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FACIES DEVELOPMENT OF THE BADENIAN (MIDDLE MIOCENE) GYPSUM DEPOSITS IN THE RACŁAWICE AREA (MIECHÓW UPLAND, SOUTHERN POLAND)

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Abstract: The Middle Miocene (Badenian) gypsum sequence was investigated by means of facies analysis on the Miechów Upland in the environs of Racławice, about 40 km northeast of Cracow. The region lies at the northwestern margin of the Carpathian Foredeep and has been omitted in detailed investigations until now. Five gypsum facies were distinguished: giant gypsum intergrowths, grass-like gypsum, palisade gypsum, sabre gypsum and microcrystalline gypsum. Except for the palisade gypsum, the other facies were described from the adjacent Nida area. The vertical arrangement of the facies is generally the same along entire northern margin of the Carpathian Foredeep. The studied sequence is reduced in thickness (up to 30 m) in comparison to the Nida area (up to 50 m). The lower part of the section, composed of the giant gypsum intergrowths and grass-like gypsum, is distinctively reduced. It is often replaced by a thin layer of palisade gypsum. The microcrystalline gypsum and the sabre gypsum are the most common facies. The giant gypsum intergrowths and the grass-like gypsum occur in the northern part of the Racławice area, while the palisade gypsum dominates in the southern part. The gypsum basin of the Miechów Upland developed in a similar way as the basin of the Nida area, but was shallower and its brines underwent more often dilution. The basin-floor morphology probably showed a variety of features.

Key words: Miocene, Badenian, gypsum facies, Miechów Upland.

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INTRODUCTION

Badenian sulfate deposits of the Carpathian Foredeep recently attracted an increased interest especially because of the development of facies analysis. This method was successfully applied in studies on gypsum sediments in the Nida area in Poland, in the Western Ukraine and in the Czech Republic (see Bąbel, 1992, 1999a, b; Kasprzyk, 1993, 1999; Peryt *et al.*, 1994; Peryt, 1996; Peryt *et al.*, 1997; Rosell *et al.*, 1998). The aim of this paper is to present the gypsum section of the Racławice area on the Miechów Upland, which was omitted in the detailed facial investigations on the Badenian gypsum in Poland until now and to compare it with the adjacent Nida area (Fig. 1). The gypsum sequence of the Nida area is the best recognized one in the Carpathian Foredeep. The results of the facial research in this region have been recently presented by Bąbel (1999a, b) from outcrop data and by Kasprzyk (1999) from boreholes. The latter author investigated the entire northern margin of the Carpathian Foredeep. Peryt (1996) characterized similar gypsum section from the Western Ukraine.

GEOLOGICAL SETTING

The studied Racławice area is situated in the south-eastern part of the Miechów Upland, 40 km north-east of Cracow and about 20 km south-west of the Nida area (Fig. 1). The gypsum deposits are related to the Działoszyce Trough – one of the Middle Miocene troughs situated south-west of the Holy Cross Mountains.

On the Miechów Upland gypsum deposits overlie the Lower or Middle Badenian deposits: quartz sands named Heterostegina sands and clay or marls of the so called Baranów beds or lie directly on the eroded Mesozoic basement (Fig. 2; Krach, 1947; Radwański, 1968). The gypsum deposits are overlain by clays and sands of the Late Badenian or Sarmatian age or by Quaternary clastics, especially by loess (Osmólski, 1972; Woiński, 1991).

The sulphate deposits of the Miechów Upland were not described in detail by former authors because of the lack of good outcrops in this region (Zejszner, 1862; Michalski, 1884; Krach, 1947, 1962; Łyczewska, 1965; Radwański, 1968; Kwiatkowski, 1972, 1974; Osmólski, 1972; Peryt &

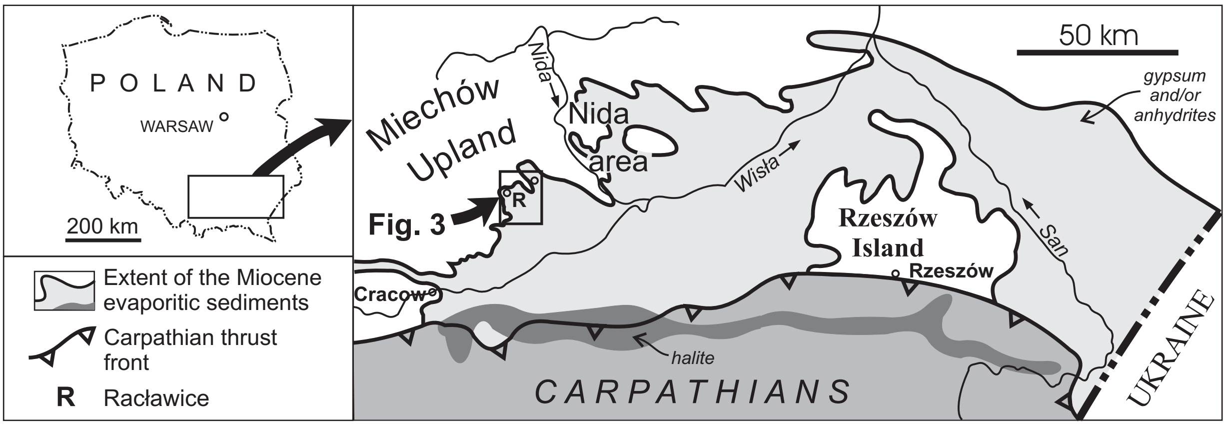


Fig. 1. General location of the studied area in the Carpathian Foredeep

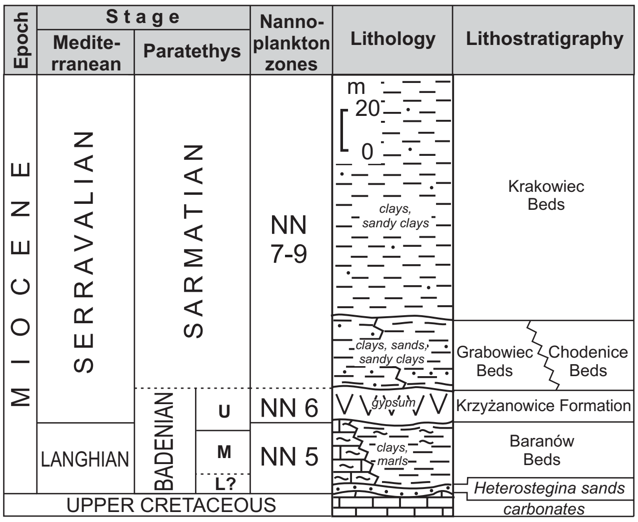


Fig. 2. Miocene sequence of the Działoszyce Trough. Lithostratigraphy and lithology after Krach (1947, 1962), Łyczewska (1965), Radwański (1968) and Oszczypko (1996). Stages and nannoplankton zones after Oszczypko (1996), Peryt (1999), Studencka (1999) and Andreyeva-Grigorovich *et al.* (2003)

Kasprzyk, 1992). Investigations in other parts of the Carpathian Foredeep showed that the gypsum sequence is in general very constant throughout the entire area (e.g. Kasprzyk, 1993, 1999; Bąbel, 1999a, b; Peryt *et al.*, 1994; Peryt, 1996; Peryt *et al.*, 1997; Rosell *et al.*, 1998). The base of the section is formed by large crystals often joined in pairs resembling twins of swallow-tail type (giant gypsum intergrowth facies), the middle part of the section is composed of gypsum built of small crystals with intercalations of alabastrine or stromatolitic gypsum and clay (grass-like gypsum facies) and gypsum built of characteristic curved crystals (sabre gypsum facies). The top of the sequence is formed by fine-grained, thin laminated gypsum (see Kubica, 1992; Kasprzyk, 1993, 1999; Bąbel, 1999a, b; Peryt, 1996). Detailed studies show that gypsum development in each region is characterized by specific features.

METHODS AND MATERIALS

The area of detailed studies of an M.Sc. project spreads between Racławice – Kościejów – Bronocice in the north and Błogocice – Szczytniki – Gunów in the south. The easternmost villages are Racławice – Radziemice, the westernmost are Małoszów – Zakrzów and the town Skalbmierz. On the basis of the Detailed Geological Map of Poland 1:50000 and the literature data especially of Zejszner (1862) and Krach (1947) nine gypsum outcrops were found and investigated in this area (Fig. 3, localities 1 – 9). The outcrop north of Działoszyce (Fig. 3, locality 10) was investigated additionally in order to reconstruct the brine palaeocurrent in that region (see Roman, 1999). The aim of the project was to understand gypsum sedimentation on the basis of outcrop data, therefore the boreholes data of Osmólski (1972) were not reevaluated.

Sedimentary structures of different gypsum facies as well as debris specimens were observed and described in field studies. Detailed measurements of the thickness of each part of the gypsum sections were made in the field. Paleocurrent directions were measured in the sabre gypsum facies to reconstruct the paths of the brine flow. Crystallographic measurements were carried out on large crystals of palisade gypsum facies. The collected data were evaluated according to the facies analysis principles.

GYPSUM FACIES DISTINGUISHED IN RACŁAWICE AREA

Five gypsum facies were distinguished in the environs of Racławice: giant gypsum intergrowths, palisade gypsum, grass-like gypsum, sabre gypsum and microcrystalline gypsum (*sensu* Bąbel, 1999a, except of palisade facies). Giant gypsum intergrowths (ggi) and grass-like gypsum facies (glg) were observed only in small blocks within debris in Głupczów (ggi), Kościejów (ggi, glg) and Działoszyce (glg) as well as in the small outcrops in Kowalówka (ggi, glg) and Działoszyce (ggi). These two facies will not be described in detail here. Palisade gypsum, sabre gypsum and microcrystalline gypsum facies are well exposed in the Racławice area so their descriptions are given below.

Palisade gypsum

Palisade gypsum facies had not been distinguished so far. The occurrence of the palisade gypsum on the Miechów Upland was mentioned briefly by Bąbel (1987, Pl. 7, Fig. 2; 1990, Phot. 3–5, 16). The facies is built of large gypsum crystals 0.7 m in length, which are similar to the giant gypsum intergrowths (see Bąbel, 1990). Palisade crystals (Fig. 5) are box-shaped, vertically arranged in beds, forming dense structures resembling palisades. Some parts of the palisade gypsum layers are enriched with clay. In such a case palisade crystals are lens-shaped and do not form palisade structures but only separate clusters. One flat side surface is characteristic for outside view of a single palisade crystal (Fig. 5A, B). This surface is similar to the composition face of the giant intergrowths (Bąbel, 1990), but has a slightly different crystallographic orientation (Roman, 1998). Other side surfaces are built of the apices of smaller sub-crystals, which compose the complex internal structure of the crystals (Fig. 5B; see Bąbel, 1987). Palisade crystals do not form intergrowths.

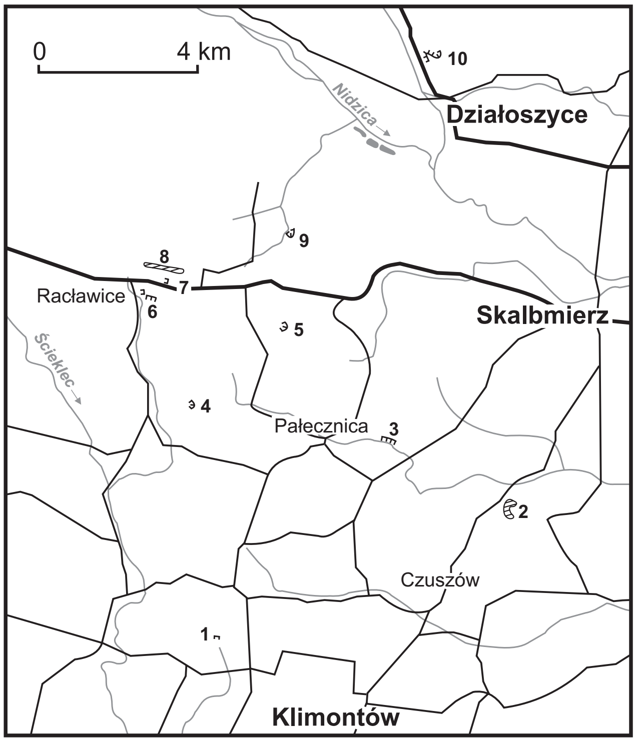
So called dissolution surfaces of synsedimentary dissolution are common within single palisade crystal as well as in the whole palisade gypsum beds.

The palisade gypsum facies crops out in Głupczów, Racławice-spring, Podgaje, Małoszów and was observed in debris in Pałecznica (see Fig. 4).

Interpretation. Palisade gypsum crystals grew simultaneously on the bottom of a shallow evaporative basin with their longer axis perpendicular to the basin-floor, similarly as the giant gypsum intergrowths (Bąbel, 1990, 1999a; Kasprzyk, 1993, 1999; Peryt, 1996). The brine was oversaturated with calcium sulfate only in a bottom part of the basin, which was density stratified (e.g., Bąbel, 1990, 1999a, b; Kasprzyk, 1993, 1999; Peryt, 1996). The abundance of dissolution traces indicates very shallow conditions and frequent interruptions of gypsum crystallization by fresh water inflows. Probably adjacent emerged areas like islands or peninsulas were the source of those inflows and of the clay material supplied into the basin.

Sabre gypsum

The main feature of the sabre gypsum facies is the occurrence of large, strongly elongated, curved crystals resembling sabres (Fig. 6; Bąbel, 1986, 1999a; Kasprzyk, 1993, 1999; Peryt, 1996). The facies forms one layer in the Racławice area, which can be divided into two parts, lower and upper, showing different appearance (see Fig. 4). Similar to the other parts of the basin the lower part of the sabre gypsum strata contains smaller, rod-like, chaotically arranged gypsum crystals in addition to the scarce large sabre crystals, below 0.5 m in length. This fabric corresponds to the so-called "skeletal gypsum facies" *sensu* Kasprzyk (1993) and Peryt (1996). In the upper part of the sabre gypsum strata space between sabre crystals are filled with granular gypsum and minor amounts of carbonate and clay. The curved crystals reach up to 1.18 m in length (Małoszów, Fig. 6B). The measurements of azimuths of the sabre gypsum crystals apices, which reflect direction of brine paleocurrent (Bąbel, 1992), showed that in the Racławice area the brine inflow came generally from the north-east (see Bąbel, 1992, 2002; Roman, 1999).



Localities:

1 Kowary
2 Małoszów
3 Pałecznica
4 Podgaje
5 Głupczów
6 Racławice-spring
7 Racławice-Widnica hill
8 Kościejów
9 Kowalówka
10 Działoszyce

Fig. 3. Studied area with the location of the investigated outcrops

The sabre gypsum facies crops out in Głupczów, Pałecznica, Racławice-spring, Racławice-Widnica hill, Kościejów, Kowalówka, Małoszów and Działoszyce.

Interpretation. The sabre gypsum facies crystallized under similar conditions as in the Nida area. The stable dense stratification of the basin enabled a permanent growth of the gypsum crystals on the basin floor (Kasprzyk, 1993, 1999; Bąbel, 1999a, b; Peryt, 1996). During the deposition of the lower part of the sabre gypsum strata gypsum crystallization occurred only on the basin floor. A strong increase of the brine salinity caused crystallization of gypsum in the whole water mass (Pawlikowski, 1982; Bąbel, 1999a, b). Lower amounts of oxygen in the stagnant highly saline bottom-brine impeded the initial growth of sabre crystals (Bąbel, 1999a, b). The upper part of the sabre gypsum strata was deposited. The depth of the evaporative basin was probably only a few meters (Kasprzyk, 1991; Bąbel, 1999a; Peryt, 1996).

Microcrystalline gypsum

This facies is formed by very thin laminated gypsum composed of grains less than 0.05 mm in size, with thin in-

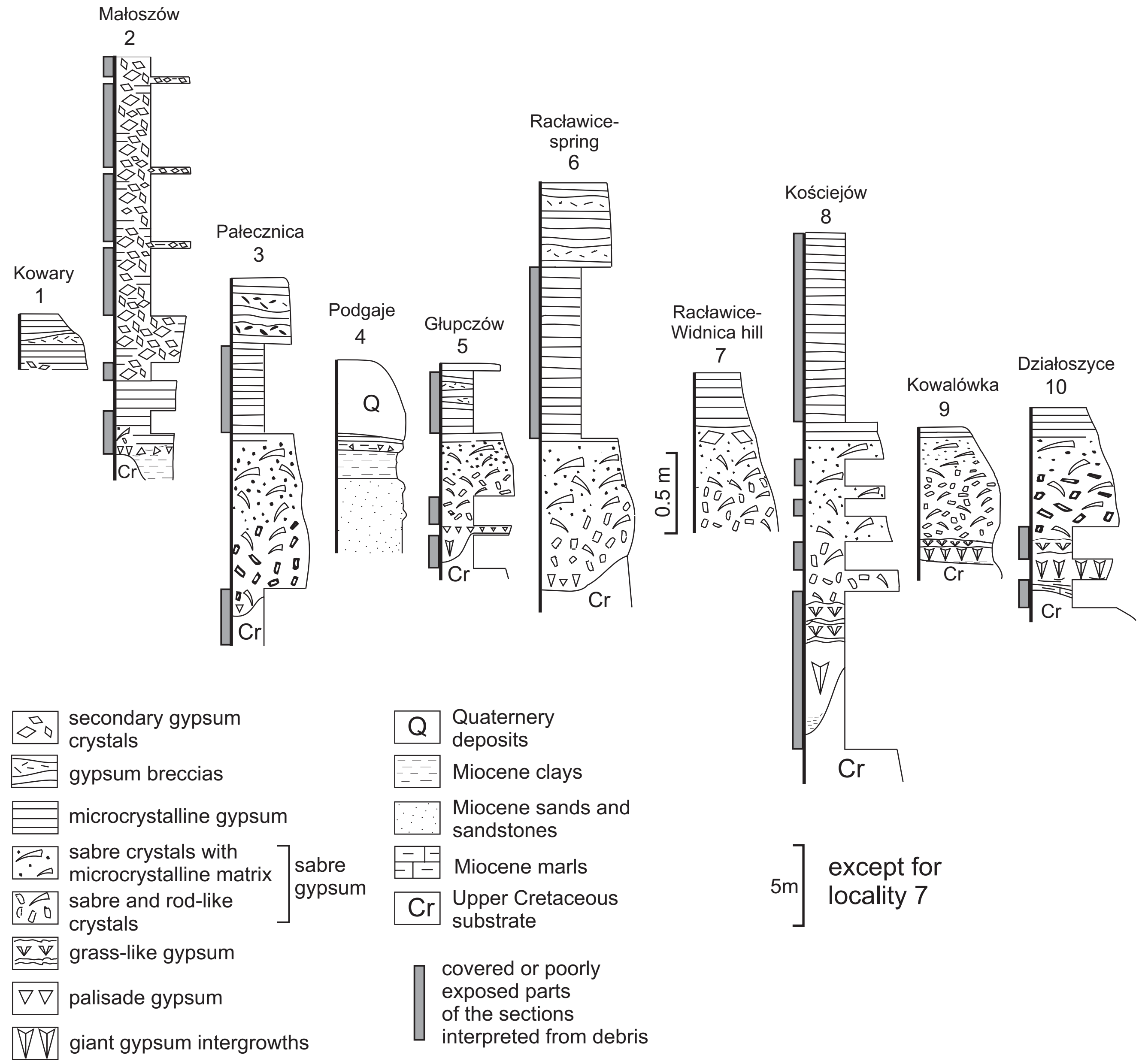


Fig. 4. Gypsum sections of the Racławice area

tercalations of carbonate, clay and organic matter of algal origin (Kwiatkowski, 1972; Niemczyk, 1988; Kubica, 1992; Bąbel, 1999a). The most common sedimentary structures are: very flat lamination, wavy lamination, wash-out structures, breccias (with and without matrix), microfolds and microfaults (Fig. 7; see also Kwiatkowski, 1972; Bąbel, 1991, 1999a). Traces after halite such as imprints of halite crystals, traces of dissolved halite crystals obliterated by gypsum mud or gypsum pseudomorphs after halite (see Kwiatkowski, 1972; Niemczyk, 1988; Bąbel, 1991; Kasprzyk, 1993, 1999) were observed only in the gypsum outcrop near Pałecznica.

The microcrystalline gypsum facies crops out in Głupczów, Pałecznica, Racławice-spring, Racławice-Widnica hill, Kowalówka, Podgaje, Małoszów, Kowary, Działoszyce and was observed as debris in Kościejów and many other localities in the region (Figs 3, 4).

Interpretation. Microcrystalline gypsum originated from gypsum grains settled on the basin floor either after crystallization in water mass or after redeposition (Pawlikowski, 1982; Bąbel, 1999a; Kasprzyk, 1999). The deficiency of oxygen in heavy bottom brine led to a lack of sulfate ions, precluding the growth of gypsum crystals and cementation of gypsum mud on the basin floor (Bąbel, 1991, 1999a). The long lasting unconsolidation of gypsum sediments enabled the formation of numerous deformational structures (Bąbel, 1991, 1999a). The rarity of traces after halite suggests that a state of oversaturation with sodium chloride was achieved rarely on the Miechów Upland. The depth of the basin during microcrystalline gypsum deposition is difficult to determine. After Kasprzyk (1999) an overall deepening took place, while Bąbel (1999b) postulates no differences between the basin depth during macrocrystalline and microcrystalline gypsum deposition.

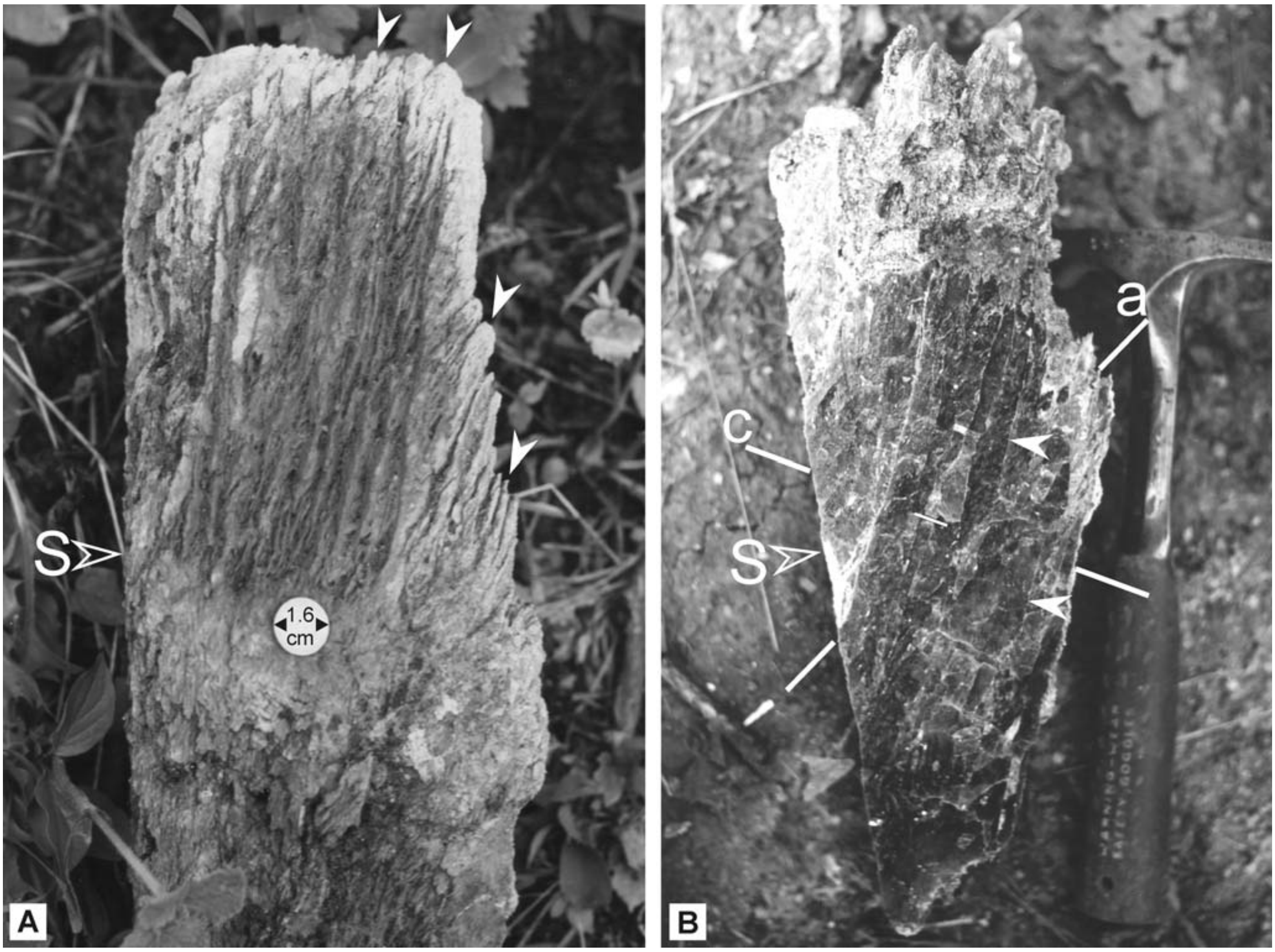


Fig. 5. Palisade gypsum facies: **A** – outside view of a single crystal, notice good developed apices of sub-crystals (full arrows), S – flat side surface, Racławice-spring, **B** – internal view of a palisade crystal with the crystallographic axis *a* and *c*, S – flat side surface, notice boundaries between sub-crystals (full arrows), Podgaje

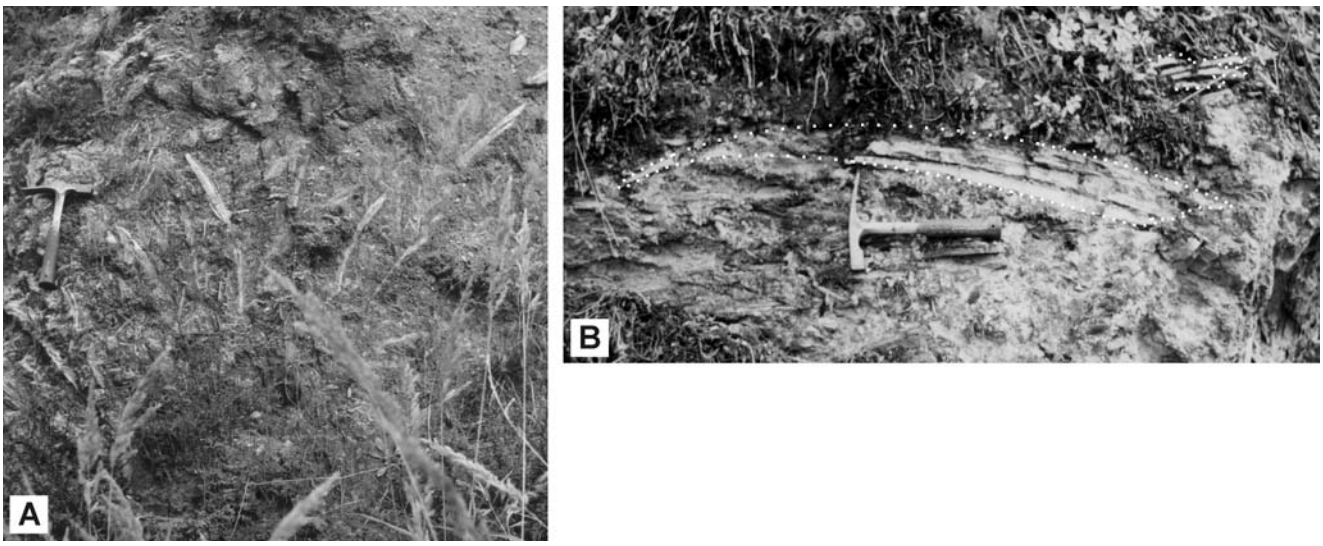


Fig. 6. Sabre gypsum facies: **A** – general view of the facies with long, curved crystals, Kowalówka, **B** – the longest sabre crystal (1.18 m in length), Małoszów

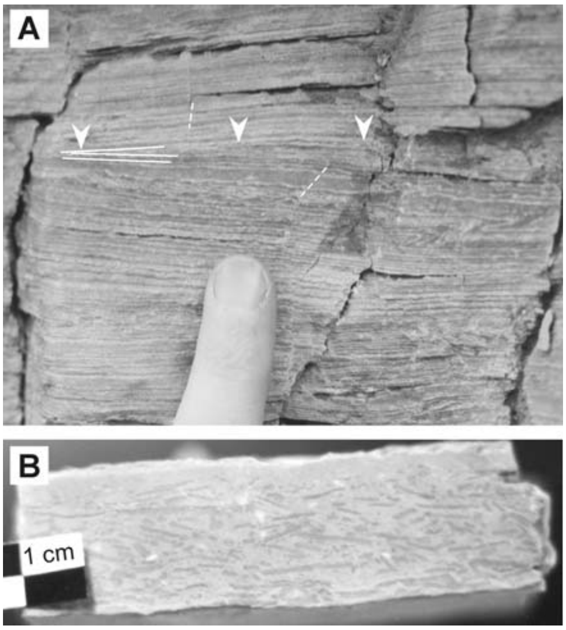


Fig. 7. Microcrystalline gypsum facies: **A** – sedimentary structures of the microcrystalline gypsum: flat lamination (upper and lower part of the picture), wavy lamination (above the finger), wash-out surface (arrows, full lines show eroded laminae), microfold (middle-right part of the picture) and microfaults (dashed lines), Pałecznica; **B** – gypsum breccia of single gypsum layers with alabastrine matrix, debris specimen, orientation of the specimen unknown, Głupczów

Porphyroblastic gypsum

This type of gypsum, which is not defined as a facies, is built of fine-grained gypsum matrix in which small gypsum crystals occur in a chaotic arrangement. The size of transparent and colourless or slightly brownish-yellow crystals is from few millimeters to few centimeters. Twins after *100* are very common. The porphyroblastic gypsum forms irregular bodies or layers within the microcrystalline gypsum. Gypsum of such a type was described by Bąbel (1992, 1999a) from the Nida area.

In the Racławice area the porphyroblastic gypsum crops out in Małoszów, Kowary and Racławice-Widnica hill (Figs 3, 4).

Interpretation. The porphyroblastic gypsum formed during early diagenesis of the microcrystalline gypsum (Bąbel, 1992).

FACIES DISTRIBUTION

The vertical succession of the gypsum facies is constant in the Racławice area (Fig. 8). The base of the sequence is built of the giant gypsum intergrowths often replaced by palisade gypsum. The giant gypsum intergrowths are overlain by the grass-like gypsum. The occurrence of palisade gypsum and grass-like gypsum facies in one section was not observed. The middle part of the complete succession is composed of sabre gypsum and its top is built of microcrystalline gypsum, partly replaced by porphyroblastic gypsum (Fig. 8). A very reduced section was observed in Podgaje where the microcrystalline gypsum overlies directly the palisade gypsum (see Fig. 4). The vertical facies succession in the locality Małoszów is not clear. In a part of the outcrop palisade gypsum is overlain by microcrystalline gypsum like in Podgaje and in another part of the outcrop two blocks of sabre gypsum were observed. Their position in the section is not clear.

The microcrystalline gypsum and the sabre gypsum facies spread out almost over the whole Miechów Upland (Fig. 9; Osmólski, 1972; Peryt & Kasprzyk, 1992). The giant intergrowths occur in the northern part of the Racławice area i.e. northwards of Głupczów. The palisade gypsum facies dominates in southern part of the studied area between Głupczów and Kowary. The grass-like gypsum facies occurs very rarely; it was found only in two outcrops in the northern part of the area (Figs 4, 9).

The total average thickness of the gypsum section in the Racławice area is 20 m (2 m in Podgaje and 31 m in Małoszów). The lithosome of the microcrystalline gypsum is the thickest one (up to 15 m). The maximum thickness of the sabre gypsum lithosome reaches 10 m. The thickness of the palisade gypsum lithosome and especially of the giant intergrowths and the grass-like gypsum lithosomes could be estimated only from the surface debris. It attains about 1 m for the palisade gypsum, up to 3.5 m for the lithosome of the giant gypsum intergrowths and up to 2.5 m for the lithosome of the grass-like gypsum. The latter two could be overestimated.

The top of the gypsum sequence is commonly eroded on the Miechów Upland (Kwiatkowski, 1972; Osmólski, 1972).

GYPSUM SEDIMENTATION

An episode of euxinic conditions preceded the gypsum deposition in the basin (e.g., Kwiatkowski, 1972; Pawlikowski, 1982; Bąbel, 1999b). This episode was very weakly expressed on the Miechów Upland (Krach, 1962; Woiński, 1991). Only a few pyrite occurrences were noticed in place of the *Ervilia* bed, well known in other parts of northern margin of Carpathian Foredeep (Osmólski, 1972). At the beginning of the gypsum deposition conditions enabling gypsum crystallization prevailed only at the basin bottom like in the adjacent Nida area (Peryt & Kasprzyk, 1992; Bąbel, 1999b). In this interval coherent crusts or rare isolated clusters of bottom-grown palisade crystals developed in the south of the Racławice area, and giant intergrowths formed in the northern part of this area. The growth of gypsum crystals of different form in similar sedimentary environments is difficult to explain. Probably it was a result of variation in basin depth and morphology as well as in frequency of fresh water inflows. If that applies the giant intergrowths would be characteristic for a deeper environment with scarce episodes of dilution and the palisade crystals could have developed in a shallower part of the basin that was diluted more often. The crystals of the giant intergrowths are generally bigger than the palisade ones and traces of dissolution in the giant intergrowths are rare. Fre-

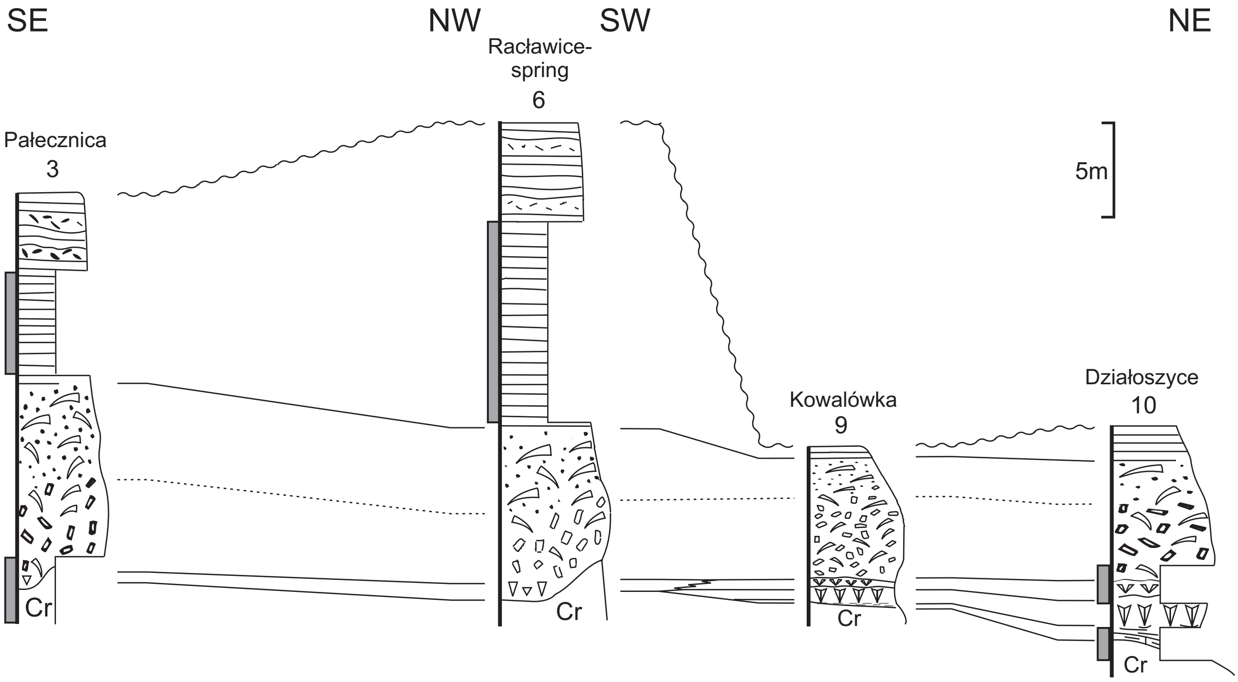


Fig. 8. Cross section of gypsum deposits of the Działoszyce Trough in the Racławice area. Wavy line for erosional top of the gypsum sequence. Further explanations as in Fig. 4

quent influences of fresh water could have been also the reason that the euxinic conditions preceding the gypsum sedimentation were very episodic on the Miechów Upland.

The crystallization of the giant gypsum intergrowths in the northern part of the Racławice area was ceased by basin shallowing like in the adjacent Nida area (Kasprzyk, 1993, 1999; Bąbel, 1999b). The deposition of a thin layer of the grass-like gypsum was a result of that environmental change (Kasprzyk, 1993, 1999; Bąbel, 1999b). At the same time the palisade gypsum deposition proceeded and probably spread northwards.

After a short shallowing episode the basin depth increased again and sabre gypsum crystallization began (Kasprzyk, 1993, 1999; Bąbel, 1999b). During deposition of this facies sedimentary conditions were uniform at the whole studied area and probably identical to those in the Nida area (Kasprzyk, 1993, 1999; Bąbel, 1999b; Peryt *et al.*, 1994). The morphology of the basin was not levelled before the sedimentation of sabre gypsum facies. Bąbel (1999b) postulates higher salinity in the basin during sabre gypsum deposition than at the beginning of gypsum crystallization. This is well documented by the occurrence of many crystallization centers in the sabre gypsum compare to the giant gypsum intergrowths or the palisade gypsum (Bąbel, 1999a, b) and by strontium content (Kasprzyk, 1994). On the Miechów Upland precipitation of gypsum in the water mass was lacking during the first phase of gypsum formation like in the Nida area (e.g. Bąbel, 1999a, b).

While the sabre gypsum was deposited, brine salinity increased enough to initiate gypsum crystallization in the water mass and fine-grained gypsum began to deposit on the basin floor (Kasprzyk, 1993, 1999; Bąbel, 1999a, b). The halocline rose and stable dense stratification depleted water circulation. Finally the development of the sabre crystals was completely ceased because of lack of sulfate ions in the bottom-brine (Bąbel, 1999b). The gypsum crystallization

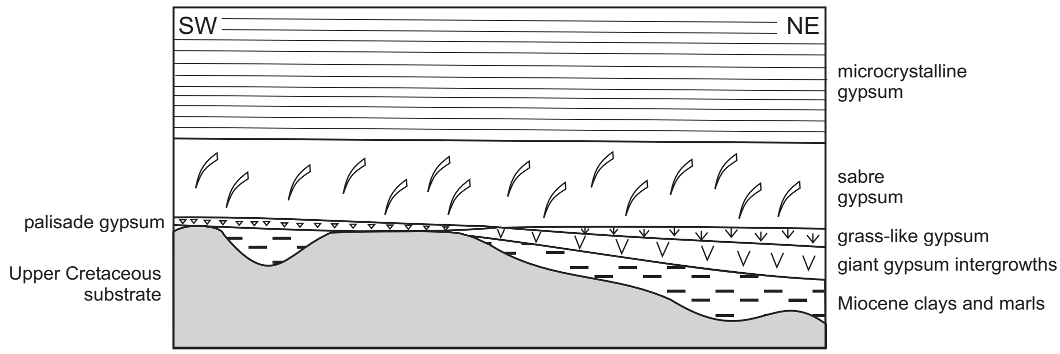


Fig. 9. A scheme of distribution of the gypsum facies in the Racławice area. Thickness not to scale

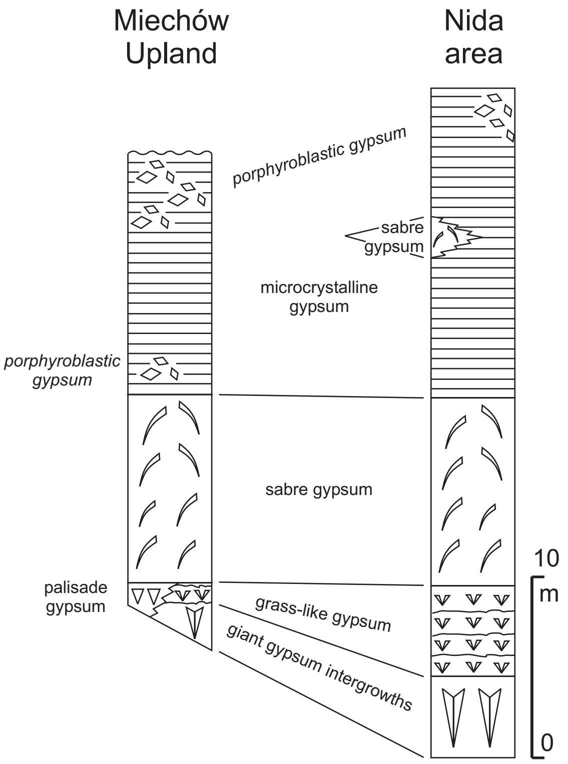


Fig. 10. Comparison of the generalized gypsum sequences of the Miechów Upland (Racławice area) and of the Nida area (after Bąbel, 1999a, b, modified)

took place in the water mass and deposition of the microcrystalline gypsum started (Pawlikowski, 1982; Bąbel, 1999b).

The advancing evaporation led to an oversaturation with natrium chloride in the most dense bottom brine initiating halite crystallization (Kwiatkowski, 1972; Kasprzyk, 1993; 1999; Bąbel, 1999b). Episodes of halite crystallization were more sporadic on the Miechów Upland than in the Nida area where the traces of halite and dissolution breccias were very common (Kwiatkowski, 1972; Bąbel, 1991, 1999a, b).

Evaporitic deposition in the studied area was ceased possibly by a decrease of brine salinity what was postulated for the Nida area as well as for the southern and the central parts of the Carpathian Foredeep (Garlicki, 1979; Bąbel, 1999b; Kasprzyk, 1999). The gypsum deposition was followed by clayey and sandy-clayey sedimentation indicating salinity characteristic for marine water (see Osmólski, 1972; Woiński, 1991).

DISCUSSION

The gypsum section on the Miechów Upland shows generally the same vertical arrangement of facies as in the whole northern margin of the Carpathian Foredeep and especially as in the Nida area (Fig. 10). The studied sequence is significantly reduced. The thickness of gypsum section in the adjacent Nida area is greater than 50 m (Kubica, 1992; Kasprzyk, 1993, 1999; Bąbel, 1999b), while on the Miechów Upland it seldom reaches 30 m (Osmólski, 1972; Kwiatkowski, 1974; Roman, 1998). The diminished thickness is especially distinct in the lower part of the sequence (Fig. 10). The giant intergrowths and the grass-like gypsum are commonly replaced by one thin layer of palisade gypsum which occurs only on the Miechów Upland. The development of the middle and upper parts of the studied gypsum section built of the sabre and microcrystalline gypsum facies is almost identical to those in the whole Carpathian Foredeep. This part of the section, especially the microcrystalline gypsum lithosome, displays also reduced thickness in the studied area. The second layer of the sabre gypsum, which divides the microcrystalline gypsum lithosome into two parts in the Nida area, was not observed on the Miechów Upland (Fig. 10).

The gypsum sedimentation in the studied area was very strongly influenced by fresh water input into the basin. The basin of the Miechów Upland was very shallow with a very variable morphology. It is possible that some islands or peninsulas of the Mesozoic basement existed before the sabre gypsum facies was deposited.

CONCLUSIONS

The gypsum section of the Miechów Upland was studied in detail in the Racławice area and was compared with the well recognized gypsum section of the adjacent Nida area.

1. Five gypsum facies were recognized in the studied area: giant gypsum intergrowths, palisade gypsum, grass-like gypsum, sabre gypsum and microcrystalline gypsum (partly replaced by porphyroblastic gypsum). The palisade gypsum facies has not been described in detail before.

2. The vertical arrangement of the facies is generally the same as in the Nida area and at the whole northern margin of the Carpathian Foredeep.

3. The studied sequence is significantly reduced – the thickness of the gypsum deposits on the Miechów Upland seldom reaches 30 m, that is 20 m less than in the adjacent Nida area.

4. The lower part of the sequence is especially diminished: giant intergrowths and grass-like gypsum are commonly replaced by one thin layer of the palisade gypsum.

5. The microcrystalline gypsum and sabre gypsum are the most common facies. The giant intergrowth and grass-like gypsum facies occur in the northern part of the studied area, the palisade gypsum facies dominates in the southern part of the studied area.

6. The development of gypsum basins of the Miechów Upland and Nida area is similar. The Miechów Upland basin was shallower and its brine was often diluted. The basin-floor morphology showed probably a variety of features including islands and peninsulas.

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Streszczenie

ROZWÓJ FACJALNY GIPSÓW BADENU (ŚRODKOWY MIOCEN) W OKOLICY RACŁAWIC (WYŻYNA MIECHOWSKA, POŁUDNIOWA POLSKA)

Anna Becker

Badeńskie osady ewaporatowe zapadliska przedkarpackiego wzbudzają coraz większe zainteresowanie dzięki rozwojowi analizy facjalnej. Utwory gipsowe Wyżyny Miechowskiej w południowej Polsce były omijane w dotychczasowych szczegółowych analizach ze względu na brak dużych odsłonięć w tym rejonie. W niniejszej pracy przedstawione są pierwsze wyniki analizy facjalnej gipsów okolic Racławic w południowej części Wyżyny Miechowskiej, 40 km na północny-wschód od Krakowa (Fig. 1). W pracy porównano profil gipsowy badanego obszaru z dobrze rozpoznanym profilem gipsów nadnidziańskich. Osady ewaporatowe Wyżyny Miechowskiej są podścielone przez utwory dolnego lub środkowego badenu, do których należą piaski heterosteginowe oraz warstwy baranowskie (Fig. 2; Krach, 1947; Radwański, 1968). Gipsy mogą również leżeć bezpośrednio na górnokredowym podłożu (Radwański, 1968). Osady ewaporatowe są przykryte przez utwory górnego badenu lub sarmatu lub przez utwory czwartorzędowe (Osmólski, 1972; Woiński, 1991).

Badaniami objęto 10 następujących odsłonięć: Kowary, Małoszów, Pałecznica, Podgaje, Głupczów, Racławice-źródło, Racławice-góra Widnica, Kościejów, Kowalówka i Działoszyce (Fig. 3). Wyróżnionych zostało pięć facji gipsowych: gipsy szklicowe, gipsy trawiaste, gipsy palisadowe, gipsy szablaste i gipsy mikrokrystaliczne (*sensu* Bąbel, 1999a, oprócz gipsów palisadowych). Gipsy szklicowe i trawiaste występują na badanym obszarze jedynie w postaci niewielkich bloków i rumoszy (Głupczów, Kościejów, Kowalówka, Działoszyce) dlatego nie zostały one dokładnie scharakteryzowane. Gipsy palisadowe, gipsy szablaste i gipsy mikrokrystaliczne są odsłonięte stosunkowo dobrze (Fig. 4). Gipsy palisadowe, po raz pierwszy opisane szczegółowo w niniejszej pracy, a stwierdzone już przez Bąbla (1987, Pl. 7, Fig. 2; 1990, Phot. 3–5, 16) są zbudowane z kryształów gipsu osiągających do 0.7 m długości, podobnych do kryształów szklicowych (Fig. 5). Kryształy palisadowe mają kształt zbliżony do prostopadłościanów i nie tworzą zrostów. Częste są ślady rozpuszczania. Gipsy palisadowe tworzyły się w podobnych warunkach jak gipsy szklicowe (Bąbel, 1999a; Kasprzyk, 1999; Peryt, 1996). Narastały one na dnie płytkiego basenu ewaporatowego w postaci zwartych pokryw. Krystalizacja gipsu była często przerywana epizodami dopływu wysłodzonych wód, które częściowo rozpuszczały powstały gips.

Gipsy szablaste zbudowane są z długich, zakrzywionych kryształów gipsu, przypominających szable (Fig. 6; Bąbel, 1999a; Kasprzyk, 1999; Peryt, 1996 etc.). Warstwa gipsów szablastych dzieli się na dwie części, dolną i górną, o różnym wykształceniu. W dolnej części przestrzenie pomiędzy kryształami szablastymi (do 0,5 m długości) wypełnione są przez chaotycznie ułożone, drobne kryształy o pałeczkowatym pokroju. Struktura ta przypomina gipsy szkieletowe *sensu* Kasprzyk (1993). W górnej części przestrzenie pomiędzy kryształami szablastymi (do 1,18 m długości) wypełnia gips mikrokrystaliczny. Sedymentacja gipsów szablastych przebiegała identycznie jak na Ponidziu (Bąbel, 1999a; Kasprzyk 1993, 1999). Kryształy narastały na dnie basenu w solance o rozwarstwieniu gęstościowym. Pod koniec sedymentacji zasolenie wzrosło na tyle, iż doszło do krystalizacji gipsu w toni wodnej.

Gipsy mikrokrystaliczne są zbudowane z bardzo drobnych kryształów gipsu (do 0,05 mm, Kwiatkowski, 1972; Niemczyk, 1988; Kubica, 1992; Bąbel, 1999a). Najczęstszymi strukturami sedymentacyjnymi są: płaska laminacja, laminacja falista, powierzchnie rozmycia, brekcje, mikrouskoki i mikrofałdy (Fig. 7). Ślady po kryształach halitu występują rzadko. Gipsy mikrokrystaliczne powstały z osadzenia na dnie basenu kryształów wytrąconych w toni wodnej lub redeponowanych (Pawlikowski, 1982; Bąbel, 1999a; Kasprzyk, 1999). Do nasycenia solanki względem halitu dochodziło epizodycznie. Gipsy mikrokrystaliczne zostały częściowo diagenetycznie przekształcone w gipsy porfiroblastyczne (Bąbel, 1992).

Gipsy szablaste i mikrokrystaliczne są najbardziej rozprzestrzenione i występują na całym badanym obszarze (Fig. 8). Gipsy palisadowe dominują na południu badanego terenu, pomiędzy Kowarami i Głupczowem, podczas gdy gipsy szklicowe i trawiaste występują głównie na północ od Głupczowa (Fig. 8). Pionowa sukcesja gipsów Wyżyny Miechowskiej jest stała, identyczna jak w całym północnym obrzeżeniu zapadliska przedkarpackiego (Fig. 9). Całkowita miąższość sekwencji gipsów rzadko osiąga 30 m, czyli jest o ok. 20 m mniejsza niż na Ponidziu (Fig. 10). Szczególnie zredukowana jest dolna część profilu obejmująca gipsy szklicowe i trawiaste, które często zastąpione są jedną cienką warstwą gipsów palisadowych (Fig. 10). Przebieg sedymentacji gipsów nie odbiegał znacząco od sedymentacji gipsów Ponidzia. Basen Wyżyny Miechowskiej był prawdopodobnie płytszy i miał bardzo urozmaiconą morfologię dna. Często dochodziło również do rozcieńczania wód basenu przez wody z lądu.