The Ordovician in the Koszalin-Chojnice region (Western Pomerania)

ABSTRACT: Within the strongly tectonically disturbed region of Koszalin-Chojnice, fragments of Ordovician sediments have been found in 12 boreholes drilled by the Oil Research Survey and in two other ones drilled by the Geological Institute. On the presence of graptolites these sediments, developed in a silty facies, have been referred to the Llandeiliian and Caradocian including the *Dicranograptus clingani* Zone. In the SE part of the above region the occurrence has been noted of tuffite layers.

INTRODUCTION

Data regarding the occurrence of Ordovician sediments in Western Pomerania are given by Dadlez (1967) and Modliński (1968) as well as by Teller & Korejwo (1967).

In concurrence with the above authors, Ordovician deposits have been found in boreholes both of the Geological Institute (Jamno IG-1 and Jamno IG-2) and of the Oil Research Survey of Piła (Miastko 1 and Nowa Karczma 1). These boreholes, drilled in an area strongly tectonically disturbed, and extending from Chojnice in the SE to Koszalin in the NW, did not pierce the Ordovician (Modliński 1968). During the last few years several new boreholes were drilled by the Oil Research Survey, ten of which (Fig. 1) reached Upper Ordovician siltstones underlying Permian, Carboniferous or Devonian deposits (Fig. 2).

In the present paper are given the results of the stratigraphic investigations of the Ordovician sediments from these ten boreholes with reference to the data obtained by the authors mentioned above. All the columns have been described by the writer in the core storage room at Piła, while the samples have been worked out in the Laboratory of
Sketchmap of the Koszalin-Chojnice area showing boreholes in which the Ordovician has been reached.

Stratigraphy of the Institute of Geological Sciences of the Polish Academy of Sciences in co-operation with the Union for Oil Mining. The Ordovician documentary materials are kept in the above named Laboratory.

The writer's most cordial thanks are due to the Head Geologist of the Union for Oil Mining for the access to materials, also to B. Sikorski, M. Sc., from the Oil Research Survey at Piła for friendly help.

**LITHOLOGO-FAUNISTIC CHARACTERISTICS OF ORDOVICIAN DEPOSITS**

The following are descriptions of the Ordovician sediments reached in boreholes drilled by the Oil Research Survey, going NW-SE.

**Borehole Sarbinowo 1**

As is shown by electric logging analysis, the Ordovician in this column directly underlies the Carboniferous sediments from a depth of 2796.0 m. It is represented by darkgrey siltstones, sometimes dolomitic with pyrite concentrations and muscovite flakes. The whole series is strongly slickensided and tectonically disturbed. The fauna (Table 1) is
Correlation of zones differentiated in the columns of the Koszalin-Chojnice area
1 - Chmacograptus bicornis — Orthograptus truncatus Zone, 2 — Glyptograptus teretiusculus — Orthograptus acutus Zone, 3 — erosional boundary between the Ordovician and the late Paleozoic sediments

Table 1

<table>
<thead>
<tr>
<th>Fauna</th>
<th>Depth in m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 - 2065.0</td>
</tr>
<tr>
<td>Chmacograptus bicornis /sp./</td>
<td>+</td>
</tr>
<tr>
<td>Amplexograptus sp.</td>
<td>+</td>
</tr>
<tr>
<td>Chmacograptus sp. cretiv. E. &amp; W.</td>
<td>+</td>
</tr>
<tr>
<td>C. cf. tuberculatus /ide./</td>
<td>+</td>
</tr>
<tr>
<td>Cl. acutus /ide./</td>
<td>+</td>
</tr>
<tr>
<td>C. acutus /ide./</td>
<td>+</td>
</tr>
</tbody>
</table>

composed chiefly of graptolites, together with which have been sporadically found isolated brachiopod shells from the Inarticulata group, also coprolites of mud-eaters.

The drilling was stopped at a depth of 3000.0 m without piercing the Ordovician sediments.
Here the Ordovician sediments have been found at a depth of 1727.0 m directly underlying Zechstein conglomerates beginning the Werra cyclothem. Lithologically the Ordovician series may be divided into three parts:

- the lower part between 2807.0 m (the final depth) and 1882.6 m consists of darkgrey siltstones with abundant fine muscovite flakes and with pyrite which is dispersed or occurs in concentrations;
- the middle part from 1882.6 to 1802.3 m is represented by dolomitic darkgrey siltstones;
- the upper part is composed of dolomitic darkgrey greenish-tinted siltstones intercalated in the top by darkgrey mudstones and red dolomitic siltstones.

The whole series is strongly slickensided, steep dips dominate to a depth of 2386.4 m, higher up being from 10 to 50°.

The relatively abundant fossil remains are shown in Table 2.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ZLUMA</td>
</tr>
<tr>
<td>Patendra sp.</td>
</tr>
<tr>
<td>Leptograptus sp.</td>
</tr>
<tr>
<td>Tetrograptus sp.</td>
</tr>
<tr>
<td>Pseudotetragraptus sp.</td>
</tr>
<tr>
<td>Orthograptus sp.</td>
</tr>
<tr>
<td>Borehole Wyszebórz 1</td>
</tr>
</tbody>
</table>

On electric logging data, the Ordovician sediments occur here under the Middle Devonian from a depth of 2724 m. The drilling was stopped at 3046.3 m without piercing the Ordovician.

Lithologically, the Ordovician is represented in this column by dark-grey siltstones with fine muscovite flakes; in places it is intercalated and laminated by dolomitic mudstones or greish-beige dolomite. From 2869.3 m upwards the mudstones intercalations grow in number and pyrite concentrations make their appearance. The whole series is strongly tectoni-
cally disturbed and it is characterized by dips ranging from 50 to 90 degrees.

The stratigraphic positions of this series are indicated by graptolites found between 2869.3 and 2873.3 m, namely Pleurograptus sp., Climacograptus cf. bicornis (Hall), C. cf. caudatus Lapw., and Orthograptus cf. calcatus Lapw. Besides these coprolites of mud-eaters of Tomaculum problematicum Groom have been found between 2865.4—2869.3 m also between 2879.4—2891.3 m.

**Borehole Karsina 1**

As is shown by electric logging data the Ordovician sediments occur here beginning at 3142.5 m and are represented by darkgrey siltstones occasionally green tinted and with pyrite concretions. The siltstones are strongly slickensided and the dips range from 40 to 60 degrees. In the top the Ordovician series is in contact with Upper Devonian sediments, its bottom is not known since the drilling was stopped at 3203.0 m without piercing the Ordovician.

At a depth from 3166.4 to 3169.1 m have been found: Dicellograptus cf. sextans exilis E. & W., Pseudoclimacograptus cf. scharenbergi Lapw., Orthograptus sp. and Glossograptus cf. hincksii (Hopk.), but only Climacograptus sp. between 3142.5 and 3143.0 m.

**Borehole Kościernica 1**

According to the electric logging data the Ordovician occurs in this column underlying the Middle Devonian from a depth of 2818.4 m. The drilling was stopped at 2853.0 m without piercing this system.

The Ordovician sediments are represented by darkgrey siltstones containing pyrite concentrations, fine muscovite flakes and browngrey dolomitic concretions in the top. The siltstones are strongly slickensided, the dips being c. 70 degrees. At a depth between 2850.0—2853.0 m have been found Climacograptus cf. brevis E. & W., Glyptograptus cf. teretiusculus (His.) and Tomaculum problematicum Groom, and Climacograptus cf. minimus (Carr.) and Tomaculum problematicum Groom between 2820.0—2824.0 m.

**Borehole Okunino 1**

The Ordovician here directly underlies the basal conglomerate of the Zechstein (Werra cyclothem) and was pierced by drilling from 1873.2 to 2009.5 m. It is represented by grey-green siltstones, spotted in the top and containing fine muscovite flakes, thin anhydrite veinlets and pyrite concentrations. The dips are of c. 20°. A fragment of Dicellograptus sp. has been found in the top part and coprolites of Tomaculum problematicum Groom at the bottom.
According to electric logging data the Ordovician here occurs from 2576.5 m underlying the Lower Carboniferous (Tournaisian?). It is developed as darkgrey brown-tinted siltstones with pyrite concentrations, in the bottom part locally with a darkbrown limestone intercalations and with mudstone interbeddings in the top. The whole series is strongly slickensided and cracked. The fissures in the cracks are filled in with white calcite. Dips vary from 30 to 90°. Drilling was stopped at 3000.0 m without piercing the Ordovician. *Amplexograptus* cf. *perexcavatus* Lapw., *Glyptograptus* cf. *teretiusculus* (His.) and *Tomaculum problematicum* Groom have been found in fair abundance but only between 2727.0 and 2733.0 m.

**Borehole Brda 3**

Ordovician sediments have been differentiated under the Zechstein anhydrites (Werra cyclothem). The electric logging data show their presence down to a depth of 2133.0 m. Down to the final depth of the borehole (2902.5 m) the Ordovician is developed as darkgrey siltstones, occasionally greenish-tinted, towards the top with thin beds of black mudstones containing fine muscovite flakes, and with pyrite dispersed or in concentrations. Tuffite has been differentiated between 2641.0 and 2647.0 m. It occurs as intercalations distinguishable by a lightgrey bluish-tinted colouration against the darkgrey colour of the siltstones. The whole series is strongly slickensided and folded. The dips range from 30 to 80 degrees. *Climacograptus* sp., *Glyptograptus* sp., *Orthograptus truncatus* Lapw., *O. cf. truncatus* Lapw. and *Tomaculum problematicum* Groom have been found between 2355.0 and 2361.0 meters.

**Borehole Nowa Wieś 1**

The electric logging analysis shows the Ordovician series to occur here under the deposits of the Late Paleozoic (Devonian or Carboniferous) from a depth of 2417.5 m. It is represented by darkgrey siltstones, in the bottom laminated by darkgrey mudstones containing minute muscovite flakes. Higher up in the column, the siltstones is sporadically brown coloured and contains numerous, irregularly shaped pyrite concretions. In the top part, between 2496.5 and 2488.3 m, lightgrey tuffite intercalations have been observed in the darkgrey dolomitic siltstones. The series is throughout slickensided, cracked and folded; the fissures of cracks are filled in by white calcite; the dips range from 40 to 80 degrees.

The fossil remains found in this column are shown in Table 3.  

---

1 The tuffite has been identified by Dr Roman Chlebowski from the Institute of Geochemistry, Mineralogy and Petrography of the Warsaw University.
In this column the presence of the Ordovician has been ascertained under the Middle Devonian which the electric logging data show to occur down to a depth of 4890.0 m. The dark grey neatly black siltstones, with numerous pyrite concretions and dips varying from 10 to 50 degrees, have been observed to the final depth of the borehole (5055.5 m). The graptolites found in fair abundance in the column are shown in Table 4.

Borehole Chojnice 5

Table 3

<table>
<thead>
<tr>
<th>DEPTHS in m</th>
<th>2490.0-2500.0</th>
<th>2502.0-2506.0</th>
<th>2507.0-2514.0</th>
<th>2515.0-2536.0</th>
<th>2537.0-2546.0</th>
<th>2547.0-2550.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphixograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Climacograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. bicaudatus /n.m.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. brevis E. a.W.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. minuta /Carr./</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. m. w. lwm.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ortho. truncatus L. p.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Orthog. sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Glyptograptus euglyphus /L. p. f.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>G. cf. tertianus /M. /</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Glyptograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tremadocus problematicus O. com.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>DEPTHS in m</th>
<th>3600.0-3602.0</th>
<th>3604.0-3606.0</th>
<th>3608.0-3609.0</th>
<th>3610.0-3617.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climacograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. bicaudatus /n.m.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. brevis E. a.W.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. minuta /Carr./</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. m. w. lwm.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. tubuliferus L. p.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Climacograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Pseudoclimacograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ortho. truncatus L. p.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Orthog. sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Glyptograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ictinograptus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Antischilleri? sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
The lithological characteristics of the Ordovician series within the Koszalin-Chojnice area show its monotonous development and strongly disturbed tectonics. Its correct differentiation is moreover impeded by extremely meagre coring. In column Brda 3 it amounts to c. 4 per cent, the maximum coring figure being 17 per cent in the Wyszebórz 1 column. Neither do the rather scarce and poorly preserved fossil remains help more accurately to determine the stratigraphy of the Ordovician.

In spite of these difficulties the writer believes it reasonable to differentiate, on the basis of graptolite assemblages, at least two local assemblage Zones, namely (going from bottom):

- **Glyptograptus teretiusculus** — **Orthograptus acutus** Zone
- **Climacograptus bicornis** — **Orthograptus truncatus** Zone

**Glyptograptus teretiusculus** — **Orthograptus acutus** Assemblage Zone

Sediments representing this Zone have been found in columns from five boreholes, namely:

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarbinowo 1</td>
<td>3000.0—2950.0 m</td>
</tr>
<tr>
<td>Skibno 1</td>
<td>2807.0—1802.3 m</td>
</tr>
<tr>
<td>Karsina 1</td>
<td>3203.0—3142.0 m</td>
</tr>
<tr>
<td>Brda 2</td>
<td>3000.0—2602.0 m</td>
</tr>
<tr>
<td>Nowa Wies 1</td>
<td>2900.0—2832.0 m</td>
</tr>
</tbody>
</table>

The graptolite assemblage on which the above Zone has been determined is as follows:

- *Dicellograptus* cf. *sextans exilis* Elles & Wood (Pl. 1, Figs 7–8)
- *Climacograptus* cf. *brevis* Elles & Wood
- *Pseudoclimacograptus* cf. *scharenbergii* Lapworth
- *Orthograptus acutus* (Lapworth) (Pl. 1, Fig. 3)
- *Glyptograptus euglyphus* (Lapworth)
- *G. teretiusculus* (Hisinger) (Pl. 1, Fig. 2)
- *G. cf. teretiusculus* (Hisinger)
- *Glossograptus* cf. *hincksi* (Hopkinson) (Pl. 2, Fig. 6)
- *Amplexograptus* cf. *perezi* Lapworth

The most representative lithological column for this Zone is Skibno 1. It is composed of darkgrey siltstones, occasionally dolomitic, intercalated by rare mudstones of the same colour with numerous concentrations of pyrite and fine muscovite flakes. In other columns the siltstones have a greenish hue (Karsina 1) or darkbrown one (Brda 2). Sporadic intercalations of darkbrown limestones have been observed in the siltsto-
nes (Brda 2). In view of the variability of the dips which range from 10 to 90 degrees, as well as the fact that the sediments here considered have not been pierced it is hardly possible to determine their real thickness.

**Climacograptus bicornis — Orthograptus truncatus assemblage Zone**

This Zone is represented by deposits ascertained in columns of the eight following boreholes:

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Depth of 2950.0—2802.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarbinowo 1</td>
<td>1802.3—1727.0 m</td>
</tr>
<tr>
<td>Skibno 1</td>
<td>3021.4—2753.2 m</td>
</tr>
<tr>
<td>Wyszebórz 1</td>
<td>2853.0—2818.5 m</td>
</tr>
<tr>
<td>Kościerńica 1</td>
<td>1975.9—1873.2 m</td>
</tr>
<tr>
<td>Okunino 1</td>
<td>2901.5—2153.0 m</td>
</tr>
<tr>
<td>Brda 3</td>
<td>2832.0—2488.3 m</td>
</tr>
<tr>
<td>Nowa Wieś 1</td>
<td>5055.5—4890.0 m</td>
</tr>
<tr>
<td>Chojnice 5</td>
<td>2853.0—2818.5 m</td>
</tr>
</tbody>
</table>

Its paleontological documentation is based on:

*Paterula* cf. *portlocki* (Geinitz),
*Anisochilina?* sp.,
*Nemagraptus?* sp.,
*Pleurograptus?* sp.,
*Dicellograptus* sp.,
*Climacograptus bicornis* (Hall) (Pl. 2, Fig. 2),
C. cf. *bicornis* (Hall),
C. *brevis* Elles & Wood,
C. cf. *brevis* Elles & Wood (Pl. 2, Fig. 8),
C. cf. *caudatus* Lapworth (Pl. 2, Fig. 5),
C. *minimus* (Carruthers) (Pl. 2, Figs 7, 9),
C. *tubuliβerus* Lapworth,
C. cf. *tuberculatus* (Nicholson),
C. cf. *wilsoni* Lapworth,
*Pseudoclimacograptus* cf. *scharenbergi* (Lapworth),
*Orthograptus* cf. *calcaratus* Lapworth,
*O. truncatus* Lapworth (Pl. 1, Fig. 5: Pl. 2, Fig. 3),
O. cf. truncatus Lapworth,
*O. truncatus* pauperatus Lapworth (Pl. 1, Fig. 1),
O. cf. *truncatus* pauperatus Lapworth (Pl. 1, Fig. 4),
*Glyptograptus* cf. *teretiusculus* (Hisinger) (Pl. 2, Fig. 1),
*Lastograptus* sp.,
*Tomaculum problematicum* Groom (Pl. 2, Fig. 6).

The *C. bicornis — O. truncatus* Zone within the Koszalin-Chojnice area is characterized by its strongly differentiated lithological development. Skibno 1 is the typical column for the north-western part of this area. It is represented by dolomitic siltstones, darkgrey, greenish-tinted
and intercalated by mudstones of the same colour in the lower part and by red siltstones with pyrite concentrations in the upper part. Here and there it shows intercalations of beige-coloured dolomite (columns Wysze-
bórz 1 and Kościernica 1).

In the south-eastern part of the Koszalin-Chojnice area column Nowa Więś 1 is the representative one for the Zone here discussed. It is composed of darkgrey siltstones, occasionally green or brown tinted, with numerous pyrite concentrations and minute muscovite flakes, also with intercalations of lightgrey bluish tinted tuffite.

In the most south-eastern borehole Chojnice 5, sediments from the C. bicornis — O. truncatus Zone differ from those already described in their darkgrey, nearly black colouration, greater degree of schistosity, abundance of graptolites and the absence of coprolites of mud-eaters so common throughout the Koszalin-Chojnice area.

Similarly as in the case of the G. teretiusculus — O. acutus Zone it is hardly possible to determine the thickness of the Zone under discussion because of the great dip variability (from 20 to 90 degrees), and of the erosional contacts with sediments of the Late Paleozoic.

The distribution of sediments belonging to the zones distinguished in the Koszalin-Chojnice area is suggested in a paper by Modliński (1968) giving data on the Ordovician yielded by the two northernmost boreholes: Jamno IG-1 and Jamno IG-2.

In column Jamno IG-2, the siltstones from a depth of 2600.0—2375.0 m, identical with those throughout the area here considered, correspond to the G. teretiusculus — O. acutus Zone. They bear Nemagraptus gracilis remotus Elles & Wood, Dicranograptus nicholsoni Hopkinson, Climacograptus cf. bicornis (Hall), Orthograptus acutus (Lapworth) and Glyptograptus teretiusculus (Hisinger).

On the other hand, siltstones with Dicellograptus sp., Pseudoclimacograptus scharenbergi (Lapworth), P. modestus (Ruedeman), Climacograptus brevis Elles & Wood, Orthograptus apiculatus Elles & Wood, O. truncatus intermedius Elles & Wood, and Glyptograptus teretiusculus (Hisinger) occurring in the same column between 2375.0—2096.0 m correspond to the C. bicornis — O. truncatus Zone.

In column Jamno IG-1, analogous sediments found between 2801.5—2747.0 m are probably referable to the same Zone, as is reasonably suggested by such forms as Paterula sp., Dicranograptus nicholsoni Hopkinson, Climacograptus bicornis Hall, Orthograptus sp., and Amplexograptus acutus Elles & Wood.

It is hardly possible to determine the stratigraphic position of the Ordovician sediments reached in boreholes Miastko 1 and Nowa Karczma 1, because of the lack of adequate paleontological documentation. The subgenus Pseudoclimacograptus angulatus sebyensis Jaanusson, identified
by Modliński (1968) from the siltstones of column Miastko 1, is known from the limestones of Seba and Folkesunda on the island of Oeland. These limestones correspond to the top members of the Didymograptus murchisoni Zone, also to beds transitional to the Glyptograptus teretiusculus Zone (Jaanusson 1973). The Ordovician siltstones from column Miastko 1 are included by the present writer in the newly established G. teretiusculus — O. acutus Zone. The accurate stratigraphic division and correlation of the siltstone-mudstone series from column Nowa Karczma 1 (Teller & Korejwo 1967) will remain an open question until the time when some reliable indices (microorganisms?) have been found.

CORRELATION OF THE DIFFERENTIATED ZONES


As may be supposed from Table 5, the vertical range of the form Pseudoclimacograptus scharenbergi (Lapw.) indicates its appearance at the beginning of the Didymograptus bifidus Zone. Such forms as Glyptograptus euglyphus (Lapw.) and G. teretiusculus (His.) make their appearance from the Didymograptus murchisoni Zone while Nemagraptus gracilis remotus E. & W. and Orthograptus acutus (Lapw.) occur beginning with the Glyptograptus teretiusculus Zone. Dicranograptus nicholsoni Hopk. is an exception not being noted before the Nemagraptus gracilis Zone.

Most of the taxons mentioned above do not overlap the Climacograptus peltifer Zone, less often the Climacograptus wilsoni Zone (Table 5).

Hence, it may be reasonably concluded that our G. teretiusculus — O. acutus Zone ought to be correlated with the G. teretiusculus — C. peltifer Zones of the standard British subdivision (Table 6). Moreover, it is not excluded that the boundaries of the Zone here discussed may overlap the lower parts of the C. wilsoni Zone. Such a correlation seems also to be confirmed by the other taxons included in the assemblage of our Zone. Namely: Dicellograptus cf. sextans exilis Elles & Wood, Amplexograptus cf. perexccivatus Lapw., Climacograptus cf. bicornis (Hall), C. cf. brevis Elles & Wood and Glossograptus cf. hincksi (Hopkinson).
Table 5
Stratigraphic ranges of the Ordovician graptolites in the Koszalin-Chojnice region and their relation to the standard British subdivision

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C. bicornis</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>O. truncatus</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The C. bicornis — O. truncatus Zone is determined by a graptolite assemblage consisting of 17 taxons. Only eight of them, however, are of help in the correlation of the zones. Five of them: Climacograptus wilsoni Lapw., Orthograptus truncatus Lapw., Orthograptus truncatus intermedius Elles & Wood, O. truncatus pauperatus Lapw. and Pseudoclimacograptus modestus (Rued.) are known beginning with the C. peiltifer or C. wilsoni Zone; two: Climacograptus caudatus Lapw. and C. tubuliferus Lapw. make their appearance in the Dicranograptus clingani Zone, and one —
Table 6

Stratigraphic position of the established graptolite zones in the Koszalin-Chojnice region and their comparison with the standard British subdivision

<table>
<thead>
<tr>
<th>Stages</th>
<th>British graptolite zones /Williams &amp; al. 1972/</th>
<th>Zones accepted in this paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashgill</td>
<td>D. aniceps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. complanatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. linearis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. clingani</td>
<td>C. bicornis – O. truncatus</td>
</tr>
<tr>
<td>Caradoc</td>
<td>C. wilsoni</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. peltifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N. gracilis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G. teretiusculus</td>
<td></td>
</tr>
<tr>
<td>Llandesii</td>
<td>G. teretiusculus</td>
<td></td>
</tr>
</tbody>
</table>

Orthograptus apiculatus Elles & Wood not before the Pleurograptus linearis Zone (Table 5).

On the basis of the taxons here mentioned, as well as on the other identified forms it may be reasonably supposed that the writer's C. bicornis – O. truncatus Zone is to be correlated with the C. wilsoni to D. clingani Zones. It is not excluded, however, that it also involves the lower parts of the P. linearis Zone as may perhaps be suggested by the presence of Orthograptus apiculatus Lapw., as well as by the uppermost parts of the C. peltifer Zone (Table 6).

PALEOGEOGRAPHIC-FACIAL DEVELOPMENT

The Ordovician sediments have been formed in a marine basin along the south-western margin of the East European platform. In the SE this basin extended to the vicinity of Rawa Ruska (Teller 1969) while in the NW it covered the area of Rugia (Jaeger 1967).

The existence of a Caledonian geosynclinal basin, similarly directed, has previously been suggested by Znosko (1964, 1965), while the first boreholes which reached Ordovician and Silurian sediments in Western Pomerania (Modliński 1968, Teller & Korejwo 1968) have confirmed these suppositions.

The rather great thickness of the tectonically disturbed Llanvirnian and Llandellian sediments in Rugia (c. 1,000 m.; cf. Franke 1967, Jaeger 1967), also the some hundred meters thick Llandellian and Caradocian sediments in Western Pomerania with tuffite intercalations, indicate the
miogeosynclinal character of sedimentation. Precambrian and early Palaeozoic sediments in southern Norway (Størmer 1967, Strand & al. 1972) are their faciai equivalents.

Thus it may be concluded that, during the Ordovician, the zone of epicontinental sedimentation in Baltoscandia (Fig. 4) was surrounded in the NW and SW by a sedimentary area of considerably thick miogeosynclinal deposits. The direction of this area, north of Rugia and west of Oslo and Västergotland (Fig. 3) is not clearly known, but it should be noted that this problem is generally connected with the question of the western boundary of the East European platform (cf. Bailey 1923; Bogdanov & al. 1964; Gaertner 1960; Pożarski 1969; Størmer 1967; Znosko 1964, 1965).

Fig. 3
Chief lithofacial types in the western part of Baltoscandia during the Llandellian (after a diagram by Jaanusson, 1973, supplement by the writer)
1 - siltstones interbedded by grey-wackes (Rugia) and sandy-muddy-clayey sediments (Kozalín-Chojnice area); 2 - siltstones interbedded by mudstones and with concretions and intercalations of calcilutites in the Oslo-Scania-Łeba area; 3 - facies of grey calcilutites in the Swedish-Latvian area; 4 - facies of grey calcarenites in the same area; 5 - hypothetical limits of the Swedish-Latvian area

Fig. 4
Thickness variability of the Middle Ordovician sediments (Viruan, graptolite zones D. murchisoni to D. clin- gani) of the western part of Baltoscandia and the neighbouring areas (after a diagram by Jaanusson, 1973, supplemented by the writer)
1 - 200–300 m, 2 - 100–200 m, 3 - 100 m, 4 - 300 m
In order to present a more accurate paleogeographic picture it seems advisable to describe the characteristics of the lithofacies within the area of epicontinental sedimentation (Baltoscandia). Thus, in agreement with Jaanusson (1973), the distribution of the Viruanu lithofacies (i.e. of sediments corresponding in age to those in Rugia and the Koszalin-Chojnice area) is as follows (going W-E):

1. Terrigenous coarse-grained sediments (mudstones, sandstones, greywackes and conglomerates) from the geosynclinal zone and the adjacent regions (including the Rugia-Koszalin-Chojnice area 2).

2. Shales, frequently graptolitic or mudstones with concretions and calcilutite interbeddings (area of Scania sedimentation west of the lake Väner) into which should also be added the area of the Leba elevation.

3. Carbonate clays mixed with calcarenite calcilutites (area east of lake Väner) of the Swedish-Latvian facial area (Määnil 1966) or the central facial area of Baltoscandia (Jaanusson 1973).

4. Oolitic-calcite calcarenites and micritic calcarenites with chamosite or limonite ooids (area of the Swedish-Latvian facial zone also including the areas of the peribaltic syneclise (Määnil 1966, Bednarczyk 1968, Modliński 1973).

5. Sandstones and calcareous sandstones, as a rule scarce and sporadic.

In Jaanusson's (1973, pp. 17, 94) opinion the sequence of the here mentioned lithofacies displays symmetry in what regards the distribution of grain-size, since the fraction of grains of greater diameter decreases towards the middle of the basin. In the case of geosynclinal sediments, however, the sequence of epicontinental lithofacies is asymmetric, since the middle and western lithofacial belts are not parallel to the axis of the geosyncline (Fig. 3). The sedimentation of fine-grained terrigenous deposits in the western part of the epicontinental basin took place along a belt running N-S of the geosyncline. In the north this belt of sedimentation turned to the NE, overlapping the margin of the geosyncline at least as far as northern Jämtland. In this belt sediments accumulated with greater intensity, probably in connection with the increased rhythm of subsidence. The alimentary areas for this belt as well as for the mio-geosynclinal area were probably situated in the island archipelago lying within the geosyncline (Jaanusson 1973). From there the material was transported farther to the foothills and only scanty amounts of it penetrated to the centre of the sedimentary basin of Baltoscandia where they were mixed up with the carbonate clays. In what concerns the area Rugia-Koszalin-Chojnice, an analogy may reasonably be supposed with

---

2 With the writer's necessary supplements.
the sedimentary conditions in the Norwegian arch of the Caledonian geosyncline. Since N and NE of this area there stretched a region of clayey-carbonate sedimentation of the Scania type, and farther on the Swedish-Latvian (Fig. 3) facial zone, the alimentary areas could have been situated only in the south. An analysis of the distribution of the coarse-grained fraction of the sediments in Rugia shows that the material was transported over a rather small distance (Jaeger 1967). Hence, it may be supposed that the terrigenous material brought into the miogeosyncline also came from the island archipelago of the southern arch of the Caledonian geosyncline.

The description of the characteristics of the marine basin within the Koszalin-Chojnice region are supplemented by palaeontological observations. From them it is seen that the fauna of the area under discussion is scarce and relatively monotonous as compared with the epicontinental one of Baltoscandia. The development of the organic world here may have been affected by the unfavourable life conditions in the marine basin. The presence of pyrite in the Ordovician of the area here considered, dispersed or in concentrations, reliably indicates the reduced conditions of the sedimentary environment which must have affected the development of the organic world.

Neither is it excluded that the here discussed part of the geosynclinal basin had, to a certain extent, been isolated from the epicontinental sea of Baltoscandia. This is reasonably suggested by the limited range of the traces of activity of the mud-eaters *Tomaculum problematicum* Groom. This type of coprolites is often found outside the Koszalin-Chojnice region in many other Ordovician profiles in England, Spain (Radig 1964), north-western (Brittany) and southern (Montagne Noire, the Voges Mts) France (Ross 1964), the Rheinische Schiefergebirge, Thuringia, Bohemia (Richter 1939a, b, 1941) and Rugia (Jaeger 1967). No information is, however, available regarding their occurrence in the Ordovician profiles of Scandinavia, NE Poland, the Holy Cross Mts and farther east outside the Polish territory. Upon accepting Stærmer's (1967) conception of the existence of an intracratonic synclise stretching from Oslo across Scania in the direction of the peribaltic areas east of Leba it will be reasonable to suppose that, west and parallel to the hypothetical syncline, submarine barriers were formed handicapping faunal migration from the marine basin of the Koszalin-Chojnice area to the epicontinental sea of Baltoscandia. However, in order more reliably to justify this supposition, a more thorough geological study is needed of the relations between the structural area here considered and the Leba elevation.

*Laboratory of Stratigraphy*
*Institute of Geological Sciences*
*Polish Academy of Sciences*
*02-089 Warszawa, Al. Zwirki i Wigury 93*
*Warsaw, December 1973*
REFERENCES


ORDOWIK W STREFIE KOSZALIN—CHOJNICE NA POMORZU ZACHODNIM

(W. BEDNARCZYK)

STRESZCZENIE

W pracy przedstawiono wyniki badań biostratygraficznych osadów ordowickich, pochodzących z 10 wiercen wykonanych przez Przemysł Naftowy w NW Polsce (fig. 1).

W oparciu o graptolity (tab. 1) wyodrębniono na badanym obszarze dwie lokalne zony zespołowe (od dołu): Glyptograptus teretiusculus — Orthograptus acutus i Climacograptus bicornis — Orthograptus truncatus.

Obecność zony G. teretiusculus — O. acutus ustalono w profilach wiercen na głębokościach: Sarbinowo 1 (3000—2950 m), Skibno 1 (2807—1803,3 m), Karsina 1 (3203—3142,5 m), Brda 2 (3000—2602 m), Nowa Wieś 1 (2900—2832 m), Mias- tko 1 (2745,4—2737,0 m), Jamno IG-2 (2600—2375 m) (fig. 2). Reprezentowana jest ona przez łowce ciemnoszare niekiedy z odcieniem zielonawym z lokalnie występującymi wkładkami mułowców i wapieni ciemnobrunatnych. Miąższość osadów wydzielonej zony, ze względu na zmienne upady wahające się w granicach od 10 do 90°, nie może być ustalona.

Zonę C. bicornis — O. truncatus udokumentowano w profilach osmiu wiercen na głębokościach: Sarbinowo 1 (3850—2802,5 m), Skibno 1 (1803,3—1727 m), Wysze- bórty 1 (3021,4—2753,2 m), Kościernica 1 (2853—2818,4 m), Okunino 1 (1975,9—1873,2 m), Brda 3 (2801,5—2153 m), Nowa Wieś 1 (2832—2488,3 m), Chojnice 5 (5055,5—4890,0 m), Jamno IG-1 (2801,5—2747,0 m), Jamno IG-2 (2037,5—2096,0 m), Nowa Karczma 1 (2783—2251 m) (fig. 2). Reprezentowana jest ona przez łowce dolomityczne ciemnoszare z odcięciami zielonawymi w górnych partiach czerwone ze skupieniami pięciu. W łowcach występują wkładki mułowca lub dolomitu, a w profilach Brda 3 i Nowa Wieś 1 wkładki tuftu. Siłę zlustrowania, lokalne sfaldowania i zmienne upady od 20 do 60° uniemożliwiają ustalenie miąższości.


Znaczne miąższości silnie zaangażowanych tektonicznie osadów lanwirnu i landelu na Rugii (ok. 1000 m — por. Franke 1967, Jaeger 1967) oraz kilkuset- metrowej miąższości osady landelu i karadoku na Pomorzu Zachodnim, zawiera- jące wkładki tuftów, wskazują na miogeosynklinalny charakter sedymentacji. Ich odpowiednikami facjonalnymi są osady prekambra i starszego paleoziku w połud- niowej Norwegii (Stier 1987). Z powyższego wynika, że strefa sedymentacji znacznej miąższości osadów miogeosynklinalnych otaczała od północnego i połud- niowego zachodu obszar epikontynentalnej sedymentacji Bałtoekandii (fig. 4, Ja-
Niejasna jest sytuacja geologiczna w obszarze na północ od Rugii i na zachód od Oslo i Västergötlandu (fig. 3). Problem ten wiąże się jednak z zagadnieniem zachodniej granicy platformy wschodnioeuropejskiej (Gaertner 1960; Bogdanov & al. 1964; Znosko 1964, 1965; Stærmer 1967). Znaczne miąższości ordowickich osadów teryrogenicznych w strefie Rugia-Koszalin-Chojnice w porównaniu z niewielkimi miąższościami osadów flasto-węglanowych ordowiku Bałtyjsko-Scandian skłaniają do wniosku, że obszarem alimentacyjnym dla omawianej strefy mogły być, co już wcześniej zauważył Jaeger (1967), jedynie tereny leżące na południe od niej. Nie wykluczone, że materiał teryogeniczny dostarczany był również z archipelagu wysp południowego łuku geosynkliny kaledońskiej.

Pracownia Stratygrafii
Zakładu Nauk Geologicznych PAN
02-089 Warszawa, Al. Zwirki i Wigury 93
Warszawa, w grudniu 1973 r.
- Orthograptus truncatus pauperatus Lapworth; otwór (borehole) Chojnice 5, głębokość (depth) 5007.45 m; × 6.
- Glyptograptus teretiusculus (Hisinger); Skibno 1 (2110.3 m); × c. 4.
- Orthograptus acutus Lapworth; Sarbinowo 1 (2933.45 m); × 6.5
- Orthograptus cf. truncatus pauperatus Lapworth; Chojnice 5 (5007.0 m); × 6.5.
- Orthograptus truncatus Lapworth; ibidem (5052 m); × c. 6.
- Tomaculum problematicum Groom; Skibno 1 (1734.8 m); × c. 3.
- Dicellograptus sextans exilis Elles & Wood; ibidem (1839.7); × 0.5.
- Dicellograptus cf. sextans exilis Elles & Wood; Karsina 1 (3167.4 m); × 11.
1 - Glyptograptus cf. teretiusculus (Hisinger); otwór (borehole) Kościernica 1, głębokość (depth) 2850.0—2853.0 m; × 10.
2 - Climacograptus bicornis (Hall); Chojnice 5 (5008.5 m); × 3.
3 - Orthograptus truncatus Lapworth; ibidem (5006.65 m); × 3.
4 - Amplexograptus cf. perexcavatus Lapworth; Skibno 1 (2330.7—2336.7 m); × 1.5
5 - Climacograptus cf. caudatus Lapworth; Wyszebórz 1 (2869.3—2873.3 m); × 7.
6 - Glossograptus cf. hincksi (Hopkinson); Karsina 1 (3168.0 m); × 7.5.
7 - Climacograptus minimus (Carruthers); Chojnice 5 (5004.0 m); × 3.
8 - Climacograptus cf. brevis Elles & Wood; Nowa Wieś 1 (2832.0—2836.0 m); × 7.
9 - Climacograptus minimus (Carruthers); Nowa Wieś 1 (2590.0—2596.0 m); × 7.