

LITHOSTRATIGRAPHIC CORRELATION OF THE OUTER CARPATHIAN BORDERLANDS OF POLAND, UKRAINE, SLOVAKIA AND ROMANIA

KORELACJA LITOSTRATYGRAFICZNA KARPAT ZEWNĘTRZNYCH NA OBSZARACH PRZYGRANICZNYCH POLSKI, SŁOWACJI, UKRAINY I RUMUNII

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Abstract. An attempt was made to correlate the lithostratigraphic units of the Outer Carpathians in Poland, Romania, Slovakia and Ukraine. The correlation covered the area presented in the previously published geological maps of the Outer Carpathians between the Biała and Risca rivers.

Key words: lithostratigraphic unit correlation, tectonic units, Outer Carpathians.

Abstrakt. Wykonano próbę korelacji wydzieleni litostratygicznych Karpat zewnętrznych dla obszaru Polski, Rumunii, Słowacji oraz Ukrainy. Korelacja obejmuje obszary przedstawione na wydanych wcześniej mapach geologicznych Karpat zewnętrznych, między rzekami Białą a Risca.

Słowa kluczowe: korelacja jednostek litostratygicznych, jednostki tektoniczne, Karpaty zewnętrzne.

INTRODUCTION

The study complements the maps of part of the Outer Carpathians arc from the Biała River meridian to the northern part of the Romanian Carpathians (Jankowski *et al.*, eds., 2004; Jankowski *et al.*, eds., 2007) (Fig. 1). The main objective is an attempt to correlate coeval facies and, if possible, tectonic units (Fig. 2). The essence of field observations and correlation work carried out in the neighbouring countries was to identify individual geological sections, to determine the meaning of lithostratigraphic terms and to determine the facies character of a number of members and formations.

The correlation between the sections was conducted not only within the individual units that directly continue in the border areas. The study also covered the units that have no equivalents in the Polish Carpathians, but they occur in Ukraine or Romania. The basis for the observations and correlations were mainly mapping materials and own observations of the authors.

The remarks, which are included in the study and concern the development of depositional systems and the nature and course of tectonic units (sometimes controversial and different from traditional), are own views of the authors. They are

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Fig. 1. Area of investigation

A – area mapped on “Geological map of the Outer Carpathians: borderlands of Poland, Ukraine and Slovakia” (Jankowski *et al.*, eds., 2004); B – area mapped on “Geological map of the Outer Carpathians: borderland of Ukraine and Romania” (Jankowski *et al.*, eds., 2007)

Obszar badań

Obszar przedstawiony na mapach: A – Geological map of the Outer Carpathians: borderlands of Poland, Ukraine and Slovakia (Jankowski *et al.*, eds., 2004); B – Geological map of the Outer Carpathians: borderland of Ukraine and Romania (Jankowski *et al.*, eds., 2007)

based primarily on the results of field observations in the area extending from the Outer Carpathians to the borders of the Pieniny Klippen Belt that is the southern border of the study area.

The first step included the development of two cartographic projects covering the eastern part of the Polish Carpathians, Slovak and Ukrainian Carpathians (Jankowski *et al.*, eds., 2004) and part of the Romanian Carpathians (Jankowski *et al.*, eds., 2007). The report: „Geological map of the Outer Carpathians; borderland of Poland, Ukraine and Slovakia 1:200 000” was carried out in association with the National Academy of Sciences of Ukraine, Institute of Geology and Geochemistry of Combustible Minerals in Lviv and Technical University Košice, Department of Geology and Mineralogy in Košice and Geological Survey of Slovak Republic. The following materials were used: maps of the Polish Outer Carpathians, scale 1:200 000 (Ślącza, Żyto, 1979; Nescieruk *et al.*, 1995; Gucik *et al.*, 1980) and map-sheets of the Detailed Geological Map of Poland, scale 1:50 000 (Cieszkowski, Ślącza, Zuchiewicz, 1988; Węclawik, Wójcik, 1993; Kopciowski *et al.*, 1997a, b; Jankowski, 1997b; Malata *et al.*, 1997; Haczewski *et al.*, 1999; Kopciowski, 2000). Maps of the Ukrainian Carpathians (Shakin *et al.*, 1976; Gavura, Danysh *et al.*, unpubl.) and Slovak (Leško, ed., 1964; Matejka, ed., 1964; Korab, 1983; Nemčok,

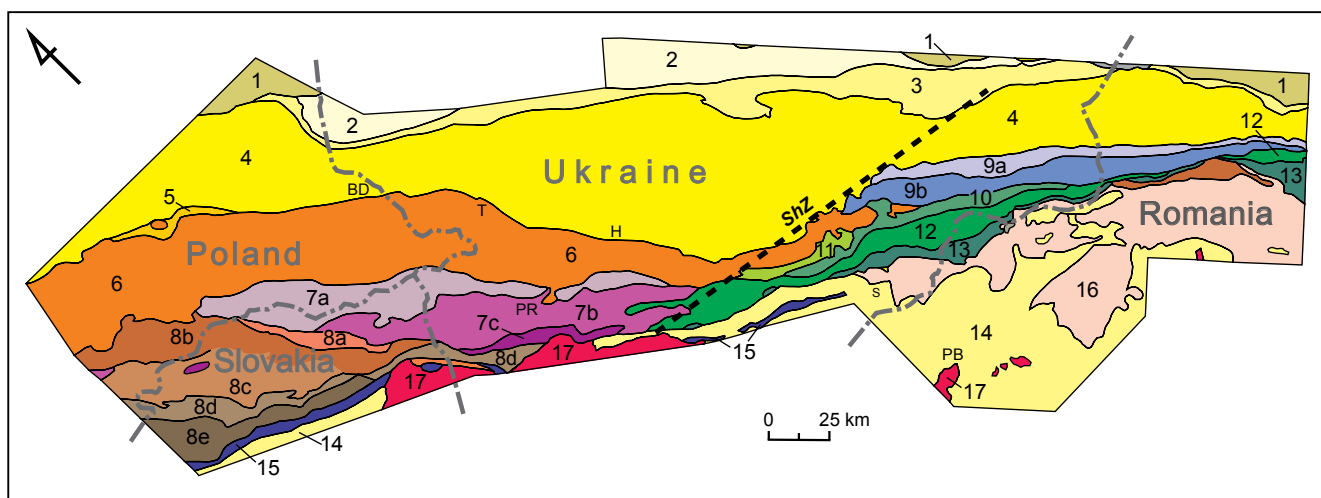


Fig. 2. Geological sketch of Outer Carpathians: borderlands of Poland, Ukraine, Slovakia and Romania

1 – Carpathian Foredeep; 2 – Folded Miocene; 3 – Boryslav-Pokuttya Unit; 4 – Skole Unit; 5 – Węglówka (Holătyn) Unit; 6 – Silesian Unit; 7a, b, c – Dukla Unit; 8a, b, c, d, e – Magura Unit; 9a, b – Chornohora Unit; 10 – Burkut, Audia Unit; 11 – Krasnoshora Unit; 12 – Sukhiv Unit; 13 – Rakhiv Unit; 14 – Maramureş, Dragovo Unit; 15 – Pieniny Klippen Belt; 16 – Subbucovinian, Bucovinian units; 17 – Neogene volcanic rocks; PB – Poiana Botizii; H – Holătyn; S – Shopurka; BD – Brzegi Dolne; PR – Polonina Runa; L – Luta; ShZ – Shopurka zone (Jasinia-Kosiv zone); T – Turka, Sn – Snina

Szkic geologiczny Karpat zewnętrznych: obszary przygraniczne Polski, Ukrainy, Słowacji i Rumunii

1 – przedgórze Karpat; 2 – utwory miocenu sfałdowane; 3 – jednostka borysławsko-pokucka; 4 – jednostka skolska; 5 – jednostka Węglówki (Holătyn); 6 – jednostka śląska; 7a, b, c – jednostka dukielska; 8a, b, c, d, e – jednostka magurska; 9a, b – jednostka czarnohorska; 10 – jednostka Audia (Burkut); 11 – jednostka krasnoszorska; 12 – jednostka suchowska; 13 – jednostka rachowska; 14 – jednostka marmaroska (drahowska); 15 – pieniński pas skałkowy; 16 – jednostki subbukowińskie i bukowińskie; 17 – neogeńskie skały wulkaniczne; PB – Poiana Botizii; H – Holătyn; S – Shopurka; BD – Brzegi Dolne; PR – Polonina Runa; L – Luta; ShZ – strefa Shopurki (strefa Jasinia-Kosów), T – Turka, Sn – Snina

1990) Carpathians were also utilized. The project “Geological map of the Outer Carpathians: borderlands of Ukraine and Romania” was carried out in association with the National Academy of Sciences of Ukraine, Institute of Geology and Geochemistry of Combustible Minerals in Lviv and

University of Bucharest. Maps of the Ukrainian Carpathians (Shakin *et al.*, 1976; Gavura *et al.*, unpubl.) and Romanian Carpathians (Gherasi *et al.*, 1967; Popoescu, Mirauta, 1967; Patrulius *et al.*, 1968; Joja *et al.*, 1968; Alexandrescu *et al.*, 1968 and Mirauta, 1968) were used.

CORRELATION OF LITHOSTRATIGRAPHIC SECTIONS

Several previous mapping projects were made with the neglect of the complex data from Slovakia, Ukraine and Romania (Fig. 3). The present study presents the correlation of data from the whole study area.

The above-listed maps and correlation of lithostratigraphic sections should be considered jointly. The attempt of correlation is not limited only to the border areas. Studies and observations were carried out throughout the whole area of the Ukrainian Carpathians and the northern part of the Romanian Carpathians, which allowed for a summary and comparison of sections of the units that are more distant from the Ukraine/Romania border, and which often show different facies types and are related to different depositional systems.

The gathered information is only a prelude to further research on the sedimentary basin analysis of the Carpathians, which should be extended to the whole area of the so-called Flysch Carpathians to fully reconstruct the history of events in the basin. The results of the correlation in that area are presented in Figure 3. The numbers given in the lithostratigraphic sections denote lithostratigraphic units used in the maps in individual countries. The colours and hatching used in the maps represent deposits similar in facies type (e.g. variegated shales) or belonging to the same depositional system (Burkut and Krasnoshora sandstones, and Chornohora Beds). The paper intentionally does not provide precise lithostratigraphical and facies descriptions because of the enormity of the material, which requires a separate study. Detailed lithostratigraphical and facies description will be presented by the authors in a forthcoming publication called “Lithostratigraphic glossary of the flysch Carpathians of Austria, Poland, Romania, Slovakia and Ukraine”.

The aim of the analysis is to reconstruct the entire depositional systems and to place the individual facies elements within the systems. Taking into account the problems associ-

ated with the ongoing formalization of the lithostratigraphic members in the Carpathians, their continuation (especially on the emergence of sequence stratigraphic techniques and the necessity of revising the concept of formation) requires reconsideration. In this study, the names of members and formations, traditionally used and common in geological literature, are assumed as a basis for correlation. They are known especially to the Polish reader. A major hurdle for both correlating and implementing the map was sometimes a different treatment of the concepts relating to the lithostratigraphic members (their boundaries or age ranges) in different countries. An example of differences in the classification is the term “svita” used in Ukraine, which has no meaning equivalent in Poland, Slovakia and Romania.

Another problem, both for the construction of the map of borderland areas and for the compilation of the correlation, is the lack of geological maps on a scale more accurate than 1:100 000 (unavailable and often classified maps of the Ukrainian Carpathians at the scale of 1: 50 000). In addition, there are many views (Danysh, Tsarnenko – pers. comm.) on the course and classification of some tectonic elements (e.g. the view on the trend and extent of the Dukla Unit in Ukraine). In many cases, the previously made correlation was random. Apart from the above examples, the main difficulties were encountered during partial correlation of the Oligocene–Miocene units, especially of the Krosno facies. The main reason is the lack of facies analysis of the Krosno basin covering large part of the Carpathians. An additional problem is that the boundaries between tectonic elements are not defined and the shear zones are not mapped. The correlation is based on field observations and literature data and points to the need to perform a basin analysis and to determine the areas of deposition of many lithostratigraphic members. The information gathered by the authors is the basis for further development in the form of an atlas of the Outer Carpathians.

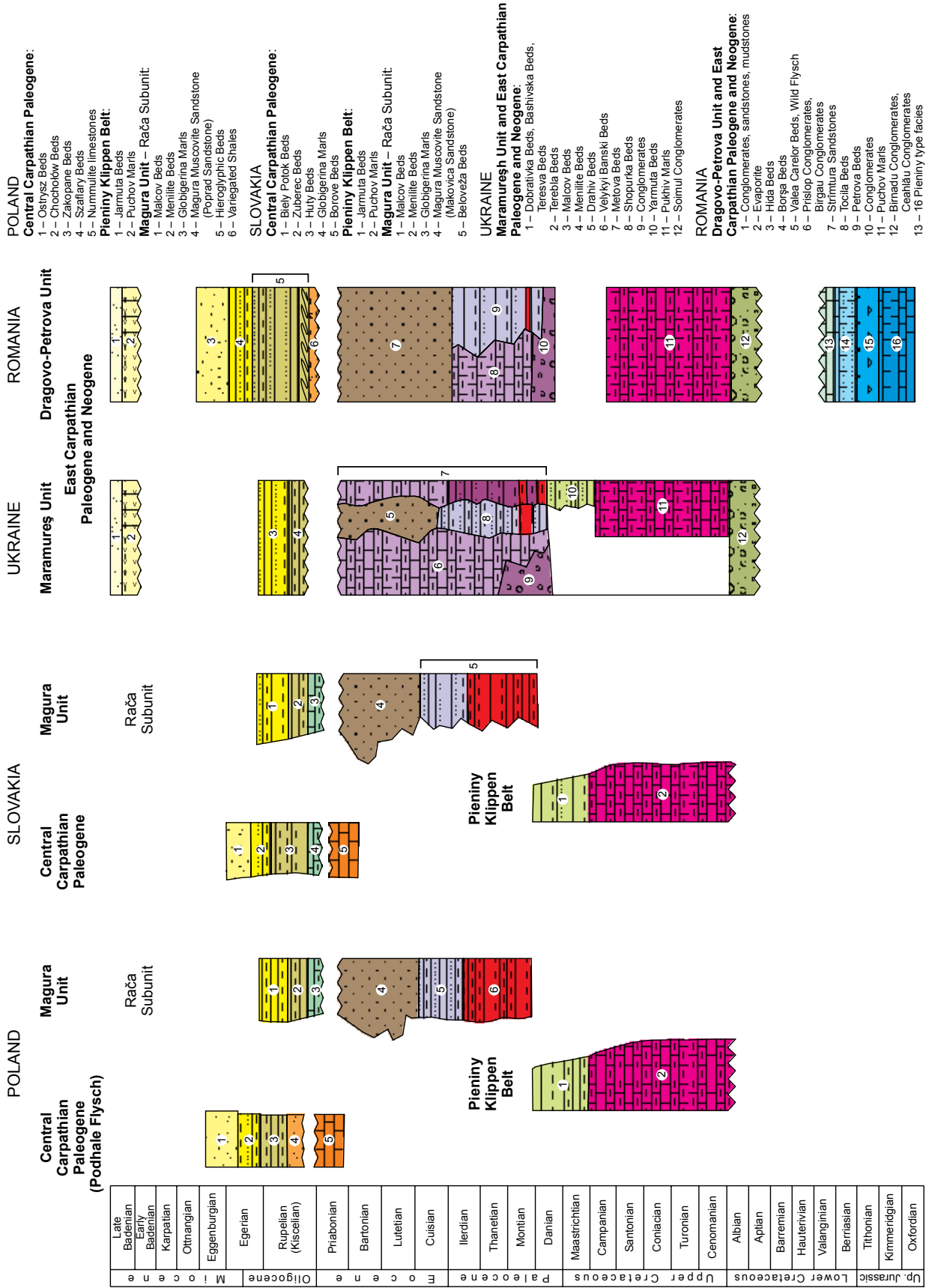
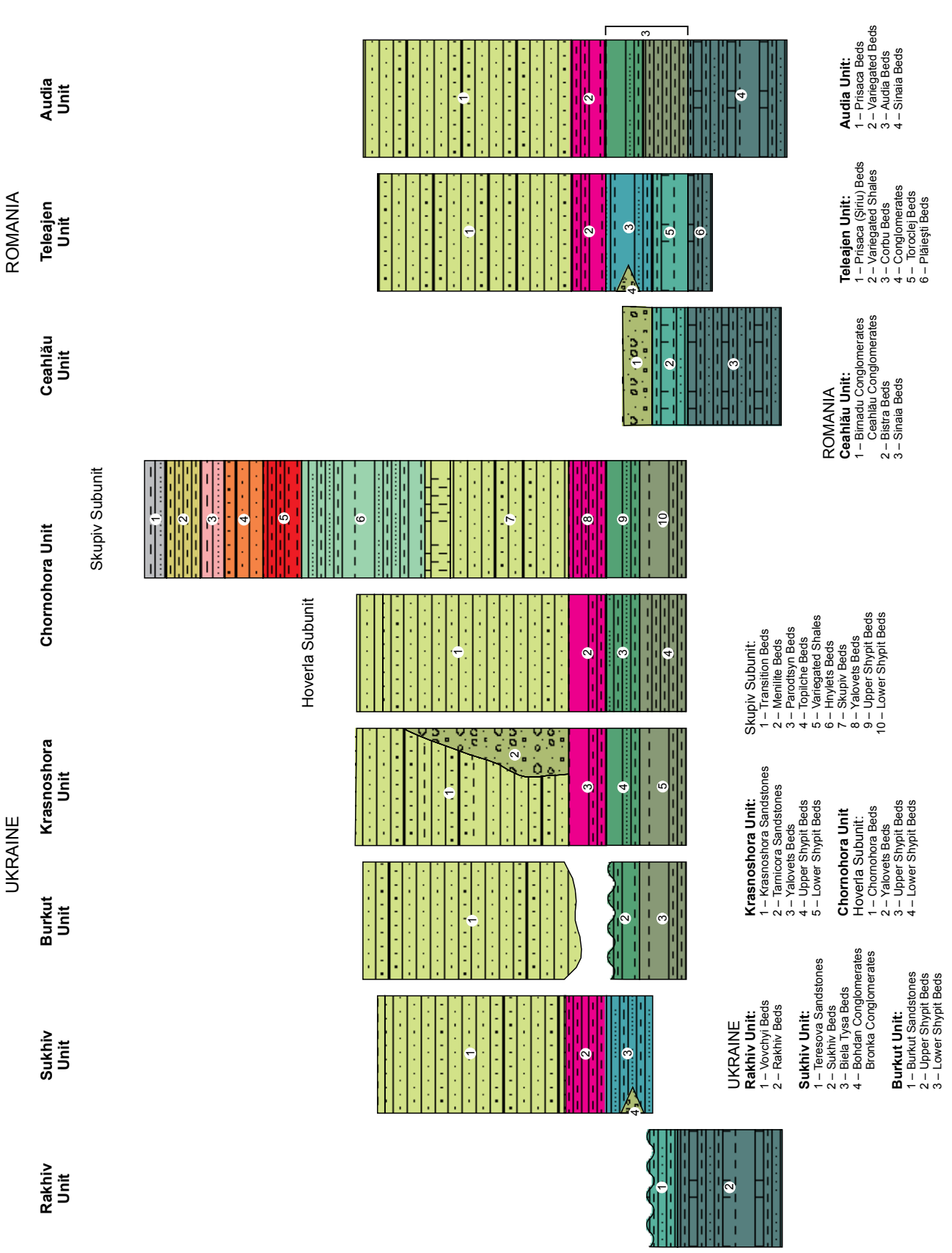
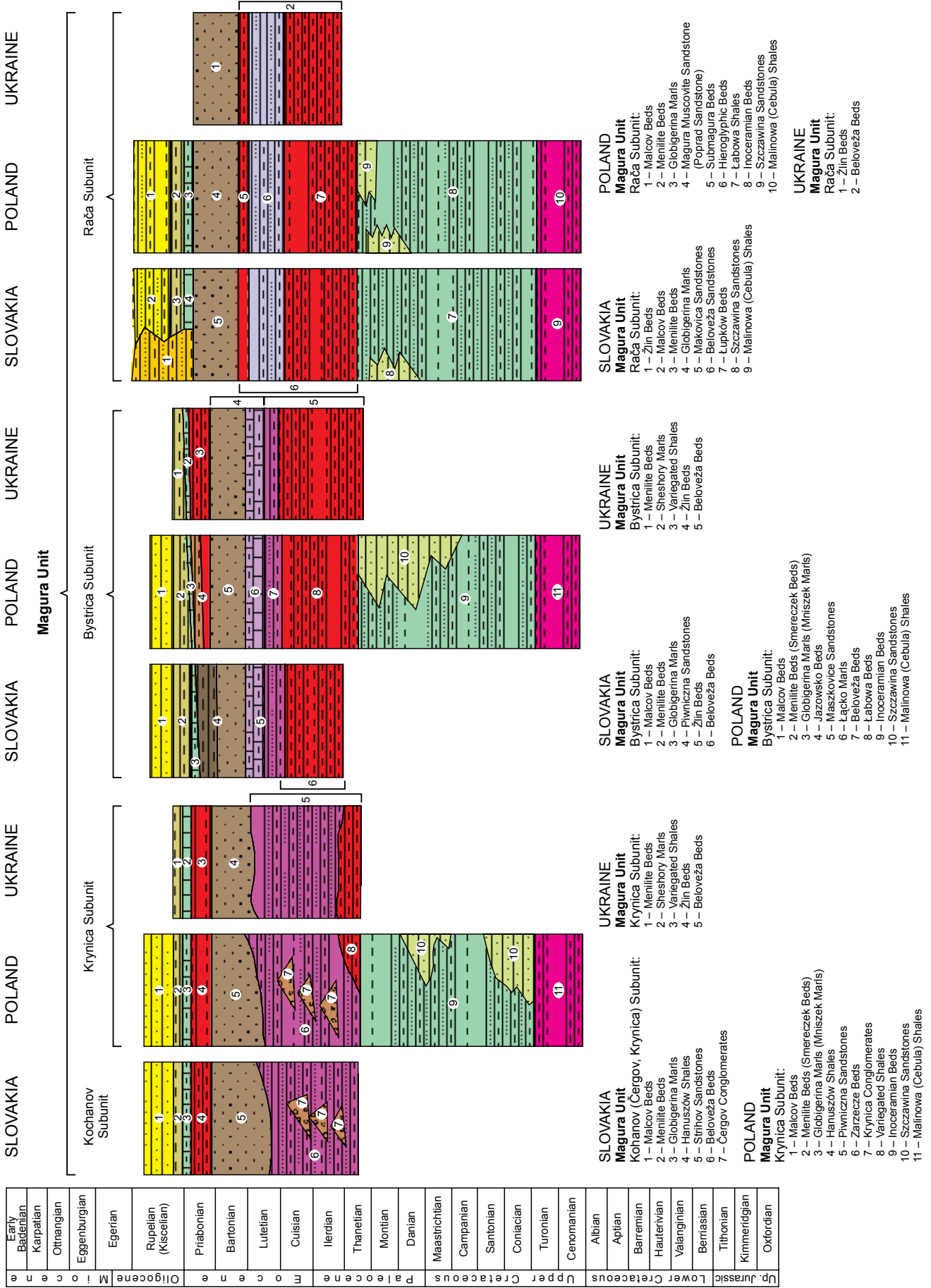


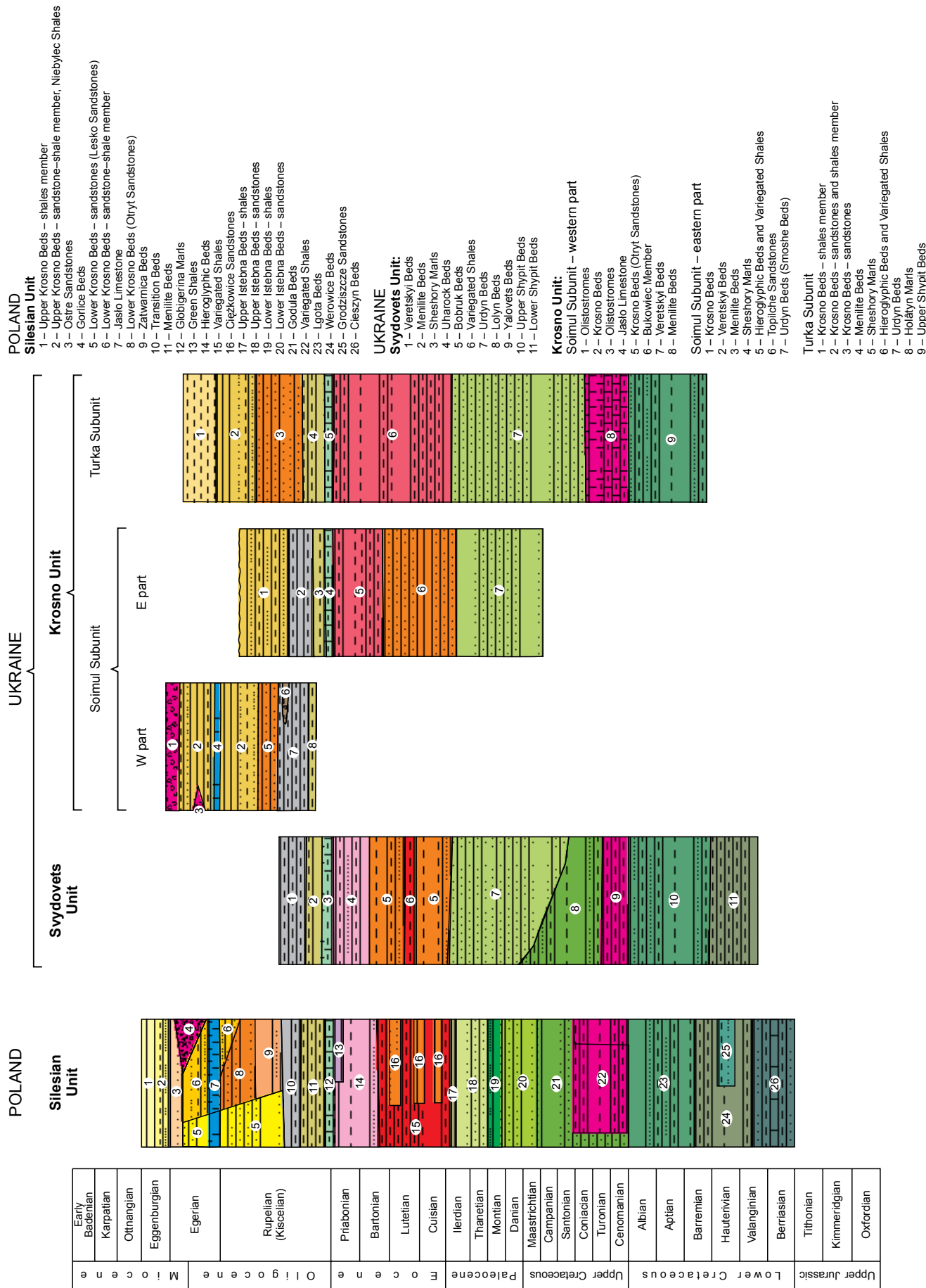
Fig. 3. Korelacja jednostek litostratigraficznych (pages 90–97)

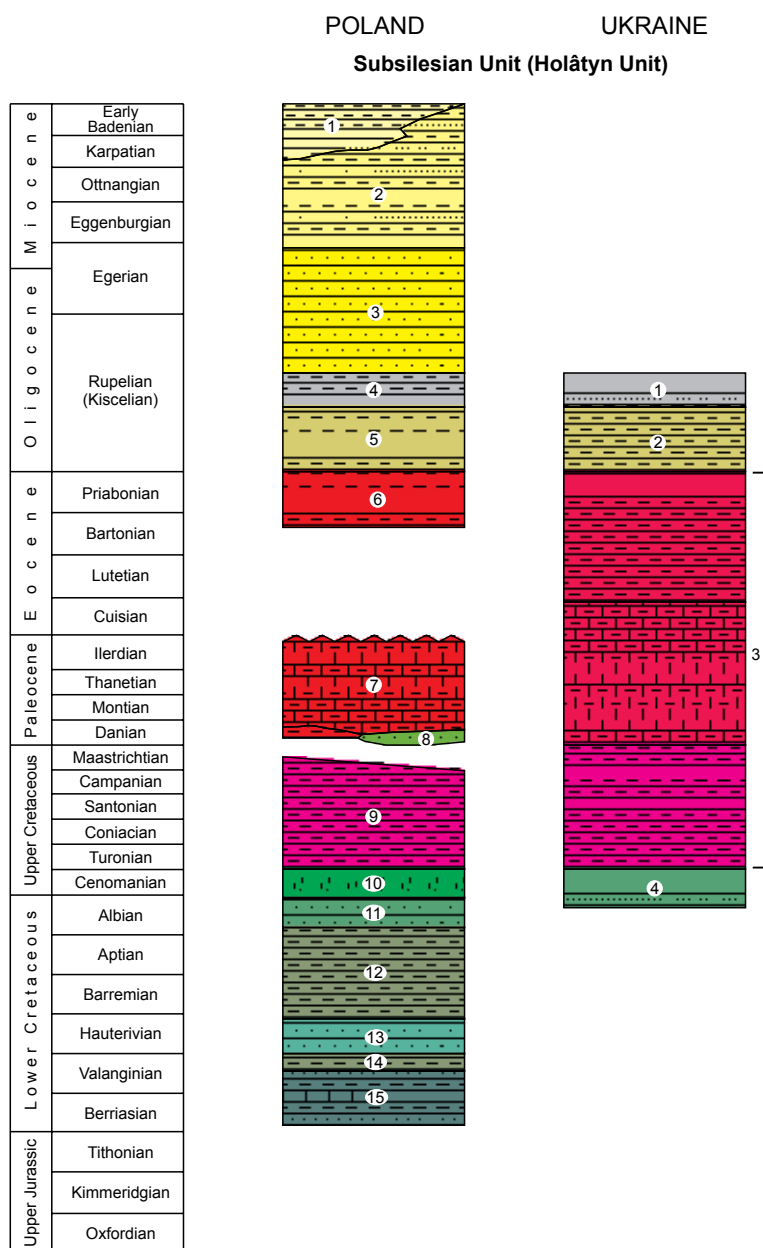
Korelacja jednostek litostratigraficznych (strony 90–97)

Early Bactonian	Up. Jurassic
Karpatian	
Ottangian	Lower Cretaceous
Eggenburgian	
Egerian	Upper Cretaceous
Rupelian (Kiscelian)	
Priabonian	Upper Cretaceous
Bartonian	
Lutetian	Upper Cretaceous
Cuisian	
Ilerdian	Upper Cretaceous
Thanetian	
Montian	Upper Cretaceous
Danian	
Maastrichtian	Upper Cretaceous
Campanian	
Santonian	Upper Cretaceous
Coniacian	
Turonian	Upper Cretaceous
Cenomanian	
Albian	Upper Cretaceous
Aptian	
Barremian	Upper Cretaceous
Hauterivian	
Valanginian	Upper Cretaceous
Berriasian	
Tithonian	Upper Cretaceous
Kimmeridgian	
Oxfordian	Upper Cretaceous







**POLAND**

Subsilesian Unit:

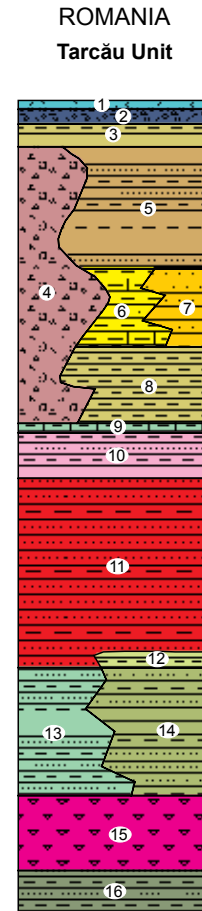
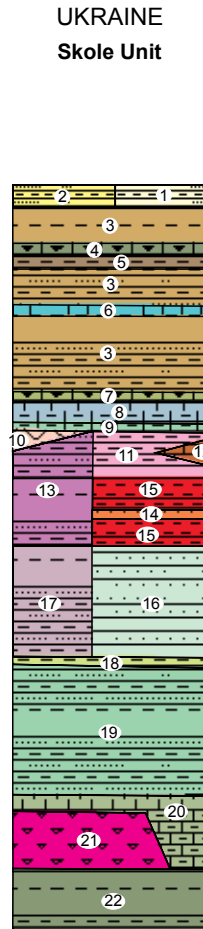
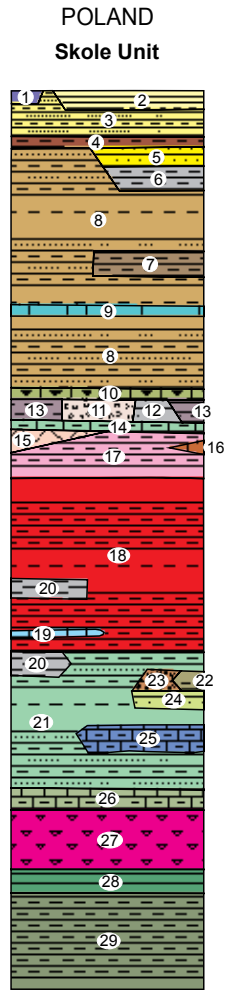
- 1 – Krosno Beds, shales member
- 2 – Krosno Beds, sandstones and shales member
- 3 – Krosno Beds – sandstones
- 4 – Transition Beds
- 5 – Menilite Beds
- 6 – Variegated Shales
- 7 – Węglówka Marls
- 8 – Godula Beds
- 9 – Godula Variegated Shales
- 10 – Gaizze Beds
- 11 – Lgota Beds
- 12 – Werowice Beds
- 13 – Grodziszcze Beds
- 14 – Werowice Beds
- 15 – Cieszyn Beds

UKRAINE (Holătyn area)

Subsilesian Unit:

- 1 – Transition Beds
- 2 – Menilite Beds
- 3 – Variegated Shales and Węglówka Marls
- 4 – Shypit Beds

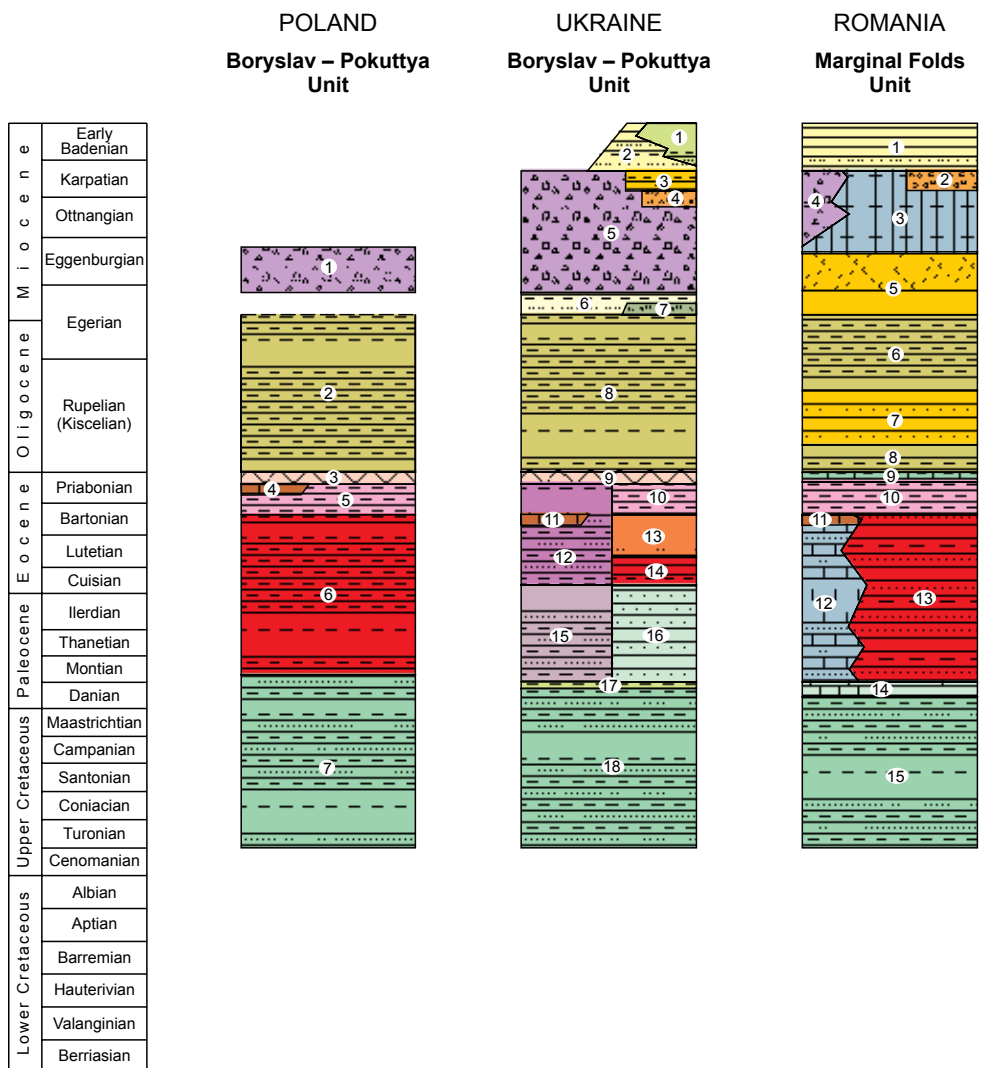
M i o c e n e	Early Badenian	
	Karpatian	
	Ottnangian	
	Eggenburgian	
	Egerian	
	O l i g o c e n e	Rupelian (Kiscelian)
	E o c e n e	Priabonian
		Bartonian
		Lutetian
Cuisian		
P a l e o c e n e	Ilerdian	
	Thanetian	
	Montian	
	Danian	
U p p e r C r e t a c e o u s	Maastrichtian	
	Campanian	
	Santonian	
	Coniacian	
	Turonian	
	Cenomanian	
L o w e r C r e t a c e o u s	Albian	
	Aptian	
	Barremian	
	Hauterivian	
	Valanginian	
	Berriasian	



- POLAND**
Skole Unit
- 1 – Leszczawka Diatomites
 - 2 – Upper Krosno Beds, shales member
 - 3 – Upper Krosno Beds, sandstones and shales member
 - 4 – Niebylec Shales
 - 5 – Lower Krosno Beds
 - 6 – Transition Beds
 - 7 – Łopianiec Beds
 - 8 – Menilite Beds, Kliwa Sandstones
 - 9 – Jasio Limestone
 - 10 – Dynów Marlsand Cherts
 - 11 – Siedliska Conglomerates
 - 12 – Boryslav Sandstones
 - 13 – Subcherts Beds
 - 14 – Globigerina Marls
 - 15 – Popeli Beds
 - 16 – Pasichna Beds
 - 17 – Hieroglyphic Beds
 - 18 – Variegated Shales
 - 19 – Bircza Limestones
 - 20 – Babica Clays
 - 21 – Inoceraman Beds
 - 22 – Węgierka Marls
 - 23 – Makówka Debrites
 - 24 – Leszczyny Sandstones (Inoceraman Beds)
 - 25 – Kropiwnik Marls
 - 26 – Holownia Marls
 - 27 – Radiolarite Shales
 - 28 – Upper Spas Beds
 - 29 – Lower Spas Beds

- UKRAINE**
Skole Unit:
- 1 – Polanitsia Beds
 - 2 – Krosno Beds
 - 3 – Menilite Beds, Kliwa Sandstones
 - 4 – Upper Cherts
 - 5 – Łopianiec Beds
 - 6 – Jasio Limestone
 - 7 – Lower Cherts
 - 8 – Subchert Marls
 - 9 – Sheshory Marls
 - 10 – Popeli Beds
 - 11 – Bystritsia Beds
 - 12 – Pasichna Beds
 - 13 – Vytktivsi Beds, Bytkiv Beds
 - 14 – Vyhoda Sandstones
 - 15 – Maniava Beds
 - 16 – Yamne Sandstones
 - 17 – Bytkiv Beds
 - 18 – Yaremche Beds
 - 19 – Stryi Beds
 - 20 – Holownia Marls
 - 21 – Ilemka Beds
 - 22 – Spas Beds

- ROMANIA**
Tarcău Unit:
- 1 – Lower Gypsum
 - 2 – Slon Beds
 - 3 – Upper Menilite Beds
 - 4 – Slon Beds
 - 5 – Vinețșu Beds
 - 6 – Fusaru Sandstones
 - 7 – Kliwa Sandstones
 - 8 – Lower Menilite Beds
 - 9 – Globigerina Marls, Lucăcești Sandstones
 - 10 – Podu Secu Beds
 - 11 – Bystritsia Sandstones
 - 12 – Straja Beds
 - 13 – Hongazu Beds
 - 14 – Hangu Beds
 - 15 – Lupchianu Beds
 - 16 – Audia Beds



- POLAND**
Boryslav-Pokuttya Unit:
 1 – Vorotyscha Beds
 2 – Menilite Beds
 3 – Popeli Beds
 4 – Pasichna Beds
 5 – Hieroglyphic Beds
 6 – Variegated Shales
 7 – Inoceramian Beds

- UKRAINE**
Boryslav-Pokuttya Unit:
 1 – Balychi Beds
 2 – Stebnyk Beds
 3 – Dobrotiv Beds
 4 – Sloboda Conglomerates
 5 – Vorotyscha Beds
 6 – Polanitsia Beds
 7 – Rusiv Conglomerates
 8 – Menilite Beds, Boryslav Sandstones
 9 – Popeli Beds
 10 – Bystrytsia Beds
 11 – Pasichna Beds
 12 – Vytktivtsi Beds
 13 – Vyhoda Sandstones
 14 – Maniava Beds
 15 – Bytkiv Beds
 16 – Yamne Sandstones
 17 – Yaremche Beds
 18 – Stryi Beds

- ROMANIA**
Marginal Folds:
 1 – Doftana Beds
 2 – Brebu Conglomerates
 3 – Salt Beds
 4 – Slon Beds
 5 – Gypsum Beds (Gura Soimului Beds, Gura Misina Beds)
 6 – Upper Menilite Beds
 7 – Kliwa Sandstones
 8 – Lower Menilite Beds
 9 – Globigerina Marls, Lucăcești Sandstones
 10 – Biserican Beds
 11 – Doamna Beds
 12 – Jgheabu Marls
 13 – Greșu Beds
 14 – Piatra Uscata Beds, Cașin Beds
 15 – Lepșa Beds

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