



PREFACE

The scientific conference entitled “Tertiary sulphur-bearing formation in the Carpathian Foredeep”, was organized by the Polish Geological Institute in Warsaw in autumn 1993. This meeting aimed to summarize a very fruitful period for sulphur exploration in Poland but unfortunately, this date coincided with a distinct decrease in demand on the world sulphur market. The results of several recent geological, petrographic, geochemical and hydrogeological studies of materials referring to sulphur deposits and regional geological structures as well as to other mineral resources co-occurring within the Tertiary of the Carpathian Foredeep were collected in this special issue of the *Geological Quarterly*.

Scientific studies, carried out on stratiform native sulphur deposits and their surroundings by S. Pawłowski, K. Pawłowska and B. Kubica (see references throughout the papers collected in this volume) allowed development of a bioepigenetic hypothesis of Polish sulphur deposits and an outline of regional geology there. Besides exploration for commercial sulphur concentrations in the foredeep and basic scientific geological research, other independent, detailed studies (petrographic, mineralogical, geochemical, tectonic, geophysical, hydrogeological, etc.) were carried out. However, an important new problem arose during the last decades: an evaluation of the influence of sulphur exploitation on the natural environment.

The article of B. Kubica, starting this volume, presents in chronological order the history of sulphur discoveries in Poland from their beginning in the middle ages up to the most intensive and fruitful period of 1953–1976, when the giant sulphur deposits of the Carpathian Foredeep were found and documented. Phases of sulphur exploitation and deposits management during the last forty years as well as tendencies in sulphur output, consumption and export according to world trends are discussed in the work of S. Przeniosło, A. Dziedzic and A. Pizon.

Native sulphur deposits occur within the Miocene (Upper Tertiary) deposits of the Carpathian Foredeep. Their general characteristics and stratigraphy as well as geology of their basement in the northern, peripheral part of the foredeep, is summarized by K. Pawłowska. The geological pattern of the Miocene in the central part of this trough and related sulphur, oil and gas occurrences are described in the next paper by P. Karnkowski.

Miocene stratigraphic units used in volume

EPOCH	MEDITERRANEAN STAGES (A.Papp et al., 1978)	NANNOPLANCTON ZONES	REGIONAL CENTRAL PARATETHYS STAGES (A.Papp et al., 1974, 1978)	STRATIGRAPHIC UNITS OF POLISH PART OF THE CARPATHIAN FOREDEEP		
			STAGES	SUB-STAGES	LITHOSTRATIGRAPHIC UNITS	
M I O C E N E	MESSINIAN	NN11	PONTIAN		margin → center	
	TORTONIAN	NN10	PANNONIAN			
		NN9	SARMATIAN		Kędzierzyn (Poznań) Fm	
	NN8 NN7			Serpula-Ctenophora Beds Syndesmya (=Abra) Beds Krakowiec Clays Chmielnik Fm Machów Fm		
	SERRAVALIAN	NN6	BADENIAN	KOSOVIAN [GRABOVIAN]	Pecten-Spiralis Beds	
		NN5		WIELICIAN [BOCHENIAN]	Evaporitic Chemical Series	Wieliczka = Krzyżanowice Fm Ervilia Layer
	LANGHIAN		MORAVIAN [OPOLIAN]	Baranów Beds (Fm)	Skawina Fm Trzydnik Fm	
	BURDIGALIAN	NN4	KARPATIAN		Kłodnica Fm	
		NN3	OTTNANGIAN			
	AQUITANIAN	NN2	EGGENBURGIAN			
NN1		UPPER EGERIAN				

In square brackets — older substages names (R. Ney *et al.*, 1974); size of unit label does not reflect its time duration; nannoplankton zones after F. F. Steininger *et al.* (1990)

The following papers discuss the problem of genesis of Polish sulphur deposits considering data of detailed studies. Bioepigenetic origin of Polish sulphur deposits includes diagenetic reaction of hydrocarbons and other fluids with solid sulphates in the presence of bacteria in geologically favourable conditions. This approach has been significantly advanced by isotope technique. Certainly, the epigenetic alteration was a complex sequence of physical and biochemical processes as is indicated, for instance, by common presence of postsulphate pseudomorphic (gypsum-ghost and others) limestones. In addition, this hypothesis has accrued many convenient assumptions which are not confirmed by field data and detailed studies. Moreover they insufficiently explain the occurrence of epigenetic carbonates as well as many features of sulphur-bearing series. Concluding, previous research on Polish sulphur deposits established the general geological conditions of sulphur origin. However, there are still many questions like sequence and conditions of diagenetic events, relative time of alteration, fluid source and others, which should be answered. Afterwards the model of Polish sulphur formation should be reevaluated.

One of the traditional approaches, explaining formation of sulphur-bearing series is presented by B. Kubica who emphasizes the facies-thickness variations of sulphates as a factor controlling the transformation processes of sulphates into native sulphur. He distinguished three stages of sulphate metasomatism based on relations of unaltered (sulphates) and altered (carbonates) rocks that, however, are questioned by A. Gąsiewicz based on both petrographic and regional characteristics of pseudomorphic (gypsum-ghost) limestones. J. Parafiniuk, W. Kowalski and S. Hałas summarize the results of sulphur isotope studies of various Miocene rocks associated with sulphur deposits and ore waters, and they argue that these data confirm a bioepigenesis theory of Polish sulphur deposits. Strontium content characteristic of Miocene sulphate series from the northern margin of the Carpathian Foredeep, given by A. Kasprzyk, indicate that for the following time this series is not of economic value. In the following paper G. Czapowski discusses the hypotheses of origin of the Miocene rock salt developed in the axial part of the foredeep and characterizes the main salt deposits there. Another mineral resource of minor economic value is lignite, occurring in the foredeep in various stratigraphic positions. Lignite distribution, sedimentary conditions and deposit characteristics are exhaustively described by J. R. Kasiński and M. Piwocki.

The overburden of the sulphur-bearing series is a monotonous, mainly pelitic complex of Upper Badenian–Sarmatian age. The nannofossils studies establish there two nannoplankton zones: NN8 and NN9 (paper of E. Gaździcka). Analysis of the algal cyst assemblages, found in the upper part of this complex (J. Paruch-Kulczycka) indicate some environmental changes during Sarmatian stage. These variations are also confirmed by the detailed sedimentological studies of the above mentioned complex and they evidence two depositional cycles, corresponding to Upper Badenian (= Kosovian) and Lower Sarmatian substages (G. Czapowski).

One of negative effects of intensive exploitation of the native sulphur deposits is quantitative and qualitative changes of Quaternary groundwaters. It may induce their intensive degradation and may become a serious menace for future consumption waters (J. Malinowski, M. Perek). Also, stable isotope investigations of groundwaters within the sulphur-bearing series, regarded as original (Tertiary), indicate that they are nearly completely replaced by recent infiltration waters (J. Szaran, H. Niezgodna, B. Jasińska, S. Hałas).

The papers presented in this volume only refer to some selected problems of geological structure in the area of the sulphur deposits, their genesis, co-occurring raw minerals, tectonics, etc. Still open is the detailed stratigraphy of Tertiary deposits and correlation of numerous local bio- and lithostratigraphic units of various stratigraphic range (table, included in this chapter, illustrates relations of selected stratigraphic units used by the authors of this volume). Also a general model of evolution of the Polish part of the Carpathian Foredeep during the Tertiary is still necessary (the one elaborated in the early seventies should be completed using newly obtained results). Very significant for further management of post-mine areas is the problem of evaluation of negative influence of sulphur mining on the natural environment as well as the elaboration of methods of its neutralization.

The editors hope that the contributions in this issue may be useful for scientists working on Miocene geology as well as on other bioepigenetic stratiform sulphur deposits especially those located in the Carpathian Foredeep.

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