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EXCURSION 2B
A transect through the Velebit Mt.

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Drive from Rab to Jablanac and along the Adriatic coastal scenic road to Karlobag. From Karlobag and across the Velebit Mt. to Gospić, and to Zagreb.

JABLANAC

ZAVRATNICA

Zavratnica fjord, is one of the most beautiful geomorphological phenomena of the Adriatic coast. It is situated 2,5 km south from Jablanac. The Bay represents a flooded river mouth or ancient torrent valley, filled with sea-water after the rise of the sea level in post-glaciation time. A prehistoric settlement was discovered above the bay, at Klasnica locality. During the Second world war a german ship sunk here, and can be approached by divers at the depth of 8 – 10 metres.

Zavratnica is almost 1000 m long, 50 – 150 m wide, with canyon walls more than 100 m high. Locality was popular among the tourists since the beginning of the 20th century. Due to its natural beauty it was proclaimed a „protected landscape" in 1964. Since 1981 it became a part of the „Velebit Park of Nature".

More data can be found at: http://www.pp-velebit.hr/zavratnica.htm, and http://www.dmmedia.com/izleti/zavratnica_hr.htm

Fig. 1. Zavratnica Cove.

CENTRAL VELEBIT MT.

KUBUS

Kubus is a pass situated along the road Gospić–Karlobag, marked with a stone cube monument (Fig. 2) from which you can see a gorgeous view to the Adriatic Sea and the Island of Pag.

Fig. 2. Stone cube, a monument to road constructors at Kubus pass.

Along the winding road towards Karlobag, subvertical carbonate beds of Jurassic age are exposed, at some places containing numerous fossils, dominantly lithiotid bivalves.

Open profile is alltogether 270 m long, presenting carbonate rocks of 5 different lithofacies (Tišljar et al. 1991).

Fig. 3. Kubus pass panorama, Jurassic deposits.

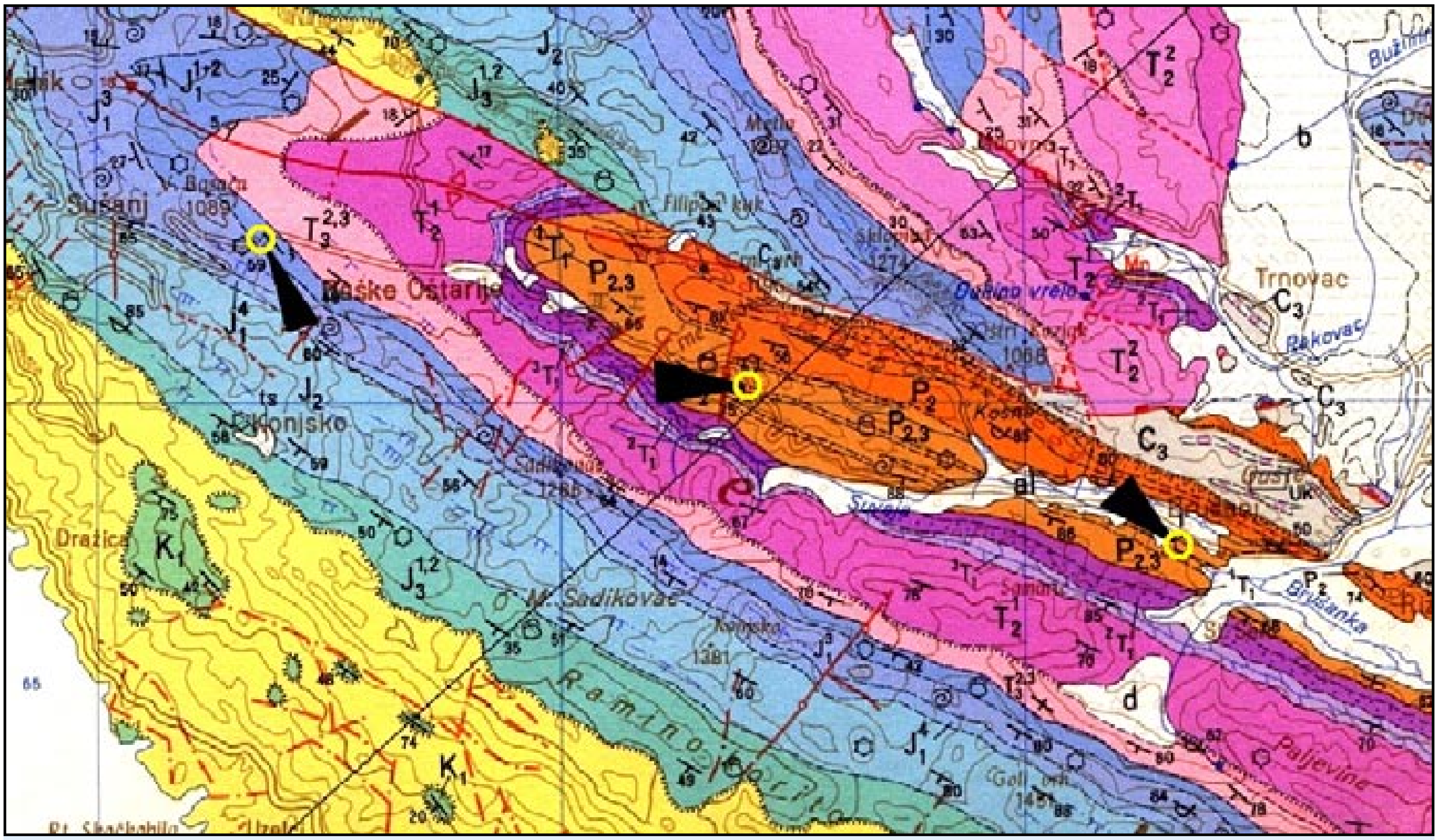

Fig. 4: Geological map of central Velebit Mt. (Sokač et al. 1974)

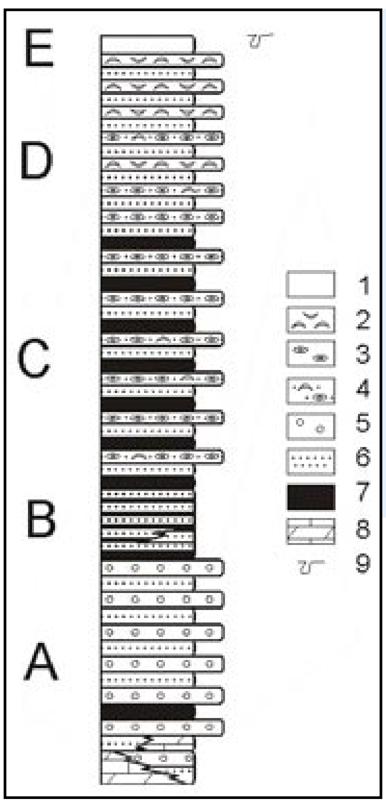

Fig. 5. Detailed geological column through the Lower Jurassic deposits NW from the Kubus pass. Lithofacies types are marked with letters A-E (partly after Tišljar et al. 1991). Key: 1. Bioturbated, stained limestones, 2. Lithiotid coquinas, 3. Onkoids, 4. Intraclast bioclastic grainstone, 5. Ooid grainstone, 6. Peloid wackestone, 7. Mudstone, 8. Late diagenetic dolomite, 9. Cross bedding

1. FACIES A

Rhythmical deposition of mudstones, wackestones and ooid grainstones is typical for this facies. Base of these sediments is composed of conglomerates with pebbles of underlaying Ladinian rocks. Early diagenetic fenestral dolomites with stromatolites, with scarce fossils prevail in the lower portions. Upper layers are often grainstones, with numerous remnants of lithiotid bivalves, crinoids, calcareous algae and benthic foraminifera.

Deposits of Facies A were common in peritidal environments during the Lower Jurassic time.

2. FACIES B

Mudstones of Facies B contain intercalations of wackestones/packstones and floatstones, with small benthic foraminifera and *Palaeodasycladus mediterraneus* (PIA).

These rocks were deposited in a lagoon or shallow subtidal environment during the middle part of Lower Jurassic.

3. FACIES C

Dark grey to black carbonate rocks of this facies present rhythmical exchange of mudstone/wackestone and grainstone/rudstone type of sediments. Among microfossils index species of foraminifera *Orbitopsella praecursor* (GÜMBEL) and calcareous algae Palaeodasycladus mediterraneus (PIA) are particularly important. Larger remnants of *Lithiotis problematica* and gastropods are also common.

Carbonate rocks of Facies C were deposited in a lagoon or shallow subtidal during the Lower Jurassic.

4. FACIES D

Deposits of Facies D can be clearly recognized in the field, due to the numerous macrofossils. They appear at several levels within the exposed profile (Fig. 3).

Shallow subtidal lagoonal limestones (peletal to peletal-skeletal wackestones to packstones, 30 to 150 cm thick, with microfossils and brachiopods) alternate with 30-160 cm thick lithiotid tempestite coquinas.

Lagoonal limestones contain benthic microfossils, sporadically with lithiotids in life position.

Coquines are composed of numerous shells of *Lithiotis problematica*, dug out from the sea floor during the tempest, and deposited in a bioclastic layer after the stress phase.

This type of facies was common in the middle part of the Lower Jurassic.

5. FACIES E

Lithofacies E is represented with «spotted limestones». Bed thickness varies from 10 to 60 cm, and the whole series is ca. 50 m thick. Limestones are in most cases mudstones to wackestones, intensively bioturbated. Feeding traces are more light-colored than the rest of the rock, due to the decreased organic content, thus resulting in typical spotted pattern.

Besides the numerous ichnofossils, small benthic foraminifera and pelagic crinoids (*Saccocoma*) were found in these deposits.

Limestones of facies E were deposited in calm, spacious shallow environments, with low deposition rate. They do not contain index taxa, but it presumed that they were deposited during the upper part of the Lower Jurassic.

STOP – PARIPOV JARAK

Jasenka Sremac

Middle to Late Permian platform carbonate rocks are well exposed along the regional road Gospić-Karlobag. They represent a core and a SW wing of the Velebit anticline, and are in most cases steeply inclined towards the south-west (Fig. 7). A particularly interesting exposure was found at the Paripov jarak (Horse Trench) locality. A complex patch-reef structure of the Middle Permian age (Zone *Neoschwagerina craticulifera*) is today a part of the Educational Route of the Velebit Park of Nature (Sremac 2003), and a proposal was sent to the UNESCO to protect the outcrop as the international geological heritage.

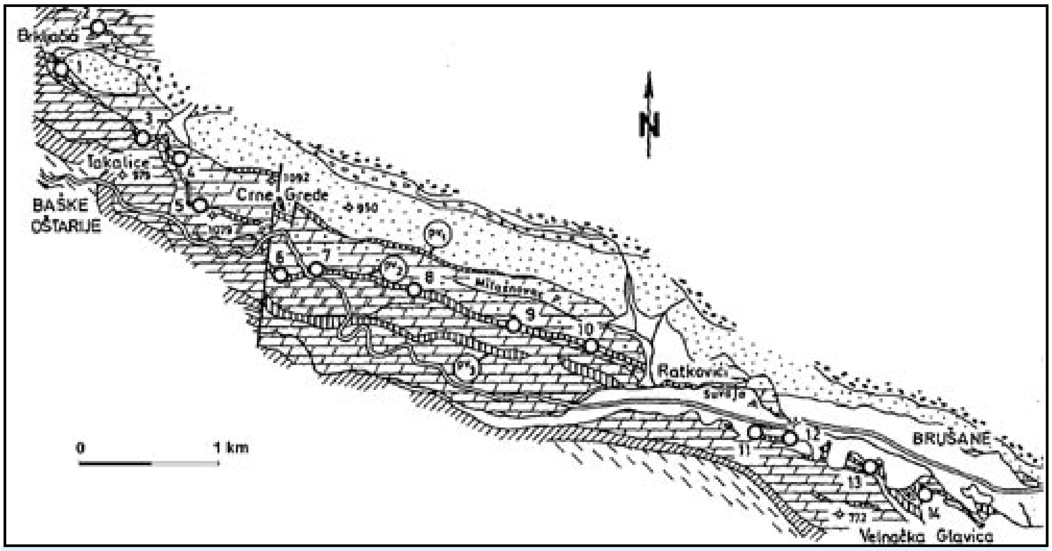

Fig. 7: Detailed geological map of Baške Oštarije area, after Salopek (1942).

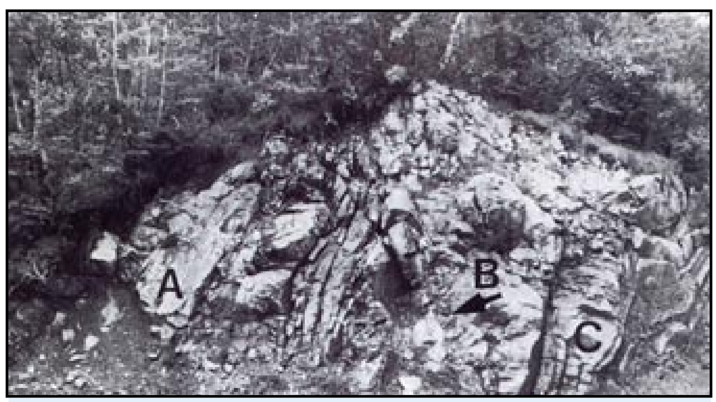

Fig 8: Reef-photo

The outcrop is ca. 12 m wide and 8 m high (Fig. 8). Reef structures have been rotated for ca. 90 degrees due to the tectonic processes (Figs. 8 and 9). In the base of the reef body, dark grey mudstone was found. Large fenestellid bryozoans were the first colonizers of the muddy substrate (Marjanac & Sremac 2000, Sremac 1991). Their large fans represented a base for growth of diverse sessile benthic biota – other bryozoans and small calcareous sponges. The first colonizers probably lived in a very shallow, nearshore environment, with

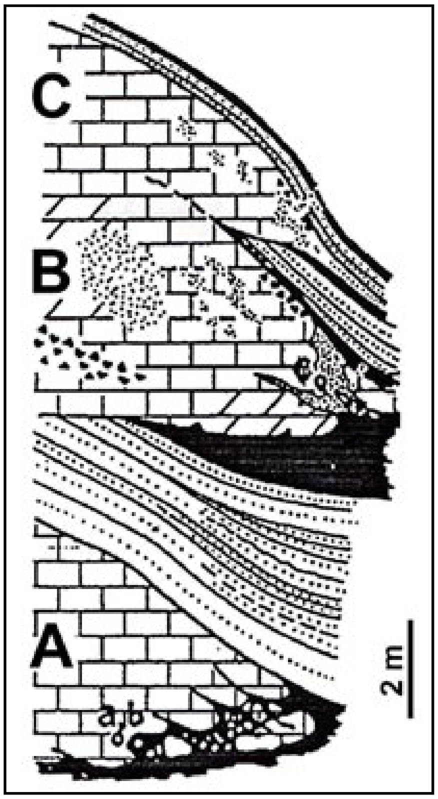

Fig. 9: Reconstruction of the reef.

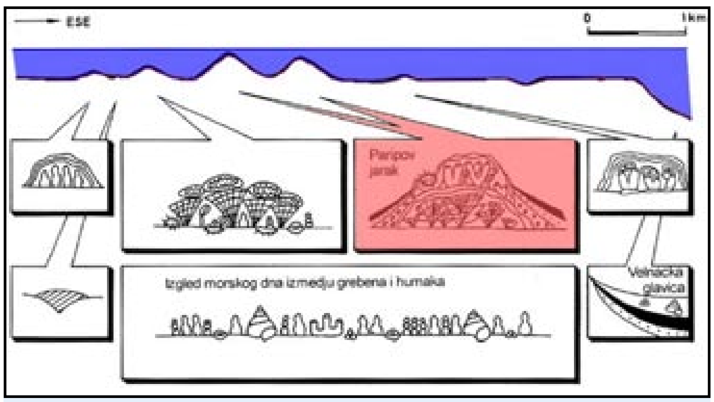

Fig. 10: Reconstruction of the platform.

important role of cyanobacteria in the community. Microbial crusts cover the whole basic part of the patch-reef. On this consolidated base, large calcisponges (*Colospongia*, *Waagenella, Sinocoelia, Guadalupia* and many others) started to produce the main part of the reef framework (Fig.11). We can conclude that the sea-level slightly rose, thus enabling the formation of the bioherm. Several taxa of invertebrates choosed these patch-reefs for their favourite niches. The most common among them were the large endemic brachiopods *Martinia velebitica* and *Enteletes salopeki*. Up to 100 specimens of M. velebitica were found within a patch-reef (Sremac 1986). Reef structure of the body A is partly covered with a floatstone type of bioclastic limestone, probably representing the average process of reef decomposition. Sea level oscillations, rather common in Middle and Late Permian, influenced these processes. At least three episodes of reef-growth can be observed at the outcrops (reef bodies A, B and C; Figs. 2 and 3). Reef growth was most probably interrupted by sea-level drop, and again initialized when the optimal conditions were restored. It is interesting that all 3 reef bodies (A, B and C) exhibit the same pattern of colonization, with fenestellids and incrustants at the base, and large calcisponges in the main part of the framework.

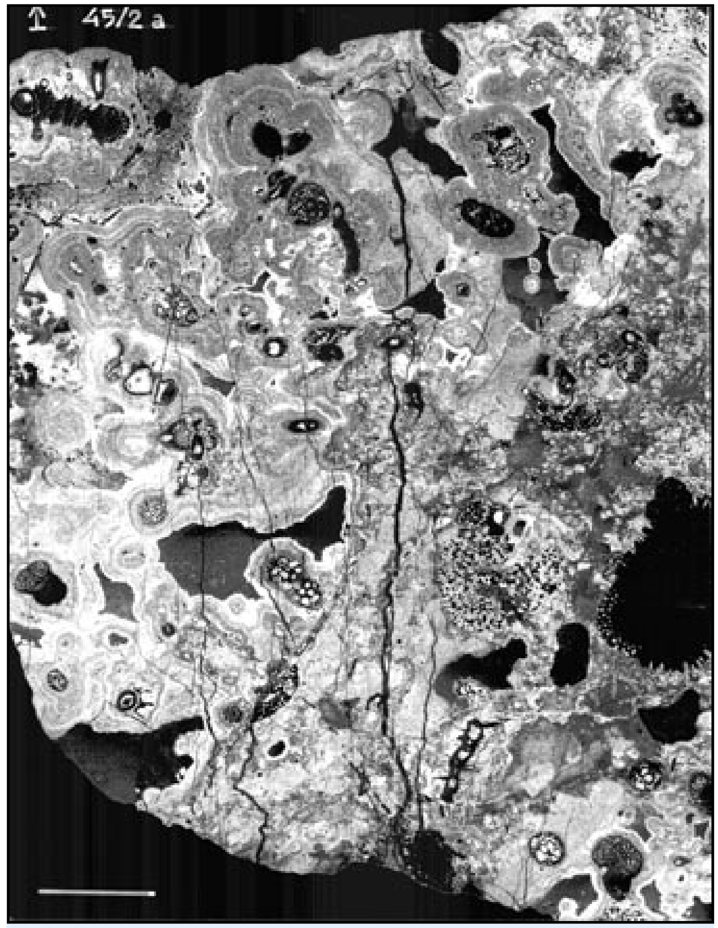

Fig. 11: Thin-section showing reef framework. Scale bar is 1 cm.

During the storms, the surrounding sediment and biota were uplifted from the sea-bottom, transported over the reef, and filled the reef cavities. These structures can be observed in the field, due to the different color of the reef structure (grey) and infill (yellowish-grey). Among the biota, calcareous algae are very common (*Mizzia, Gymnocodium, Permocalculus*), together with ball-shaped *Neoschwagerina* which could be easily transported without damage of the test. During the very strong storms, possibly hurricanes, even surrounding Tanchintongia settlements were influenced. These large and thick shells were destroyed and fragmented, and can be found in coquinas between the reef bodies.

The reef was finally burried in mud, and typical algal dolomites overlay the reef body C.

VELNAČKA GLAVICA (KLAVARIJA)

Profile from Brušane village to Velnačka glavica hill (Figs. 12, 13), crossing a small hill Kalvarija, is well known for a well exposed succession of sedimentary rocks ranging in age from the Middle Permian to the Lower Triassic (Salopek 1942, Kochansky-Devidé 1971, Sremac 1991, 2005).

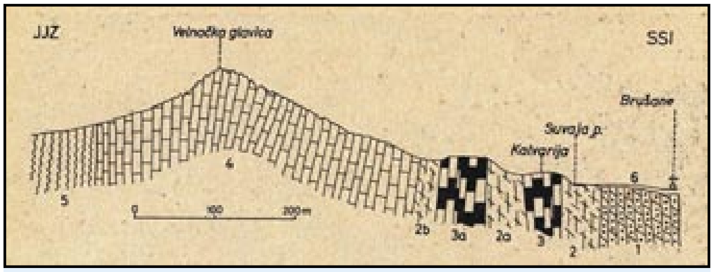

Fig.12. The first published reconstruction of geological profile Brušane - Velnačka glavica (after Salopek 1938, from Kochansky-Devidé 1971) with position of Kalvarija hill marked with red arrow. Key: 1) Dark spotted dolomite (Middle Permian), 2a. & 2b) White crystalline massive dolomite (Middle to Upper Permian), 3) Black limestone and shale; Zone *Neoschwagerina craticulifera* (Middle Permian), 3a) Black limestone and shale; Zone *Yabeina syrtalis* (Upper Permian), 4) Transitional dolomite (Upper Permian-Lower Triassic), 5) Sandstone (Lower Triassic).

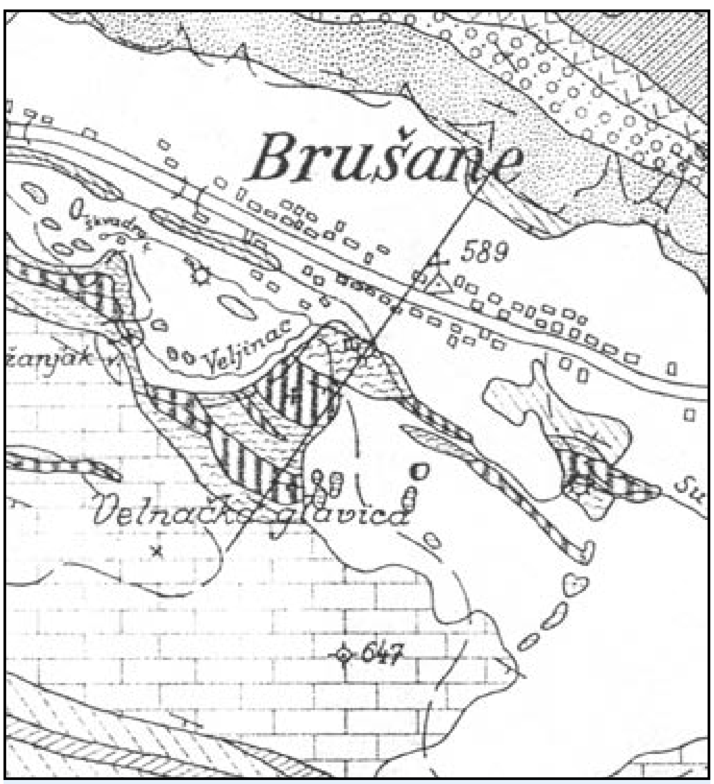

Fig. 13. A detail from the first large scale geological map 1:12.500 (after Salopek 1942). Spotted Permian dolomite is presented with wave lines, black limestones of 2nd and 3rd zone with black vertical marks, and transitional P/T dolomites with blocks. Position of the locality is marked with black arrow.

Fig. 14. Almost vertical layers of Middle Permian deposits in a canon trench at Kalvarija locality.

During the Second World War Italian army dug out a trench for heavy artillery, accidentally situated perpendicular to the bedding, and thereby opened a geological profile through the Middle Permian deposits (Zone *Neoschwagerina craticulifera*).

Numerous Permian fossils were collected at this locality, including encrusting cyanobacteria, calcareous algae (20 taxa, with predominance of *Mizzia*, *Permocalculus* and *Gymnocodium*), benthic foraminifera (31 taxa including the index species *Neoschwagerina craticulifera* (Schwager), small fusulinids, different species of *Hemigordius* and *Glomospira*), microproblematica (*Tubiphytes*), sponges, corals, bivalves (eg. particles of giant shells of *Shikamaia ogulineci* Kochansky-Devidé), gastropods, cephalopods, bryozoans, endemic brachiopods (*Martinia velebitica* Sremac), echinoderms, ichnofossils (*Zoophycos*).

Middle Permian deposits at this locality were deposited by down-slope transport of shallow marine sediment and biota into an intraplatform depression (Sremac 1991). Fine

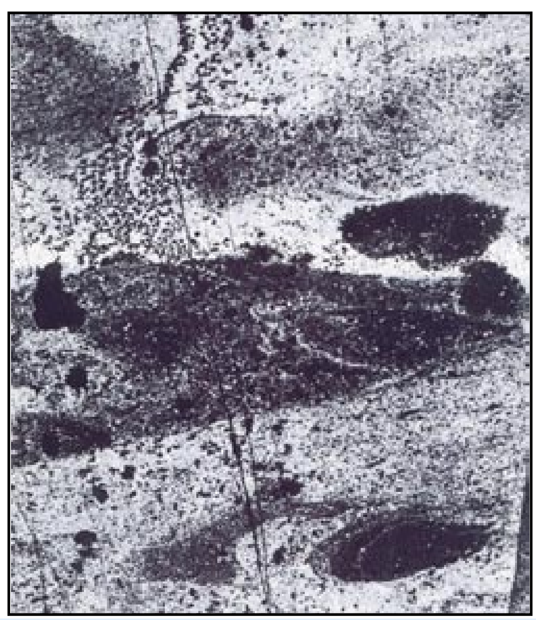

Fig. 15. *Zoophycos* bioturbations at Kalvarija locality. Acetate peel. X2. (after Sremac 1991).

grained material from the suspension was deposited between the stress episodes, containing food particles for deposit-feeders, whose traces are clearly visible on weathering surfaces (Figs. 15, 16)

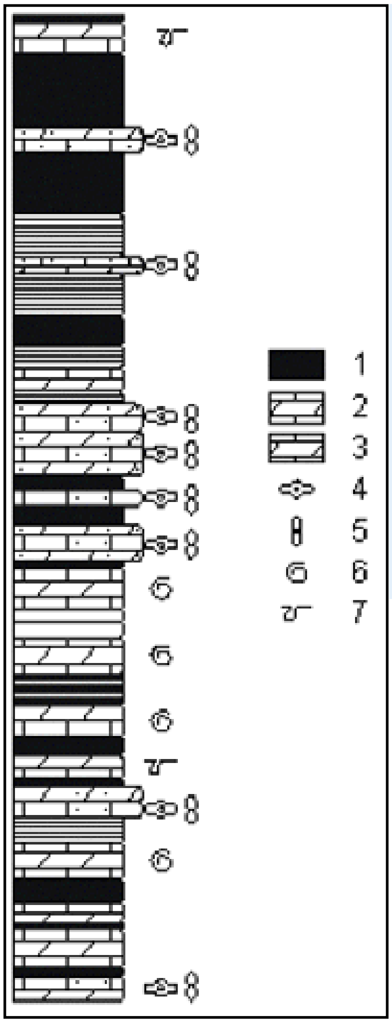

Fig. 16. Simplified geological column through Middle Permian deposits at Kalvarija locality presenting several repeated phases of down-slope transport. A full cycle comprises biokalkarenites (3), black shales (2) and bioturbated dolomites (1). Biokalkarenites contain numerous remnants of foraminifera (4), calcareous algae (5), sporadically with brachiopods, bryozoans and echinoderms. Dolomites contain mollusks (6) and ichnofossils (7).

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