BULLETIN OF THE POLISH
ACADEMY OF SCIENCES
EARTH SCIENCES
Vol. 42, No. 4, 1994

PETROGRAPHY

Fragments of petrified, Rhaetico-Liassic Coniferous Trees of Poręba near Zawiercie

by

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Presented by R. NEY on July 5, 1994

Summary. The paper deals with the results of mineralogical, petrographical and paleobotanical investigations of petrified fragments of tree logs, found in Poręba near Zawiercie (Cracow-Częstochowa Upland). Macroscopic observations as well as microscopic ones in the transmitting light and X-ray analyses were carried out. It has been found that the fossils in question represent fragments of the coniferous, Rhaetico-Liassic trees, silicified under the conditions of the tropical climate. The fragments have been determined as *Araucarioxylon* sp. The fossils of Poręba, despite difficulties in definition of their genus affinity, deserve a detailed description being rare findings in Mesozoic rocks of Poland.

1. Introduction. During the field work, carried out by one of the authors (W.H.) in the locality of Poręba-Krawce near Zawiercie (Fig. 1), single specimens of petrified fragments of tree logs were found in 1991. Most of the fossils were spotted about 1 km to NW of the center of Krawce, in the area dissected by a small stream, emerging at the front of the western part of the local forest. The basement of the stream, from which the fossils were collected, is built of Keuper or Rhaetico-Liassic rocks. They are formed by argillaceous-sandy sediments with ash-grey and grey colours, and diversified granulometry. Samples numbered 3, 4, and 5 were subjected to detailed investigations.

2. Geological setting of the petrified wood fragments. Systematic prospecting, within the north-eastern border of the Upper Silesian Ore Basin with the

Key words: fossils, coniferous trees, petrified trees, cyclothem.

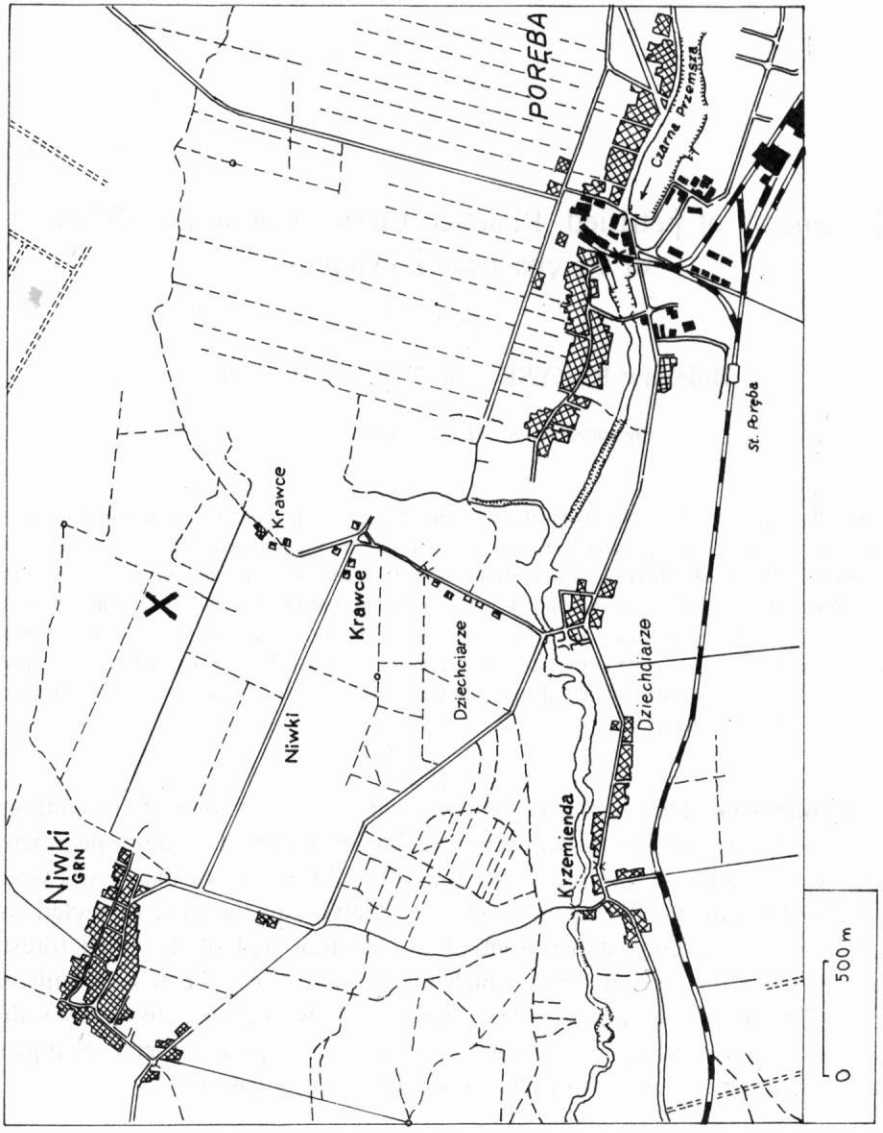

Fig. 1. Localization of the petrified tree logs (marked with a cross) in Krawce-Poręba near Zawiercie.

aim to calculate the reserves of zinc and lead ores, was done by the Geological Enterprise of Cracow. The results of the field work in the vicinity of Poręba near Zawiercie indicate that the thickness of the beds with Zn-Pb mineralization in Krawce and Siewierz is relatively small, and the beds lie at the depth of ca. 100 m. The "Siewierz" and "Poręba" zinc and lead deposits are of a low economic value.

One of the boreholes in the NW part of Krawce intersected the following stratigraphic profile:

0.0-1.0 m Quaternary
1.0-2.0 m Keuper
2.0-13.0 m Tarnowice Beds
13.0-60.0 m Diplopore Dolomite
60.0-80.0 m Ore-bearing Dolomite
80.0-128.0 m Gogolin Beds
128.0-ca. 200.0 m Carboniferous

In other boreholes instead of the Keuper rocks there are the Rhaetico-Liassic ones.

According to Kotański [4], because of the first phases of the old-Cimmerian orogeny visible in the Silesian-Cracow monocline, in the Carpathian foreground, and in NW Poland, there is a distinct angular discordance between the Keuper and Norian, which rests on a strongly eroded basement. For instance, in the vicinity of Zawiercie and Częstochowa the Norian rocks overlie various members of the Keuper and Muschelkalk, and even directly — the Devonian.

Rocks in which the described fragments of petrified tree logs in Krawce near Poręba were found belong probably to a sedimentary megacyclothem II distinguished there [4], and composed of two cyclothems.

A cyclothem II_1R_2 (the Warta cyclothem) begins with grey basal conglomerates, built of local carbonate rocks and marls. They contain in places also an exotic material in the form of quartz, quartzites and lidites, which is the evidence of initiation of uplifting and erosion in alimentary areas. The conglomerates are overlain by laminated sandstones, mudstones and claystones with the plant detritus. There occur also bands of mudstones and marls with foraminifers, indicating marine ingressions. Sediments of the Warta cyclothem are known mainly from boreholes in the vicinity of Zawiercie where their thickness ranges from over a dozen to tens of meters, and reaches 150 m near Wieluń.

A cyclothem II_2R_2 (the Woźniki cyclothem) is built of the Woźniki limestones, known from occurrences between Zawiercie and Wożniki. They are represented by nodular, grey or pinkish and greenish, marly limestones, crystalline oolithic limestones, and also algal limestones with onkoids and stromatholites. In cores of the onkoids there are fragments of molluscan shells and of wood, often crushed or of a cerebroidal character, and calcitized fragments of other continental

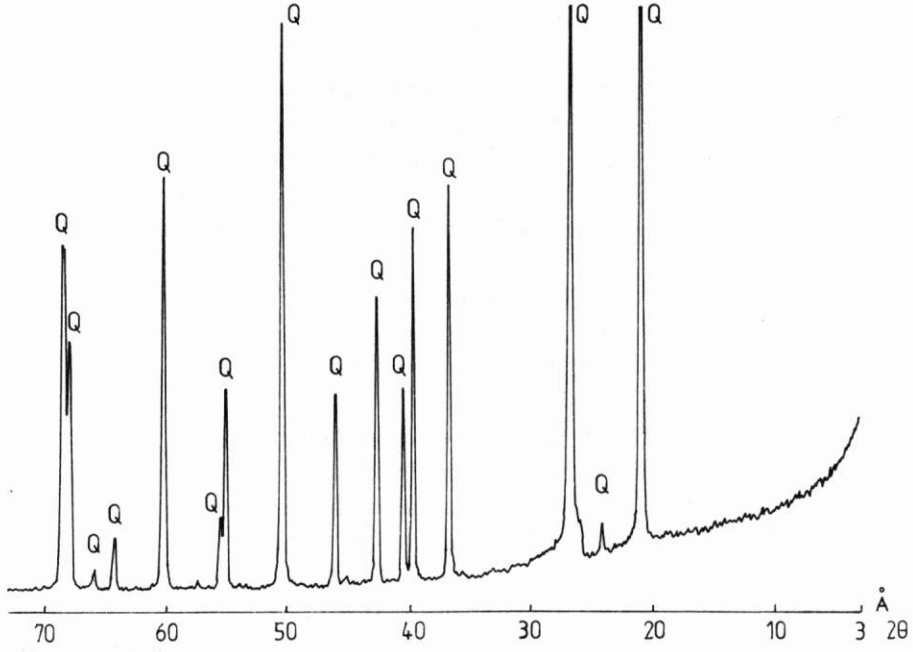

Fig. 2. An X-ray pattern of a petrified tree log.

plants, eg. cones. The Woźniki limestones indicate a peak of marine ingression; the sea was still very shallow as it is indicated by onkoids and stromatholites, and the sea shore was nearby. The sediments of the Woźniki cyclothem also contain grey and variegated breccias, calcareous conglomerates (locally quartz ones), sandstones, mudstones, claystones and marls. The Woźniki cyclothem is completed by carstic limestones and beds containing siderites. The thickness of this cyclothem is ca 20 m, reaching 80 m again in the vicinity of Wieluń.

It is possible that the fossils analysed here represent the wood fragments derived from the Woźniki limestones of the II_2R_2 cyclothem.

3. Mineralogical and petrographical investigations. The described fragments of petrified tree logs are of a variable colour, mostly brownish-yellow. The biggest specimen is ca 20 cm long with a diameter of 15 cm (Plate I). Almost all outer parts of the petrified wood are distinctly cracked and coated with fine aggregates of iron oxides and coal.

Under the microscope the fossils represent the rocks with the glomeroblastic texture and reveal a distinct cellular wood structure. Fine inclusions of iron oxides (goethite) and coal are visible. The glomeroblasts are formed by aggregates of quartz of almost equal size, ca 0.20 mm. An average size of the quartz grains within these aggregates is ca 0.04 mm. A half of the aggregates with all their quartz grains extinct light at any position of the microscope table, the other

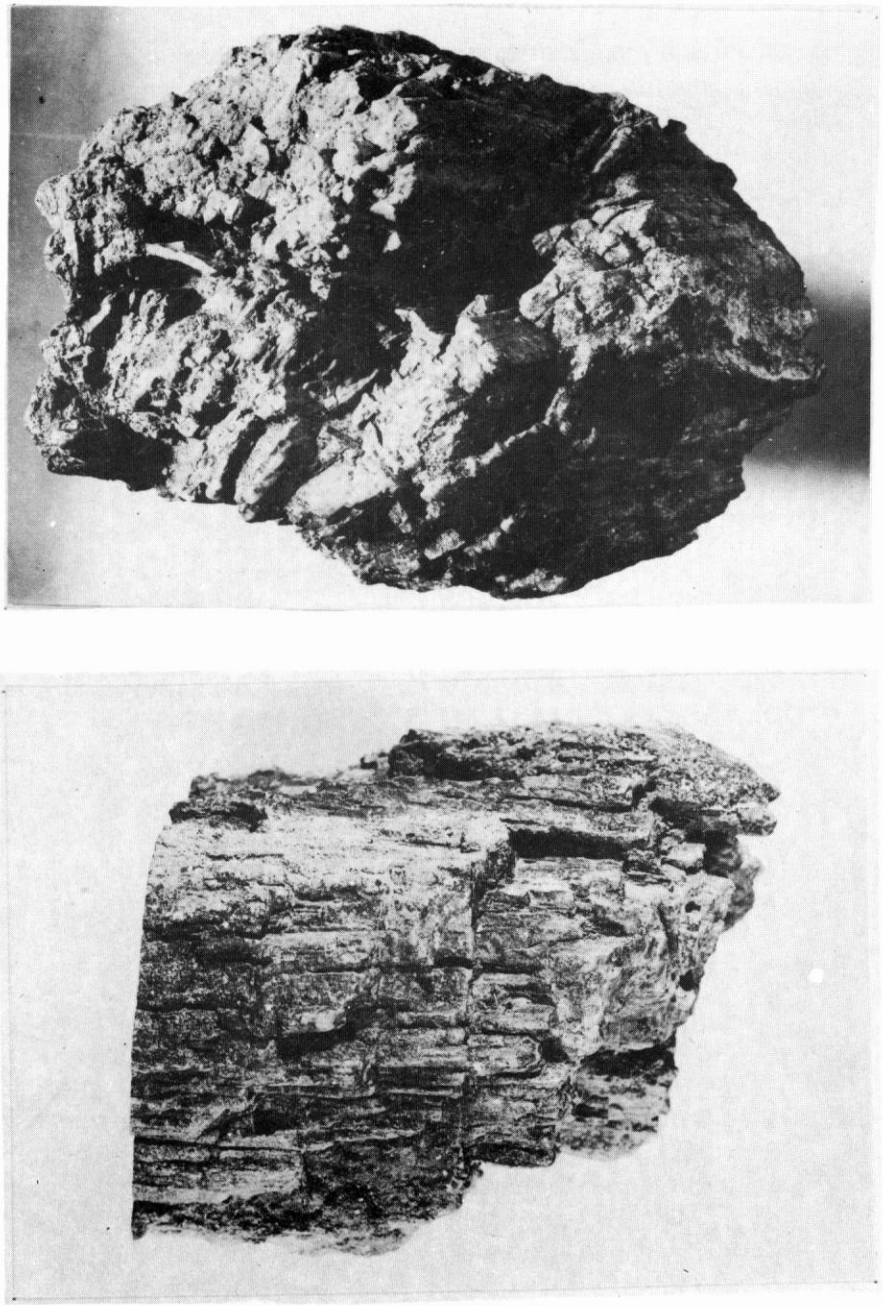

PLATE I

Two best-preserved specimens of the petrified wood (samples No. 3 — top and No. 4 — bottom); about a half of the natural size.

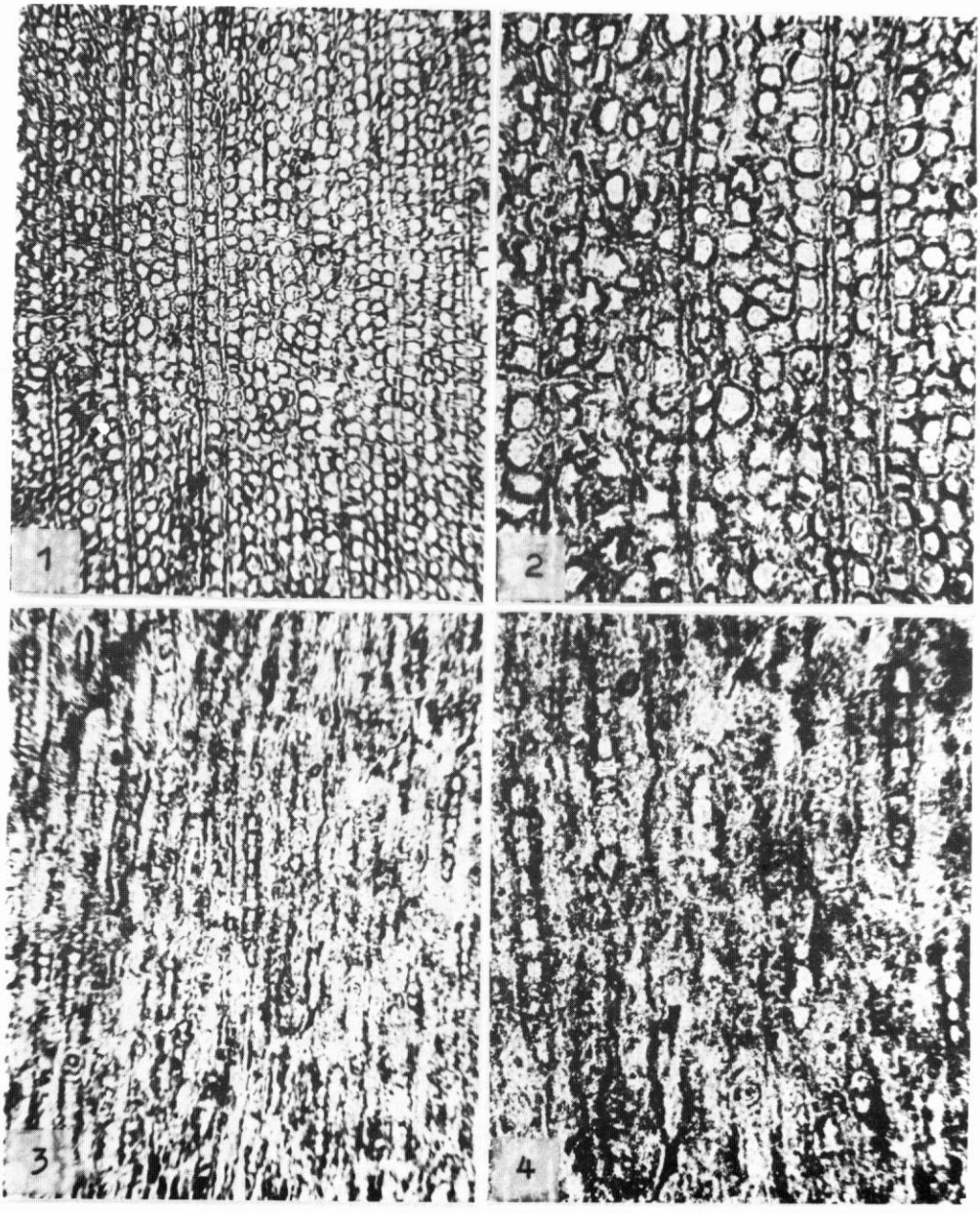

PLATE II

Inner structure of the petrified wood

1, 2 — the transversal sections, magn. 70 × and 130 ×, respectively

3, 4 — the tangential sections, magn 70 × and 130 ×, respectively

half being at the same time in the position of maximum interference colours. Distribution of such aggregates, with the completely different orientation, is random. The arrangement of the quartz crystals indicates that the environment in which the aggregates crystallized, including the plant tissue of the currently petrified wood (the lumen of cells), favoured conditions under which the quartz grains could grow oriented in perpendicular directions.

Results of X-ray analyses (Fig. 2) indicate that the petrified wood in question is built solely of quartz.

4. Paleobotanical investigations. The three analysed specimens of the petrified tree (samples 3–5) differ in the degree of preservation of the cellular structures. One of them (No. 5), the most altered, has been excluded from further investigations because it can only be stated that it is a fragment of a coniferous tree. The other two (Nos 3 and 4) also represent conifers, however despite being less altered, their biological provenience cannot be fully identified. Both are similar as far as their tissue structure and its mineralization are concerned but the degree of petrification is lower in the specimen No. 4, so they must come from two different tree logs. However, their similarities reach so far that the further description has been carried out jointly.

Tissue structures of the remains in question have not been mechanically deformed during fossilization (there is no compaction, disturbance of arrangement, formation of cracks and gaps) but their interpretation is considerably limited as the organic matter of wood has been decomposed to a large extent and substituted by the mineral matter. As a result even the tissue elements, being intact, in their natural orientation, are visible only in the weakly outlined borders of cell walls, and some taxonomically important features of the cell structure have been completely obliterated.

Details of the tissue structures in particular planes, seen under a microscope in the transmitting light, are as follows.

Transversal section (Plate II: 1, 2). The cell structure is generally regular. There are no annual rings at all. Tracheids are differentiated in their sizes and outlines of the cell walls, with the subcircular cells prevalent. The medullary rays are relatively densely distributed, separated by 1–10 (most often 3–5) rows of tracheids. The resin ducts are absent. Well-preserved cells of resin parenchyma are hardly visible; the cells resembling them are scarce and irregularly scattered. In some tracheids there are dark fillings, probably built of the resin.

Tangential section (Plate II: 3, 4). Possible pitting of the tangential tracheid walls is difficult to find. The medullary rays are monoseriated, from 2 to 13 cells high (most often 3–8), and only exceptionally biseriated; the last case is usually limited to the low rays and to only one level of cells, localized approximately in the middle of the rays. Cells of the medullary rays have different sizes even within one particular ray, they are oval (with a vertical elongation)

or barrel-shaped, but triangular-like at the end of the rays. Deformed, single cells, possibly of the resinal parenchyma, can be seldom found in the main mass of the wood.

Radial section (Plate III: 1–4). The pitting of the radial walls of tracheids is poorly preserved, and as a rule visible only in fragments and in very few cells. The pits are monoseriated, relatively large (they occupy almost 2/3 of the tracheid lumen); usually adjacent one to another but can also be densely packed and then adhere along more or less flattened sides. Poruses of the pits are rather large and circular. The structure of the medullary rays is strongly obliterated. The transversal and tangential walls of the ray cells seem to be thin, straight, and free of pits on the cross-fields. The type of pits is not discernible on the radial walls because of the advanced alteration of the delicate tissue elements. Dark colouration of some of the medullary rays indicates the presence of the resin.

4.1. Taxonomic classification. The provenance of the fossilized wood fragments to the *Coniferopsida* class is obvious considering their preserved, basic features. Among some old families of the coniferous plants, known already from the border of the Triassic and the Jurassic, two — *Araucariaceae* and *Podocarpaceae* — have the features to which the specimens of Poręba are the most similar. The most significant facts, analysed — among others — according to [3, 7], namely the lack of annual rings and resin ducts, adhering of the pits on the radial walls of the tracheids, the lack of pitting on the transversal and tangential walls of the medullary rays, and a relatively lower height of the medullary rays, indicate that the fossils in question should be linked with the *Araucariaceae* family. The fossilized members of that family contain, among others, organ genera of *Agatoxylon* and *Araucarioxylon*. Comparisons of the structural features of the wood fragments of Poręba with features of the two mentioned taxons characterized by Gregus [2] were made next. It can be concluded that the most similar to our specimens are *Agatoxylon hungaricum* Greg., described from the Upper Liassic of Hungary, and *Araucarioxylon* sp., described from the Lower Liassic of Hungary also by Greguss [2] and denoted as No. 2. The last taxon is stratigraphically closer to the findings from Poręba. Their identification as the *Araucarioxylon* genus is further supported by their anatomical similarity to the specimens of Łuków (middle Jurassic) and Stempina near Rzeszów (Lower Cretaceous), described in detail by Reyman [7]. Unfortunately, as some important features of the anatomic structure in the specimens of Poręba are indiscernible, their genera cannot be identified and, eventually, the recognition only as the *Araucarioxylon* sp. must be accepted.

There is a probability of finding other specimens of petrified wood from the vicinity of Zawiercie revealing more details in thin sections. It refers to cross-sections in the radial plane, where the cross-fields of the cells belonging to the

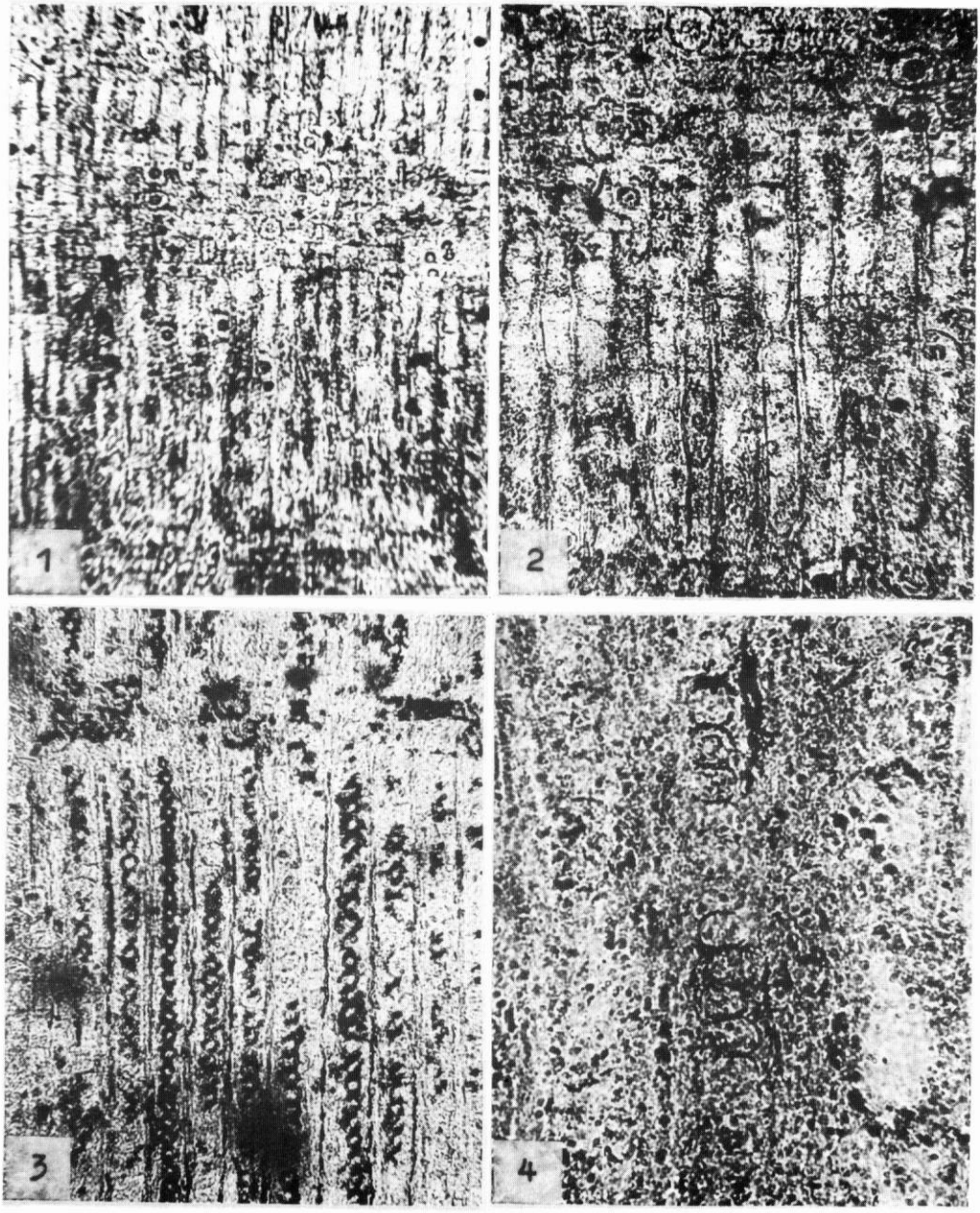

PLATE III

Inner structure of the petrified wood

1, 2 — the radial cross-sections, magn 70 × and 130 ×, respectively; 3 — the radial cross section (the only one preserved in thin sections) showing a tissue fragment with numerous, distinct concentrations of pits, magn. 130 ×; 4 — the radial cross-section showing pits adhering to each other along flattened sides, magn. 340 ×

medullary rays with tracheids provide specific taxonomic features of particular value.

The petrified wood of Poręba, despite its poor preservation and incomplete taxonomic recognition, deserves some attention because such fossils from the border between the Triassic and Jurassic are very rare in Poland. Although there are in Poland some sites (Kluczbork, Woźniki, Tomanowa Valley in the Tatra Mts, the northern slopes of the Holy Cross Mts, vicinity of Cracow) with the fossil plants in the Rhaetico-Liassic rocks, i.e. the rocks of the same age as the Poręba finding, none of them contains petrified trees. A fragment of the petrified log of the Keuper age found under the Sarnia Skała (Deer Rock) in the Tatra Mts is an exception [5]. Some undetermined, petrified trees of the Rhaetic age present in the Woźniki limestones were observed by Kotański [4]. Fully documented findings of petrified trees with distinctly preserved cellular structures from the sediments of the Permian, Triassic and Lower Jurassic (Liassic) have not, probably, been known in Poland so far, or — at least — relevant papers have not been published(*). There are, however, interesting findings from the middle Jurassic: petrified trees *Xenoxylon phyllocladoides* Goth. and *Podocarpoxylon* sp. from the vicinity of Częstochowa [1], *Cedroxylon jurense* Felix, *Cedroxylon polonicum* Rac., *Cedroxylon* sp. and *Araucarioxylon* sp. from the region of Cracow [6] and *Araucarioxylon* sp. from Łuków [87.

It should be added that in the recent years there have been collected new, minute specimens of petrified conifeorus trees of the Lower Jurassic age in Grodzisko near Częstochowa, hence corresponding to the proximal finding of Gothan [1]. These fragments of a various but most often poor degree of preservation have been taken from spherosiderites present in clays cropping out in a brick-yard quarry. Samples from that site are being prepared for further investigations.

5. Conclusions. Results of the current investigations indicate that the petrified trees found near Poręba represent probably wood fragments derived from the Woźniki limestones of the II_2R_2 cyclothem [6]. Their transport was relatively short as it is indicated by their angularity and rather big sizes. Sedimentation and silicification took place in the continental environment. According to paleomagnetic investigations, the territory of Poland was intersected in the Triassic by the 20th magnetic parallel, a situation corresponding to the subtropical zone with the isotherm of 16°C as concluded from general paleoclimatic considerations. Summers were very hot and dry but periodical torrential rains resulted in a high annual rainfall, estimated at 800–1,200 mm. Such showers and resulting floods played a substantial role in the continental transport and deposition. Also

(*) Widely known petrified tree logs of the *Dadoxylon* sp. from the vicinity of Chrzanów are of the Stephanian age.

silica was relatively easily liberated from weathered minerals and rocks under conditions of such a climate, and could metasomatize and accumulate in the tree logs.

All the collected pieces of petrified wood originate from coniferous trees (*Coniferopsida*), and the specimens studied have been classified as belonging to the *Araucariaceae* family and eventually recognized as the *Araucarioxylon* sp. It should be noticed that the taxon distinguished here remains the most similar to *Araucarioxylon* sp. described from the Lower Liassic of Hungary [2] and from the Middle Jurassic of Łuków (Podlasie). Despite insufficient preservation of anatomic details of the fossils found in Poręba (particularly of cellular structures observed in the radial cross-section) that made recognition of a genus impossible, the finding deserves an attention because this type of fossils is very rare in the Mesozoic rocks of Poland. The analysis of petrified trees from that era described so far, proves that rocks of the Rhaetico-Liassic and Dogger may contain more similar fossils.

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