistostrome is grain supported, the clasts are centimeter- to tens of centimeters-sized (mostly grey limestone and green rhyolite clasts). **2** — A characteristic feature for pressure solution: displacement of layering on certain planes in the Telekesoldal Complex olistostrome. **3–5** — Greenish grey silty claystone basin facies is erosionally overlain by a 2 cm thick lithoclastic, bioclastic packstone layer (3). It is overlain by a 1 cm thick sponge spicule packstone (partially silicified) layer (4), which is followed by a turbidite layer (lithoclastic crinoidal packstone (5)).

thonian in age. The stratigraphic relationship of this lithofacies unit with the previously described one is not proven.

Interpretation of depositional conditions of the Telekesoldal Complex

The sedimentological characteristics of the sandstone layers such as alternation of shale and sandstone layers, erosional base of the sandstone layers and slump folds indicate their turbiditic origin. The sandstone-bearing shale lithofacies was formed in a relatively deep pelagic basin that was reached by proximal to distal siliciclastic turbidity currents. The sand to silt-size siliciclastic material can be derived from a distal provenance and multiple redepositions of fine siliciclasts via river–delta–deep sea fan can be assumed.

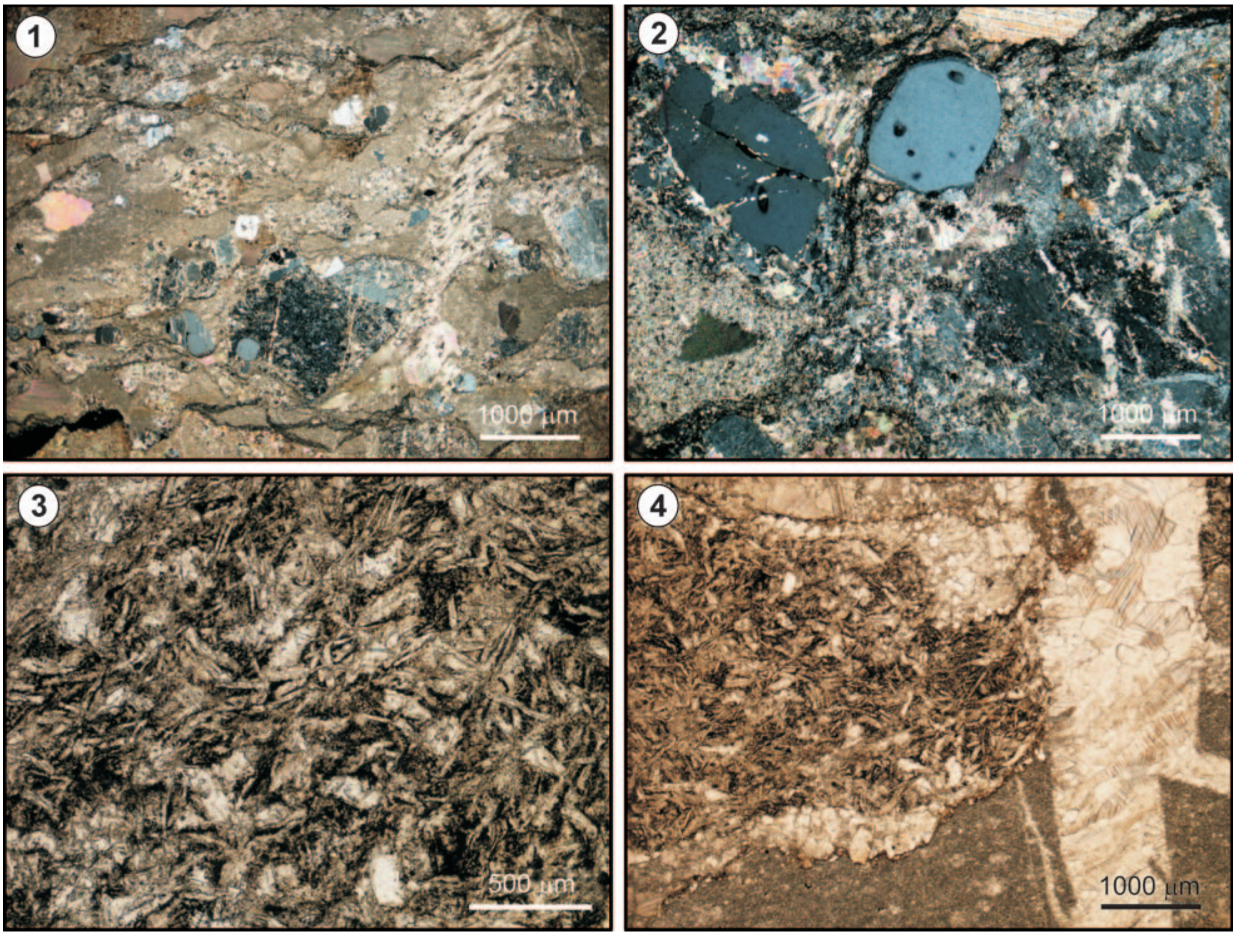

Fig. 18. **1** — Rhyolite fragment with holocrystalline partly spherulitic matrix, rounded quartz and large K-feldspar crystalls. Crossed polars, Telekesoldal key section. **2** — Resorbed quartz and large K-feldspar crystals in a strongly carbonatized fragment, in a carbonate rich olistostrome. Crossed polars, Telekesoldal key section. **3** — Strongly altered opacitized and carbonatized intersertal basalt fragment with skeletal structured laths of plagioclase and some parallel shearing zones. 1 polar, Telekesoldal key section. **4** — Strongly altered opacitized and carbonatized intersertal basalt fragment with skeletal structured laths of plagioclase, calcite and limonitized magnetite aggregates. 1 polar, Telekesoldal key section.

The coarse-grained gravity deposits (debrites, coarse grain turbidites) must have been accumulated close to the slope. The carbonate components (extraclasts) of the gravity flow deposits (olistostromes) are predominantly Middle to Late Triassic (Kovács 1988) pelagic limestones showing features of the grey Hallstatt (Pötschen) facies (radiolarian and "filament" wackestones), crinoidal limestones and rarely limestones of reworked platform facies. The age of the radiolarian wackestone and mudstone clasts is ambiguous (Triassic or Jurassic or both). Rhyolite volcanoclasts and related quartz and feldspar grains are also common and typical components of the gravity mass flow deposits. The rhyolitic clasts are derived both from lava rocks and ignimbrites. They contain large perthitic orthoclase and fractured quartz of undulating extinction which may derive from assimilation, partial melting of acidic to neutral intrusive rocks. Smaller amounts of sericitic plagioclase accompany this assemblage locally, rock inclusions showing intrusive rock texture and consisting of these kinds of feldspar also occur, rarely. The large rhyolite-ignimbrite olistolith at the base of the Jurassic succession (Rb-661 and Sza-10 cores), implies a close volcanic source area and base-of-slope depositional setting. The higher part of the exposed section where smaller rhyolite clasts and various carbonate lithoclasts occur indicates decreasing slope related redeposition, and more distal slope-related setting. We have no relevant radiometric age data for these volcanic rocks.

The lithological features described above imply a relatively deep marine basin in the proximity of a submarine slope as the depositional environment of these lithofacies units. The typical components of the olistostromes indicate that the Triassic and probably Jurassic carbonates formed on an attenuated continental crust (Hallstatt facies zone) and volcanic rocks (probably Jurassic) must have been present in the source area of the gravity flows. Poor rounding of the coarse grains implies an escarpment as the primary source of the clasts; accordingly fluvial transportation prior to the gravity redeposition cannot be considered as a realistic model. Compressional tectonics leading to nappe stacking of the ocean margin may have created suitable conditions for this sedimentation pattern. Nappe stacking brought superposition of Triassic pelagic carbonates and volcanic formations. These

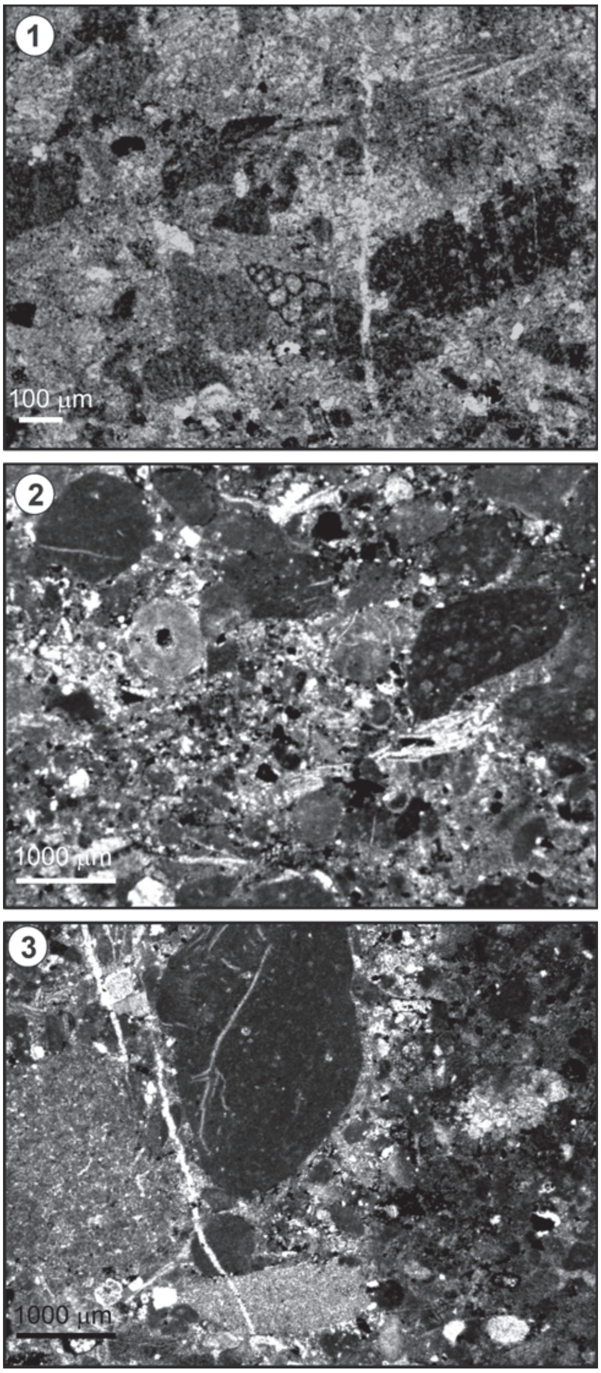

Fig. 19. Detailes of calciturbidite layers from Csipkés Hill olistostrome. Lithoclastic, bioclastic packstone of medium arenite grain size (1) alternates with fine-grained lithoclastic peloidal grainstone (2). "Filament" wackestone and packstone, radiolarian wackestone and dark brown limonitic sparites are the typical lithoclast types (3).

movements led to formation of steep slopes and intense tectonics caused fragmentation of hard rocks and triggered gravity mass movements. The coarse gravity deposits formed slope apron along the foreland of the thrust belt in a subduction related basin.

The above described mainly calc-alkalic volcanic association may have derived from a coeval suprasubduction in a magmatic arc. It is evident that in the TC the rhyolites are predominant among the volcanoclasts, while the basalt clasts are rare. However, no relevant geochemical analysis has been performed on the basalt clasts, so far.

The depositional area must have been in the vicinity of the ongoing nappe stacking of the thinned continental margin in connection with the Middle–Upper Jurassic subduction and obduction processes of the Neotethys Ocean (Schmid et al. 2008). However, the coeval exitence of a suprasubduction magmatic arc system, that may have acted as a source area of the rhyolite clasts and blocks, has not yet been proven due to the lack of relevant radiometric age data.

The depositional environment, stratigraphic and tectonic position of the Csipkés Hill olistostrome

On basis of their microfacies pattern, the above mentioned components are derived most probably from the formations of the Middle to Upper Triassic Hallstatt facies. However, the light grey limestone clasts of peloidal wackestone–packstone texture and clotted micrite with shrinkage pores texture, may have originated from platform limestone, likely from the Anisian Steinalm Limestone. The red cherts (the calcitized radiolarites found in thin sections, too) and pink limestones with thin-shelled bivalve ("filament") coquina are possibly equivalent to the Ladinian to Carnian Bódvalenke Limestone (red cherty limestone). The dark grey or black cherty limestones (radiolarian wackestone, micritic mudstone in thin sections) may have been derived from the Bódvarákó Formation (dark grey cherty limestone and marl).

These coarse-grained gravity deposits must have been accumulated close to a slope. The typical components of the olistostromes indicate that Middle to Upper Triassic carbonates formed in the Hallstatt facies zone must have been present in the source area of the gravity flows.

Taking into account that a shallow-marine carbonate platform was the habitat of *Siphovalvulina* and *Protopeneroplis*, and platform foreslope to deeper shelf of *Callorbis minor* these fossils must have been derived from a penecontemporaneous active platform just like in the case of the similar genera found in the Bükkzsérc Limestone in the Mónosbél Complex in the Bükk Mts (Haas et al. 2006).

However, both the stratigraphic and the tectonic position of the Csipkés Hill olistostrome are quite uncertain; from a tectonic point of view it is likely to be part of the Telekesvölgy Complex. The main reasons are the lack of metamorphic overprint and ductile deformation, which are the characteristic features of the TVC in contrast with the TC (Kövér et al. 2007). However, the sedimentary features (gravity mass transport, olistostrome horizons, and turbidites) and supposed depositional environment (slope) shows greater similarity to the TC, than the mostly basinal facies of the TVC. Accordingly, the olistostrome and carbonate turbidite beds of Csipkés Hill were deposited close to a slope like the sediments of the TC, but they did not form in the same (or in the same part of this) basin, because the clastic components and accordingly the source areas (red and grey Hallstatt facies zones) and the further structural evolution (ductile deformation, metamorphism) are completely different.

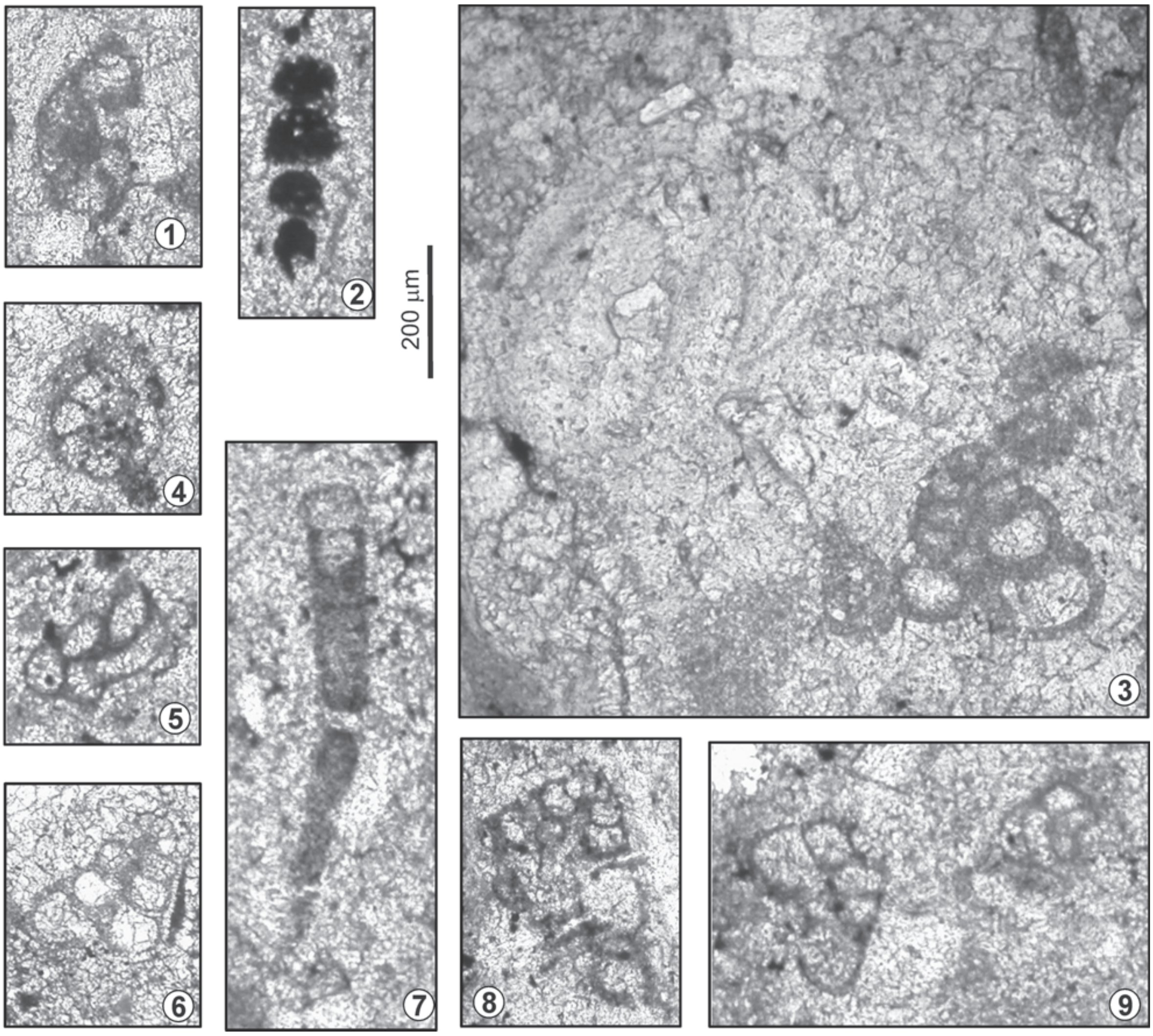

Fig. 20. The encountered foraminiferal assemblage from the matrix of the calciturbidites in Csipkés Hill. **1** — *Callorbis minor*? Wernli & Metzger. **2** — *Nodosaria* sp. **3** — *Eoguttulina* sp. and *Trochammina* sp. **4** — *Protopeneroplis striata*? Weynschenk. **5** — *Planiinvoluta* sp. **6** — *Siphovalvulina*? sp. **7** — *Tubinella*? sp. **8** — *Valvulina* sp. **9** — *Trochammina* sp.

Comparison

The formation of the Jurassic complexes exposed in the Rudabánya Hills can be related to the evolution and mostly to the closure of the westernmost sector of the Neotethys Ocean. Complexes showing more or less similar features and evolution occur north of our study area near to Meliata and Jaklovce villages, Slovakia (Meliaticum) (Kozur et al. 1996; Mock et al. 1998) and also south of the Rudabánya Hills, in the Darnó-Bükk area, North Hungary (Haas & Kovács 2001; Haas et al. 2006). Both areas are close to the Rudabánya Hills; however the former one shows affinity with parts of the "Hallstatt Mélange" in the Northern Calcareous Alps (Kozur & Mostler 1992; Gawlick et al. 1999, 2002; Frisch & Gawlick 2003; Gawlick & Frisch 2003), whereas the latter one is probably of Dinaric origin (Vardar Zone and Dinaridic Ophiolite Belt) (Karamata et al. 2000; Pamić et al. 2002; Dimitrijević et al. 2003; Karamata 2006). Therefore the aim of the comparison is to decide which of these complexes show closer affinity with those in the Rudabánya Hills.

Western Carpathians — Meliata Unit

There are two important occurrences of the Meliata Unit in SE Slovakia. Near to Meliata village, dark shales with radiolarite, sandstone and olistostrome intercalations occur. Based on radiolarians, the age of the radiolarite interbeds is Middle Bathonian to Early Oxfordian (Kozur & Mock 1985; Kozur et al. 1996). Large blocks (olistoliths) of Triassic rocks and Triassic and Jurassic radiolarites commonly occur in the shaly matrix. The olistostromes contain mostly carbonates of a different composition. The lowermost olistostrome bed contains 10–30 cm sized subangular clasts of Carnian grey cherty limestone and 10–20 cm sized angular clasts of red radiolarian chert. It is followed by calcareous shale containing an upward decreasing amount of Carnian and Norian limestone blocks (Mock et al. 1998). It is overlain by spotty shale with radiolarite interlayers and greyish green shales with sandstone to microbreccia interlayers. In the coarser-grained breccia metamorphosed limestone clasts are predominant, but non-metamorphosed limestones of oomicrite and oosparite texture also occur along with individual ooids and oncoid grains and crinoid ossicles. In the finer-grained breccia, the volcanic components (various kinds of submarine basalts showing glass to "dolerite" texture — Mock et al. 1998) are dominant, but metamorphic carbonates and rarely non-metamorphic oosparit are also present. Mn-bearing beds are visible in the topmost part of the exposed section (Mock et al. 1998).

The other important occurrence of the Meliata Unit is located near to Jaklovce village. Here the melange is made up mostly by olistoliths of various sizes whereas the sandstone to microbreccia and olistostrome intercalations are less common in the Middle Jurassic dark shale matrix (Kozur & Mock 1995). The blocks consist of light, probably shallow-marine slightly metamorphosed limestones (Honce Limestone of unknown age), siliciclastic rocks, pelagic cherty limestones, dolomites, radiolarites, rhyolites, basalts, serpentinites.

In summary, the Meliata Unit in Slovakia is made up of black and spotty shales with sandstone and olistostrome intercalations. The main components of the olistostrome beds are as follows: Anisian to Norian grey limestones, metamorphosed limestones, ooilitic limestones, red cherts, basalts of backarc basin origin, rhyolites, and serpentinites. The supposed age, the sedimentological features and the predominance of the Middle to Upper Triassic basin facies in the carbonate components show a great similarity to the components of the olistostrome beds of the TC in the Rudabánya Hills. Moreover, the style of ductile deformation and the temperature, pressure and age constraints of the low to very-low grade metamorphism are very similar (Kövér et al. 2007). However, there are differences in the composition and particularly in the proportion of the olistostrome components. In the TC metamorphosed limestone clasts are rare, the serpentinite clasts are missing and among the volcanic components the rhyolite is predominant, while the basalt is rare. In spite of the differences, the major similarities in the sedimentation pattern and the later structural evolution may indicate a common basin for the depositional area of these units, in the vicinity of the ongoing nappe-stacking of the attenuated continental margin and oceanic crust of the Neotethys Ocean. The differences in the rate of clast composition can be explained by deposition in other parts of the same basin, with variable distances from the distinct source areas.

Northern Calcareous Alps — Tirolic Nappe Group, Hallstatt Mélange, Meliata

In the Northern Calcareous Alps various gravity mass flow deposits occur in the Middle to Late Jurassic deep marine sequences reflecting closure of the Neotethys Ocean. In the area of the Tirolic Nappe Group various basins of different time range and sediment fill came into existence: Lammer Basin (Callovian to Oxfordian), Tauglboden Basin (Oxfordian to Tithonian), Sillenkopf Basin (Kimmeridgian to Tithonian) (Gawlick et al. 1999, 2002; Gawlick & Frisch 2003). From among these developments the Lammer Basin was roughly coeval with the formation of the complexes studied in the Rudabánya Hills.

The Lammer Basin received mass-flow deposits and large slides derived from the grey Hallstatt facies zone ("Hallstatt Mélange"). The thickness of the basin fill may reach 2000 m (Gawlick 1996; Gawlick & Suzuki 1999). Cherty limestone and marl basin facies and turbidites characterize the Callovian. Olistostromes and large olistoliths originated from the Pötschen Limestone occur in the Callovian to Lower Oxfordian. The Middle Oxfordian is made up mostly by large slided blocks of the Lower Triassic Werfen Formation, Upper Triassic Pötschen and reworked Hallstatt Limestone and variation of olistostromes, marls and radiolarian cherts. The upper part of the succession is composed of Middle and Upper Triassic platform carbonate mega-slides (Gawlick 2000).

The "Hallstatt Mélange" was defined as a complex that is made up of reworked fragments of deposits formed on the Late Triassic to Early Jurassic attenuated Neotethys margin, and small remnants of the oceanic basement (Meliata Zone) (Frisch & Gawlick 2003). It contains elements of the Zlambach/Pötschen and Hallstatt Limestone and Meliata facies zones, respectively. The "Hallstatt Mélange" was formed in the late Early to early Late Jurassic interval as a result of a successive shortening of the distal shelf area (Hallstatt Zone). During this process trenches developed in the foreland of the advancing nappes and filled up by various deposits, incorporated into the accretionary prism, subsequently. Parts of the accretionary prism were resedimented in the Lammer Basin or occur as overthrusted remnants (e.g. the Florianikogel Formation in the eastern Northern Calcareous Alps — Mandl & Ondrejičková 1991, 1993; Kozur & Mostler 1992).

Remnants of the Meliata facies zone — representing the most distal part of the shelf area and the continental slope, as well as the transition to the Neotethys Ocean floor — are reported from the eastern (Mandl & Ondrejičková 1991, 1993; Kozur & Mostler 1992) and central part of the Northern Calcareous Alps (Gawlick 1993). These remnants occur partly as metamorphosed, isolated slides (Florianikogel area) or as clasts in olistostromes, consisting of Middle Triassic radiolarites and cherty marls, Carnian Halobia beds and Late Carnian to Sevatian Hallstatt Limestone (Gawlick 1993).

The roughly coeval lower part of the Lammer Basin fill shows some similarity in lithology (pelagic limestone and radiolarite), sedimentary features and supposed geodynamic position to that of the TC in the Rudabánya Hills. However, there are remarkable differences in the clast composition of the olistostromes. Those of the Lammer Basin consist only of Middle to Upper Triassic pelagic limestone clasts, clasts from the Lower Triassic Werfen beds, and bentonite, indicating a depositional area further from the arc.

Bükk–Darnó area — Mónosbél Unit

In the Bükk–Darnó area the Middle to Upper Jurassic Mónosbél Complex — containing great amounts of gravity mass flow deposits in shale and radiolarite matrix — is comparable to the contemporaneous formations in the Rudabánya Hills.

In the western part of the Bükk Mts, the Mónosbél Unit is made up of Bajocian to Kimmeridgian deep marine siliciclastics, carbonates and siliceous sediments with intercalations of olistostrome beds, containing very heterogeneous clasts transported into the basin via gravity mass movements. In the olistostrome beds, along with fragments of acidic, intermediate and basic magmatites, phyllites, metasiltstones, metasandstones, pelagic carbonates and radiolarites, and lithoclasts of redeposited carbonates — containing grains of shallow-water origin (ooids, oncoids, and skeletal fragments of shallow marine biota) — are common. Large blocks (olistoliths and blocks) of platform derived ("Bükkzsérc-type") limestones of Bajocian to Bathonian age are particularly common and typical in the Mónosbél Unit (Haas et al. 2006).

Gravity deposits of the Mónosbél Unit are also exposed in the Darnó area and in ore exploratory wells at Recsk, Mátra Mts. Olistoliths of marine Upper Permian and Upper Triassic Hallstatt Limestone were encountered within Bajocian to Callovian shale and radiolarite (Haas et al. 2006). The thickness of the olistostrome-rich intervals may exceed 100 m. The usually matrix supported breccia is typically oligomict, consisting mostly of carbonate clasts of various colours and compositions (Haas et al. 2006). Detailed component analysis of the olistostromes is under way.

In a borehole drilled near Peak Kékes, Mátra Mts, Bajocian platform derived redeposited carbonates, more proximal than those in the Bükk Mts, were encountered in a remarkable thickness (Haas et al. 2006).

In summary, the most characteristic features of this Mónosbél Unit are the presence of coeval platform-derived foraminifers, ooids, oncoids, peloids — redeposited as individual clasts — and large amounts of Middle Jurassic shallow-water limestones of mm to tens of hundred m in size. The individual clasts indicate that the source area of the platform material must be a coeval, active carbonate platform, most probably the Adriatic Carbonate Platform, which was the only known Middle Jurassic active platform in the whole region (Tišljar et al. 2002; Vlahović et al. 2005). The presence of rhyolite, andesite and basalt clasts are also common in some horizons indicating the complexity of the provenance.

There is a common feature in the composition of the olistostromes of the Mónosbél Unit and the TC, as well. The TC contains some rhyolite and basalt, but the volcanic clasts from the Mónosbél Unit are more varied.

Among the examined Jurassic series of the Rudabánya Hills, the only one, which has Middle Jurassic platform derived material, as a characteristic feature, is the Csipkés Hill olistostrome. Like the Mónosbél Unit, it contains carbonate turbidite beds with platform derived foraminifers (following the previous reasoning: it probably originated from the Adriatic Carbonate Platform) and olistostrome horizons, but in contrast to that, volcanites and roughly coeval lithoclasts are missing among the clasts.

In the Dinarides ophiolite mélange complexes comparable to those in the Bükk–Darnó area occur in the Dinaridic Ophiolite Belt (Dimitrijević et al. 2003). In the Dinaridic Ophiolite Belt the ophiolite mélange contains fragments of obducted ophiolites (lherzolite), Triassic and Jurassic limestone blocks, and polymict olistostromes containing clasts of Middle Triassic to Middle Jurassic radiolarian cherts, greywackes, basalts, gabbros, ultramafic rocks, granites and Triassic and Jurassic limestones in a Jurassic argillaceous, silty matrix (Karamata et al. 2000; Pamić et al. 2002; Karamata 2006).

There are a lot of common sedimentological features in the Middle to Upper Jurassic complexes discussed above that can be attributed to the processes of the Neotethys closure. However, due to their different paleo-position, the composition of the redeposited clasts shows significant differences depending on geological features of the source area. Fragments originating from the Hallstatt facies zone occur in all of the compared units. Grey Hallstatt-type limestones are typical components of the Telekesoldal Complex; they are also characteristic elements of the lowermost olistostrome of the Meliata-type section. Both grey and red Hallstatt-type pelagic carbonates prevail in the Lammer and Sandlingalm Basin fill, and they are present as olistoliths in the Mónosbél Complex of the Darnó area. The clasts derived from the red Hallstatt-type area are predominant in the olistostrome of Csipkés Hill.

Conclusions

Lithological and microfacies studies on the Jurassic sedimentary rocks of the Aggtelek-Rudabánya led to the following conclusions on the relationship, position, and age of the different lithofacies units of the investigated complexes:

1. The Telekesvölgy Complex (TVC) is the sedimentary cover of the Upper Triassic of the Bódva Series. The Norian Hallstatt Limestone — well dated by conodonts — gets more argillaceous upward and gradually progresses into reddish to greenish and then grey marl that can be correlated to the latest Triassic Zlambach Formation. Locally, it may contain slided blocks of Middle to Upper Triassic hemipelagic limestones, similar to those found in deeper stratigraphic levels of the same succession. The variegated marl progresses into grey marl and calcareous marl, containing significant amounts of redeposited crinoid fragments. It may be interpreted as a hemipelagic facies, relatively close to submarine highs. The uppermost lithofacies unit of the TVC is black shale, rich in radiolarians and sponge spicules. It is a typical deep pelagic basin facies, Bajocian to Early Bathonian in age, according to the revised radiolarian fauna.

2. The Telekesoldal Complex (TC) represents a mélange-like subduction-related complex, composed of black shales, sandstone turbidites and olistostrome horizons, deposited by gravity mass flows. The most characteristic microfacies types of the lowermost shale and marl lithofacies units are radiolarian-sponge spicule wackestone and barren mudstone, representing deep hemipelagic basin facies, akin to that of the youngest lithofacies of the TVC. There are sandstone and siltstone intercalations of turbiditic origin in the shale. The sandstone-bearing shale lithofacies was formed in a relatively deep pelagic basin that was reached by proximal to distal siliciclasic turbidity currents. A relatively deep marine basin in the proximity of a submarine slope is likely to be the depositional environment of the olistostrome lithofacies. The components of the olistostromes are predominantly Middle to Upper Triassic hemipelagic limestones rarely limestones of platform facies, rhyolite and basalt. Bajocian–Callovian age was proved from the complex by revising the radiolarian data and finding the first marine palynomorphs in the Aggtelek-Rudabánya Hills.

3. The Csipkés Hill olistostrome consists of carbonate turbidite beds containing Jurassic platform-derived material (including foraminifers) and olistostrome horizons containing limestone clasts of the Middle–Upper Triassic of red Hallstatt facies. On the basis of the encountered foraminiferal assemblage, the Jurassic depositional age of these beds is proven and a Middle Jurassic (Bajocian?) age is highly probable. The platform derived individual foraminifers indicate a coeval active carbonate platform in the neighbourhood of the depositional basin.

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