Discontinuity in Upper Permian (Zechstein) Succession of Evaporites in Eastern Pomerania, Poland

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ABSTRACT

In Eastern Pomerania, Poland, the Upper Permian, (Zechstein) saliferous Formation was deposited in the marginal basin of Gdańsk Bay separated from the main basin of Central Europe by the Koszalin-Grudziądz structural element. The area of that secondary basin covers the geological regions of Leba Elevation and adjoining Baltic Syneclize.

Close to the end of Zechstein 1 (Z1) time the substratum was uplifted resulting in emergence of the oldest salts and a break in normal succession of evaporites. Karst phenomena developed during continental phase of Z2. The renewed normal sedimentation started with the transgression of the "gray salty clay" (Grauer Salzton) sea of Z3 time.

INTRODUCTION

The author refers to the paper presented at the Third Symposium on Salt, Cleveland, Ohio, U.S.A., April 1969. (J. Poborski: "The Upper Permian Zechstein in the Eastern Province of Central Europe"). There a general lithofacies map of Zechstein series in Poland and partly U.S.S.R. was provided and described, the area of the sedimentary basin having been divided into three fields of the following facies: 1) Central field of chloride facies which is potassium-bearing, 2) Surrounding zone of chloride facies without potassium salts, and 3) The peripheral, sulphate-carbonate-littoral facies.

Within the borders of the salt basin proper (chloride facies) the Zechstein was differentiated cartographically into two parts: the lower comprising stage Z1 + Z2 and the upper one, Z3 + Z4. This could not be done in the peripheral zone.

In the described province (Fig. 1), the distinctness of the Zechstein profile in the zone of Polish anticlinorium and the adjacent synclinoria was emphasized as correlated to the Hanover standard in the North German Lowland.

In the northern part of the country, the area covered by chloride facies is divided by a wedge of littoral facies widening northwestward to the Baltic Sea. Along the axis of this wedge (Koszalin-Grudziądz), between Lower and Upper Permian time there must have existed an archipelago built of old Paleozoic rocks which was degraded during deposition of Zechstein Z1 and Z2. To a certain point, this archipelago formed a barrier which dismembered the central area of the basin, i.e. chloride facies field.

The paper presented at the V-th Symposium on Salt is offered on the abnormal Zechstein sequence within a marginal basin of Gdańsk Bay, ranging over the geologic regions of Eastern Pomerania, the so-called Leba Elevation and Baltic Syneclize. The unusual paleogeographic conditions for Zechstein sedimentation have been considered as well.

ADVANCES IN GEOLOGIC RECOGNITION OF ZECHSTEIN SALT BASIN IN POLAND

The first lithofacies map of the Polish Zechstein basin, drawn by the author in 1957, was published in a special geological atlas of Poland, prepared for the celebrations of the 40th anniversary of the foundation of Geological Institute (State Geological Survey) of Poland ("Wyd. Geol.", Warsaw 1960). In the years 1961–70 subsequently revised and supplemented versions of that map were published. The latest revised version, prepared in 1975, presents the fifth member in the evolutionary series of the image of the Zechstein salinary basin in the eastern province of Central

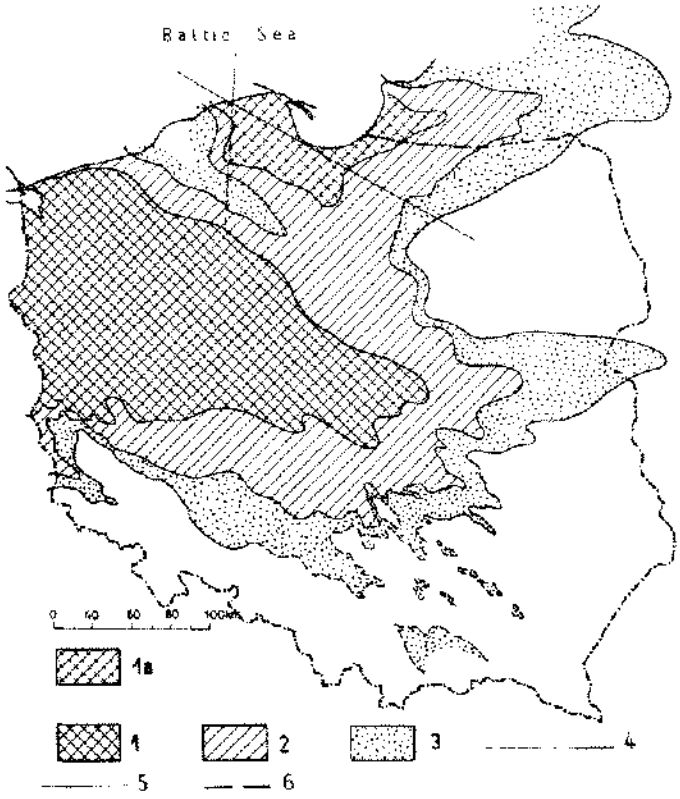

Figure 1. Sketch lithofacies map of Zechstein basin in the eastern province of Poland. 1, field of chloride facies (rock salt) with Mg and K salts; 1a, field of chloride facies with Mg-K salts mostly destroyed by karst processes; 2, field of chloride facies (rock salt) without Mg-K salts; 3, peripheral zone of sulphate-carbonate-littoral facies; 4, section line for Figure 2; 5, section line for figure 4 (chronostratigraphic situation); 6, section line for figure 5.

Europe. Figure 1 shows a highly generalized sketch of the last map which was prepared in editional scale 1:1.000.000.

The area of the basin is as well divided into 3 lithofacies fields (Fig. 1). All Zechstein stages (Z1, Z2, Z3, Z4) have been integrated. Concentric arrangement of the fields may be noted too. Contrary to previous views, however, the central potassium-bearing field has no extension toward the northeast, but there must have been an additional potash field of Gdańsk Bay.

ABNORMAL ZECHSTEIN SEQUENCE

The region of Leba Elevation is a 40–50 km broad zone stretching along the Baltic coast up to Puck Bay. The Zechstein Formation lies fairly flat, dipping 2–3° toward SES. It ranges from 300 to 400 m in thickness, increasing in the dip direction. About 20 years ago, the regional position of the formation was fixed in the first section across Leba Elevation, based on 3 wells (Fig. 2).

From the very beginning of our investigation, the Zechstein section in that region has appeared unusual and difficult for stratigraphic subdivision. It consists of the following lithologic sections in stratigraphic order (Fig. 3).

Section A. Conformable superposition of the classic members of the Zechstein 1 stage, i.e., 1) "Weissliegendes", 2) copperbearing shale (barren), 3) Zechstein limestone, 4) lower anhydrite, 5) log of the oldest rock salt which used to be broken off at different heights, the reconstructed primary thickness approaching 190 m or more.

Section B. "Descendant" rock salt of unusual lithological kind, unequally coarse grained without stratification, occasionally containing suspended clay, anhydrite or poly-

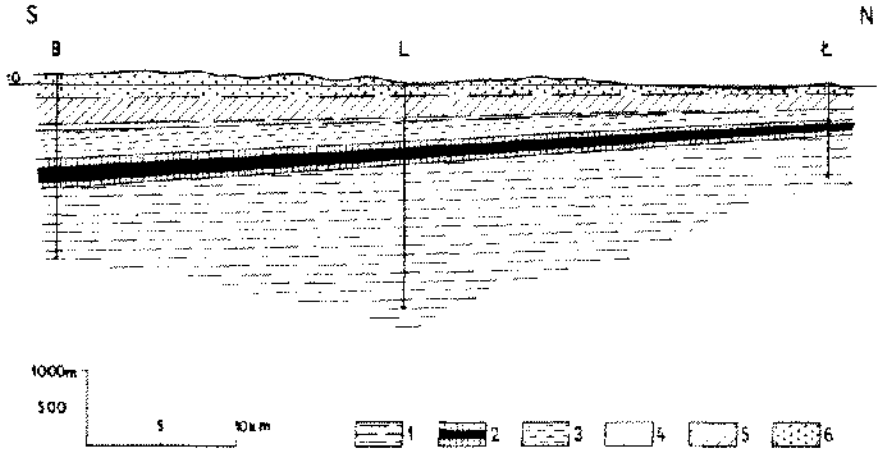

Figure 2. Zechstein position in the section over Leba Elevation 1, Silurian shales; 2, Zechstein Formation including rock salt (black); 3, Lower Triassic "Buntsandstein"; 4, Jurassic; 5, Cretaceous; 6, Cenozoic.

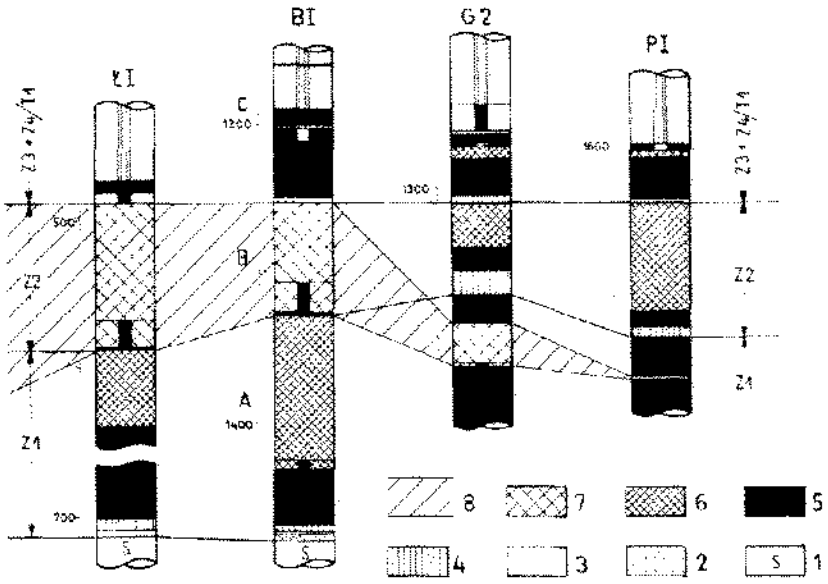

Figure 3. Abnormal Zechstein profile in the Leba Elevation region. 1, Silurian; 2–7, Zechstein: 2, "Weissliegendes"; 3, clayey sediment; 4, carbonate dolostone, limestone, and marl; 5, sulphate anhydrite, gypsum; 6, chloride, i.e., rock salt in the normal Zechstein sequence; 7, "descendant" rock salt of epigenetic origin; 8, sedimentary break in the normal Zechstein succession.

halite, commonly underlain by anhydrite rock of the gypsum-cap type.

Section C. Alternating sedimentary sequence of low grade evaporites, carbonates, and sulphates, starting with clay and clayey anhydrite at the base. They are covered by marly shales, reddish colored and variegated, the tiny partings and intercalations of the lowest grade evaporites being usual.

In general the most of Zechstein key members are lacking.

STRATIGRAPHIC DECISIONS

In course of time the stratigraphic subdivision of the representative Zechstein log for Leba Elevation has been understood and explained as follows.

A sharp and conformable boundary between the sections B and C has been noted (Fig. 3). It is marked by the first continuous clayey horizon covering the irregular and uneven salty member (section B). This clay member was easy to correlate and identify with the "gray salty clay" (Grauer Salzton) overlain by the "main anhydrite" (Hauptanhydrit) or corresponding "platy dolostone" (Plattendolomit) at the base of Zechstein 3 stage (Z3).

The most striking feature, however, seems to be a sedimentary break or hiatus between the incomplete column of the oldest salts (Z1) and the basal member of the Z3 stage, "descendant" rocks of problematic origin filling up a gap of this kind.

Regardless of the sedimentary break (hiatus), the oldest salt sequence (Z1) must have been destroyed down to a certain level. However it is possible to drill through exceptional "fossil" monadnocks or outliers which represent the preserved upper horizons of the oldest salts (Z1). At this position a remnant of the kieseritic carnallite bed was discovered to be the oldest potash bed within the marginal basin of Gdańsk Bay.

Section C may be subdivided into the stages Z3 and Z4 following the sulphate or carbonate layer corresponding to the "Pegmatitanhydrit". The uppermost clayey and marly shales of this section are likely the transition beds from the stage Z4 to the "variegated sandstone" (Buntsandstein) of the Lower Triassic.

SEDIMENTATION VERSUS THE PALEOGEOGRAPHIC BACKGROUND

In the area of Leba Elevation as well as in the adjoining zone of Baltic Syneclize, the Zechstein sedimentation started with deposition of typical stratigraphic members of the Z1 stage. However, close to the end of the Z1 time the substratum of the basin was uplifted, resulting in emergence of the oldest rock salt including potash bed at the higher horizon. Then a break in normal sedimentation of the evaporites took place. Such a diastrophic phenomena must have occurred within a region covering the Leba Elevation and the adjoining Baltic Syneclize.

Figure 4 shows chronostratigraphic situation during the Late permian Zechstein along the NW–SE section from the vicinities of Leba to Elblag (Fig. 1). Vertical strokes mark

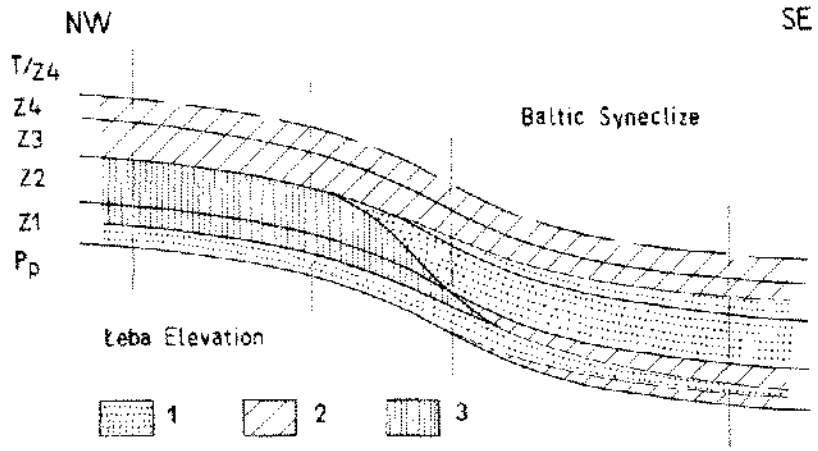

Figure 4. Chronostratigraphic situation during the late Permian along the NW-SE section through Leba Elevation and Baltic Syneclize. 1, chloride facies sedimentation; 2, sulphate-carbonate facies sedimentation; 3, sedimentary break in normal Zechstein succession.

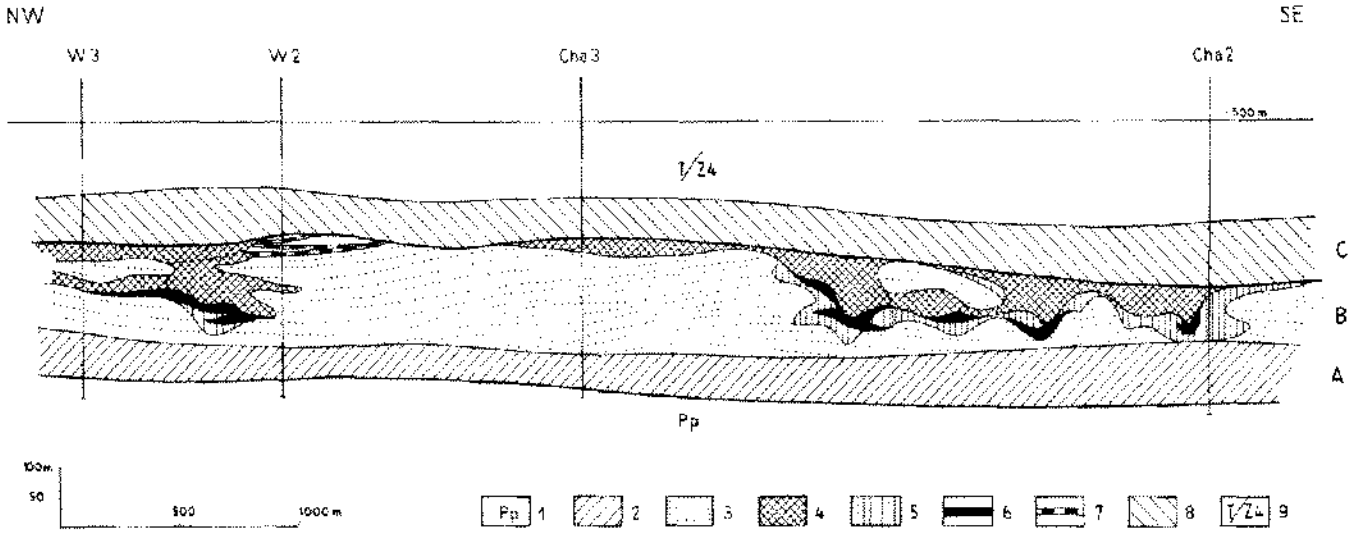

Figure 5. Irregularities in Zechstein succession upon the Puck Bay. 1, Pre-Zechstein substratum; 2, lower part of Zechstein Formation as a whole (A); 3–7, middle part of Zechstein Formation (B): 3, the oldest rock salt; 4, "descendant" rock salt of epigenetic type; 5, anhydrite and gypsum cap; 6, polyhalite rock nests and veins; 7, primary Mg-K salt of chloride type, remnant of the carnallite rock layer; 8, upper part of Zechstein Formation as a whole (C); 9, Permotriassic clays of the transition beds.

the part of the section corresponding to a gap in normal Zechstein sedimentation. At the same time it may be noted that this sedimentary gap in the area of Leba Elevation comprises the whole Z2 stage as well as the uppermost part of the Z1 stage, which pinches out southeasterly.

The potash field of primary extension in the basin of Gdańsk Bay might be reconstructed approximately (Fig. 1).

THE RESULTANT KARST PHENOMENA OF HALOGENIC TYPE

During the continental stadium, close to the end of Z2 time, when climate changed from arid to humid, there was an intense development of karst phenomena in Leba Elevation area. The oldest rock salt layer was subjected to leaching and there originated an hydrographic network comprised of dolines, karst depressions and a complex system of underground caves. Negative phenomena of such type were more intensely developed in the areas of stronger uplift of the substratum as may be observed in the more detailed maps.

At the end of Z2 time all negative karst forms underwent complete infilling as a result of development of positive halogenic phenomena. Residuum after dissolution of the oldest rock salt, i.e., mostly gypsum, formed a typical gypsum cap. The gypsum or anhydrite was locally subjected to

further secondary alteration under the influence of magnesium-potassium lye which resulted in polyhalitization of calcium sulphate, a common metasomatic process. Thus some nests and veins of polyhalite rock occur within the fossil gypsum cap as well as in the underlying anhydrite of the Z1 stage.

The negative karst features were finally filled with brines. "Descendant" salts precipitated from these saturated solutions as the main product of positive karst phenomena of halogenic nature. This resulted in complete infilling of crystal caves and karst depressions.

At the beginning of the Z3 epoch the sea of "gray salty clay" (Grauer Salzton) transgressed the Leba Elevation area and sedimentation of evaporites of sulphate-carbonate-littoral facies began again.

Figure 5 shows a segment of the geological section over the chosen field upon the Puck Bay where irregularities within the Zechstein formation have been reconstructed.

DISCUSSION

G. Richter-Bernburg:

Question. Es ist von großregionalem Interesse, daß am Nordrande des Zechsteinbeckens ähnliche Erscheinungen entdeckt worden sind, wie wir sie im Spessartgebiet (= Südrand des Beckens) kennen: Verkarsteter Z1-Kalk, von Z3 bzw. Z4 überlagert. Z2 und Z3 waren Zeiten des Meeresrückgangs oder randlicher Trockenlegung.

Answer. This is probably a question of the position of altitude of the sea level.