2.16. Lókút Hill Section (Lókút)

The Lókút Hill (abbreviated as LH in this work), with the studied Upper Jurassic–Lower Cretaceous section on the hilltop, is situated about some hundred metres east from the village of Lókút. The Lókút Hill is an exceptional place where 7 of the 11 Jurassic stages are documented by means of macrofossils (mainly ammonites), and presence of the remaining stages can be inferred on the basis of lithology and/or geochemical data. The Hettangian–Toarcian rocks are exposed in a long artificial trench while Bajocian rocks were studied in a large pit, both dug on the southern part of the hill (Géczy 1976, Galácz 1976). The Lókút Hill represents the most complete and thickest as well as probably the best documented Jurassic outcrop of the Transdanubian Range. Since the Upper Jurassic and the Lower Cretaceous is also relatively complete, the site offers a good opportunity to study the Jurassic/Cretaceous transition, too.

The Upper Jurassic succession is exposed in a shallow, artificial trench on the SW slope of the Lókút Hill (Fig. 1/E). Geological coordinates for this section are: 47° 12′ 14.83″N, 17° 52′ 52.07″E (for the base), and 47° 12′ 16.86″N, 17° 52′ 51.96″E (for the top). Apart from this "main" section, which was referred by Lodowski et al. (2021) as LO-I, another side-section, named LO-II, was also studied for magnetostratigraphy (Fig. 16/A).This small section fills the gap which was observed towards the end of the LO-I section. Geographical coordinates for section LO-II are: 47° 12′ 16.37″ N, 17° 52′ 55.89″ E.

By now the Upper Jurassic–Lower Cretaceous section of Lókút Hill is well studied; the most relevant papers in chronological order are the following: Wein (1934), Fülöp (1964), Vígh (1984), Vörös (1989), Grabowski et al. (2010), Főzy et al. (2011), Price et al. (2016), Grabowski et al. (2017) and Lodowski et al. (2021).

Our new structural results contribute to the characterisation of different fracture sets; these were formed in several phases but mostly before the mid-Cretaceous tilt (folding), see details in Fodor (2022, this volume). The section is important for basin evolution perspective, summarized in Fodor & Főzy (2022, this volume).

2.16.1. The section

The Lókút (LH) section was excavated and collected in the early 1960s by the team of the GIH, and its length was expanded towards Cretaceous strata in 2018 (Fig. 16/E) when an extension of the section was excavated during the course of recent study (Fig. 16/C). In the lowermost part of the entire LH section the cherty Lókút Radiolarite Formation crops out. This is succeeded by 0.1m of light red-brown clay, followed by a light red-brown, nodular ammonitico rosso-type cherty limestone (Pálihálás and Szentivánhegy Formations) and the biacone-type light coloured and thin bedded carbonates with cherty beds on the top (Mogyorósdomb Formation) (Fig. 16/B). No sharp boundaries between the last three calcareous formations are apparent. The entire thickness of the studied carbonate formations in the roughly 60 metres long trench is about 27 metres (Fig. 17). However the succession continues below the meadow. Strata dip to north with mean orientation 360°/20°. The main section and a site nearby preserved fractures which were formed before the mid-Cretaceous tilting of the layers (D3 phase) thus they may have implication for Early Cretaceous basin evolution. One strike-slip fault also displaced the layers of the main trench and caused slight disturbance in the stratigraphy.

Some ammonites from the Lókút (LH) section were collected in the early 1960s by the team of the GIH and named on the original ammonite labels as "Lókút 1962" and referred as LH-I. Since no traces of any parallel trenches can be found around this locality in the field, we presume that other labels of fossils refer to particular segments of the same section, where additional collecting work has been done later. In 1963, a second, more extensive fossil collecting campaign was done and Kimmeridgian to the lower upper Tithonian ammonites were collected. On the basis of their original labels, these ammonites are referred here as LH-II specimens. Vígh (1984) and Főzy et al. (2011) investigated this LH-II fauna. For some reason, they stopped collecting and the team returned in 1964 and continued the work on the uppermost part of the section, where very characteristic, several age indicative forms of the latest Tithonian and the earliest Berriasian were found. On the original labels these ammonites are from "Lókút 1964 LH-II/I", we

Figure 16 – Upper Jurassic–Lower Cretaceous formations on the top of the Lókút Hill

A: Small abandoned limestone quarry (Section LO-II) where the brittle biancone limestone is cropping out some 25 metres to the SE from the main J/K hilltop section.

B: Bedded, light cream, pelitic, biancone limestone above the J/K boundary in the hilltop section, LH-II.

C: The newly extended part at the top of LH-II trench in the biancone on Lókút Hill –. Prof. Jacek Grabowski (in the background with cap) and Damian Lodowski (in the front) are taking oriented samples for magnetostratigraphic investigations.

D: Excavating the biancone in the topmost (Berriasian) part of the Lókút section in 2018.

E: The Kimmeridgian and Tithonian part of the LH-II section. The photo was taken in the early 1980s. By now the section is heavily overgrown by vegetation, but beds are still accessible.

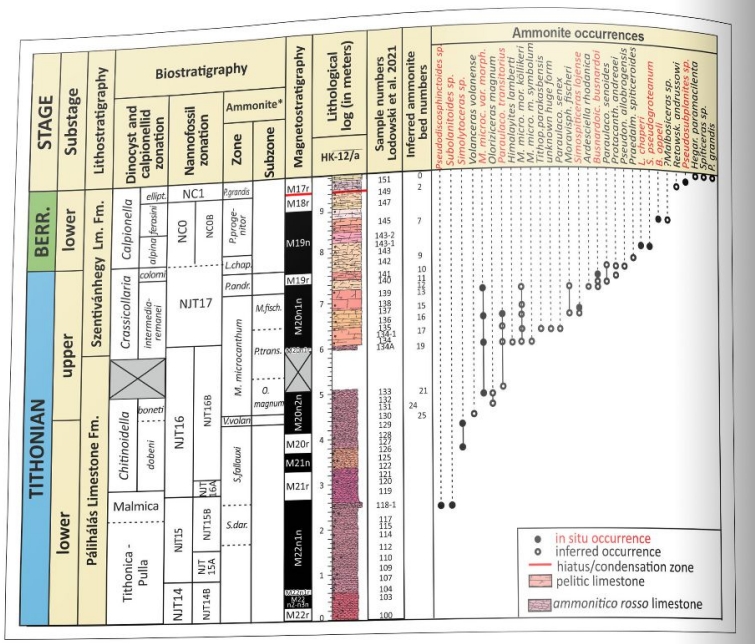

Figure 2 – Stratigraphy of the Hárskút, HK–12/a section. Dinocyst and calpionellid zonation, nannofossil biostratigraphy, magnetostratigraphy and lithologic log are taken from Lodowski et al. (2022)

*Ammonite zonation is after Szives & Főzy (2022). Abbreviations: *S. sem.* – *Semiformiceras semiforme* Zone, *O. magnum* – *Oloriziceras magnum* Subzone, *M. fisch.* – *Moravisphinctes fischeri* Subzone; furthers see on Figure 1. Colours in lithological log correspond to the colours of the fresh rock surfaces.

al. (2013) as a replacement for the "Durangites" Zone (Énay & Geyssant 1975, p. 45) or the equivalent "Vulgaris" Zone of Sarti (1988, p. 473). The faunal assemblage of Andreaei Zone is rather characteristic with the presence of *Busnardoceras*, *Protacanthodiscus*, and *Proniceras*. Related to its FO, *Protacanthodiscus* appears together with *M. microcanthum* at HK–II section in bed 37.

The Andreaei Zone is established in the following sections of Hungary: HK-II (Figure 1), HK-12/a (Figure 2), Szilas Ravine (Figure 3) and Lókút (Figure 4).

3.2.4. Lopeziceras chaperi Zone

Nikolov (1967, p. 729) introduced the Chaperi Subzone as the youngest subzone of the late Tithonian Transitorius Zone. Fortunately, *Lopeziceras* appeared in situ at Hárskút 12/a section. Chaperi Zone marks the topmost Tithonian due to the current state of the T/B boundary (Tavera et al. 1994). Faunal content of the Zone in the Hungarian material is given by Szives & Főzy (2022).

The Chaperi Zone is established in the following sections: HK-II (Figure 1), HK-12/a (Figure 2), Szilas Ravine (Figure 3) and Lókút (Figure 4).

Elenaella cularense Subzone

Tavera et al. (1994) introduced *Elenaella cularense* as a horizon marker, a species with great abundance in the Puerto Escaño, Spain. Its total stratigraphic distribution is restricted to a narrow level that may serve to define the topmost Tithonian of certain areas of the Mediterranean *sensu* Cecca (1999). *E. cularense* is a useful index fossil that may characterize its nominal subzone of the Chaperi Zone. Further discussions see in Szives & Főzy (2022).

The Cularense Subzone is established in the Szilas Ravine (Figure 3) section.

3.2.5. Praedalmasiceras progenitor Zone

Introduction of *P. progenitor* Zone was given by Szives & Főzy (2022). In the Hungarian material *P. progenitor* occurs in the Szilas Ravine and Lókút LH–II/I sections, however other *Praedalmasiceras* species are present in all the examined sections. Its faunal content in the Hungarian sections is: *Praedalmasiceras* sp., *Praedalmasiceras progenitor*, *Praedalmasiceras* cf. *botellae*, *Spiticeras* sp. Besides, from literature compilations listed above, *Proniceras pronum*, *Berriasella* spp. (*chomeracensis, moreti, oppeli, oxycostata*), *Hegaratella paramacilenta*, *Pseudoneocomites beneckei* are parts of the assemblage. The Zone is also characteristic of some Vocontian sections (Frau et al. 2016b).

The Progenitor Zone is established in the following sections: HK-II (Figure 1), HK-12/a (Figure 2) and Szilas Ravine (Figure 3).

3.2.6. Pseudosubplanites grandis Zone

We support the use of the Grandis Zone in its original meaning established by Le Hégarat (1973), as an interval zone between the FO of *P. grandis* and the FO of *S. occitanica* or FO of *S. subalpina*. In the Hungarian material, *Hegaratella paramacilenta*, *Pseudosubplanites grandis*, *Pseudosubplanites* sp., *Spiticeras* sp., *Neocosmoceras curelense*, ?*Himalayites kasbensis* and *Retowskiceras andrussowi* characterize the interval between LO of *P. progenitor* and FO of *S. occitanica*.

The Grandis Zone is established in the following sections: HK-II (Figure 1), HK-12/a (Figure 2) and Szilas Ravine (Figure 3).

Delphinella informal unit

Genus *Delphinella* may have a special importance in Berriasian biostratigraphy, however in Hungary it is rarely present. Hoedemaeker et al. (2016) mentioned that in ammonitico rosso/biancone sections *Delphinella* is absent or very rare, so is the case in Hungary. Only one specimen occurs in the HK-12 section (which is the upper composite to HK-12/a section, for details see Lodowski et al. 2022). Due to the scarity of our material, we cannot make any further biostratigraphic observations.

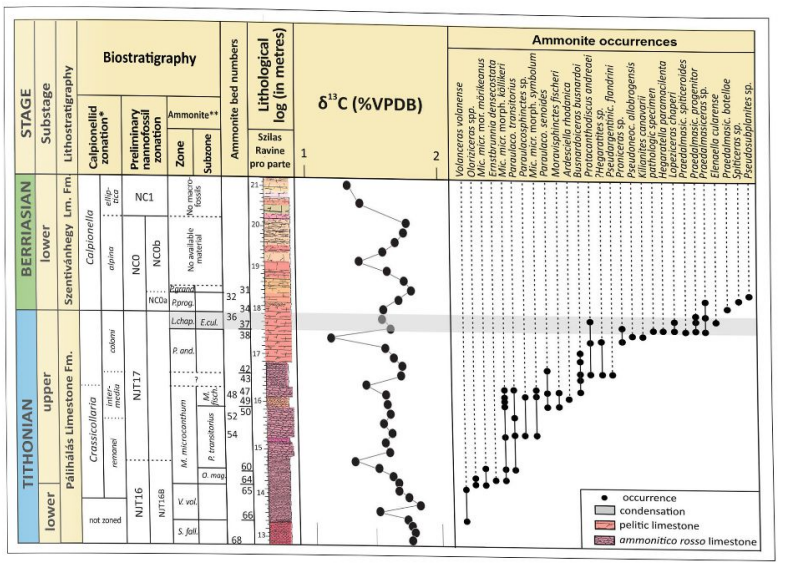

Figure 3 – Biostratigraphy of the Borzavár, Szilas Ravine section, modified from Szives & Főzy (2022)

*Calpionellid zonation is taken from Császár (1985). **Ammonite zonation is after Szives & Főzy (2022). Abbreviations: *E. cul.* – *Elenaella cularense* horizon; furthers see on Figures 1. and 2. Colours in lithological log correspond to the colours of the fresh rock surfaces.

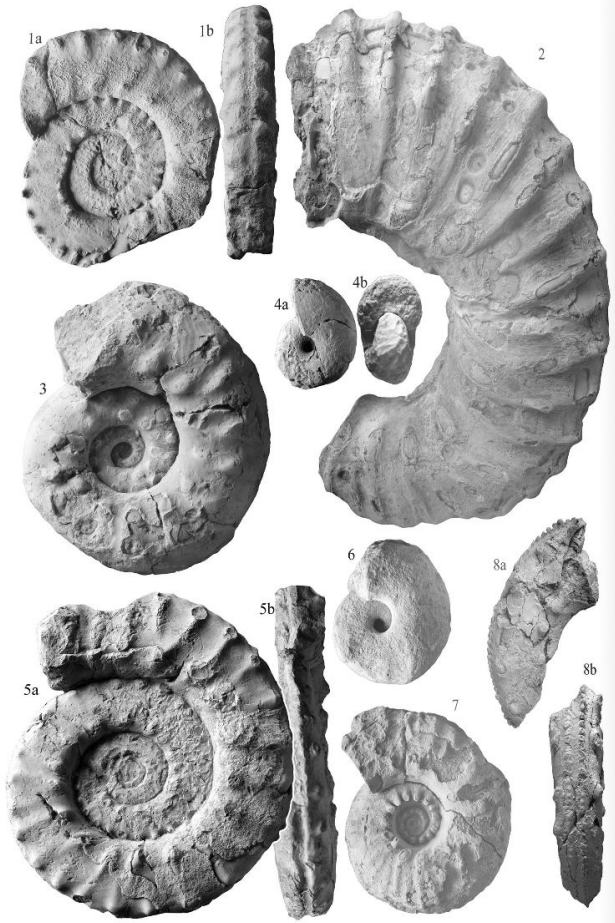

Plate 53 – Aspidoceratidae

Figures are reduced in size to 0.5x

1a, 1b. *Hybonoticeras hybonotum* (Oppel, 1863) – J.2021.131.1, Sümeg, grab sample, characteristic for the early Tithonian, Hybonotum Zone.
2. *Toulisphinctes inflatoides* (Quenstedt, 1888) – J.8898, from the Kimmeridgian, (presumably early Kimmeridgian) of Borzavár, Páskom Hill.
3. *Aspidoceras iphicerum* (Oppel, 1863) – J.8797, from the Kimmeridgian of Borzavár, Páskom Hill.
4. *Physodoceras neoburgense* (Oppel, 1863) – J.2021.132.1, Hárskút, Édesvízkút-1 section, bed 10, early Tithonian, ?Darwini Zone.
5a, 5b. *Hybonoticeras hybonotum* (Oppel, 1863) – J.9112, Sümeg, grab sample, characteristic for the early Tithonian, Hybonotum Zone. For suture of this specimen see Fig. 8/3 in the text.
6. *Physodoceras neoburgense* (Oppel, 1863) – J.2021.133.1, Hárskút, Édesvízkút-1 section, bed 10, early Tithonian, ?Darwini Zone.
7. *Toulisphinctes inflatoides* (Quenstedt, 1888) – J.8987, from the Kimmeridgian, (presumably early Kimmeridgian) of Borzavár, Páskom Hill.
8a, 8b. *Hybonoticeras kamikense* (Schopen, 1888) – J.2021.134.1, from the Kimmeridgian, of Borzavár, Páskom Hill, most probably late Kimmeridgian, Beckeri Zone.

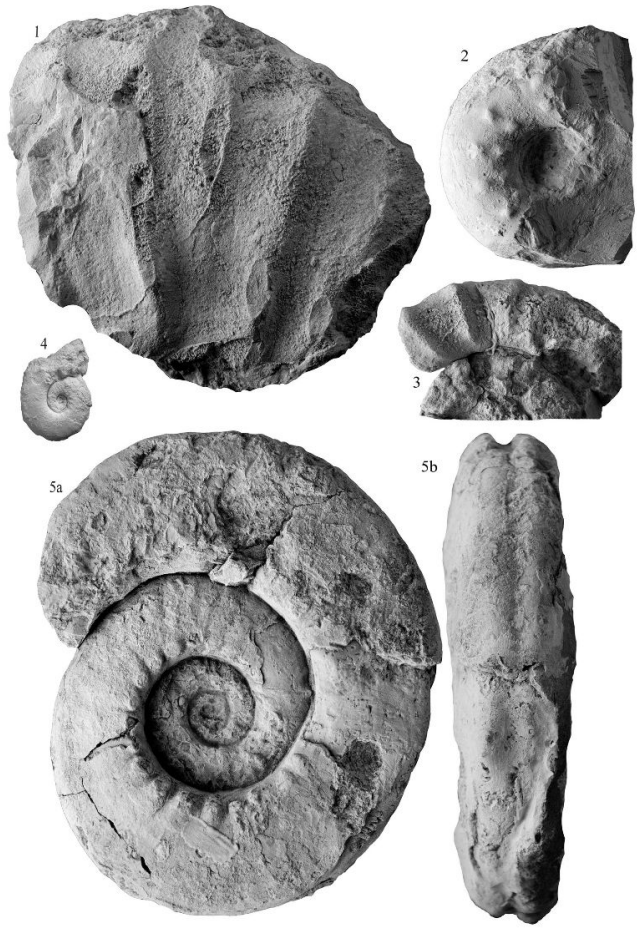

Plate 54 – Aspidoceratidae

All figures natural size

1. *Toulisphinctes* sp. – J.2021.135.1, Lókút Hill, bed 62, late Kimmeridgian, Beckeri Zone.
2. *Aspidoceras taverai* (Checa, 1985) – J.10562, Hárskút, HK-II section, bed 38, late Tithonian, Microcanthum Zone.
3. *Hybopeltoceras linaresi* (Olóriz, 1978) – J.2021.136.1, Hárskút, Édesvízkút, from debris, supposedly basal Tithonian.
4. *Simocosmoceras* sp. – J.2021.137.1., Olaszfalu, Eperkés Hill, early Tithonian, Semiforme Zone.
5a, 5b. *Hybonoticeras pressulum* (Neumayr, 1873) – J.9106, Bakonybél, Som Hill, grab sample, characteristic for the late Kimmeridgian, Beckeri Zone.