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LECH TELLER & KRYSTYNA KOREJWO

Early Paleozoic deposits in the deep substratum of north-western Poland*

ABSTRACT: New data are presented about folded Ordovician and Silurian strata pierced in some bore-holes in NW Poland, reliably suggesting the presence there of foldings connected with the late Caledonian orogenic cycle.

EARLY PALEOZOIC DEPOSITS IN BORE-HOLES AND THEIR STRATIGRAPHY

New material, obtained between 1965—1967 from bore-holes drilled by the Oil Industry and the Geological Institute, indicate the presence of early Paleozoic rocks in the deep substratum of north-western Poland (fig. 1). Among the more important bore-holes of this region, situated between Chojnice in the SE and Koszalin in the NW are: Nowa Karczma 1, Miastko 1, Lutom 1, Chojnice 3, Stobno 1 and Jamno 2.

In bore-hole Nowa Karczma 1 (Teller & Korejwo 1967), a 529 m thick silty-argillaceous series of strongly disturbed Ordovician deposits was pierced at a depth of 2251.0 m, conformably overlain by rocks probably Permian in age. The dips here being 70°—90°, it is hardly possible exactly to determine the thickness of the Ordovician deposits.

The Ordovician age of this series is claimed on meagre and poorly preserved organic remains of inarticulate brachiopods of genus *Paterula* and of graptolites from genus *Climacograptus* encountered only in the top part between 2251.0 and 2264.0 m. These two forms reasonably suggest that the Llandeilo and Caradocian are probably represented.

A thick and extremely monotonous silty-argillaceous series was reached at a depth of 2463.0 m in bore-hole Lutom 1 (Teller & Ko-

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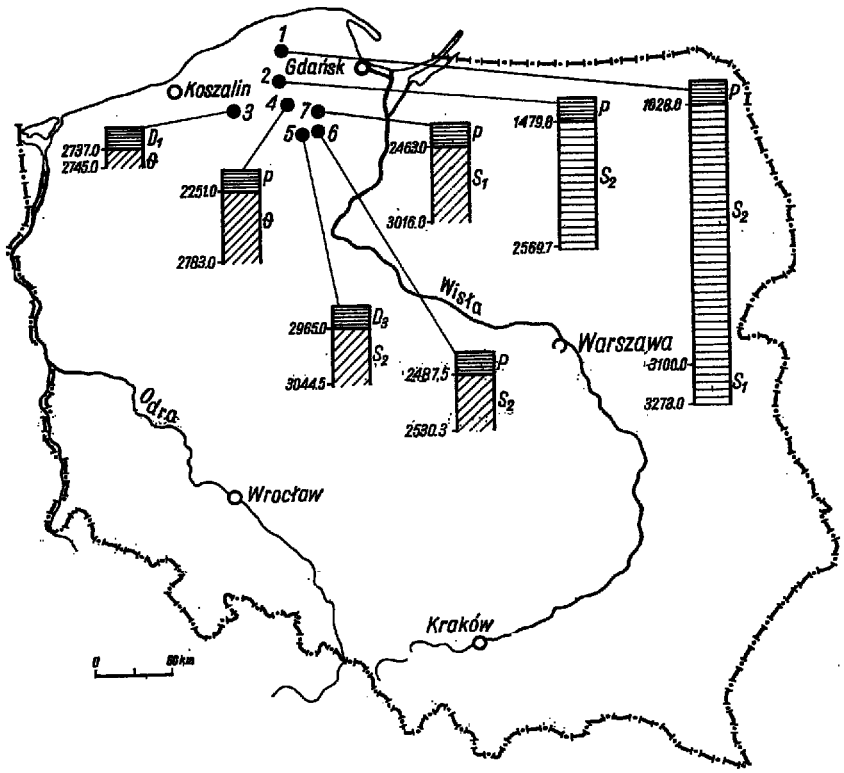

Fig. 1

Occurrence of folded early Paleozoic sediments of the geosynclinal region and unfolded of the epicontinental region in bore-holes of NW Poland

Bore-holes: *1* Lębork, *2* Bytów, *3* Miastko 1, *4* Nowa Karczma 1, *5* Chojnice 3, *6* Stobno 1, *7* Lutom 1. Stratigraphy: Θ Ordovician, S_1 Lower Silurian, S_2 Upper Silurian, D_1 Lower Devonian, D_3 Upper Devonian, *P* Permian

rejwo 1968a) over 10 km N of Chojnice. It is unconformably overlaid by the Permian and contains Lower Silurian graptolite remains. At a depth of 3016.0 m it was not yet pierced. The dips here are 30°—90°.

The presence of the following Lower Silurian graptolite zones has been established on a graptolite fauna:

betw. 2463.0—2581.0 m — the Spirograptus turriculatus zone,

betw. 2581.0—2998.0 m — the Rastrites maximus zone,

betw. 2998.0—3016.0 m — top of the Monograptus sedgwicki zone.

Hence, the above series represents the middle part of the Valentian, while a boundary may be drawn between the Gala-Tarannon and the Birkhill at a depth of 2998.0 m. Since the whole series is very much tectonically disturbed it is hardly possible to establish the thickness of the particular zones reached in bore-holes.

In bore-hole Stobno 1 (Teller & Korejwo 1968b), lying a little south of bore-hole Lutom 1, Silurian deposits have been pierced between 2487.5 and 2530.3 m, likewise unconformably underlying Permian rocks. This series is represented by black, slightly calcareous claystone bearing a meagre and poorly preserved fauna. Tectonically it is rather strongly disturbed, with dips up to 70°. Owing to the unsatisfactory state of preservation the graptolite remains here are specifically indeterminate but without doubt they all belong to the genus *Pristiograptus*. The non-graptolite faunal remains are apparently represented by Ludlovian forms.

In bore-hole Chojnice 3, still farther south of Stobno 1, folded Silurian deposits were reached at a depth of 2965.0 m, underlying Upper Devonian limestones (Łobanowski 1968). They had not been pierced at 3044.5 m. The Silurian series here has dips 5°—30°. The fauna reliably suggests (Teller & Korejwo 1968b) that the above deposits correspond to the Neodiversograptus nilssoni and maybe Lobograptus progenitor zones. This dating is indicated by the presence at a depth between 2987.1 and 2991.6 m of *Colonograptus* sp. and of *Atrypa reticularis dzwinogrodensis* Kozł., found between 2970.0—2974.7 m. Hence this series corresponds to the Lower Ludlovian.

The Silurian series found in bore-hole Stobno 1 is most likely analogous in age.

Steeply inclined (with dips of about 70°) Ordovician deposits in an argillaceous facies, underlying a 800 m thick series of Middle and probably Lower Devonian rocks, were reached at 2737.0 m in bore-hole Miastko 1 (Łobanowski 1968), situated about 70 km NW of bore-hole Lutom 1. A fragmentary graptolite specimen found there belongs to the genus *Climacograptus*. A more accurate dating of this Ordovician series is, however, hardly possible owing to the meagreness and bad preservation of the fauna.

In bore-hole Jamno 2, in the region of Koszalin, at a depth between 2096.0—2600.0 m there occurs a strongly folded silty-argillaceous Ordovician series which underlies sandy ?Devonian deposits. On the presence of a graptolite fauna two zones, characteristic of the Lower Caradocian, were distinguished by Z. Modliński (1967) there, viz.:

betw. 2096.0—2375.0 m — the Diplograptus multidens zone,
betw. 2375.0—2600.0 m — Nemagraptus gracilis zone.

Moreover, Silurian deposits are also known in north-western Poland from bore-holes drilled a few years ago in the region of Łeba, Lębork and Bytów. Everywhere they are characterized by considerable thickness; e.g. in bore-hole Lębork, Upper Ludlovian deposits and post-Ludlovian deposits attain a little over 2000 m, while in bore-hole Bytów they were not pierced at a depth of 2569 m, after attaining

a thickness of 1000 m (Tomczyk 1962). In bore-holes Łeba 1—7 Upper Silurian deposits were only just reached.

In bore-hole Lębork the Wenlockian and Llandoverian have a total thickness 173 m, out of which only 25 m, are referable to the Llandoverian (Tomczyk 1962). The dip of beds in these bore-holes is small, the deposits rest sub-horizontally.

THE CALEDONIAN FOLD-ZONE OF NORTH-WESTERN POLAND

The folded Ordovician and Silurian deposits of great thickness, occurring west of the marginal line of the pre-Cambrian platform in north-western Poland, have but recently been reported (Teller & Korejwo 1968a).

A new light is shed on the subsurface geology of the area under consideration by the study of the folded Ordovician and Silurian deposits, developed in a silty-argillaceous facies, which have been reached over the last few years in bore-holes Nowa Karczma 1, Lutom 1, Miastko 1, Stobno 1, Chojnice 3 and Jamno 2.

The character of these deposits, the great thickness of the Lower Silurian (bore-hole Lutom 1) and of the Ordovician (bore-holes Jamno 2, Nowa Karczma 1 and Miastko 1), as well as the strong tectonic disturbance prevailing there all indicate the presence of a geosynclinal zone. The unconformity of the various late Paleozoic members, particularly of the Devonian and the Permian, resting on the strongly folded Ordovician and Silurian deposits, is observable at many places over a distance of 140 km. This reasonably suggests the occurrence in this part of Poland of a structural element which may, no doubt, be associated with the Caledonian orogeny. The presence of folding in this region of Poland, connected with the Caledonian orogeny, has been suggested by many authors (vide Znosko 1962, 1964) but no direct evidence has been available to confirm this supposition (Pawłowski 1947; Gaertner 1950, 1960; Pożaryski 1957; Znosko 1962, 1963, 1964, 1965). The first evidence has recently been recorded by the writers in the bore-hole Lutom 1 (Teller & Korejwo 1968a).

The axis of the Caledonian structures, so far traced from Chojnice to Jamno, runs sub-parallel to the margin of the pre-Cambrian platform.

The Caledonian age of the foldings may be moreover indicated by the occurrence here of the Devonian in the sandy facies found on folded Ordovician deposits in bore-holes Miastko 1 and Jamno 2. The sandy deposits were most likely brought to the Devonian basin from the adjacent areas emerged in result of the Caledonian cycle of orogeny. It is not out of the question that the sandy material is partly

referable to the denudation of Cambrian deposits that were also embraced by the Caledonian foldings. This supposition is suggested by the presence of folded Ordovician and Silurian deposits between Chojnice and Koszalin. Obviously, Ordovician and Silurian rocks also took part in supplying material into the Devonian basin.

The great thickness of the sub-horizontal, unfolded post-Ludlovian and pre-Lower-Devonian deposits, observed foremost in the Bytów and Lębork bore-holes (comp. fig. 1), suggests not only the strong denudation of the Caledonian folds but also the formation of a Caledonian foredeep. This foredeep stretched SE—NW along the NE side of the folds and was filled up by material brought owing to the denudation of the uplifted Caledonides. It occurred as a relatively narrow transition zone from the deeply submerged margin of the platform to the adjacent Caledonides.

At present it is hardly possible to reconstruct the character of the Caledonian folds in the zone under consideration. The absence of metamorphism and volcanism reasonably suggests that in this zone there are no discontinuous nappe-like folds so typical of the area of the Norwegian Caledonides. The occurrence here is admissible of continuous folds with high amplitudes, dissected by faults similar to those observable in the southern part of the Holy Cross Mts. in Central Poland.

The NW extension of the Caledonian zone beyond Polish territory seems obvious on evidence from bore-hole Arkona in the island of Ruegen (Kölbel 1963) and bore-holes in Denmark (Gregersen & Sorgenfrei 1951), in Jutland and Fionia (vide Znosko 1964) and in Zeelandia (Larsen & Buch 1960). It is also apparently confirmed by the NE increase in thickness of the post-Ludlovian deposits in Poland (Bytów, Lębork), in southern Scania and in the Oslo graben. This fact has been noted and its importance stressed also by R. v. Gaertner (1960) and J. Znosko (1964).

On the other hand the distinct trend of the Caledonian folds in the region of Bergen (Gaertner 1960) allows to connect the folds of NW Poland — across Ruegen and Denmark — with the zone of the Norwegian Caledonides.

The SE prolongation of the Caledonian zone along the SW margin of the pre-Cambrian platform has been reliably traced as far as Dobrugea (Znosko 1964).

Intensive research work in north-western Poland will probably provide new evidence more accurately to confirm the above data.

Laboratory of Stratigraphy
Institute of Geological Sciences
Polish Academy of Sciences
Warszawa 22, Al. Żwirki i Wigury 93
Warsaw, April 1967

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L. TELLER i K. KOREJWO

OSADY STAROPALEOZOICZNE GŁĘBOKIEGO PODŁOŻA PÓŁNOCNO-ZACHODNIEJ POLSKI*

(Streszczenie)

W artykule przedstawiono nowe dane o utworach starszego paleozoiku w głębokim podłożu NW Polski, uzyskane z wierceń wykonanych w latach 1965—1967 przez Przemysł Naftowy i Instytut Geologiczny. W wierceniach Miastko 1, Nowa Karczma 1 i Jamno 2 stwierdzono sfałdowane osady ordowickie, a w otworach Chojnice 3, Stobno 1 i Lutom 1 — osady sylurskie.

Niezgodne spoczywanie różnych ogniw osadów młodopaleozoicznych, a szczególnie dewonu i permu, na wyraźnie sfałdowanych osadach ordowiku i syluru, stwierdzone w różnych punktach na odcinku długości około 140 km (fig. 1), pozwala przyjąć, że uchycony został w tym rejonie Polski nowy element strukturalny, którego powstanie wiązać można jedynie z orogenezą kaledońską. Obecność fałdowań związanych z tą orogenezą w NW Polsce przewidywało wielu badaczy (Pawłowski 1947; Gaertner 1950, 1960; Pażaryski 1957; Znosko 1962, 1963, 1964, 1965), jednakże na ich potwierdzenie brak było dotychczas bezpośrednich dowodów (por. Teller & Korejwo 1968a).

Pracownia Stratygrafii
Zakładu Nauk Geologicznych PAN
Warszawa 22, Al. Żwirki i Wigury 93
Warszawa, w kwietniu 1967 r.

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