On the Tectogenesis of Some Diapiric Salt Structures in Central Poland, Upper Permian

Jozef W. Poborski
Academy of Mining and Metallurgy
Krakow, Poland

ABSTRACT

The Upper Permian Zechstein salt structures in central Poland reveal upward movement of the lowest unit more than 6,000 meters. Stratigraphic and geophysical studies at Klodawa in the Kujawy region form the basis of this preliminary report.

INTRODUCTION

The Upper Permian Zechstein in the Eastern Province of central Europe was described by the author in 1970. There a lithofacies map of the Permian salt basin was provided to show the concentric displacement of facies. Within the central potash-bearing field in the Kujawy region, central Poland, a group of diapiric domes has been discovered which ascend from a depth which exceeds 6,000 meters. Some of these are exploited by underground mine workings at Inowroclaw, Klodawa, and Wapno.

The salt domes were formed during more than ten halokinetic stages extending from the late Triassic to Quaternary. All these movements are reflected in the pattern of internal structure which might have been recognized by subsurface cartographic methods.

TECTONIC STUDIES

A special tectonic study was undertaken to decipher the successive halokinetic stages based on drawings of inner structures of the domes as exposed in the form of geologic cross sections. Thus the tectogenesis of those domes has been deduced in general. Several tectonic phenomena were revealed by the study. It appears, for example, that even the oldest stratigraphic members of the Zechstein participated in the formation of the upper part of some salt domes in the Kujawy region.

The tectogenetic process has been studied first on the basis of cross-sections over Klodawa salt structure which was reconstructed throughout its whole height and considered against the background of structural geology of the region.

The salt structure of Klodawa, as well as its prolongation, grew up in a horizontal zone which strikes NW-SE along the margin of the East-European Pre-Cambrian platform in the deep subsurface (Fig. 1). The diapiric structure itself is 26 km long and 1–2 km broad in the uppermost part, its height has been determined to be about 7 km by geophysical methods. The stratigraphic column of the salt formation is composed of four evaporate cyclothems denoted as the stages: Z1 (the oldest salts), Z2 (older salts), Z3 (younger salts), and Z4 (the youngest salts). At the same time, the column can be divided into two contrasting segments from the point of view of rock mechanics.

1) a lower segment containing stage Z1, Z2 and lower part of the stage Z3 where thick masses of chlorides predominate; and

2) an upper segment consisting of the upper part of the stage Z3 as well as stage Z4 with its prevailing salty clays. Such a lithological bipartition must have been reflected in the tectonic processes.

INTERPRETATION

The following sequence of tectogenetic phenomena can be deduced in a simplified way.

Two waves of halokinetic flow were followed gravitationally the inclined planes from the opposite sides, i. e. from SW and NE. They collided with each other in form of two salt folds inclined or nearly recumbent, thus originating the Klodawa structure (Fig. 2a). Those forms initiated the plastic growth of two salt anticlines built up of the lower segment of the salt formation. They are observed

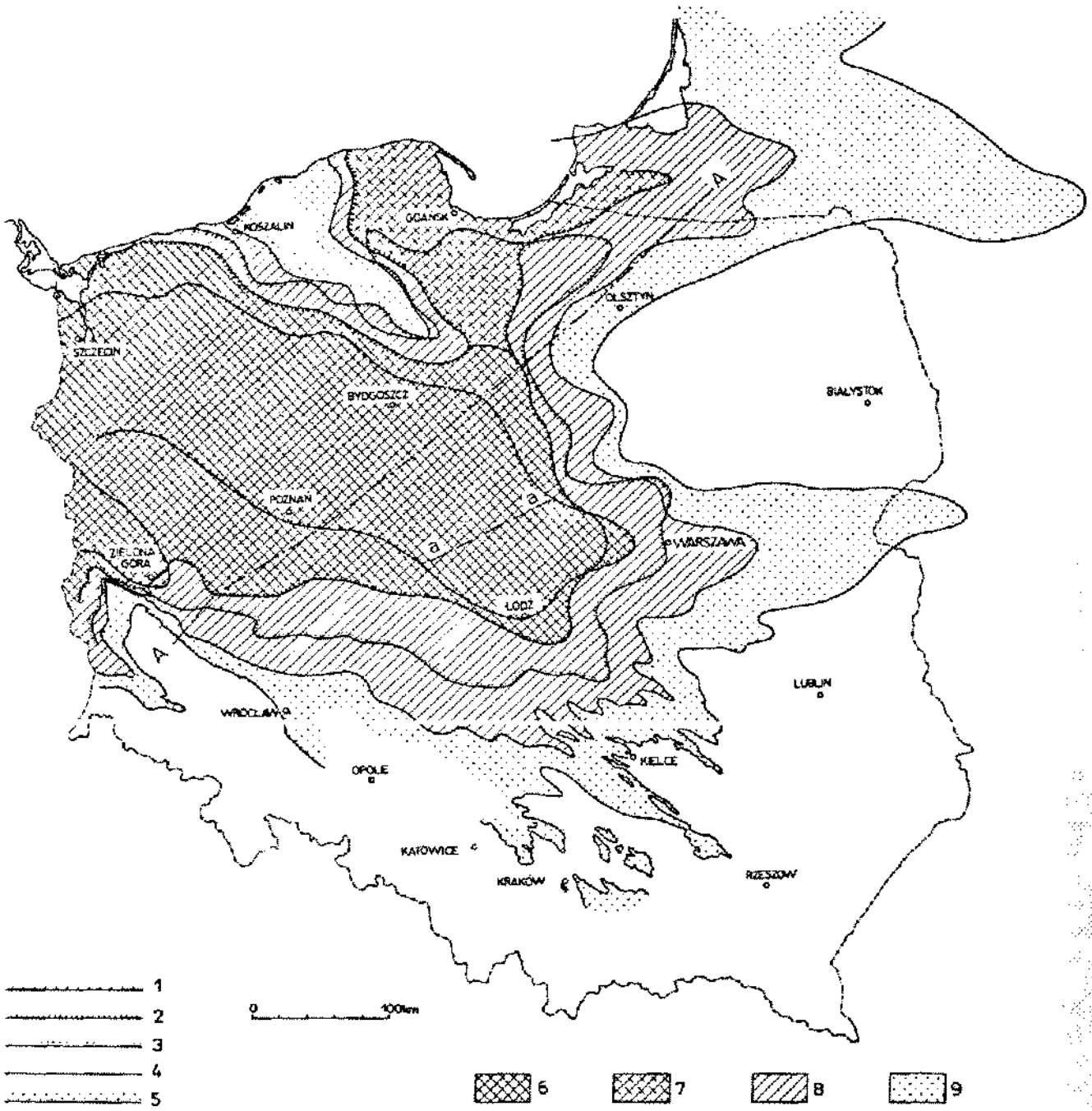

Figure 1. General lithofacies map of the Upper Permian Zechstein Series in Poland and Lithuania (USSR). Limit of the chloride facies with Mg-K salts in the upper division of the Zechstein (Z3 + Z4); (2) Limit of the chloride facies with Mg-K salts in the lower division of the Zechstein (Z1 + Z2); (3) Limit of the chloride facies (without Mg-K salts) in the upper division of the Zechstein (Z3 + Z4); (4) Limit of the chloride facies (without Mg-K salts) in the lower division of the Zechstein (Z1 + Z2); (5) Limit of peripheral facies (sulfate-carbonate, littoral facies); (6 & 7) Chloride (rock salt) facies which is potassium-bearing; (8) Chloride (rock salt) facies without potassium salts; (9) The peripheral, littoral, carbonate-sulphate facies.

now as the so-called border anticlines (Fig. 2b), i. e. southwestern and northeastern one, divided by a very deep syncline where the upper segment of the salt formation had been squeezed and brecciated to some extent. Both anticlines tightened together along a big fault zone in the deep substratum which is deflected in Mesozoic cover as the southwestern border line of Kujawy Ridge "Anticlinorium."

Within the border anticlines of the prime order (Fig. 2a) some phenomena of importance for structural geology were observed. These are the zones of sudden gas and rock outbursts in the mine which must have been predisposed as follows:

1) In the early halokinetic stage, during the Triassic, when the salt waves were creeping down following the substratum plane inclined to SW, at the width of Kujawy Ridge, the low-angle thrust the oldest salts (Z1) over the older ones (Z2). These overthrust planes were folded at a later stage.

2) During Jurassic and Cretaceous, however, the dip direction of the substratum plane turned away to the NE. At the same time the substratum platform was dissected into acute-angle overlapping blocks.

3) In course of time, the main fault in the substratum was growing larger and larger as much as one or two thousand meters. In this connection one may recognize the large displacement, i. e. the plastic pulling up and exposure of the oldest (Z1) and older (Z2) salts in the south-western anticline against the nucleus of the substratum. This nucleus turned up at a sharp angle and must have been pulled up by halokinetic forces as if flowing up in a current of salt. That is why even the lowest members of the oldest salts (Z1) may be mapped by subsurface methods in the mines.

CONCLUSIONS

The type of salt structure described above may be considered the most significant within the zone above the western margin of the East-European Pre-Cambrian platform.

The vertical displacement of the main fault in the deep subsurface as well as halokinetic phenomena appear very large. However, it seems that the horizontal components of epeirogenic movements played an important part in tectogenesis of the salt structure.

In general, the classic theory (Trusheim, 1957) of halokinesis developed originally in the German Lowland may

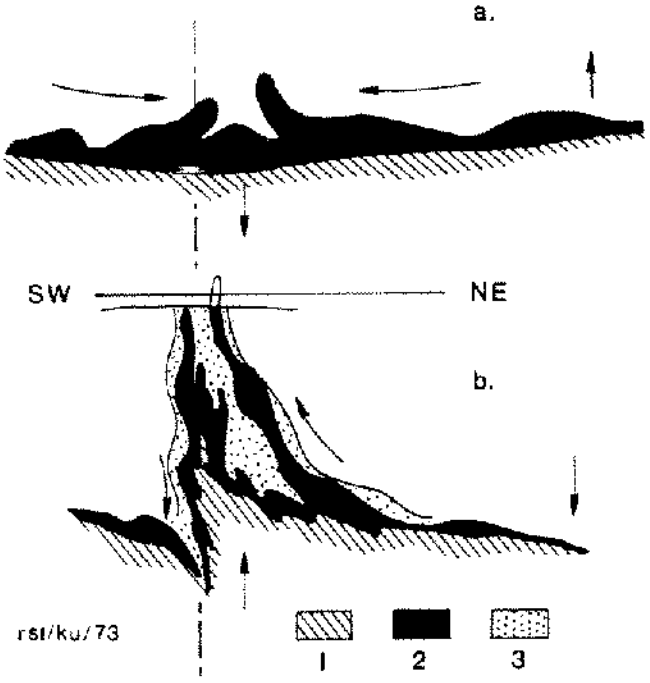

Figure 2.

be modified. All independent movements of salt masses result from gravitational forces. These flows, however, are initiated or at least connected with epeirogenic movements.

It is the first time that the occurrence of the oldest members of the Zechstein formation within the upper part of these diapiric structures has been noted. These strata, including the "Kupferschiefer" key bed must have been sheared off from underlying rocks of Lower Permian (Rotliegendes) and later brought up with the salt flow.

The recorded tectonic phenomena placed a new light on the question of hydrocarbon occurence which possibly may be derived from the older Paleozoic. Bituminous occurrences and sudden gas and rock outbursts within the salt mines can thus be explained.

REFERENCES

Poborski, J. W., (1970) The Upper Permian Zechstein in the eastern province of central Europe. *Third Symposium on Salt*, 1:24–29. Northern Ohio Geo. Soc., Cleveland, Ohio.

Trusheim, F., (1957) Über Halokinese und ihre Bedeutung für die strukturelle Entwicklung Norddeutschlands. *Deutsche Geol. Ges. Zeitschr.* 109: p. 1.—