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INTERRELATION BETWEEN MICROFAUNA AND NATURE OF DOGGER DEPOSITS OF THE CZĘSTOCHOWA JURA (POLAND)

Abstract. — Seven sedimentary complexes and two cyclothems are differentiated in the "ore-bearing clays" from the Częstochowa area. The nature of deposits and microfauna evidence deposition in shallow-marine oxidizing environment and oscillatory changes of depth.

Total number of foraminiferid individuals is correlated neither with granulation nor $CaCO_3$ content of deposits. A small variability and high dominance are most strongly marked in the case of foraminiferid assemblages from three parts of the geological section and emphasize the two sedimentary cycles distinguished. The reaction of foraminiferdis to environmental changes is delayed as the changes are first reflected bý deposits and later by foraminiferid assemblages. The stratigraphic and ecological value of miliolids is confirmed.

INTRODUCTION

The paper presents preliminary results of studies on variability of microfauna due to changes in sedimentary environment. The Częstochowa area was selected for the purposes of these studies as it is best known from the geological viewpoint. The Częstochowa Jura is the region of classic investigations on the Jurassic stratigraphy in Poland (Różycki 1953, Znosko 1954, Deczkowski 1960, 1976) and Dogger "ore-bearing clays" (the name widely accepted in the geological literature) were exploited on industrial scale since the 18th c. Petrographic studies on these deposits were carried out among others by Jaskólski (1928), Osika and Sawicka-Ekiertowa (1954) and micropaleontological studies dealing only or partly with the Dogger of that region were conducted by Terquem (1886), Pazdro (1954, 1958, 1959, 1960, 1969 *a*, *b*), Bielecka and Styk (1969), Błaszyk (1967), Kopik (1967, 1969) and Małecki (1953, 1971). Up to the present, the problems of interrelationships between lithofacies and microfauna as well as quantitative relations in microfaunal assemblages did not get much attention if ever.

In papers dealing with the origin of ore deposits of the minetta type published prior to 1966 the majority of authors assumed that these are syngenetic deposits from reducing sedimentary environment (e.g. Hemigway 1951, Hamilton 1951, James 1954, 1966, Znosko 1957, Dunham 1960, Huber 1958, Borchert 1960, Turnau-Morawska 1962). The presence of benthic fauna in situ in such deposits (Hallam 1966) as well as the results of the studies on various contemporaneous marine environments (Berner 1964, 1971, Curtis and Spears 1968) suggest that the presence of pyrite and siderite is not always indicative of reducing sedimentary environment.

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MATERIAL AND METHODS

The studies covered core material from boreholes (no 22 and 79) N W of Częstochowa, the former of which is situated about 7 km south to the latter. Petrographic studies were carried out by Dr. Łącka and micropaleontological — by Dr. J. Garbowska (geological section no 79) and Prof. O. Pazdro (geological section no 22). Samples for micropaleontological and petrographic studies were taken simultaneously at the same places marked on the logs (figs: $1b_2$ and $2b_2$). Samples taken for the micropaleontological studies, each 100 g in weight, were wet sieved using a 240 (0.06 mm aperture) mesh sieve. The residue was subsequently dried and carefuly mixed for averaging. Later a part of the residue, 10 g in weight, was separated and divided into two fractions: finer, with grain diameter ranging from 0.06 to 1.00 mm, and coarser, with grains over 1.00 mm in size. This procedure was chosen because of the fact that almost all the microfaunal elements fall within finer fraction of residue and the 10 g sample of the residue appeared sufficient for quantitative analysis of foraminiferids. Wetsieving of 10-times larger amount of deposit made it possible to smoothen nonuniformities in distribution of microfauna in a sample. The amount of residue and number of foraminiferids derived from every sample are given on graphs (figs 1d, f, 2d, f). Because of technical reasons (scale of graphs) the results of calculation for points situated very closely to each other on Figure 2 are summarized and presented in the form of arithmetic mean. Samples yielding less than 10 foraminiferids are neglected in the graphs of faunal dominance.

LITHOLOGICAL CHARACTERISTICS

The studies (figs 1*a*, *b*, 2*a*, *b*) comprise deposits traditionally named as "Ore-bearing clays" and occuring above Koscieliskie sandstones of the Aalenian and Bajocian age and passing into carbonate Callovian deposits.

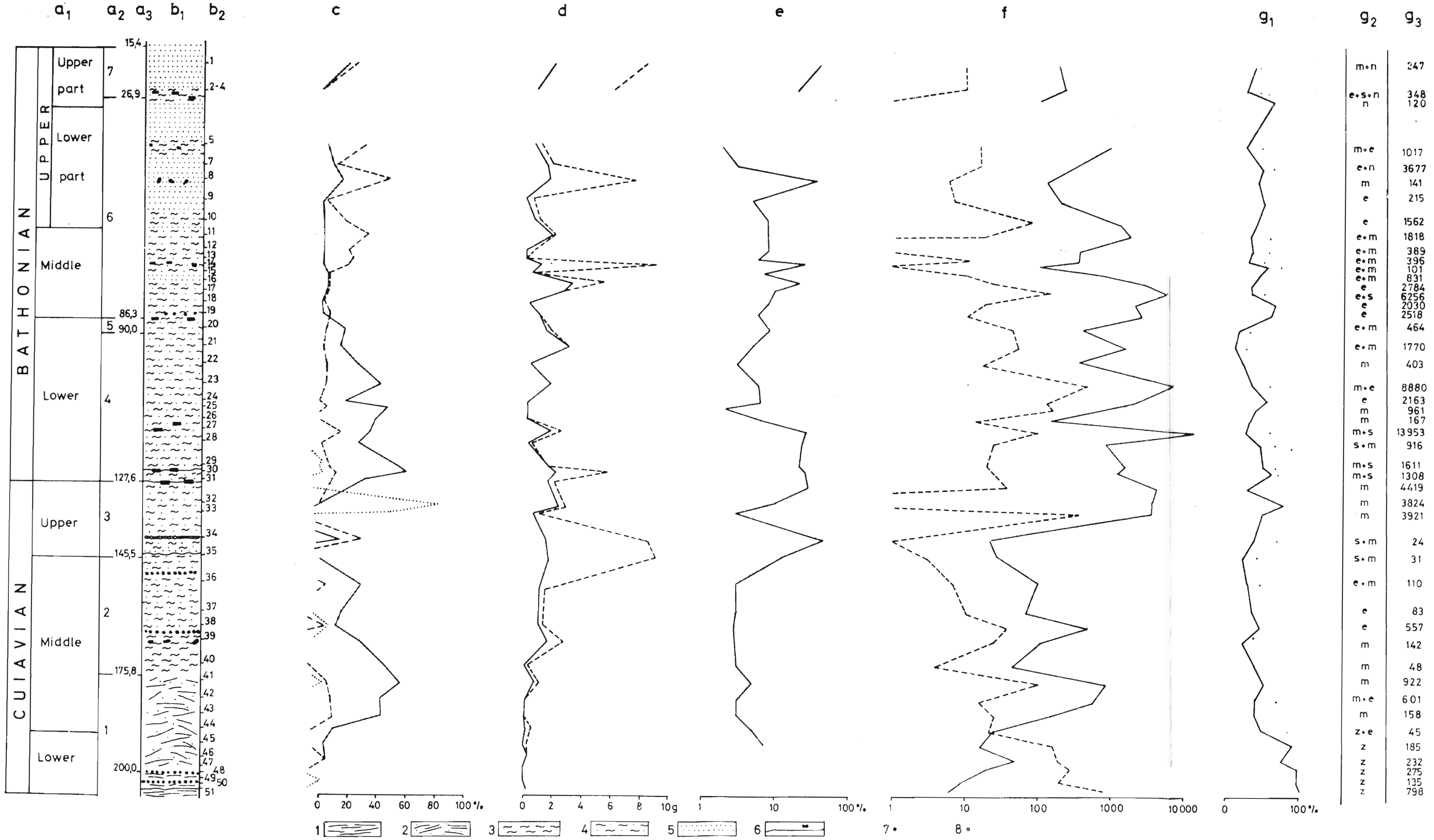

Fig. 1. Geological section from borehole no 22 and results of studies a_1 stratigraphic subdivision, a_2 cyclothems and sedimentary complexes, a_3 depth in meters b_1 lithological column: *1* clay shales, *2* clay-sandy shales, *3* silty shales, *4* silty-sandy shales, *5* sandstones, *6* sideritic mudstones and sandy siderites, *7* siderite nodules, *8* calicite nodules, b_2 location and numbers of samples, *c* percentage of miliolids: ...... *Ophthalmidium carinatum terquemi* Pazdro, ——— *Ophthalmidium carinatum agglutinans* Pazdro, — — — — *Palaeomiliolina czestochowiensis* Pazdro, *d* amount of residue after washing 10 g sample on mesh sieves with 0.06 mm aperture diameter: — — — — total amount of residue, ——— grains 0.06—1.00 mm in diameter, *e* $CaCO_3$ content in per cents, *f* number of foraminiferids from 0.06—1.00 mm grain fraction; ——— calcareous foraminiferids, — — — — agglutinated foraminiferids; g_1 curve of dominance in foraminiferid assemblages, percentage of most common individuals connected with continuous line, dots not connected with one another — cumulative percents of successive groups g_2 name of group dominant in a given sample: *e* epistominids, *m* miliolids, *n* nodosarids, *s* spirilinids, *z* agglutinated foraminiferids, g_3 total number of foraminiferids in a sample.

Note: on figs 1 and 2 instead of Cuiavian should be Kuiavian. On fig. 1e the plot should be prolonged to 1% of $CaCO_3$ in the last samples (nos 46, 47 and 49).

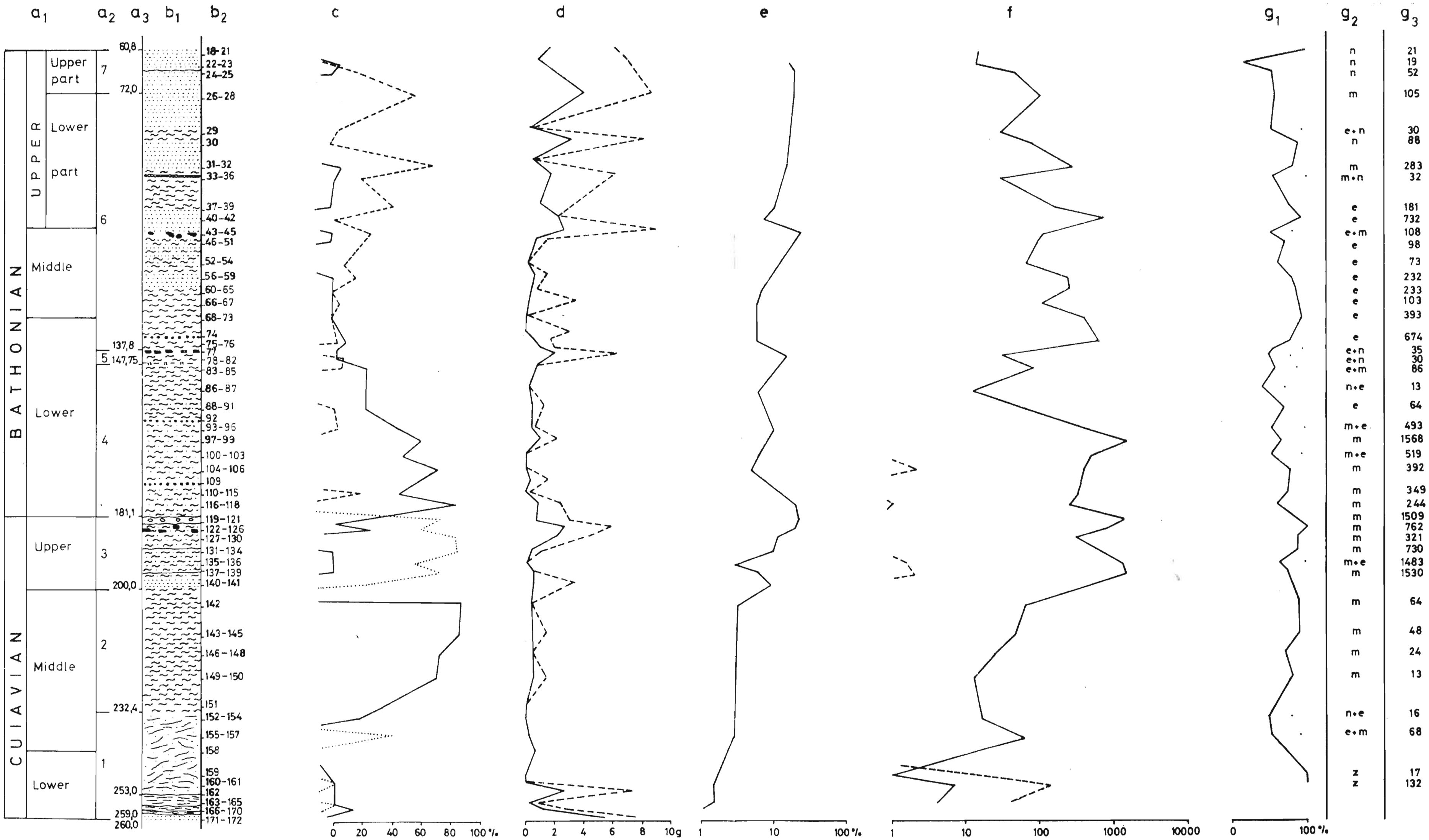

Fig. 2. Geological section from berehole no 79 and results of studies. Explanations as given in fig. 1.

Ore-bearing clays are represented by clastic deposits: clays, clay-sandy and silty-sandy shales, siltstones and fine-grained sandstones. Sideritic nodules are found throughout the geological section and intercalations of sidertic mudstones and sandy siderites — in some, sandy-silty parts of the section. Discontinuous intercalations of argillaceous siderte are found just above sandstones in basal part of the geological section.

In the course of detailed studies seven complexes were differentiated in the geological section on the basis of changes in lithology.

Complex 1

Complex 1 is 26.5 m and 30.8 m thick in the vertical sections no 79 and no 22, respectively. It comprises clay shales with discontinuous intercalations of argillaceous siderites and siderite nodules in its lower part and clay shales with lenticular accumulations of quartz sand and silt in the upper part. The accumulations are usually monomineral, well-washed and not cemented, becoming more and more numerous towards the top of the complex. The accumulations of secondary pyrite are fairly numerous in the intergranular spaces. The clay deposits consist mainly of kaolinite whilst hydromicas occur in subordinate amounts.

Complex 2

Complex 2 is 32.4 m and 29.3 m thick in vertical sections no 79 and no 22, respectively. It consists of silty and silty-sandy shales becoming more and more sandy and richer in shell debris towards the top. Channels made by burrowing organisms (of the endichnia type) are fairly common in the upper part of that complex. Quartz and hydromicas are main detrital components of that deposit whilst feldspars (orthoclase, microcline and albite), kaolinite and chlorites occur in subordinate amounts. Heavy minerals are represented by tourmaline, zircon and rutile grains. Epidote, staurolite and garnet occur in trace amounts. Authigenic pyrite is mainly concentrated in shell infillings, spaces between quartz grains and in infillings of the channels made by burrowers. Siderite is here occasionally found, mainly in the form of innumerous nodules (vertical section no 22).

Complex 3

Complex 3 is 19 m thick in both vertical sections. It begins with well-sorted sandstones with calcite and siderite cement (e.g. 79/140 [1]). These sandstones are rich in molluscan shell debris and echinoderm fragments. Towards the top they pass into sandy siltstones in places cemented with calcite and also rich in shell debris. Siltstones are intercalated with numerous sideritic mudstone layers. The degree of sideritization is highly variable. Sideritic mudstones usually display relicts of sparry calcite (e.g. 79/126) or clay and silt matrix (e.g. 79/125, 124). Sideritization also effected goethite ooids found in some samples of sandy

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[1] the first number represents number of borehole, the second — number of sample

siltstone. The uppermost part of the complex 3 from the vertical section no 79 is formed by very weakly sideritized clays intercalated by layers consisting of large fragments of micritic and biomicritic limestones and with accumulations of underformed goethite ooids, in some parts cemented by sparry calcite. In the vertical section no 22 the intercalations of sideritic mudstone are confined to lowermost and uppermost parts of this complex.

Complex 4

Complex 4 is about 39 m and 37 m thick in vertical sections no 79 and no 22, respectively. It is formed by silty-sandy shales with innumerous intercalations of fine-grained sandstons. The composition of detritial material is the same as in the complex 2. Deposits with indistinct parallel bedding prevail in lower parts of this complex. Upwards, the orginal texture of deposits is obscured by more intense bioturbations. Secondary calcite cement occurs in sandstones and in some parts of silty-sandy shales. Pyrite is concentrated in shells, infillings of channels made by burrowers and spaces between quartz grains. In the latter case it is often accompanied by calcite. The variability of the deposits of the complex 4 in the vertical sections studied is limited to differences in the mode of occurrence of siderite: in lower parts of that complex in the vertical section no 22 there were found thin intercalations of sideritic mudstone and in the vertical section no 79 — siderite nodules occuring *in situ* or redeposited.

Complex 5

The complex 5 attains about 4 m in thickness in both vertical sections. It comprises silty-sandy shales with intercalations of sandstones with calcite cement (79/82) and sideritic mudstones (79/77). Deposits of this complex are characterized by very common pelecypod shell debris and echinoid fragments and very numerous burrowings. Intercalations of sandy siderites with calcitized and kaolinized ooids as well as lumachelle intercalations were found in uppermost parts of that complex in the vertical section no 22.

Complex 6

The complex 6 attains about 66 m in thickness in vertical section no 79 and about 60 m in the section no 22. It comprises silty-sandy deposits and displays a trend to increase in contents of sand-size debris towards the tcp. Silty-sandy deposits forming lower part of this complex are sometimes intercalated by fine-grained sandstones with good sorting. Sandy deposits prevail in the upper part of that complex: sandstones with calcite cement or clay-silty matrix.

The siderite nodules mainly occur in sandy intercalations. They are often enriched in pyrite in marginal parts of the concretions. In general, sideritic nodules occurring in that complex differ from the remaining in marked enrichment in pyrite. The latter also occurs in siderite nodules of the septaria type and it forms small nodules in sandstone intercalations of the uppermost parts of the complex 6.

Complex 7

The complex 7 attains about 19.5 m in thickness in both sections. It comprises fine-grained sandstones with secondary calcite cement as well as innumerous intercalations of sandy-silty shales. Sideritic mudstones with goethite ooids (e.g. 79/18, 25a, 22/2) and sandy siderites (e.g. 79/22, 24b, 22/3, 4) occur in upper part of that complex. Goethite ooids and, sometimes, irregular accumulations of goethite occurring in sandy-silty shales are heavily deformed. Superficial ooids developed around quartz grains are here the exception as they do not display any deformations. The core of some ooids is built of coarse-platy chamosite. Detritial material of shales comprises single fragments of sandstones with calcite cement and micritic limestones. Sandy siderites intercalating these deposits also yield goethite ooids which are, however, undeformed and only occasionally sideritized (e.g. 22/3).

The petrographic characteristics of litological complexes indicate that "the ore-bearing clays" are shallow-water, marine deposits formed of weakly differentiated clastic material, mainly of quartz and hydromicas. Granulation and composition of grains of these deposits indicate that the material was derived from highly peneplenized areas and even from scouring of bottom deposites in the same basin. Abundant benthic fauna (numerous shells and burrowings) as well as the presence of goethite ooids in some horizons seem to evidence good aeration of the water in the sedimentary basin.

The sequence of layers with contribution of sand-size grains gradually increasing upwards and with numerous intercalations of sideritic mudstones and sandy siderites with accumulation of goethite ooids and limestone debris at the top is twice repeated in the geological section. This was accepted as a premise for differentiation of two cyclothems. First of them comprises complexes 1-3 and its sedimentary sequence is as follows: clay shales, clay-sandy shales, silty-sandy shales, sandstones, sideritic mudstones, claystones with conglomerate intercalations and accumulations of goethite ooids. A gradual transition from pelitic deposits through silty to sandstones presumably evidences slow increase in water agitation, the maximum of which coincides with deposition of complex 3. Psefitic detritus and goethite ooids were supplied with breaks in these times and very slow deposition of clay material was favourable for early diagenetic processes of sideritization of underlying deposits (Curtis and Spears 1968, Sellwood 1971, Berner 1971, Garbowska and Łącka 1974a).

The second sedimentary cycle comprises complexes 4-7 and its sedimentary sequence is as follows: silty-sandy shales locally intercalated by sandstones and sideritic mudstones or sandy siderites (complex 5), sandstones, sideritic mudstones and sandy siderites with goethite ooids.

The variability is here very similar to that of the first cycle. The lack of clay deposits in lower part of the cyclotheme and predominance of sandy deposits over silty seem to indicate higher-agitated sedimentary environment of the second cyclothem.

Similar variability of deposits is found in the Lias of the western Europe. The repeated occurence of deposits: clays — siltstones — sandstones — carbonate rocks or ironstones is explained by Hemigway (1951), Duff, Hallam and Walton (1967) and Wells (1960) by changes in basin bathymetry connected with its shallowing. According to Hallam (1963, 1964) this variability may be connected with changes in sea level and formation of condensed sedimentary sequence during progress of transgression.

The cyclicity of sedimentation of the "ore-bearing clays" in the area studied was undoubtedly connected with development of the transgression in the country. Dadlez and Kopik (1972) emphasized gradual oscillatory nature of that transgression. Oscillations were connected with perennial shallowings and deepenings of the basin, accompanied by decreasing and increasing extent of the sea, respectively. Oscillations of such type are responsible for commonness of sedimentary sequences corresponding to reversed cyclothems in the Middle Jurassic according to above mentioned authors. The sequences are characterized by gradual passage from clay to sandy sediments. A rapid passage of Kościeliskie Sandstones into clay deposits of the complex 1 may be related to a drastic change in sedimentary conditions. The lowermost zone of the Kuiavian (*Strenoceras subfurcatum* Zone) is lacking in the Częstochowa region which may indicate even a short-time emersion of that region and subsequent submersion long with a further progress in transgression in the *Garantiana garantiana* Zone (Dayczak-Calikowska and Kopik 1976, Dadlez and Kopik 1975).

MICROPALEONTOLOGICAL CHARACTERISTICS AND DEPENDANCE OF FORAMINIFERID ASSEMBLAGES ON DEPOSITS

Benthic foraminiferids appear to be the main component of microfauna in samples studied. Ostracodes are very rare, especially in the deep section no 79. Small skeletal elements of echinoderms (crinoids and echinoids) are very numerous in several samples. Calcareous foraminiferids markedly predominante in foraminiferid assemblages whilst agglutinated forms are confined to clay deposits from the lowermost part of the geological section (complex 1) and are only occasionally found and never in larger amounts in higher parts of the section. Agglutinated forms are somewhat more common in the vertical section no 22 than in the section no 79. Mainly represented families are Epistominidae (genera *Epistomina*, *Garantella* and *Reinholdella*) and Miliolidae (*Ophthalmidium* and *Palaeomiliolina*) whilst the representatives of the families Nodosariidae and Spirillinidae predominate in foraminiferid assemblages from innumerous some samples only.

Foraminiferid tests are commonly well-developed, smooth and glittering, relatively well-preserved and not heavily ornamented and normal in size. Tests derived from samples cemented with either calcite or siderite are here the exception as they are opaque and corroded. Phenomena of regeneration of broken tests of miliolids are fairly common in some samples and primarily those derived from the complex 3. Agglutinated foraminiferids belong to genera with simple structure of test and specimen with highly complex structure are very rare.

Distribution of foraminiferids in the vertical section is highly uneven, ranging from 0 to 3500 individuals per 10 g rock sample in vertical section no 79 and to about 14000 individuals per 10 g rock sample in the vertical section no 22. Deposits penetrated by borehole no 22 yield richer foraminiferid assemblages than those penetrated by borehole no 79, as 73637 foraminiferids were found in 48 samples from borehole no 22 and 44339 foraminiferids in 137 samples from borehole no 79.

In order to trace dependence of foraminiferids on the nature of rock the number of foraminiferids, amount of rock residue of wet-sieved samples and content of calcite carbonate were plotted on graphs (figs 1 *d-f*, 2 *d-f*). The residue fraction with grain diameter ranging from 0.60 to 1.00 mm roughly reflects the content of sand-size fraction into which fall the foraminiferids gathered. The fraction exceeding 1.00 mm in diameter mainly comprises coarser quartz grains, not desintegrated rock fragments and remains of animal skeletons.

Despite of apparent monotonous development of deposits studied there are numerous sharp breaks of the curves on plots. It should be noted that the curve of the number of foraminiferids makes greater and more numerous oscillations than the curve of residue. The maxima of total amount of residue coincide with samples of rock cemented with siderite and/or calcite or with samples of nodules (e.g. 79/36, 109, 22/8, 30, 34, 35). The maxima are not correlated with the maxima in number of foraminiferids but they often rather with minima. (e.g. 79/33—36, 109, 122—126, 140—141, 22/8, 14, 30, 34). This is primarily connected with the fact that it was usually impossible to macerate and thus to obtain microfauna from siderite nodules and deposits heavily cemented with calicite.

The peaks in number of foraminifierds not always coincide with peaks in amount of finer fraction of the residue (0.06—1.00 mm). The two curves are not similar to one another despite of the fact that the foraminiferids covered by the analysis were gathered from this fraction. The lack of any distinct dependence of the number of benthic foraminiferids on granulation of deposits indicates that foraminiferid tests were not brought together with detrital material but are rather autochtoneous.

The attempts to correlate the number of foraminiferids and the content of calcium carbonate in deposit were the most numerous but their results seem to be contradictory (e.g. Groiss 1970, Wernli 1971, Joachim 1970). In order to test whether or not this correlation is valid in the case of the Częstochowa area $CaCO_3$ content was measured in most samples from borehole no 22 and in several samples from borehole no 79 (figs 1*e*, 2*e*). The plot of $CaCO_3$ content versus the number of foraminiferids found in a given sample does not reveal any distinct correlation. A small number of calcareous foraminiferids usually coincides with high contribution of $CaCO_3$ except for the sample no 22/27 which is surprisingly rich in both foraminiferids (about 14000 individuals) and $CaCO_3$ (about 24% $CaCO_3$). The sample is also very rich in calcareous fragments of echinoids. It appears that $CaCO_3$ content is rather correlated with contribution of coarse fraction in the residue (figs 1d, e, 2d, e) which evidences that the amount of $CaCO_3$ in the rocks studied does not depend on contribution of foraminiferid tests and other calcareous bioclasts but rather on the presence of secondary calcite cement. It may be stated that calcareous foraminiferids are very scarce in almost noncalcareous clay deposits of the complex 1 in the vertical section as well as in deposits very rich in calcium carbonate (complex 7). In turn, a larger number of foraminiferids is connected with moderately high content of calcium carbonate. Foraminiferids are relatively scarce in lower parts of both geological sections (complexes 1 and 2) which are formed by strongly clay deposits poor in $CaCO_3$ and most abundant in middle parts of the geological sections (complexes 3–4) characterized by predominance of silts and by highly variable calcium carbonate content. The number of foraminiferids decreases once more in upper parts of the geological sections (upper part of complex 6 and complex 7), where there is a marked increase in contribution of both sand fraction grains and $CaCO_3$.

Attemps were made to use quantitative and qualitative change of foraminiferid assemblages in the vertical section for reconstruction of bathymetry and transgressive trend with the use the methods of faunal dominance described by Walton (1964). Such logs are shown on figs 1*g* and 2*g*. The ecological studies of recent foraminiferid assemblages have shown (Walton 1964) that dominance, i.e. a predominance of number of individuals of given species or genus or group expressed in percent, is inversely proportional to faunal variability expressed by number of species or systematic groups in the assemblage. The dominance is at present found to be the greatest close to the shore, in shallow-water condition, becoming less clear towards the open sea up to the slope of continental shelf. It follows that the trend to increase of dominance among benthic foraminiferids indicates shallowing of epicontinental sea in the case of both recent and ancient deposits.

Figures 1*g* and 2*g* present share of most important groups in foraminiferid spectrum (in percents) under consideration. These groups include: miliolids (abbreviated as *m*), epistominids (*e*), spirillinids (*s*), nodosarids (*n*) and agglutinated forms (*z*).

In foraminiferid assemblages from the vertical sections it is possible to distinguish 4 periods of the strongest dominance of:

1 — agglutinated forms (*z*) at the base of complex 1
2 — miliolids (*m*) in complex 3
3 — epistominids (*e*) at the base of complex 6
4 — nodosarids (*n*) at the base of complex 7

A weakening of dominance in foraminiferid assemblages is marked in complex 2, 4, 5 and 6, but even there it is possible to note some oscillations of the curve especially in the geological section no 79.

The analysiis of dominance curves has shown that complexes 3 and 7 as well as lower parts of complexes 1 and 6 originated under the conditions of maximum shallowing of marine reservoir in this region. This conclusion is consistent with results of petrographic studies of deposits of complexes 3 and 7 but not 1 nor 6. Complex 1 yields assemblage almost exclusively consisting of primitive agglutinated forms which may evidence marginal-marine environment (Walton 1964). This may be explained by a reaction of foraminiferids to environmental changes. Microfauna from basal parts of the complex 1 was related to the beginnig of a great transgression from the *Garantiana garantiana* Zone (Dayczak-Calikowska and Kopik 1976) and the change in its nature was delayed in relation to changes in deposits. Similarly, a short-term shallowing displayed by complex 5 evoked a reaction of microfauna with some delay as the latter was marked not before the base of the complex 6. A concordance of changes in microfauna and deposits is observed only in the case of stronger and prolonged shallowings such as those from the complexes 3 and 7. Small oscillations of dominance curve are fairly common, evidence slow, insignificant oscillations in depth of the reservoir which was characterized by mobile bottom floor during the Middle Jurassic and oscillatory nature of the sea (*vide op. cit.*).

The course of dominance curve for the two geological sections gives support to the differentiation of two cyclothems.

A general distribution of dominating foraminiferid groups is very interesting. In both geological sections, irrespectively of the degree of dominance, agglutinated forms prevail in lower parts, miliolids and later epistominids in the middle and nodosarids in upper parts. The predominance of spirilinids was found only in the case of a few samples from the vertical section no 22.

STRATIGRAPHY

The stratigraphy (figs 1*a*, 2*a*) of the geological sections studied was established on the basis of correlation with neighbouring deep sections from Kłobuck and Iwanowice Wielkie (Znosko 1954, Deczkowski 1960). The names of stages are accepted after Resolution of I-st Jurassic Colloquium in Poland in 1964 (Kotański and Znosko 1967) and justification given by Kopik and Znosko (1968). The name Kuiavian, corresponding to the Upper Bajocian of the international stratigraphic scheme, was accepted in the edition "Geology of Poland, Stratigraphy, Mesozoic" published in 1973 (English version 1976) by the Geological Institute, Wydawnictwa Geologiczne, Warszawa.

The material studied confirmed stratigraphic applicability of miliolids for zonation of ore-bearing clays in Poland (figs 1c, 2c). *Ophthalmidium carinatum terquemi* Pazdro is known from the Kuiavian where sometimes occur in masses, and only occasionally passes to younger strata. *Ophthalmidium carinatum agglutinans* Pazdro is common in the Kuiavian and lower Bathonian but becomes less numerous than: *Palaeomiliolina czestochowiensis* Pazdro in the Middle and Upper Bathonian. The latter is known from the whole Middle and Upper Kuiavian and Bathonian of Częstochowa area but it did not prevail quantitatively before the Middle and Late Bathonian (Pazdro 1959). Therefore the statement of Małecki (1971) that *Palaeomiliolina* is most common in the Upper Kuiavian of the Częstochowa area seems unsubstantiated. It is not exluded that Małecki assigned to *Palaeomiliolina czestochowiensis* anomalously coiled representatives of *Ophthalmidium carinatum terquemi* which are usually common in the Upper Kuiavian (Pazdro 1958).

The Lower Kuiavian is differentiated taking into account dominance of agglutinated forms, lithology and roughly uniform thicknesses in neighbouring deep sections.

The Upper Bathonian is differentiated on the basis of correlations with neighbouring deep sections and a strong predominance of *Palaeomiliolina* upon *Ophthalmidium*.

CONCLUSIONS

(1) The deposits studied originated in very shallow, oxidizing marine environment. The sedimentation was mainly finely-clastic, clay-silty and sandy. The shallow-water nature of this sedimentary environment is evidenced by: structure and texture of deposits, mass occurence of miliolids, small variability and large dominance in foraminiferid assemblages, simple structure of walls of agglutinated foraminiferids, occurence of

goethite ooids in some parts of the geological sections. Oxidizing nature of the environment is shown by rich organic life, mass occurrence of calcareous debris of benthic organisms. The autochtoneous character of the latter is evidenced by good preservation of foraminiferid tests and no correlation between number of foraminiferids and granulation of deposits. The lack of correlation between number of foraminiferids and nature of deposits was also shown by statistic studies (Garbowska and Łącka 1974*b*). A temporarily higher water energy is reflected by the occurrence of conglomeratic intercalations in some parts of the geological section and the phenomena of regeneration of broken tests of miliolids which are especially commmon in most extremely shallow-water deposits. The regeneration of tests is fairly common whilst broken tests occur in negligible amounts if ever which indicates that miliolids were not transported along with detritial material but rather lived in agitated waters in that area.

The mode of occurrence of pyrite, siderite and inorganic calcite evidence their early diagenetic origin. Spatial relations between pyrite and calcite and siderite suggest that siderite was usually formed after calcite. The latter was being formed almost simultaneously or somewhat later than pyrite. Diagenetic origin of pyrite and siderite as well as a low variability in the content of Corg and pyrite (about 1% and 1.2%, respectively) throughout the geological section (Garbowska and Łącka 1974*b*) do not evidence reducing conditions in sedimentary environment from this part of the reservoir in the Middle Jurassic times.

(2) Taking into account lithological differentiation the geological section is divided into 2 cyclothems and 7 sedimentary complexes. The cyclothem I corresponds to the Kuiavian and comprises 3 complexes of clastic deposits becoming more and more sandy towards the top. The uppermost complex 3 comprises deposits formed in the highest energy environment in times of maximum shallowing of the reservoir.

The cyclothem II corresponds to the Bathonian and comprises 4 complexes of deposits close to the cyclothem I in variability but differing in higher content of sand-size grains. Coarser-grained deposits predominate. The nature of deposits evidence higher water agitation and numerous periods of serious shallowing (complex 5). This cyclothem, similarly as the former, ends with a maximum shallowing (complex 7).

(3) The conclusions drawn from lithological analysis are supported by the results of analysis of curve of dominance in foraminiferid assemblages. Peaks in dominance coincide with periods of shallowing. The correlation of dominance peaks with these periods is incomplete because of delayed reaction of microfauna on changes in sedimentary environment: a change is first marked in deposits and later in foraminiferid assemblages.

(4) There is no correlation of the number of foraminiferids with $CaCO_3$ content of rock. Migration of Ca^{2+} in deposits obscures orginal pattern

of concentration of this element. A large number of foraminiferids very rarely coincides with high content of this element in deposit.
(5) Regularities in qualitative and quantitative distribution of miliolids found in the geological sections studied seem to be the same as in other deep sections from the Częstochowa area (Pazdro 1954, 1959). This confirms stratigraphic value of these foraminiferids.
(6) Upper boundaries of the Kuiavian, complex 3 and cyclothem I closely coincide in the geological sections studied. It follows that biostratigraphic and lithostratigraphic boundaries are here concordant.
(7) Microfauna is more numerous in the vertical section no 22 than the vertical section no 79 which may be explained by smaller thickness of strata in the former; in turn larger number of agglutinated foraminiferids found in the vertical section no 22 may be explained by smaller depth of water.
(8) A higher total thickness of deposits in the vertical section no 79 is consistent with a general distribution of facies in this area and an increase in thickness of the Middle Jurassic deposits towards the north-west (Różycki 1960, Deczkowski 1960, 1976).

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JADWIGA GARBOWSKA, BOŻENA ŁĄCKA I OLGA PAZDRO

UWAGI O ZWIĄZKACH MIKROFAUNY Z OSADAMI W DOGGERZE OKOLIC CZĘSTOCHOWY

Streszczenie

Zbadano metodami petrograficznymi profile doggeru z dwóch wierceń na NW od Częstochowy. Tzw. „iły rudonośne" są osadami drobnoklastycznymi, ilasto-mułkowymi i piaszczystymi. Wydzielono w nich 7 kompleksów w dwóch cyklotemach,

I w kujawie, II w batonie, na podstawie zróżnicowania litologicznego i dwukrotnego powtórzenia się sekwencji osadów o wzrastającym zapiaszczeniu. W górnych partiach tych cyklotemów występują skupienia ooidów getytowych i okruchy skał węglanowych. W całym profilu występują konkrecje syderytowe, wkładki osadów zsyderytyzowanych, a w najniższych warstwach wkładki syderytów ilastych.

Badane osady tworzyły się w płytkomorskim, utleniającym, okresowo dość ruchliwym środowisku, o czym świadczą struktury i tekstury skał, ooidy getytowe, wkładki zlepieńców, liczne wapienne szczątki organizmów bentonicznych, mała zmienność a duża dominacja w zespołach otwornic, prosta budowa ścian otwornic aglutynujących, masowe występowanie miliolidów. O ich występowaniu *in situ* świadczy brak korelacji liczby otwornic z uziarnieniem osadu, dobry stan zachowania skorupek, zjawiska regeneracji połamanych skorupek miliolidów. Okresowe nasilanie się tych wskaźników świadczą o oscylacyjnym charakterze zbiornika, spłycaniu i pogłębianiu, związanym z rozwojem transgresji morza (Dadlez i Kopik 1975 i inni).

Analiza wykresu dominacji w zespołach otwornicowych pozwala również na wydzielenie 2 cykli, a szczyty dominacji przypadają na maksymalne spłycenia zbiornika. Niezależnie od stopnia dominacji stwierdzono 4 jej okresy: w dole profili otwornice aglutynujące, wyżej miliolidy, potem epistominidy, a w górze nodosariidy.

Górna granica kujawu, z zasięgu *Ophthalmidium carinatum terquemi* Pazdro, kompleksu 3, cyklotemu I i szczytu dominacji zgadzają się ściśle ze sobą w obydwóch profilach. Granica litostratygraficzna jest tu zgodna z biostratygraficzną.

Czasem mikrofauna reaguje na zmiany warunków środowiska sedymentacyjnego z opóźnieniem. Najpierw zmiany zaznaczają się w osadzie, a potem w mikrofaunie (np. krótkotrwałe spłycenie w kompleksie 5, a wzrost w dominacji u dołu kompleksu 6, lub silne spłycenie poniżej kompleksu 1, a szczyt dominacji w dole tego kompleksu).

Wykresy residuum skalnego po szlamowaniu próbek, zawartości $CaCO_3$, liczby otwornic i dominacji otwornicowej wykazują słabsze lub silniejsze oscylacje, ale brak jest zgodności między nimi. Często tylko krzywe residuum wykazują dodatnią korelację z zawartością $CaCO_3$, a ujemną z liczbą otwornic, co świadczy o tym, że niektóre partie osadu zostały silnie zcementowane spoiwem wapnistym, które utrudniło macerację próbek.

Chronologiczne rozprzestrzenienie jakościowe i ilościowe miliolidów wykazuje takie same prawidłowości w badanych profilach jak w innych profilach doggeru rejonu częstochowskiego (Pazdro 1954, 1959). Potwierdza się ich użyteczność stratygraficzna.

Znacznie większa ogólna liczba otwornic w profilu nr 22 niż w profilu nr 79 jest spowodowana redukcją miąższości osadów w tym obszarze ku południowemu wschodowi, a większa liczba otwornic aglutynujących może świadczyć o płytszych wodach.

ЯДВИГА ГАРБОВСКА, БОЖЕНА ЛОНЦКА, ОЛЬГА ПАЗДРО

ЗАМЕЧАНИЯ О СВЯЗИ МИКРОФАУНЫ С ОТЛОЖЕНИЯМИ В ДОГГЕРЕ ОКОЛО ЧЕНСТОХОВЫ

Резюме

Были исследованы петрографическими и микропалеонтологическими методами профили доггера двух скважен на северо-западе от Ченстоховы. Так называемые „рудоносные глины" являются мелкокластическими, глиноалевритовыми и песчаными отложениями. Из них выделено 7 комплексов в двух циклотемах: I — в куяве, II — в бате, на основе литологической неоднородности и двукратного повторения секвенции осадков с увеличивающимся песчаным заносом. В верхних частях этих циклотем наносятся скопления гетитовых ооидов и обломки карбонатных пород. Во всём профиле выступают сидеритовые конкреции, прослойки сидеритовых алевритов и пещанистых сидеритов, а в самых нижних частях — прослойки глинистых сидеритов.

Исследованные отложения образовались в мелководной, морской, окисляющей и, частично, довольно подвижной среде, на что указывает структура и текстура пород, гетитовые ооиды, прослойки конгломерата, многочисленные известковые остатки бентонных организмов, малая изменчивость и большое доминирование в комплексах фораминифер, простое строение стенок агглютинирующих фораминифер, часто встречающиеся милиолиды. На их существование в форме „*in situ*" указывает отсутствие корреляции между количеством фораминифер и зернистостью осадков, хорошо сохранившиеся раковины, а также явление регенерации сломанных раковинок милиолидов. Периодическое увеличение этих показателей указывает на осцилляционный характер бассейна, обмеления и углубления, связанные с развитием трансгрессии моря (Dadlez и Kopik 1972, 1975 и др.).

Анализ графика доминирования в комплексах фораминифер позволил также выделить 2 цикла, наибольшее доминирование приходится на максимальное обмеление бассейна. Независимо от степени доминирования обнаружено 4 его периода: внизу профиля — агглютинирующие фораминиферы, выше — милиолиды, затем эпистоминиды, а наверху — нодосарииды.

Верхняя граница куява, местонахождение *Ophthalmidium carinatum terquemi* Pazdro комплекса 3, циклотемы 1 и максимумы доминирования точно совпадают друг с другом в двух продилях. Литостратиграфическая граница в этом случае согласуется с биостратиграфической.

Иногда микрофауна реагирует на изменение седиментационных условий среды с опазданием. Вначале изменения намечаются в осадке, а потом уже в микрофауне (напр. коротковременное обмеление в комплексе 5, и увеличение доминирования внизу комплекса 6, или резкое обмеление ниже комплекса 1 и максимум доминировнаия внизу этого комплекса).

Графики остатков пород после промывки проб, содержание $CaCO_3$, количества фораминифер и доминирование фораминифер указывают на малую или большую осцилляцию, но не существует между ними согласованность. Часто только кривые графиков остатков пород имеют положительную корреляцию с содержанием $CaCO_3$, а отрицательую с количеством фораминифер, что указывает на то, что некоторые партии отложений были сильно сцементированы известковым цементом, что препятствовало мацерации проб. Качественное и количественное хронологическое распространение милиолидов выявляет такие же самые закономерности в исследованных профилях, как и в других профилях доггера района Ченстоховы (Pazdro 1954, 1959), подтверждается их стратиграфическая пригодность.

Значительно большое общее количество фораминифер в профиле № 22, чем в профиле № 79 вызвано уменьшением мощности пласта в этом районе в сторону юго-востока, а увеличение количества агглютинирующих фораминифер может указывать на мелководье.