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Accumulations of Late Silurian serpulid tubes and their palaeoecological implications (Blumau-Formation; Burgenland; Austria)

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(With 4 text figures and 2 plates)

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Abstract

Allochthonous occurrences of serpulid tubes are for the first time recorded from Late Silurian carbonate beds near Kirchfidisch in southern Burgenland (Austria). According to the palaeoecology of the serpulids, based on information from thin sections and washed residues, an allochthonous sedimentation of these serpulid-bearing beds is assumed. An interpretation of the interaction between the former serpulid bioherm and its palaeoenvironment is presented.

Key words: Late Silurian, Austria, Allochthonous accumulations, Serpulid tubes, Palaeoecology

Zusammenfassung

Erstbeschreibung eines allochthon angereicherten Serpulidenvorkommens in Karbonatbänken des Ober-Silur nahe Kirchfidisch im südlichen Burgenland. Aufgrund der aus Dünnschliffen und Lösungsrückständen gewonnenen Informationen, wird eine allochthone Sedimentation dieser Serpuliden führenden Bänke angenommen. Eine Interpretation der Interaktion des ursprünglichen Serpuliden-Bioherms mit seiner Umwelt wird präsentiert.

Schlüsselwörter: Ober-Silur, Österreich, Allochthone Anreicherungen, Serpulid-Tuben, Paläoökologie

Introduction

Sedimentological and palaeontological studies were carried out in the 'Baron von Kottwitz' quarry at the Hohensteinmaißberg near Kirchfidisch (southern Burgenland). The excavation site at the so-called 'Kirchfidischer Schieferinsel' consists mainly of Palaeozoic slates, limestones and dolomites, and is surrounded by Tertiary sediments.

The investigated section was first mentioned by HOFFMANN (1877), who mapped this region (from NE to SW along the 'Kohfidischer Schieferinsel'). He collected several tabulate and rugose corals, different crinoid stem plates and a single brachiopod shell. These fossils were determined by TOULA (1878), who suggested a Devonian age for the fossiliferous beds.

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The following fossils were determined by TOULA from the outcrop at the Hohensteinmaißberg: *Favosites goldfussi* d´ORB., *F. reticulata* BLAINV., *Entrochus (Cupressocrinus) abbreviatus* GLDF., *Entrochi tornati* QUENST., *E. impares* QUENST.

Further investigations on the Palaeozoic rocks of the 'Eisenburger Comitat' (Eisenberggruppe) (HOFFMANN 1877) were conducted by POLLAK (1962) and TOLLMANN (1987). These authors worked on a stratigraphic definition for this group and attempted to correlate it with similar lithological units of the Upper Austroalpine (e.g. 'Palaeozoic of Graz').

The occurrence of conodonts has been described from cores taken in 'Waltersdorf 1', 25 km west of Sulz, of Early Devonian age (EBNER 1978), from outcrops in Sulz near Güssing, probably of Late Silurian age (SCHÖNLAUB 1984) and in Weinhandl quarry near Hannersdorf, defined as Early Devonian (SCHÖNLAUB 1994). According to the biostratigraphic data on macro- and microfossils, the section contains sediments of Late Silurian to Early Devonian age (FLÜGEL 1988).

The present paper deals with the base of a sandy slate complex (representing the main part of the section in the 'Baron von Kottwitz' quarry), where dark to light grey carbonate beds are exposed (approx. 3.5 m; text-fig. 2). In some of these carbonate beds, secondary accumulations of serpulid tubes are recorded for the first time. Own investigations reveal that the accompanying fauna of these serpulid-bearing beds consists of poriferans (triaxon spiculae; pl. 2, figs. 1-3), ostracods (pl. 2, figs. 4-9) gastropods (pl. 1, fig. 2), brachiopods (pl. 1, fig. 12), echinoderms (indeterminable fragments; pl. 1, fig. 11) and a small, determinable conodont fauna (pl 2, figs. 10-12).

Geography, Location and Geological Setting

The section lies about 9 km south of Hannersdorf in the 'Baron von Kottwitz' quarry (text-fig. 1), on the Hohensteinmaißberg, near Kirchfidisch (ÖK 168, 1:50 000, Eberau; southern Burgenland) (SCHÖNLAUB 1994). The section within Late Silurian to Early Devonian is part of the Blumau-Formation (FLÜGEL 1988). Two main lithological complexes have been distinguished by POLLAK (1962):

1) 'Dolomit-Kalkkomplex', thickness: 250-300 m and

2) 'Phyllit-Kalkschiefer', thickness: about 150 m.

The investigated outcrop containing the serpulid-bearing beds is located at a small wall (bed dipping 250/45) at the southern side of the abandoned quarry. It is exposed over a length of 7 m and a height of about 4 m. Steep terrain makes the sampling difficult. The exact position of the section is fixed by GPS data: N 47° 09' 01" and E 16° 21' 10".

Lithology and Biostratigraphy

The log (text-fig. 2) is located at the basal part of the 'Dolomit-Kalkkomplex' (POLLAK 1962). The upper part of the investigated section contains six beds of dark grey limestone (pelloidal wacke- to packstone; pl. 1), which are extremely rich in numerous monospecific accumulations of serpulids, interrupted by only few-centimeter-thick slate layers (rare in fossils).

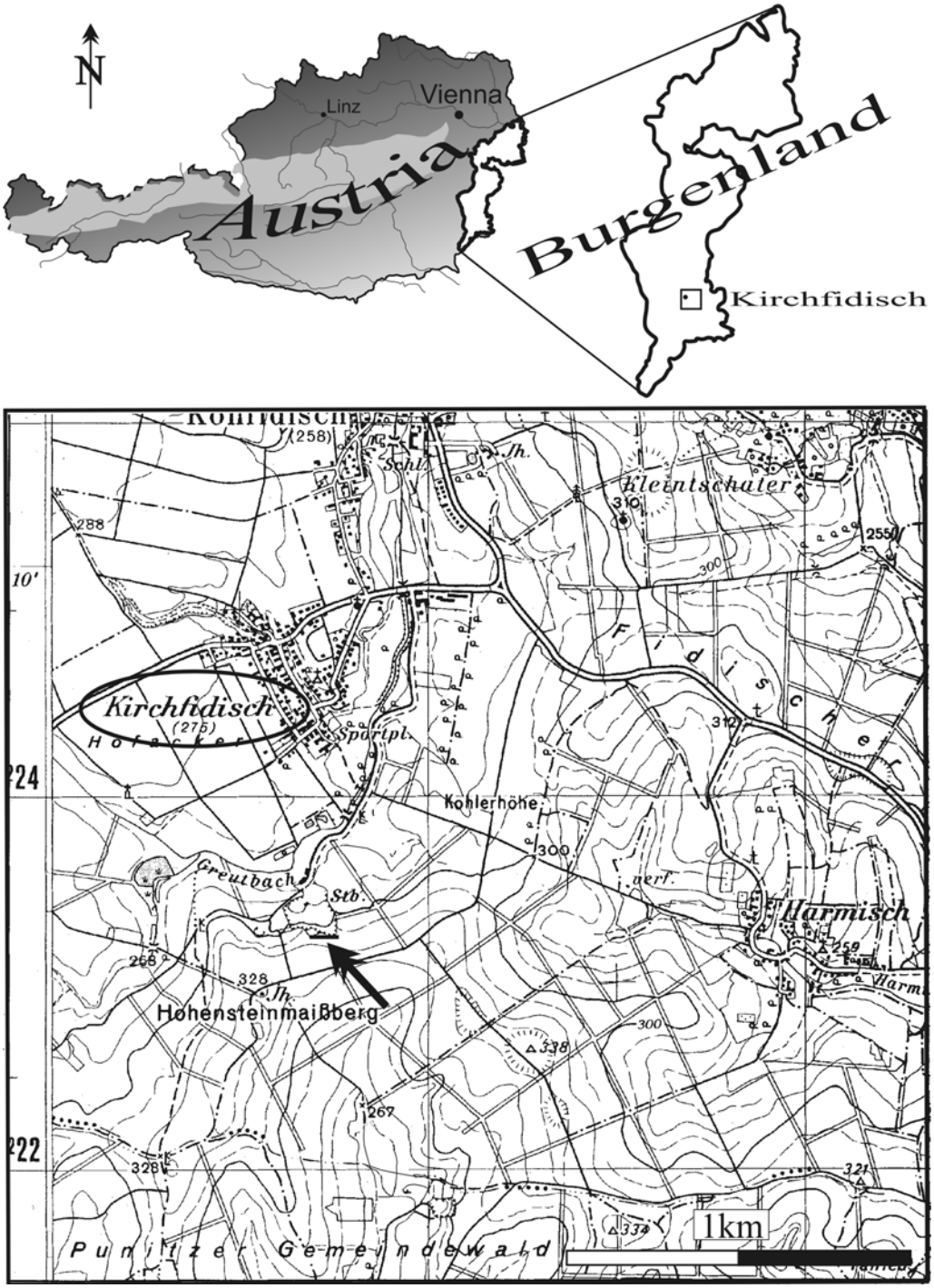

Fig. 1: Detailed position and map of the investigated outcrop of the 'Baron von Kottwitz' quarry (southern Burgenland, ÖK 168 Eberau).

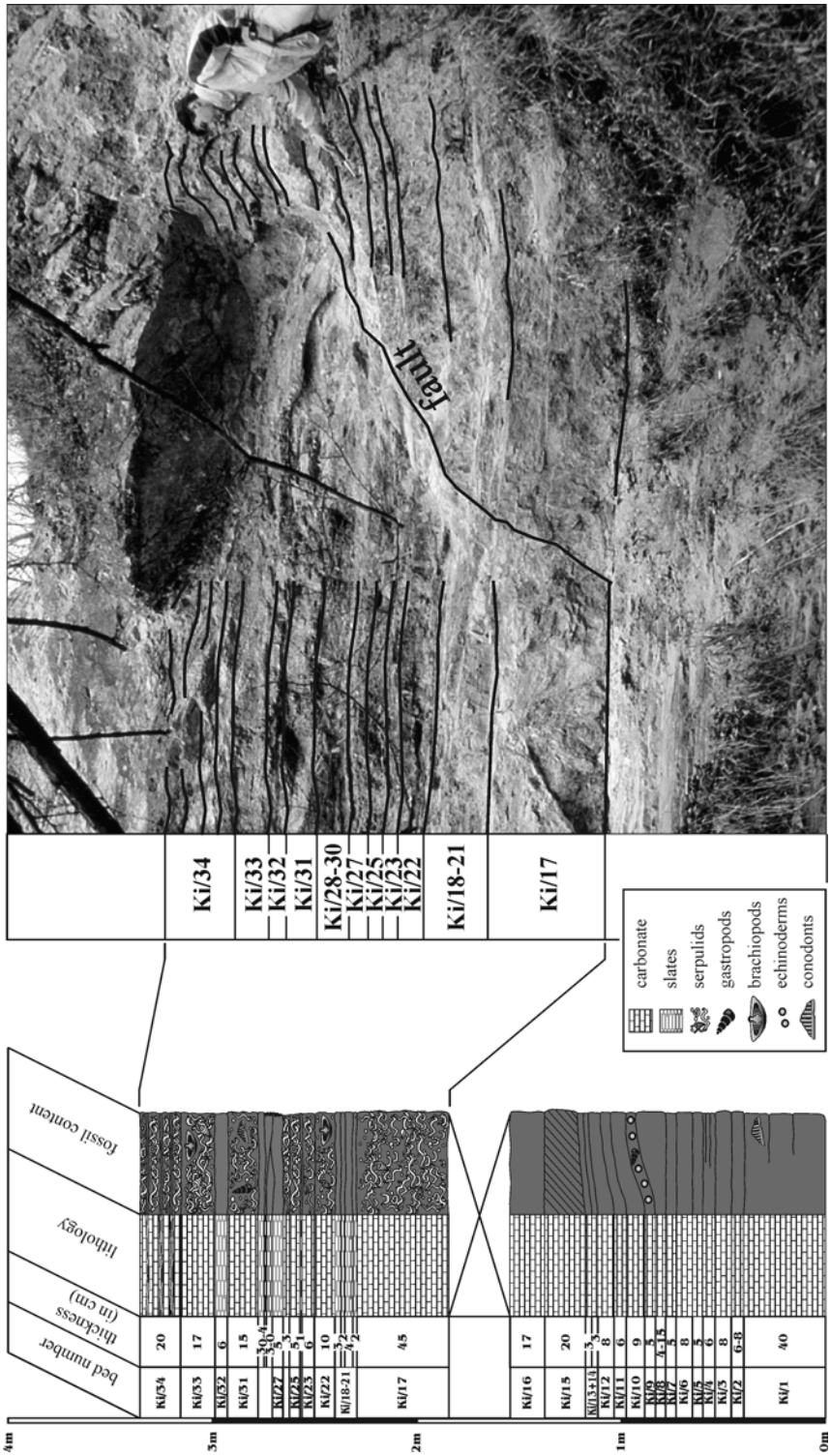

Fig. 2: Detailed log, of the investigated section indicating fossiliferous layers (serpulid-bearing beds).

The presented paper follows the correlations of SCHÖNLAUB (1994), who observed lithofacial similarities between the section near Kirchfidisch and the outcrop near Hannersdorf (9 km to the north).

According to the conodont assemblage, an Emsian age is suggested for the section near Hannersdorf (KLAPPER & ZIEGLER 1979; CHLUPÁC 1982; SCHÖNLAUB 1994). Based on new conodont data (this paper), we propose a Late Silurian age for the lowermost part in the quarry near Kirchfidisch (detailed section text-fig. 2). The small assemblage of conodonts (pl. 2, figs. 10, 11 and 12) was determined by SCHÖNLAUB. Only few, badly preserved conodont elements (showing CAI 5; CAI = Color Alteration Index) were found: one ozarkodiniform element (bed Ki/1; thin section figured on pl. 1, fig.1) and two Pa-elements (bed: Ki/1 and Ki/31), both probably belonging to *Ozarkodina confluens* (BRANSON & MEHL) or *Ozarkodina fundamentata* (BRANSON & MEHL). The exact stratigraphic zone could not be clearly determined. Further stratigraphic investigations are planned.

Systematic Palaeontology

Conventions: Dimensions of serpulids, brachiopods, echinoderms and gastropods are given in mm; dimensions of spiculae, ostracods and conodonts in µm. Abbreviations are: Ki Kirchfidisch, NHMW Natural History Museum Vienna; concerning the classification of serpulids the authors follow the Treatise of Invertebrate Paleontology, part W (HASS et al. 1962).

Class Polychaeta GRUBE, 1850

Order Sedentaria LAMARCK, 1818

Family Serpulidae BURMEISTER, 1837

Genus *Serpula* LINNÉ, 1758

***Serpula* sp. A + B** (pl. 1, figs. 3-10)

Material: Several specimens, thin sections and rock samples (NHMW 2002z0166/0001 – 0020; pl. 1 and 2): Two representative serpulid morphotypes: 1) trochospiral serpulid (*Serpula* sp. A; plate 1, fig. 8) and 2) helical serpulid (*Serpula* sp. B; pl. 1, fig. 9). All specimens are stored at the Natural History Museum (NHMW, Vienna).

Washed residues were obtained from slates and limestones by dissolution using formic acid and acetic acid, and later washed through sieves of 500 µm to 63 µm mesh. In some cases, ultrasonic treatment was necessary to clean aggregated or encrusted specimens.

Locality: All specimens are from the 'Baron von Kottwitz' quarry at the Hohenstein-maißberg near Kirchfidisch (southern Burgenland).

Description: Two different morphotypes of serpulids are distinguished:

1) *Serpula* sp. A: high trochospiral tube (measurement of a representative morphotype (pl. 1, fig. 8): length 4 mm and diameter 0.9 mm).
2) *Serpula* sp. B: helical (loosely coiled cylindrical helix) tube (measurement of a representative morphotype (pl. 1, fig. 9): length 6.8 mm and diameter 0.7 mm).

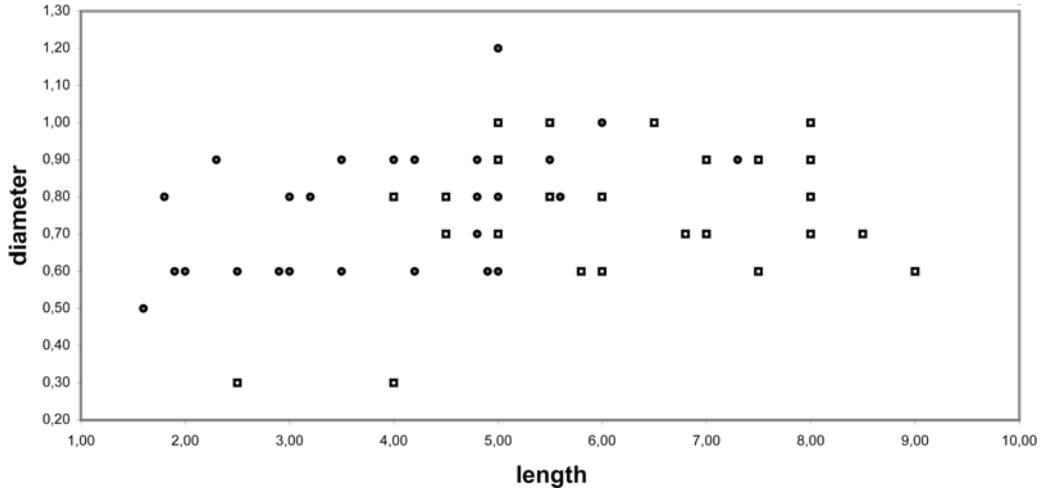

Fig. 3: Dimensions of the serpulid morphotypes (in mm); trochospiral tubes indicated by black circles (type A); helical tubes indicated by grey squares (type B).

The diameter ranges from less than 0.4 up to 1 mm (at maximum) within the high trochospiral type A, whereas it is relatively constant in the helical type B at about 0.7 mm (pl. 1, fig. 7).

The wall structure of the tubes consists of two concentric layers. The thinner inner layer is built of a lamellar structure (parallel to the inside). The thicker outer layer consists of a parabolic structure (the curvature of this structure shows to the oral side) (see GÖTZ 1931). The proportion of the thickness between the inner and outer layer of these serpulid tubes is: 0.5:1 (shown in thin section: pl. 1, fig. 6).

Measurements: see text-fig. 3.

Remarks: The specimens of the helical morphotype are identical in shape (morphology, annular ridges; pl. 1, fig. 9) and size to the specimens of *Serpula helicalis* (BEUS 1980) described by BEUS (1980) from Devonian dolomites of the Martin Formation (Arizona).

The serpulid specimens presented in this paper differ from similar-shaped vermiform gastropod tubes (Early Carboniferous) described by BURCHETTE & RIDING (1977) by lacking planspiral basal whorls and any evidence of internal septa.

Occurrence: Serpulids of this type and size are known from the Early Devonian of Arizona (Martin Formation) and Late Silurian of Austria (Blumau Formation).

Stratigraphy: The small conodont fauna of the serpulid-bearing beds indicates Late Silurian age.

Palaeoenvironment

The macrofauna of the serpulid-bearing beds is dominated by serpulid tubes. The first impression of a rather low-diversity benthic fauna changes upon examination of the thin

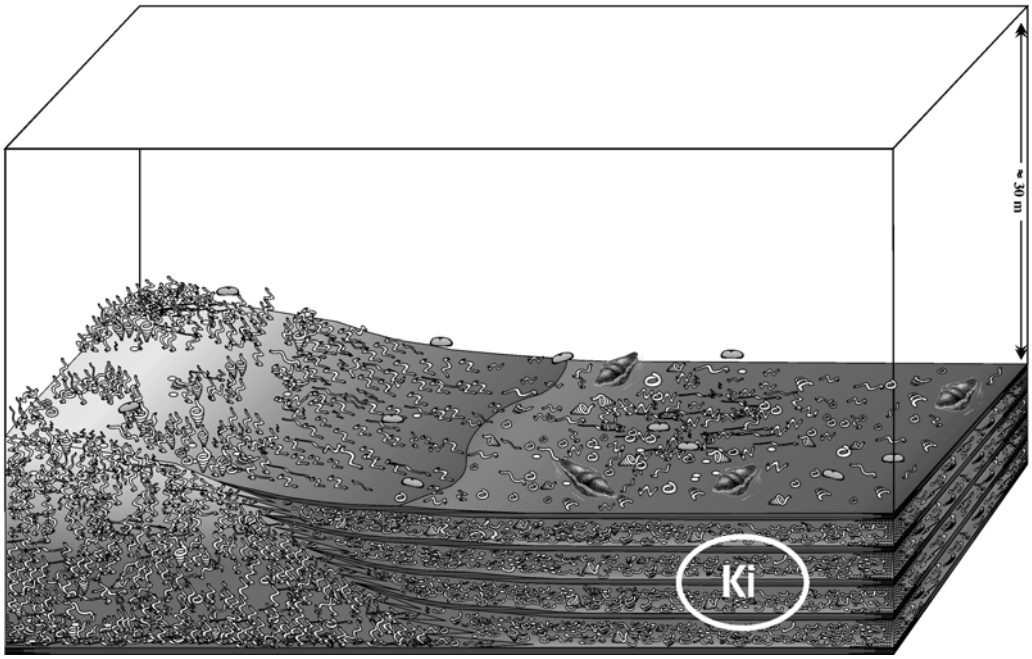

Fig. 4: Reconstruction of the palaeoenvironmental conditions during the deposition of the serpulid-bearing beds (based on sedimentological investigations, the fossil content, thin sections and washed residues); note indicated position of the investigated outcrop (not to scale).

sections and washed residues (e.g. brachiopods, poriferans). The poorly preserved but rich microfauna consists of numerous elements of ostracods, conodonts and poriferans (spicules).

In contrast to the occurrence of serpulid bioherms in Arizona, the accumulations of serpulid tubes in southern Burgenland are not *in situ*. After investigating washed residues, acid etched surfaces, weathered bed surfaces, polished sections and thin sections, an allochthonous deposition for the serpulid-bearing beds is proposed. Currents were apparently strong enough to transport 'reef debris', clasts and single worm tubes, forming an allochthonous deposit (text-fig. 4). At first glance, it appears as if entire serpulid aggregates were transported (pl. 1, figs. 3, 4 and 6), but most of the thin sections (pl. 1, fig. 5) clearly show that no specimen is attached either to another serpulid tube or to other secondary hardgrounds; in contrast to the thin sections from LEEDER (1973). Biostromes and bioherms constructed by erect serpulid worm tubes are known from the Devonian of Arizona (BEUS 1980), the Carboniferous (LEEDER 1973) and Recent fringing serpulid reefs (BOSENCE 1973) of Eire, and Recent sediments of Baffin Bay, Texas (ANDREWS 1964).

In most cases full marine, shallow, lagoonal to subtidal water is suggested to be the preferred living-habitat of such serpulid build-ups (ANDREWS 1964; LOGAN et al. 1970).

Typically, the biocoenosis is first formed by encrusting and then upward free growth from larvae settling on rock, boulders and gravel-sized clasts.

The single tubes of the presented serpulid-bearing beds show no orientation and 'float' in the limestone matrix. Due to the minimal fragmentation of the trochospiral and heli-

cal tubes and the accompanying fauna we conclude only little transport activity from the primary habitat to a final depositional depth perhaps less than 30 m.

Results

1) Serpulid-bearing beds (mass-occurrences with trochospiral and helical types) are recorded for the first time from Late Silurian sediments (Blumau Formation, southern Burgenland).
2) Based on palaeontological investigations an allochthonous occurrence of the serpulids from the excavation site is suggested.
3) A transport of the single serpulid tubes from serpulid patches to a deeper environment is concluded.
4) 64 tubes of well-preserved specimens were measured comprising maximum lengths between 1.6 and 6.8 mm.
5) The accumulation of such serpulid-bearing beds is interpreted to be the result of periodic 'turbidity flows', which derived from more shallow areas where small serpulid patches were located.
6) The associated conodont fauna indicates a Late Silurian age for the serpulid-bearing beds.
7) Sedimentological work in progress and ecological studies of Palaeozoic 'reefoid-buildups' may help to explain the significance, dynamics and exceptional development of these fossil serpulid-bearing beds.

Acknowledgements

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Plate 1

Fig. 1: conodont-bearing bed Ki/1, NHMW 2002z0166/0001, x 2.

Fig. 2: gastropod shell, bed Ki/9, NHMW 2002z0166/0002b, x 5.

Fig. 3: serpulid tubes, bed Ki/22, NHMW 2002z0166/0004a, x 2.

Fig. 4: serpulid tubes, horizontal section, bed Ki/22, NHMW 2002z0166/0005, x 2.

Fig. 5: peloidal pack-wackestone, serpulids and fragmented brachiopod, bed Ki/33, NHMW 2002z0166/0008a, x 2.

Fig. 6: single trochspiral serpulid specimen (type A), bed Ki/33, NHMW 2002z0166/0008b, x 5.

Fig. 7: REM photograph of serpulid tubes, a. enlarged (x 20) details of b. (x 10); bed Ki/31, NHMW 2002z0166/0009b.

Fig. 8: trochospiral specimen (type A), bed Ki/31, NHMW 2002z0166/0011c, x 8.

Fig. 9: helical specimen (type B), bed Ki/31, NHMW 2002z0166/0011d, x 6.

Fig. 10: rock surface with trochospiral (type A, bottom) and helical (type B) specimens, bed Ki/31, NHMW 2002z0166/0011b, x 3.

Fig. 11: crionoid-section, rock surface, bed Ki/9, NHMW 2002z0166/0013, x 3.

Fig. 12: fragmented brachiopod valves, bed Ki/33, NHMW 2002z0166/0012d, x 3.

Figs 1-6 are thin sections. Fig. 7 is a REM photograph. Specimens of figs 8-12 are exposed on rock surfaces.

All specimens were collected at the 'Baron von Kottwitz' quarry, which is situated 9 km S of Hannersdorf, at the Hohensteinmaißberg, Burgenland. (Complementary thin sections and rocks comprising further specimens are stored at the NHMW)

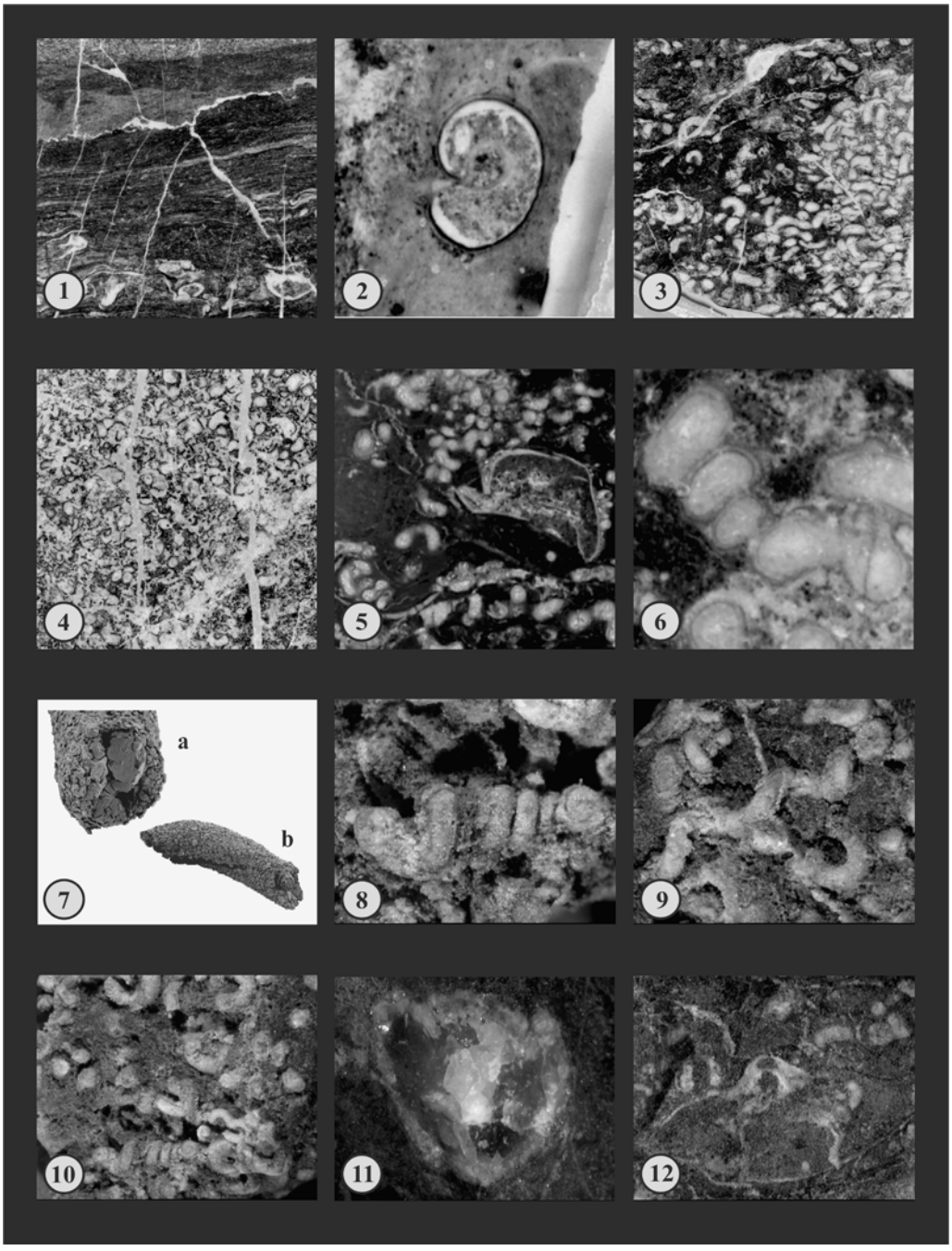
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Plate 2

Fig. 1-3: porifera spicules, REM photographs, bed Ki/31, NHMW 2002z0166/0014a - c.

Fig. 4-9: ostracods, a. dorsal view, b. lateral view, bed Ki/31, NHMW 2002z0166/0014d - i.

Fig. 10: ozarkodiniforme element, ?*Ozarkodina* sp., a. upper view, b. lateral view, c. oblique lower view, bed Ki/1, NHMW 2002z0166/0015a.

Fig. 11: *Ozarkodina* cf. *confluens*, a. upper view, b. lateral view, bed Ki/31, NHMW 2002z0166/0015b.

Fig. 12: *Ozarkodina* cf. *confluens*, a. upper view, b. lateral view, bed Ki/31, NHMW 2002z0166/0015c.

Figs. 1-12 are REM photographs. All specimens were coated with gold.

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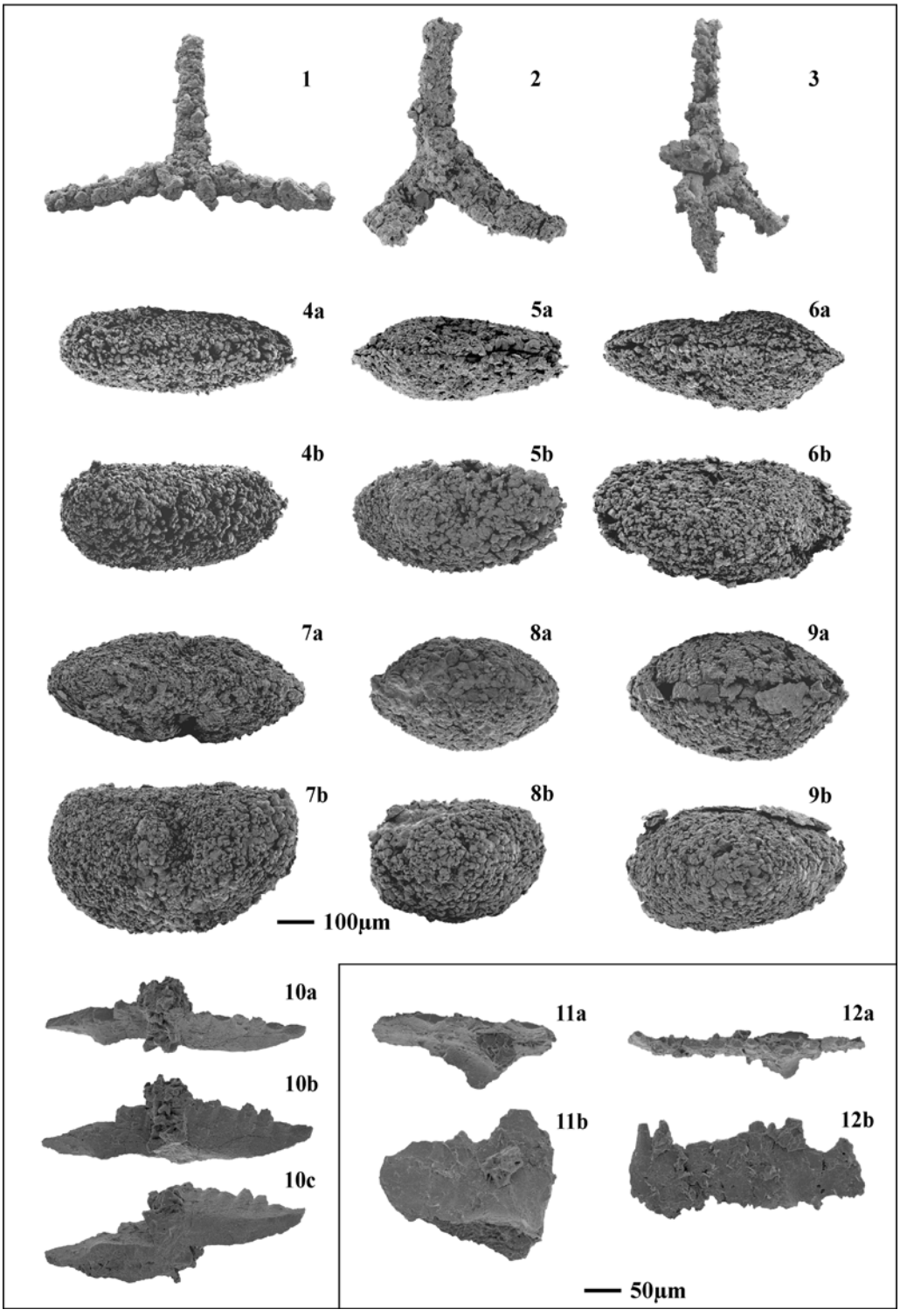
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