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UPPER PERMIAN (LOPINGIAN) SPONGES NEAR VOJSKO (SLOVENIA)

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INTRODUCTION: Sponge fauna was studied from the carbonate succession east of Vojsko plateau (Slovenia) located in the north-western part of the External Dinarides (Fig. 1). Sponge patch-reef crops out just below the Permian-Triassic boundary (PTB). Permian strata close to the PTB are intensively dolomitized. Neomorphic macrocrystalline dolomitic structure obscures its primary composition. Nevertheless, coarse-grained bioclastic detritus (algae, echinoderms, gastropods) can be recognized in dolomites. Locally, at the same locality, bioclastic, reef–like limestones were found. They are composed of poorly sorted fragments of sponges, echinoderms, algae, benthic foraminifera and gastropods.

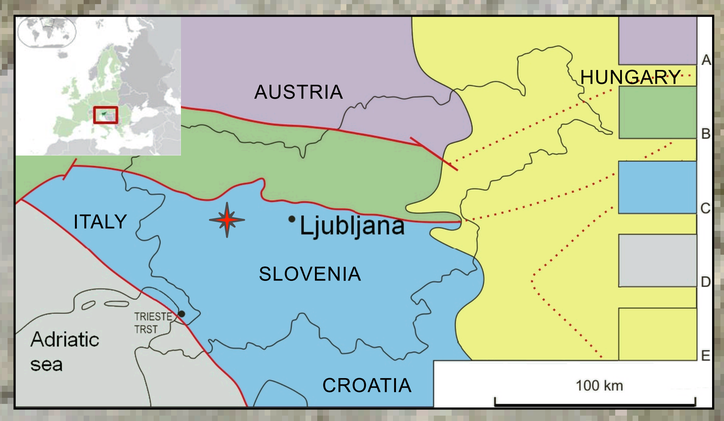

Fig.1. Map of geotectonic units in Slovenia with position of Vojsko plateau (star).
A – Eastern Alps; B – Southern Alps; C – External Dinarides;
D – Adriatic – Apulia foreland; E – Pannonian Basin (modified after Placer, 1999).

During the whole Earth history reefs and reef-building biota were extremely sensitive to environmental conditions and were significantly restricted during the biotic crises. During the Late Permian two pulses of extinction (Fig. 4) strongly affected the biota and almost disabled reef production. First of them, End-Guadalupian crisis, caused the decrease of biodiversity of reef-builders and restriction of sponge reefs, to a very few localities. Such isolated reefs were previously described from South China and Greece (Fig. 5 B), and are here reported from Western Slovenia.

RESULTS: Sponges from the studied uppermost Permian patch- reef, even fragile branching sphinctozoans, are preserved in situ, or slightly moved. Unfortunately, fine skeleton microstructure is not preserved, due to the recrystallization. All together twelve taxa of sponges were determined, belonging to classes Demospongea and Calcarea. Demospongea are more common and diverse than calcareous sponges, particularly large porous chambered forms (*Colospongia, Amblysiphonella*), which are visible on weathered surfaces at the outcrop (Fig. 2 A,B) . Some of sponge chambers exhibit differently preserved wall microstructure and geopetal infill (Fig. 2 D), suggesting that they were only partly buried in the bottom sediment soon after death. Such texture pattern suggests slow deposition, rather than abrupt burial. Micropalaeontological research reveals other reef building sponge taxa within the patch reef (Table I.), such as *Sollasia* (Fig. 3 A,B), *Parauvanella*, *Hikorocodium* and *Heptatubispongia* (Fig. 3 C). Cosmopolite calcareous sponge *Peronidella* (Fig. 3 D) is common in thin sections, while small benthic foraminifera occur in some parts of the reef.

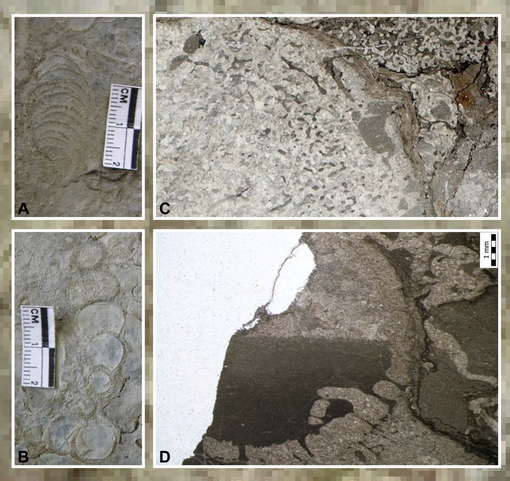

Fig.2. Abundant porous chambered sponges (Sphinctozoa - Porata) on weathered surfaces (A, C) and in thin sections (B, D) : A, B. *Amblysiphonella*; C, D. *Colospongia*.

Taxon	SLOVENIA	ITALY	CROATIA	TUNIS	OMAN	IRAN	THAILAND	S. CHINA	PRIMORYE	TEXAS
DEMOSPONGEA										
Amblysiphonella cf. ramosa	x			x						
Amblysiphonella sp.	x	x		x	x	x		x	x	x
Colospongia salinaria	x	x	x					x		
C. cortexifera	x	x		x	x	x				
Colospongia sp.	x		x							
Heptatubispongia symmetrica	x			x		x				
Hikorocodium sp.	x	x	x				x	x		
Parauvanella paronai	x	x			x			x		
Sollasia cyllindrica	x					x				
Sollasia? sp.	x	x		x	x	x	x	x	x	x
CALCAREA										
Peronidella recta	x					x		x		
Peronidella sp.	x		x	x		x	x	x		

Table I. List of determined sponge taxa and their regional distribution, according to the available literature.

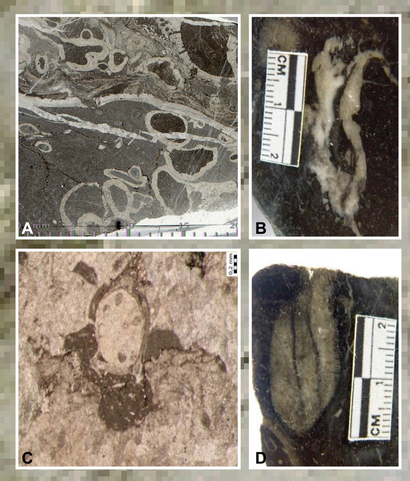

Fig. 3. Non- porous chambered demosponges (Aporata - *Sollasia*) (A, B), peculiar Agelasida (*Heptatubispongia*)(C) and tollerant cosmopolite Calcarea (*Peronidella*) (D). A, C. Thin sections. B, D. Polished surfaces.

DISCUSSION: Sponge fauna shows similarities with Middle Permian assemblages from neighbouring countries (Italy, Croatia, Tunisia), Islamic Republic of Iran, Sultanate of Oman in Neotethyan realm, and Middle-Late Permian faunas from South China in the Palaeotethys (Fig. 5 A). Heavily calcified demosponges (e.g. *Amblysiphonella, Colospongia, Parauvanella*) are known as PTB survivors, while, according to the state of knowledge, *Heptatubispongia* and *Hikorocodium* disappeared during the end-Permian biotic crisis. Cosmopolite calcareous sponge *Peronidella* was obviously extremely tolerant, and survived several biotic crises, with last occurrence in the Palaeogene period. The most recent evidence from the Lopingian sedimentary rocks of China shows that Peronidella was capable of producing biostromes in deeper shelf environment. Palaeontological and sedimentological characteristics of sponge patch-reef from Vojsko also suggest somewhat deeper depositional area. Such behaviour is probably linked with abrupt warming of sea-water and increased volcanic activity in Siberia (Fig 5 B), which could also contribute to the input of silica into the basin and enable the process of silicification.

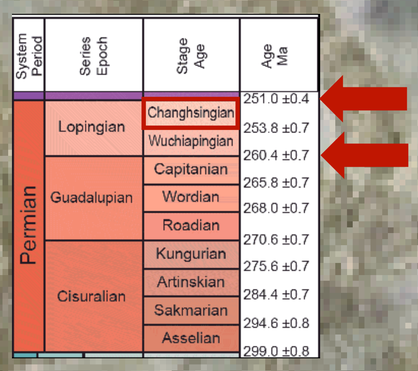

Fig. 4. Two phases of Late Permian extinction and stratigraphic position of the Vojsko section. Most of the sponge reefs in Palaeotethys already vanished during the Guadalupian/Lopingian extinction event.

CONCLUSIONS: Changshingian patch-reef near Vojsko in Slovenia represents one of the last Palaeozoic metazoan bioherms in the Palaeotethys-Neotethys realm, occuring right below the Permian-Triassic boundary. Reef framework is dominantly composed of heavily calcified demosponges and cosmopolite tollerant calcisponges, which generally represent the base for the future Triassic bioherm recovery. It seems that the scarce Uppermost Permian reefs survived due to the adaptation of reef-builders to deeper, less hot marine environments.

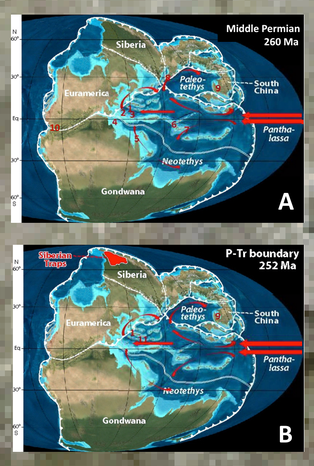

Fig. 5. Palaeogeographic reconstruction of Permian oceans, land masses and palaeocurrents. with position of Guadalupian (A) and Lopingian (B) sponge reefs. Paleogeography based upon Blakey's Molewide projections (http://jan.ucc.nau.edu/rcb7/mollglobe.html) Red arrows represent warm palaeocurrents pointing to to the possible migration routes along the shelves of Pangaea.
Localities with sponge reefs:
1. Slovenia (Bled, Vojsko)
2. Italy (Sicily)
3. Croatia (Velebit Mt.)
4. Tunisia (Djebel Tebaga)
5. Sultanate of Oman (Ba'id area)
6. Iran (Alborz, Shotori Mts., Hambast Mts.)
7. Thailand (Sibumasu block)
8. Russia (Primorye)
9. South China (Hubei, Guangxi)
10. USA (Mexico)
11. Greece (Skyros)

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