

## Ichnofabrics of ?Oligocene silcretes at Kryry and Dětaň, Western Bohemia, Czech Republic

### Ichnostavba prokřemenělých písečných zvětralin (?oligocén) v okolí Kryry a Dětaně (západní Čechy, Česká republika)

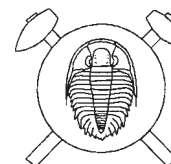
(1 plate)

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Sand-dominated residual sediments of Oligocene or pre-Oligocene age are exposed at the Dětaň locality. They form several tens of centimetres thick lenses encrusted by secondary silica cement. These silicified lenses yielded a biogenic structure, probably a nesting chamber of hymenopterid insects, which was filled with sand. A temporary outcrop of thick tabular blocks of silcrete of the same age at Kryry displayed two blocks with irregular, occasionally branching bodies of more strongly silicified sandstone, orientated mostly oblique to the silcrete surface. These bodies probably represent molds of larger tree roots. The possibility of conservation of plant root systems in sand residues by silcretization is significant from ichnological viewpoint as well as from the viewpoint of possible timing of the silicification process. The origin of insect nesting chambers is supposed to take place in the stage of weak lithification of the substrate.

*Key words:* Silcrete; Oligocene; Czech Republic; Root traces; Insect traces



### Introduction

Tropical weathering of quartzose sandstones or quartz sands results in formation of rocks having the petrographic features of quartzites. Such rocks form tabular bodies many metres thick (silcrete) or various subvertical “infiltrations”, which cannot be designated as “crusts”, but still fall under the general term “silcrete” (cf. Lamplugh, 1902, Summerfield, 1983). Apart from the characteristic micromorphology of quartz grains, biogenic structures of these rocks have not been hitherto described. Rocks corresponding to silcretes in their petrological character and position in the stratal succession were found in western Bohemia in the last years and were used in multidisciplinary paleoenvironmental reconstructions (Mikuláš et al., 2003). These rocks locally display a relatively prominent ichnofabric. The aim of this paper is to describe, illustrate and interpret the observed ichnofabric, and to evaluate the possibilities of biogenic reworking of silcretes and their parent residues. This information may be used for a more efficient description of biogenic structures at other sites of analogous rocks as well as for the determination of certain environmental limits and succession of geological events leading to the origin of the described rocks.

### Geological setting

The area southeast of the Doupovské hory Mts. is formed by Permo-Carboniferous detrital sediments, mostly psammites, overlain by Tertiary rocks (mostly basaltic tuffs and tuffites) on the margin of the Doupov volcanic centre (Fejfar – Kvaček, 1993 and references herein). In pre-Oligocene times, the Permo-Carboniferous rocks were subjected to prolonged tropical weathering which, in the case of the arkoses, led to the formation of kaolin deposits. These are still being exploited. Walls of kaolin sur-

face mines represent the most instructive exposures. A section in the former kaolin surface mine near Dětaň was studied in detail recently (Mikuláš et al., 2003). The former exploitation concentrated on the lowermost exposed strata, i.e., kaolinized arkoses and sandstones. Overburden strata are up to 50 m thick. Irregular lenses of white quartzose sandstones to quartzites (max. 80 cm thick) are present on top of the kaolinized arkoses, being followed by a non-lithified to weakly consolidated, non-laminated bed of sand mixed with basalt ash 1–2 m thick. The remaining 30–40 m of the section are represented by tuff and tuffite beds usually several tens of centimetres thick. The position of the silicified weathering product above the arkoses and immediately below the basaltic tuff with quartz sand admixture is therefore obvious.

A temporary exposure originated on the western periphery of the small town of Kryry, ca. 20 km ESE from the preceding site, showing silicified rocks derived from weathering products of Permo-Carboniferous psammites (Pl. I, Fig. 1). More than 10 “silcrete” blocks 1–3 m in size and max. 60 cm thick were exhumed from an excavation site for family house construction of approximate dimensions 20 by 30 m. Two of these blocks showed well developed structures, which can be interpreted as fills of plant root systems belonging probably to trees, as suggested by their dimensions (cf. Pl. I, figs 3–4). Some other blocks revealed protrusions of circular cross section, up to several tens of centimetres high, on one side (interpreted herein as the lower surface). These protrusions resemble short, massive stalactites (Pl. I, Figs 5–6).

### Biogenic structures

A rather weakly silicified residue at the site of Dětaň contains a drop-like cavity, originally filled by almost loose sand, 14 mm in diameter and 25 mm in preserved height,

orientated subvertically in the rock (Pl. I, Fig. 2). Similar shapes can be hardly produced by non-biogenic mechanisms. On the contrary, the overlying Oligocene tuffs contain numerous chambers of analogous shape, securely identified (based on rarely preserved spiral closures in some of them) as nesting burrows of solitary bees (ichnogenus *Celliforma*; cf. Mikuláš, 1998; Mikuláš et al., 2003). Similar modern structures are often present in consolidated sands, in loess (Mikuláš – Cílek, 2002) and also near the surface of weakly cemented sandstones (Mikuláš – Cílek, 1998). It can be speculated that the observed trace fossil also represents a nesting chamber of hymenopterid insects.

Ichnofabric of the blocks at the Kryry site is represented by irregular, locally somewhat swollen, occasionally irregularly branching bodies of more strongly silicified sandstone, usually orientated oblique to the surface of the silcrete table. These bodies are 1–10 cm in diameter and reach a maximum observed length of 30 cm. It can be assumed that passively filled tunnel after large tree roots acted as conduits for silica-rich fluids since the sand filling the tunnel was of higher porosity than the ambient lithologies. This eventually resulted in the formation of a much harder quartzite in these tunnels compared to the surrounding rock.

## Discussion

The wider area of the Ohře Rift displays sites of silicified sandstones in different geological settings. Some quartzite bodies are clearly associated with the proximity of volcanic rocks (Lahošť near Teplice, Ulrych et al., 2002), hence with hydrothermal processes or contact metamorphism in a wide sense of the term. Other occurrences are problematic as for their genesis, such as Salesiova výšina Hill near Osek (cf. Váně, 1961). The latest field experience from this site (which will be a subject of the paper in preparation) indicates at least two stages of silicification. A similar complicated pattern of processes can be presumed at many other sites, ranging from various forms of hydrothermal activity including metasomatic alteration of sands underlying pyroclastic flows (Cajz, 2004) to intensive multiphase chemical weathering and silcrete formation, or a combination of both processes.

Two alternatives can be suggested for the tabular quartzite bodies along the southern periphery of the Doupovské hory Mts.: (1) hardening of the weathering products by means of silcrete formation before the deposition of basaltic tuffs in the Oligocene, and (2) post-Oligocene leaching of silica from fluids penetrating through the basaltic tuffs and tuffites. The situation at Dětaň, as observable today, evidences only the first alternative: the processes must have involved a partial silicification of the residue, followed by colonization of the

substrate by hymenopterid insects, and a final filling of the chamber with sand not subjected to silicification. The silcrete was then buried beneath washed volcanic ash and quartz grains, and later subaerially deposited tuff horizons. At the Kryry site, the second possibility cannot be excluded; however, it could not have been of major importance here because of the long distance from the Oligocene volcanic centres of the Doupovské hory Mts. The “erratic” character of any silica precipitation which is very sensitive for even subtle changes of the rock environment should, however, retain all the above mentioned alternatives of the genesis of quartzites in the area.

An important ichnological aspect is the observed possible conservation of plant root systems by silcrete formation in sand residues. Moreover, the preservation of insect trace fossils formed in the stage of weak silicification of the substrate can be also assumed.

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## **Ichnostavba prokřemenělých písčných zvětralin (?oligocén) v okolí Kryry a Dětaň (západní Čechy, Česká republika)**

Na lokalitě Dětaň je odkryto písčité reziduum oligocenního nebo před-oligocenního stáří, v několik dm mocné čočce zpevněné druhotným křemenným tmelem. V této prokřemenělé čočce byla nalezena biogenní textura, pravděpodobně hnízdní komůrka blanokřídlého hmyzu, vyplněná pískem. Příležitostný odkryv mohutných desek silkrety stejného stáří v Kryrech poskytl dva bloky s nepravidelnými občas se větvičnými tělisky silněji prokřemenělého pískovce, orientovanými zpravidla šikmo vůči ploše desky, které patrně reprezentují pasivně vyplněné kanály po větších kořenech stromů. Z ichnologického hlediska i s ohledem na možnost určit načasování silifikace je významné, že v písčítých reziduích mohou být silkretizací konzervovány kořenové systémy rostlin. Vznik hmyzích hnízdních komůrek lze předpokládat v době, kdy substrát byl slabě litifikován.

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### **Explanation of Plate**



- 1 – A general view of the landscape between Kryry and Doupovské hory. The photo was taken from the Schiller lookout tower at Kryry towards the WNW. The temporary exposure with silcrete is visible at bottom centre;
- 2 – A chamber (?nesting burrow of hymenopterid insects) from Dětaň,  $\times 0.75$ ;
- 3–4 – Two blocks of silcrete with irregular bodies of rather strongly silicified sandstone, probably representing passively filled tunnels after large tree roots, Kryry;
- 5–6 – Lower side of a silcrete block showing stalactite-like protrusions, Kryry. The blocks depicted on Figs 3–5 are 40–50 cm in thickness.

*Photo R. Mikuláš 2001*

R. Mikuláš: Ichnofabrics of Oligocene silcretes at Kryry and Dětaň, Western Bohemia, Czech Republic



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