Upper Permian Reef Complex in the Basinal Facies of the Zechstein Limestone (Ca1) Wolsztyn High, Western Poland*

Tadeusz Marek Peryt[1], Pawel Raczynski[2], and Krzysztof Chlódek[3]

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[1]Polish Geological Institute-National Research Institute, Warsaw, Poland (tadeusz.peryt@pgi-gov.pl)
[2]University of Wroclaw, Wroclaw, Poland
[3]Polish Oil and Gas Company, (POGC), Zielona Góra, Poland

Abstract

In West Poland, isolated reefs have originated, and were growing, on the topmost edges of tilted blocks and/or on the top of uplifted horsts in the basin facies. They are sealed by evaporites and are important gas reservoirs. The reef biota are typical bryonoderm associations, indicating cool-water and cold-water environments. The Zechstein Limestone basin was sourced by temperate to cool water from the Boreal Sea when the Rotliegend basin lay well below the contemporaneous sea level due to flooding in mid or late Wuchiapingian times. The sequence of lithofacies and biofacies includes deposition of a coarse coquina and subsequent establishment of a diverse, stenohaline bryozoan community followed by the start of reef growth with aggradational geometries by a stenohaline fauna, including bryozoans, brachiopods , and various encrusters. Later, bryozoan community changed to encrusting reef-builders, and the depositional geometries changed from aggradation to progradation until sea level lowstands resulted in subaerial exposure of the reefs. The main part of reefs is built of rudstones, and only stromatolitic crusts form massive construction. Astonishing is the mechanism of origin of clearly separate morphological reef constructions from remains with relatively low potential for fossilization. Zones built of crushed remains clearly dominate over parts representing massive constructions. The Zechstein Limestone reefs abound in the hemispheroid aragonitic cement, which is otherwise common for the reefs elsewhere in the Zechstein basin. The abundance of the cement recorded in Permian reefs is interpreted as the result of an unusually high saturation state of surface seawater because of a number of factors. The occurrence of reefs at the base of the Zechstein Limestone indicates that, locally and very quickly after the onset of the Zechstein deposition, the environmental conditions were favorable for local carbonate production. However, over a large area in the region, the regime was hostile for much carbonate production, and hence condensed sequences were deposited.

References

Scotese, C.R., 2012, Paleomap Project, Late Permian 255 Ma: Web accessed 24 July 2012. http://www.scotese.com/newpage5.htm

Ziegler, P.A., 1990, Tectonic and palaeogeographic development of the North Sea rift system, *in* D.J. Blundell and A.D. Gibbs (eds.), Tectonic evolution of the North Sea rifts, Oxford University Press, New York, New York, USA, p. 1-36.

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*Polish Geological Institute – National Research Institute, Warsaw, Poland
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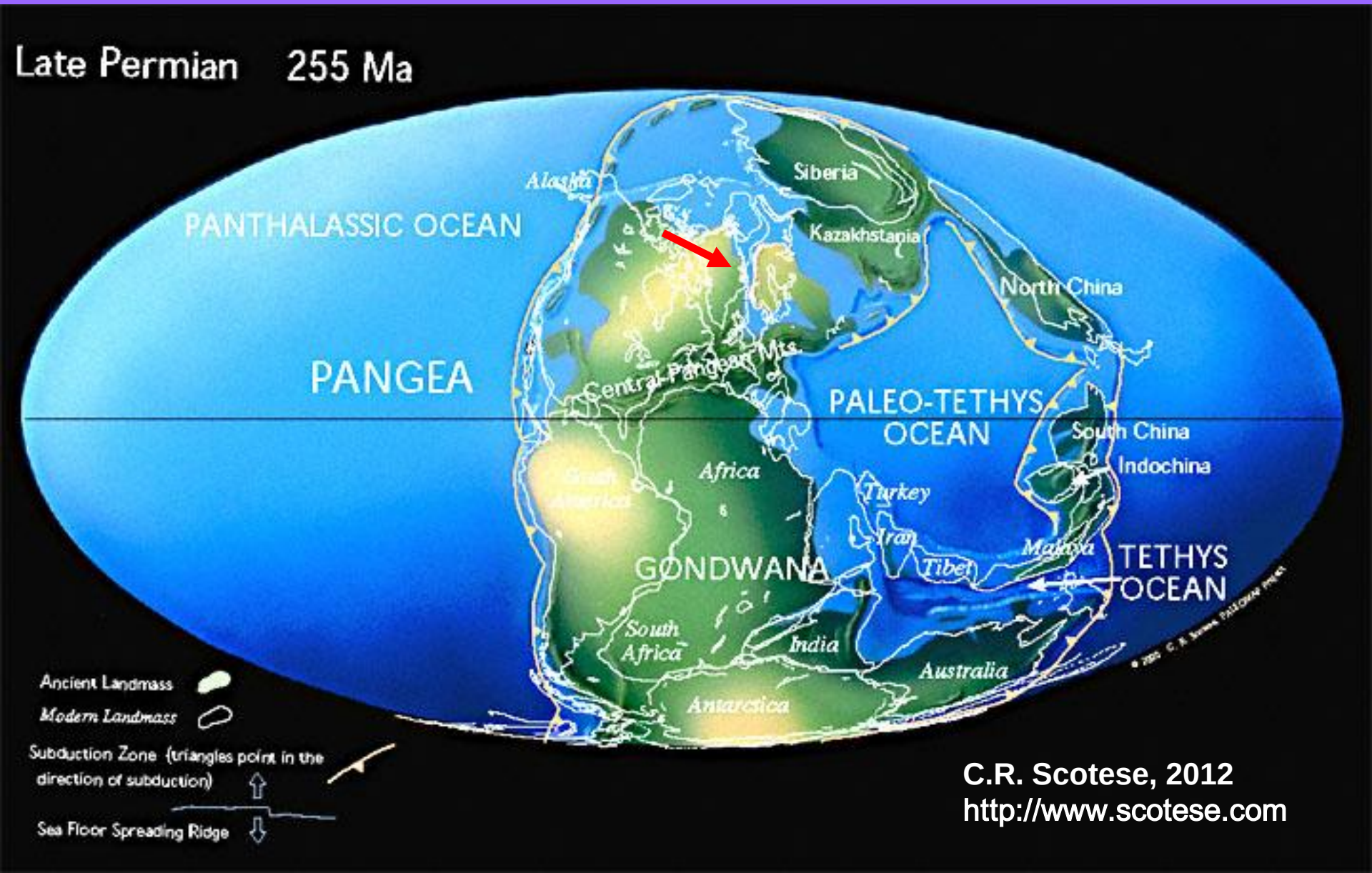
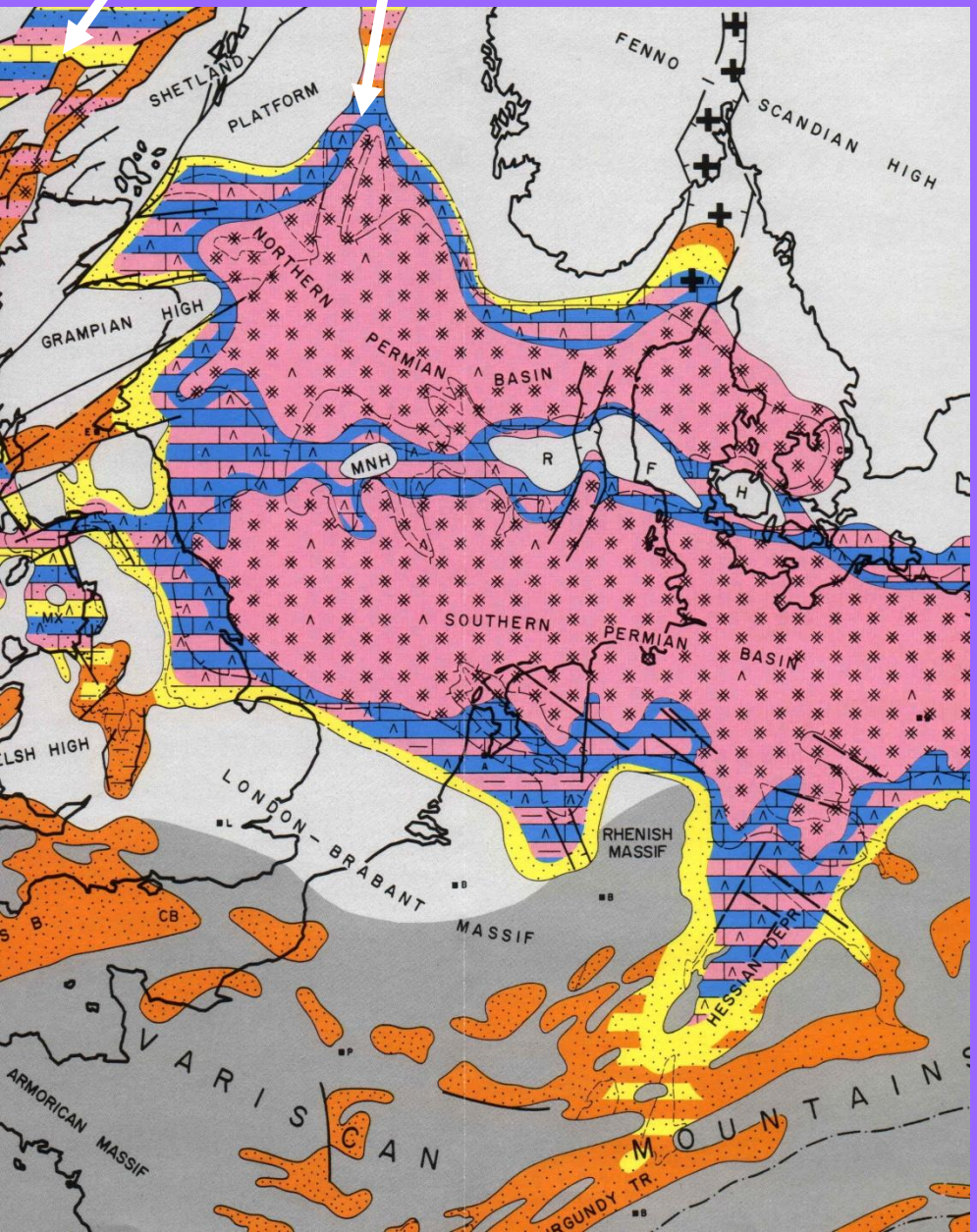
***Polish Oil and Gas Company, Zielona Góra, Poland

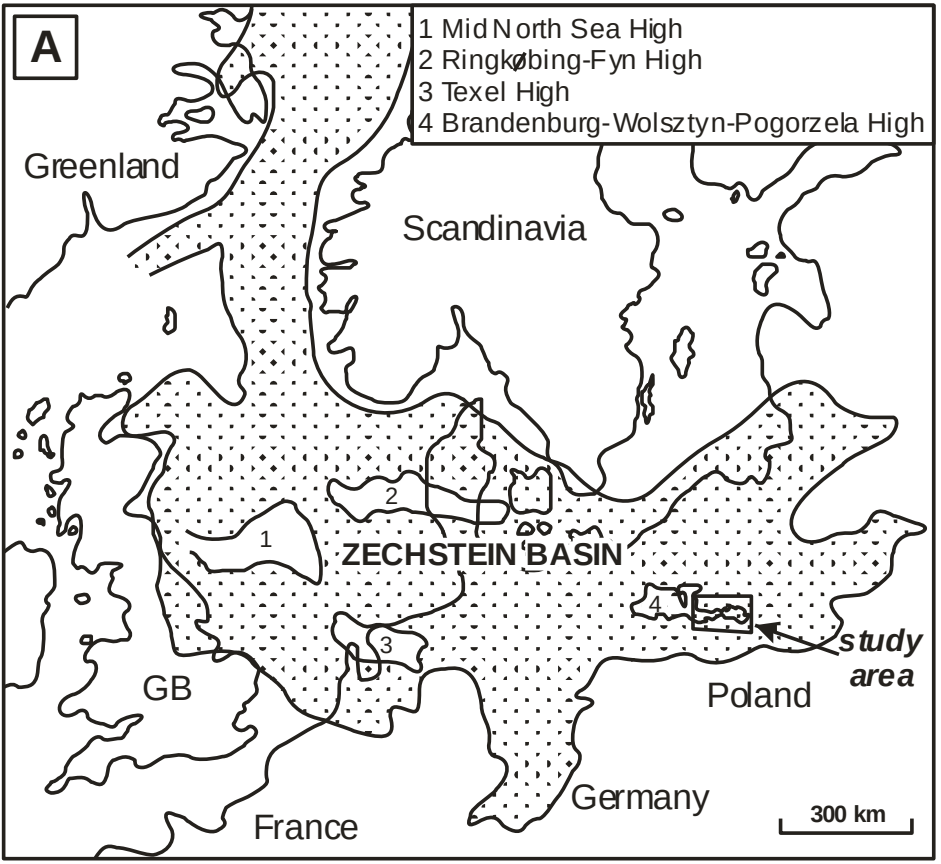

Late Permian 255 Ma
PANTHALASSIC OCEAN
PANGEA
Alaska
Siberia
Kazakhstania
North China
Central Pangean Mts.
PALEO-TETHYS OCEAN
South China
Indochina
Africa
South America
Turkey
Iran
Malaya
Tibet
TETHYS OCEAN
GONDWANA
South Africa
India
Australia
Antarctica
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge
C.R. Scotese, 2012
http://www.scotese.com

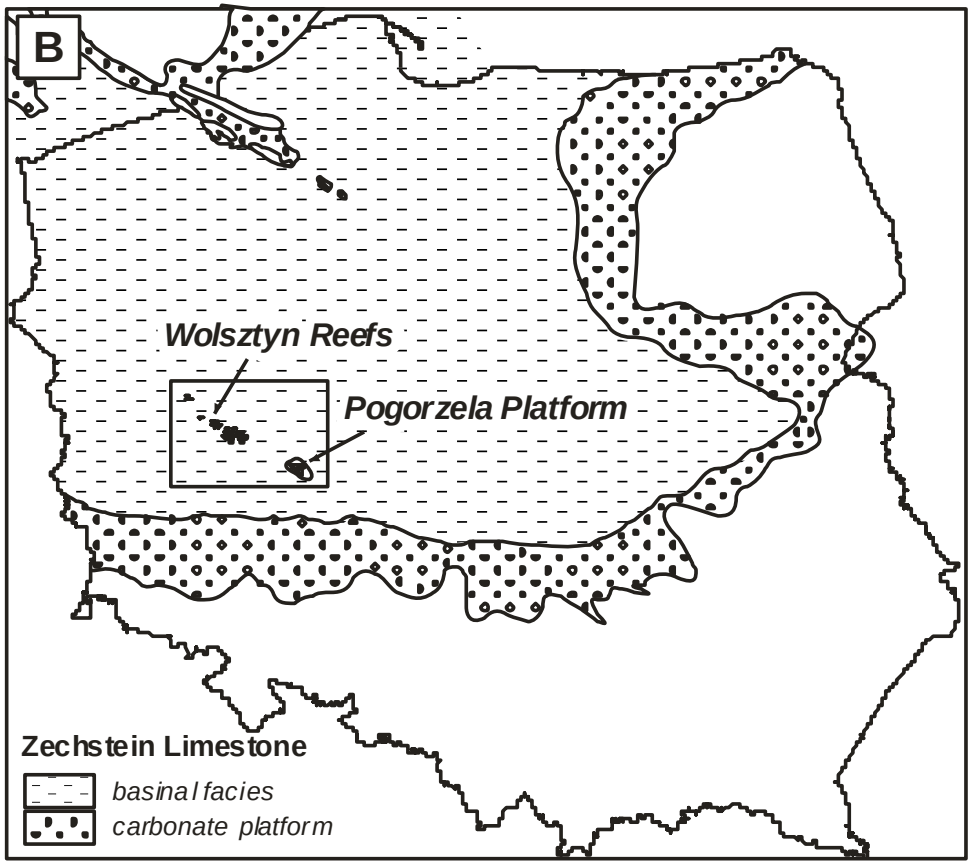
Late Permian, Zechstein

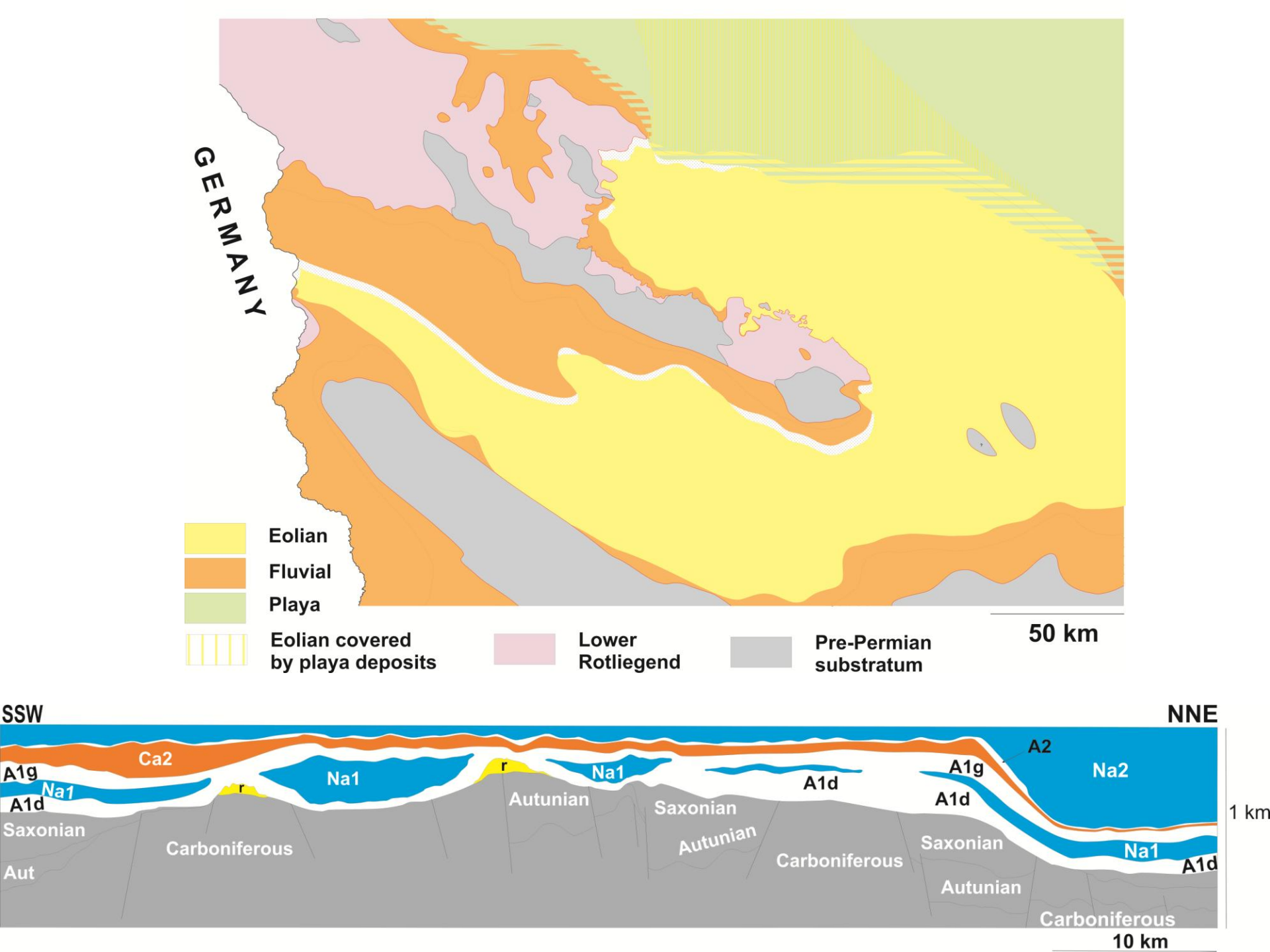


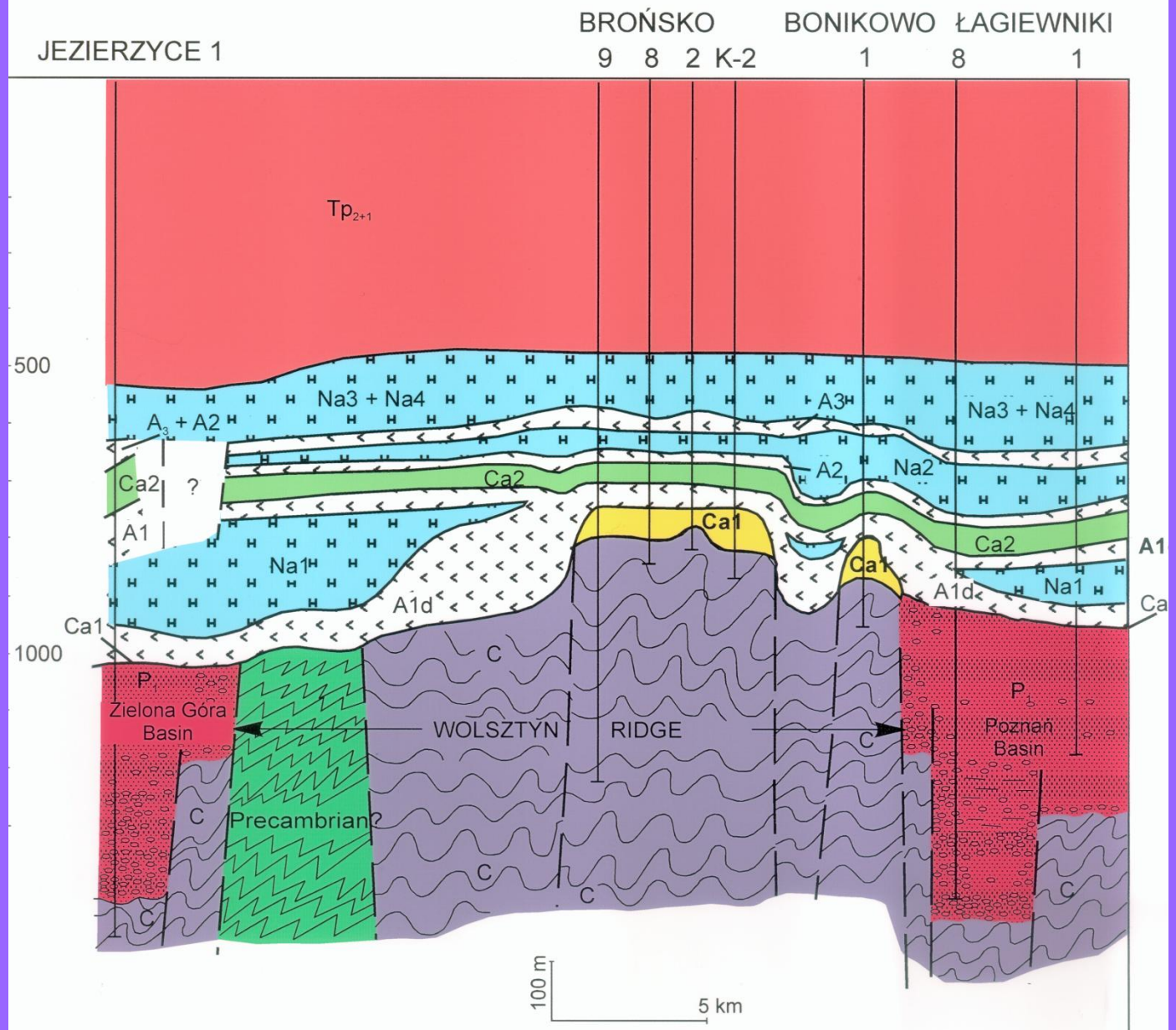
Transgression from the Barents Sea, episodic periods of evaporation

(Ziegler, 1990)

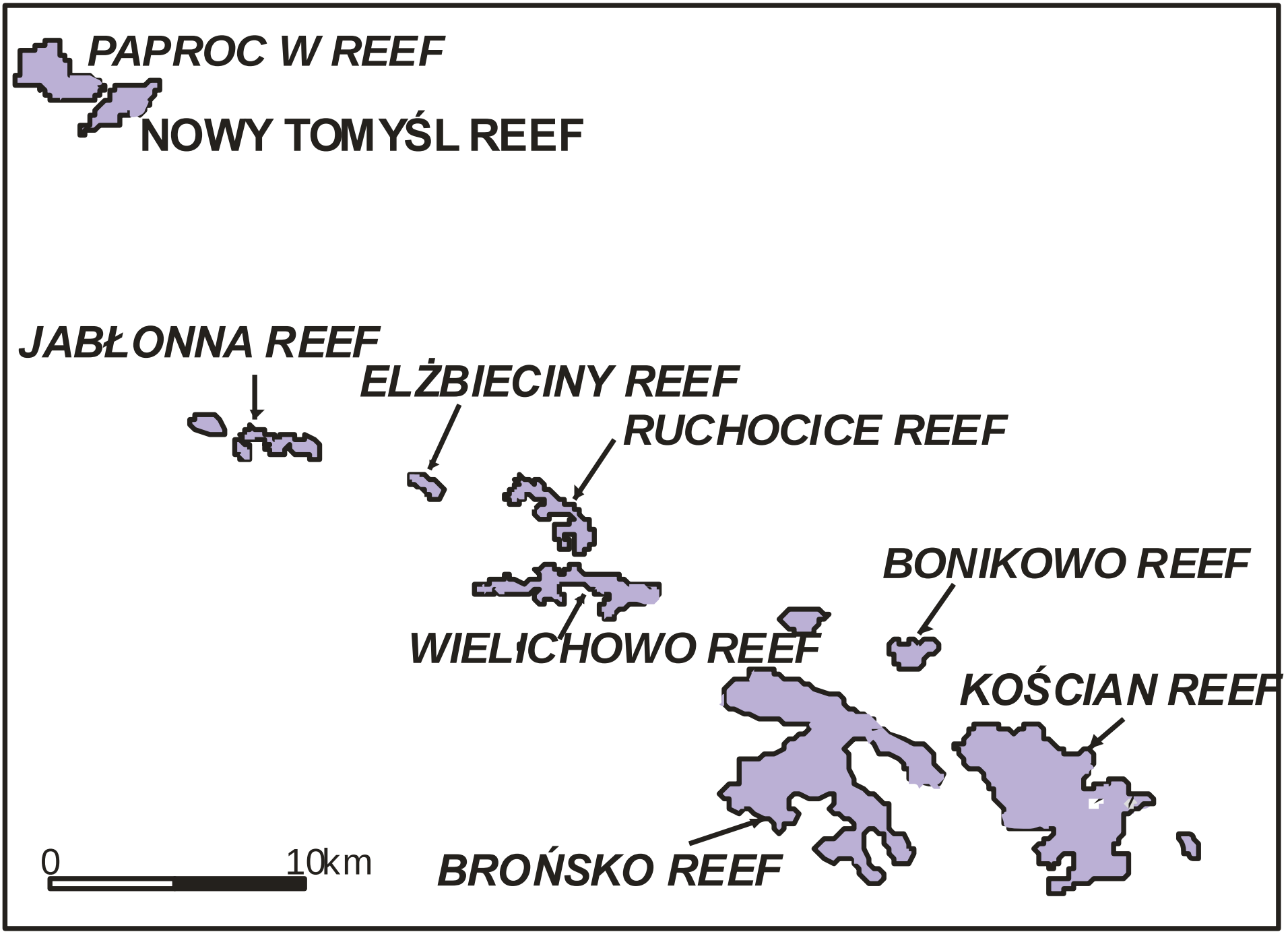

A
1 Mid North Sea High
2 Ringkøbing-Fyn High
3 Texel High
4 Brandenburg-Wolsztyn-Pogorzela High
Greenland
Scandinavia
1
2
3
4
ZECHSTEIN BASIN
study area
GB
Poland
Germany
France
300 km

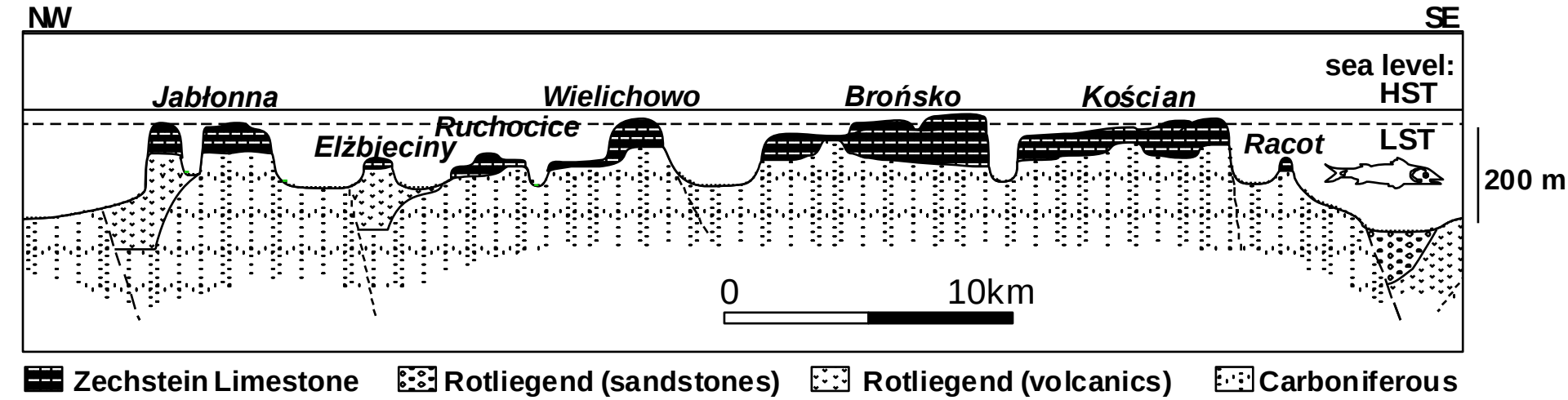

B
Wolsztyn Reefs
Pogorzela Platform
Zechstein Limestone
basinal facies
carbonate platform

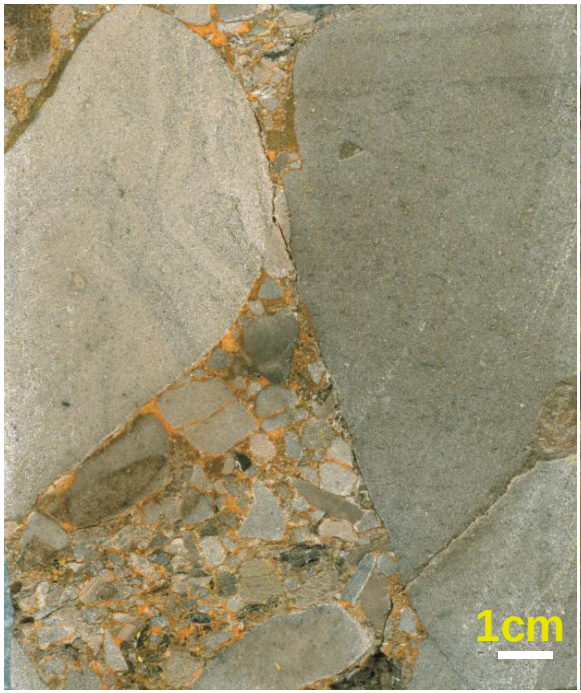

GERMANY
Eolian
Fluvial
Playa
Eolian covered by playa deposits
Lower Rotliegend
Pre-Permian substratum
50 km
SSW
NNE
A1g
Na1
A1d
Saxonian
Aut
Ca2
r
Carboniferous
Na1
r
Autunian
Na1
Saxonian
Autunian
A1d
Carboniferous
A1g
A1d
A2
Na2
Saxonian
Na1
A1d
Autunian
Carboniferous
1 km
10 km



Paleogeological cross-section through Brońsko Reef (Kościan region).
The top of Middle Buntsandstein is reference level.

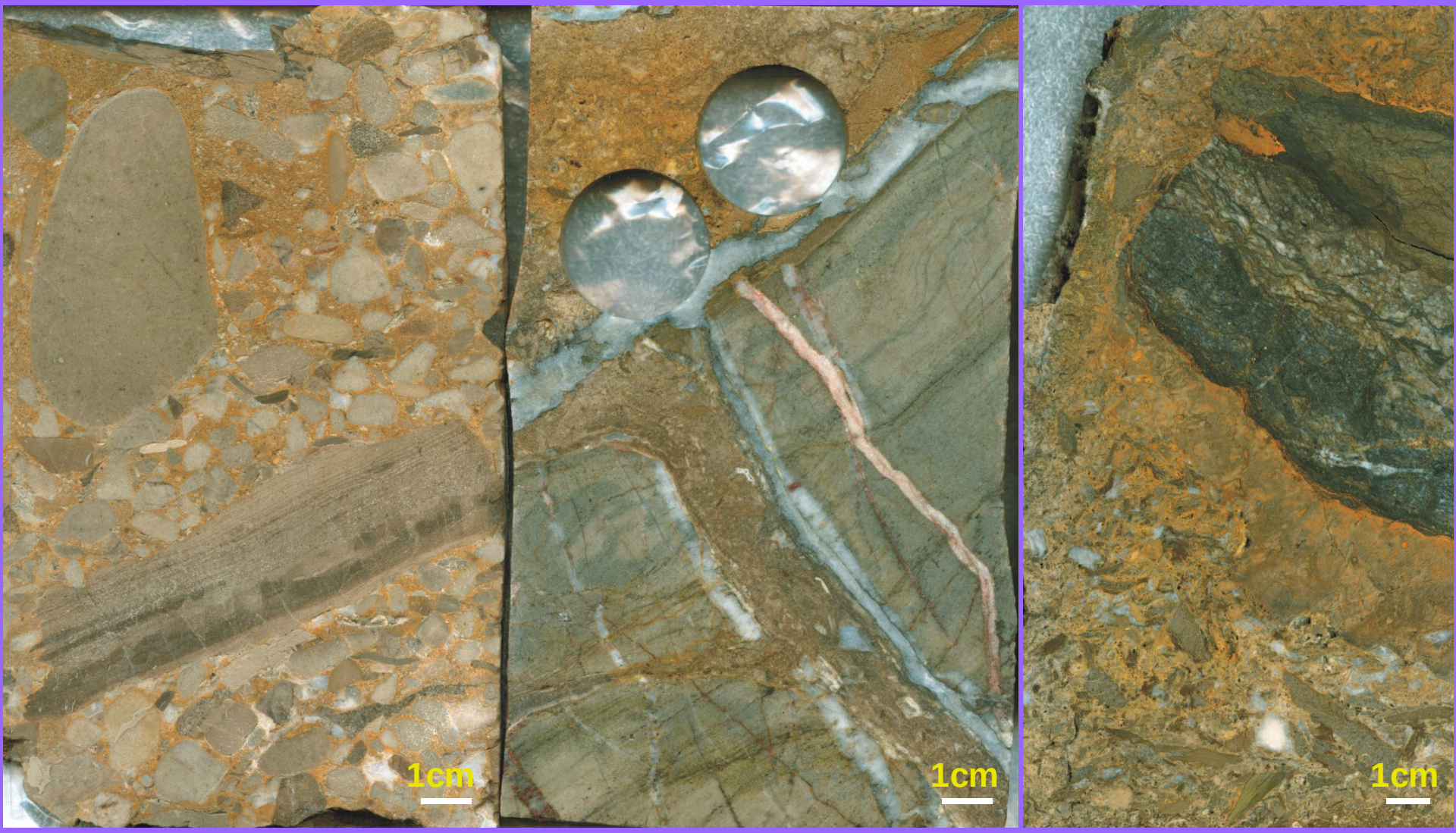

PAPROC W REEF
NOWY TOMYŚL REEF
JABŁONNA REEF
ELŻBIECINY REEF
RUCHOCICE REEF
BONIKOWO REEF
WIELICHOWO REEF
KOŚCIAN REEF
BROŃSKO REEF
0
10km


NW
SE
sea level:
HST
LST
Jabłonna
Elżbieciny
Ruchocice
Wielichowo
Brońsko
Kościan
Racot
200 m
0
10km
Zechstein Limestone
Rotliegend (sandstones)
Rotliegend (volcanics)
Carboniferous


1cm


1cm


1cm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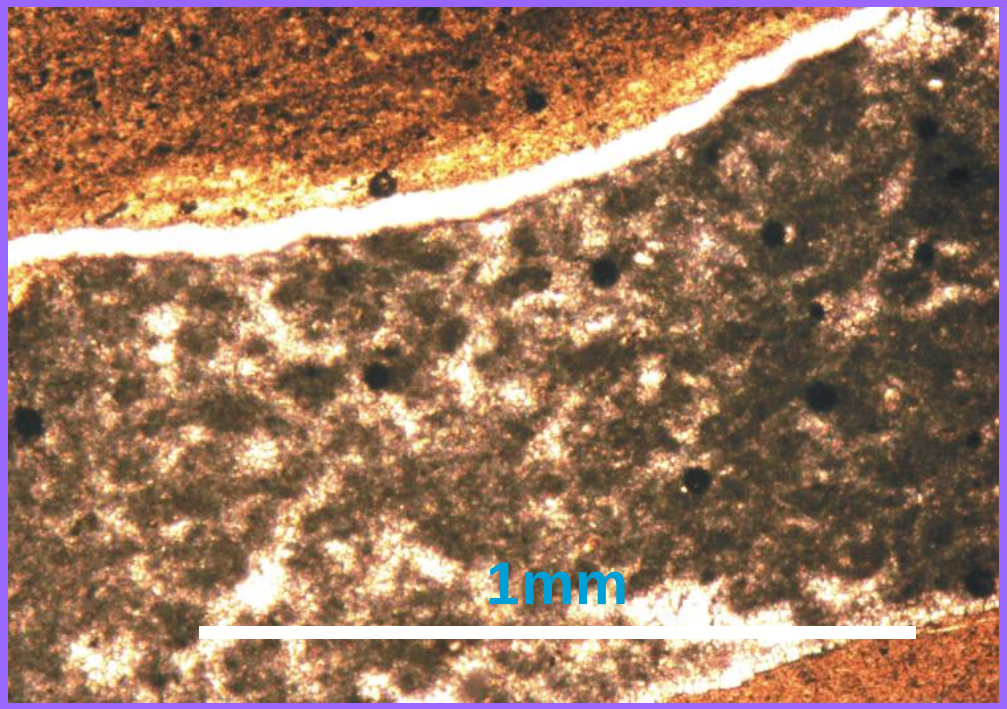
1cm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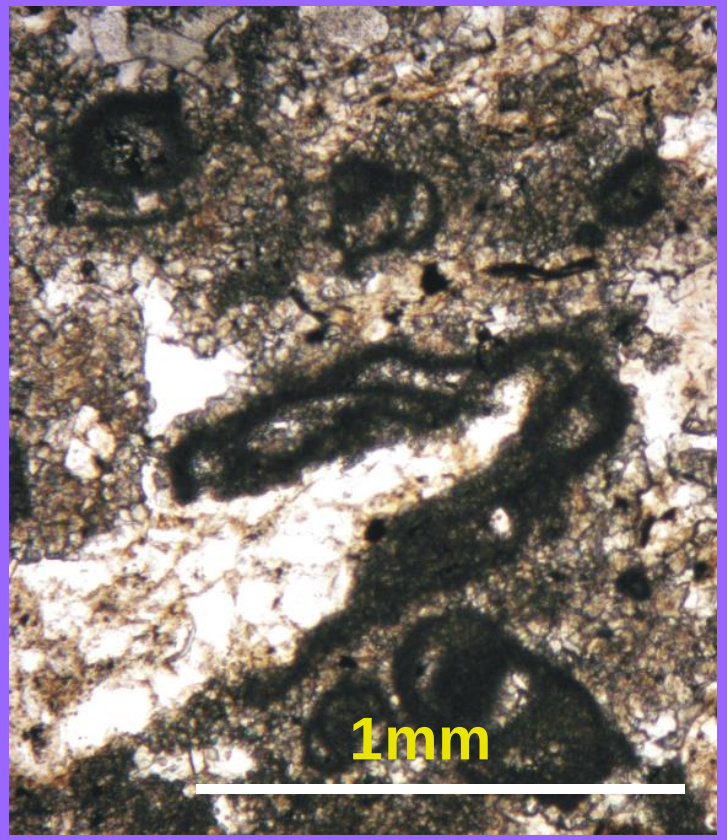
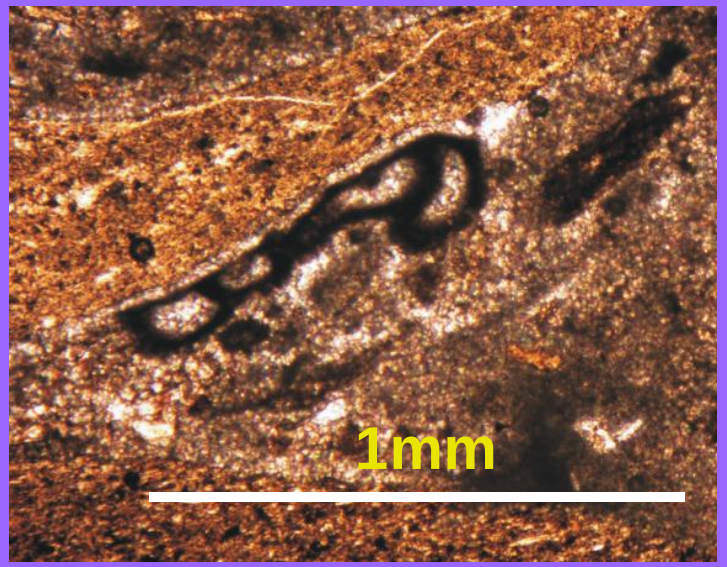

1mm


1mm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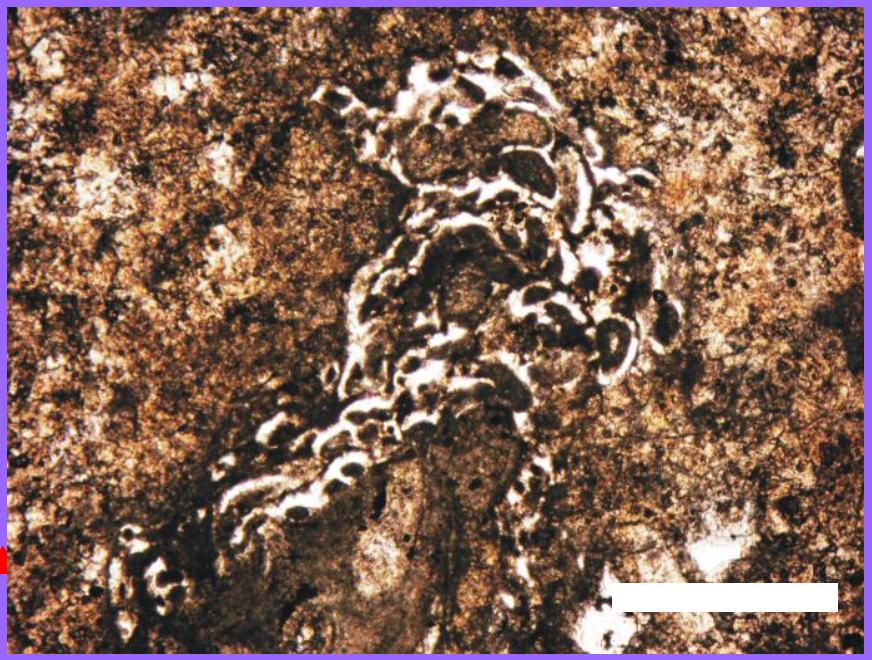

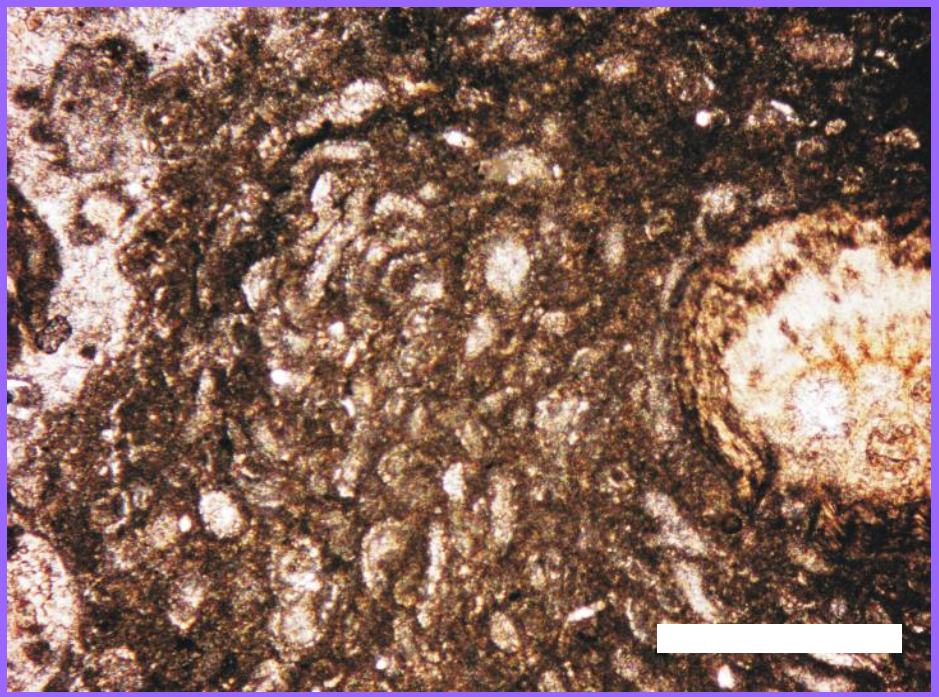

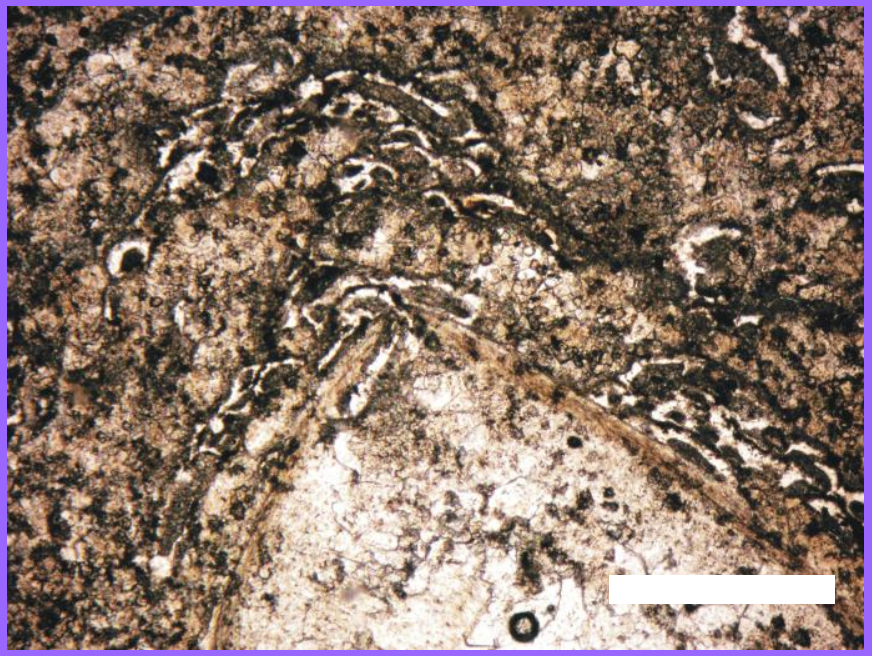

Scale bar = 0.5 mm


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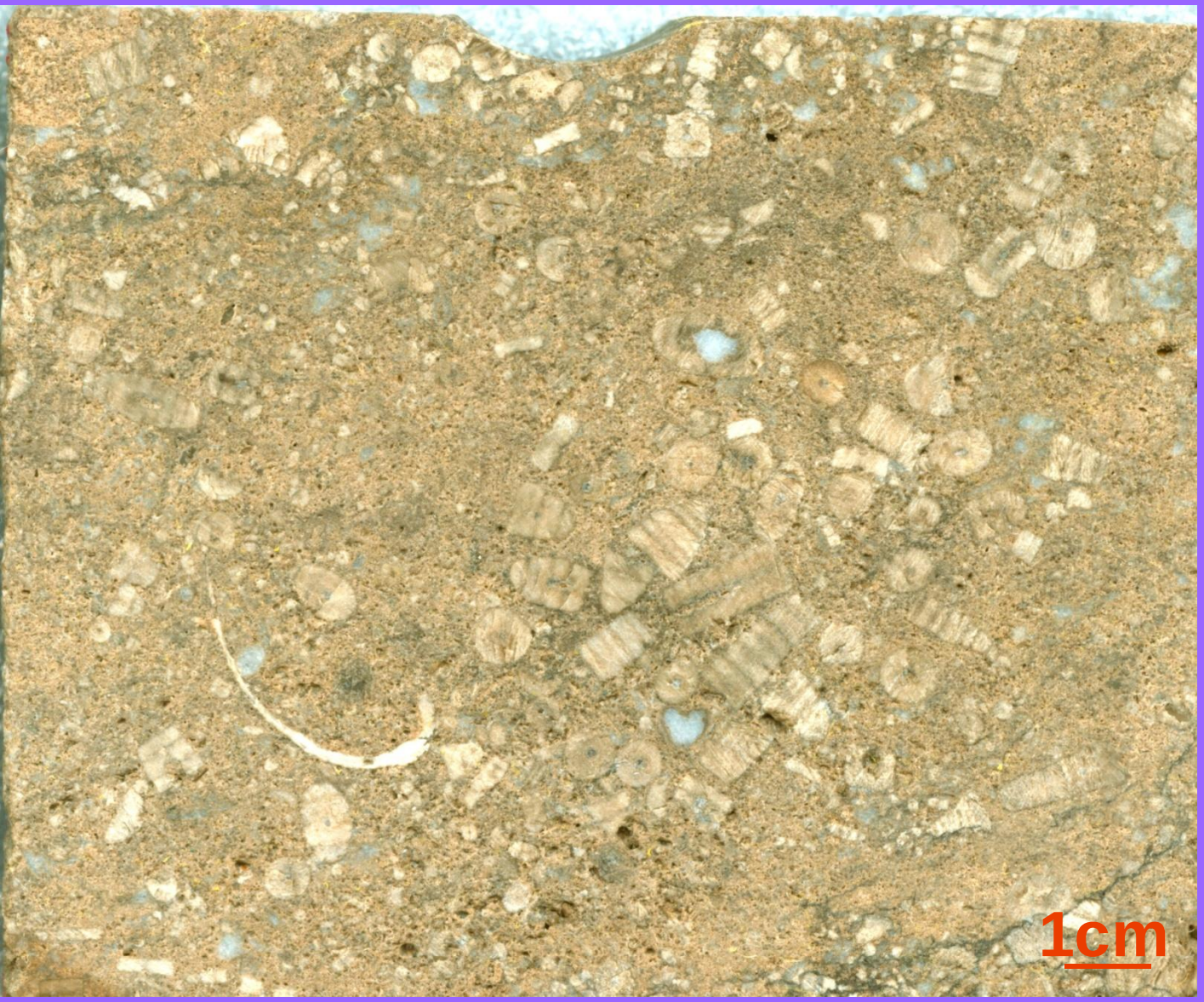
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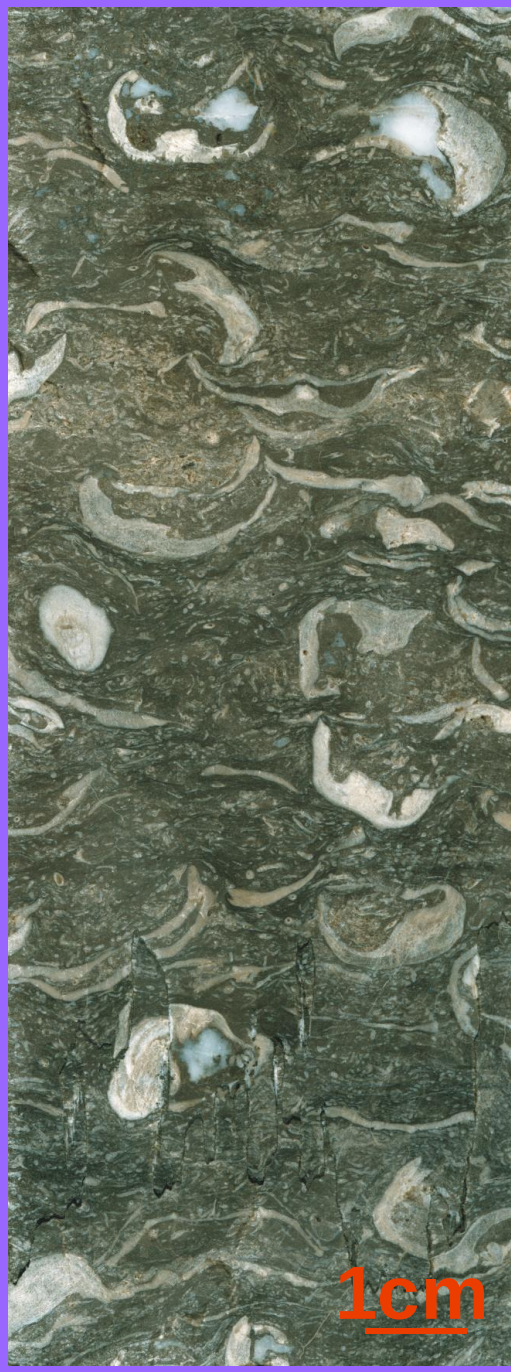
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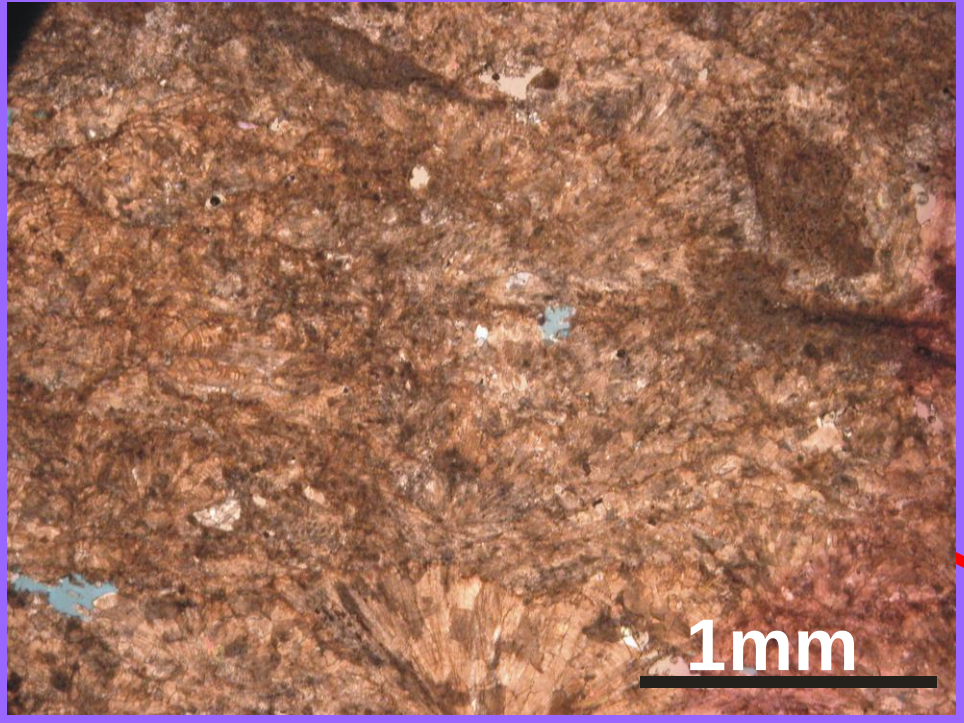
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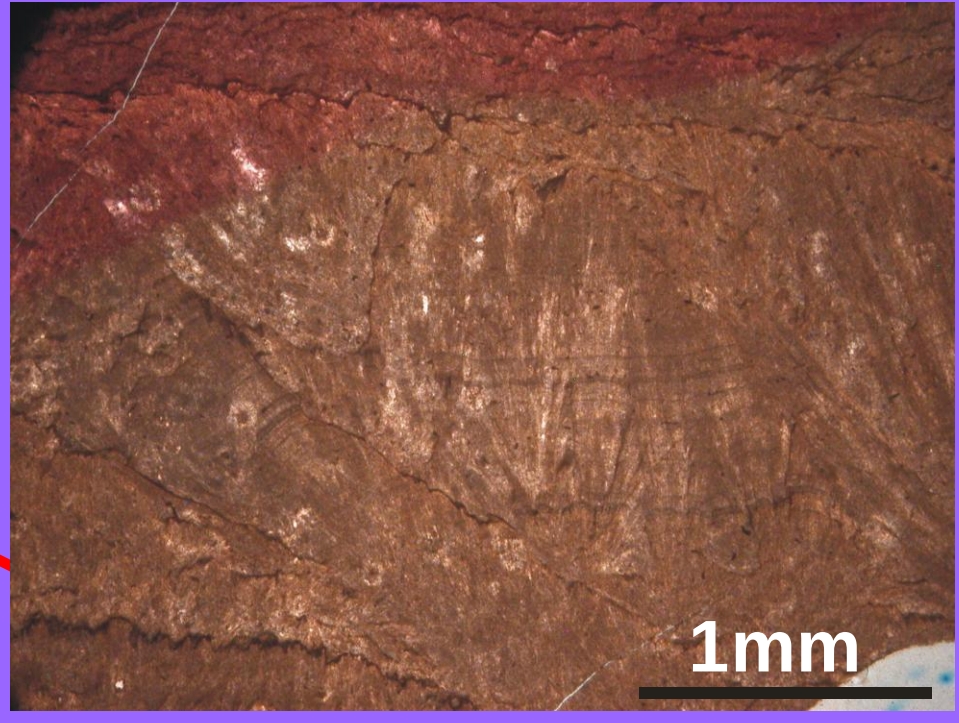
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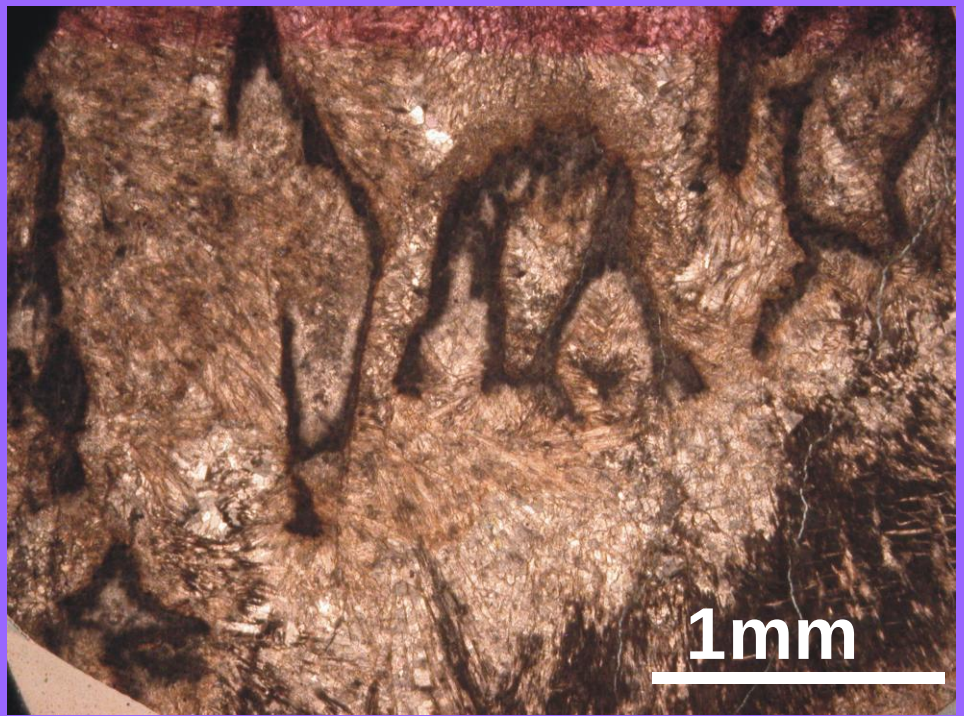
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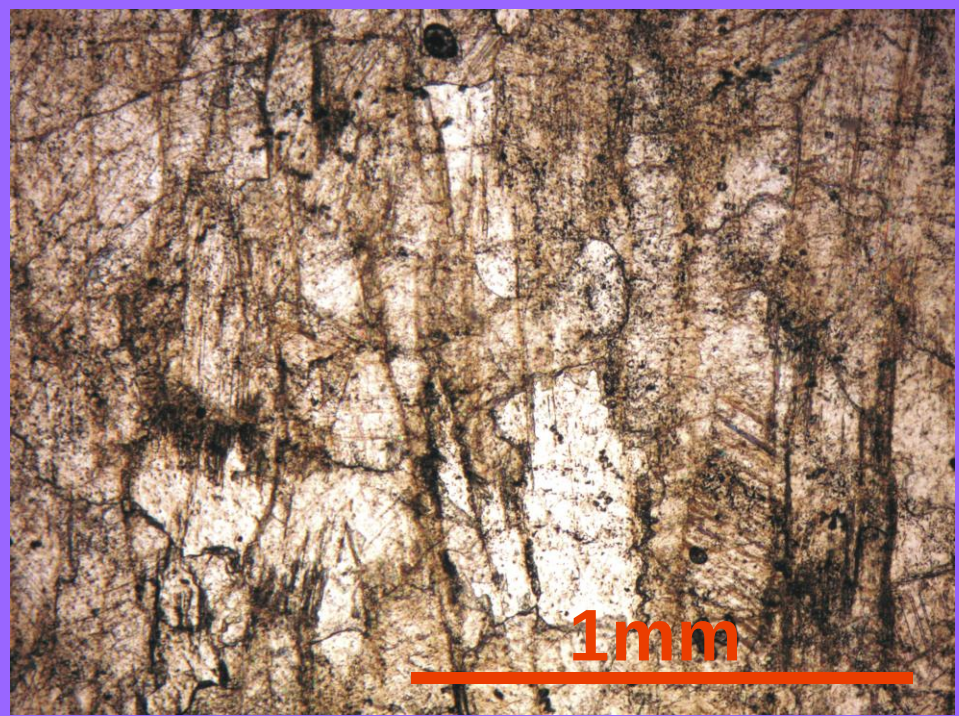
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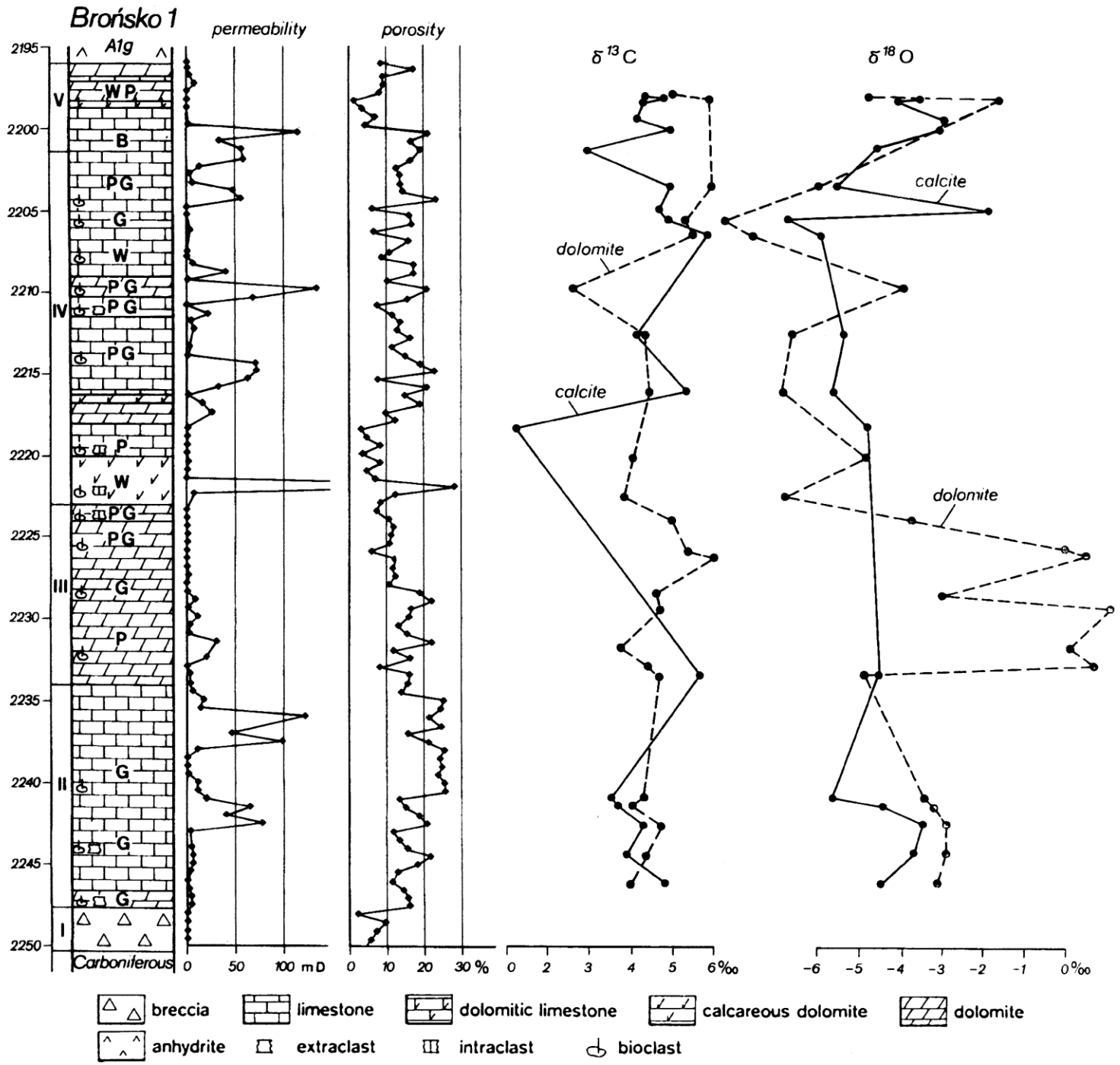
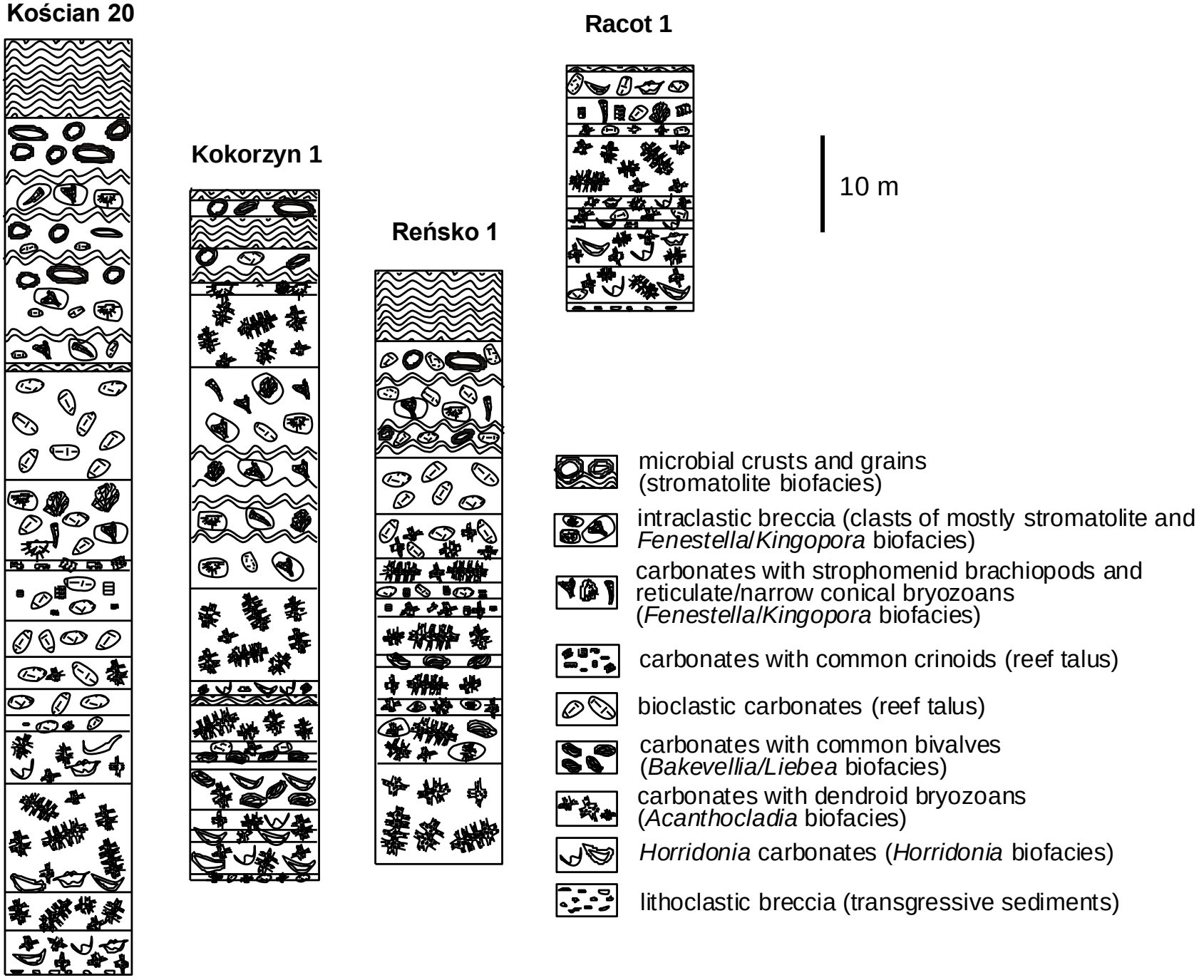

Brońsko 1
permeability
porosity
δ 13 C
δ 18 O
A1g
Carboniferous
dolomite
calcite
calcite
dolomite
0 50 100 mD
0 10 20 30 %
0 2 3 4 5 6‰
-6 -5 -4 -3 -2 -1 0‰
breccia
limestone
dolomitic limestone
calcareous dolomite
dolomite
anhydrite
extraclast
intraclast
bioclast

Five Zechstein units can generally be recognised below the Werra Anhydrite, the evaporite which caps the Zechstein Limestone, in the Wolsztyn Ridge area:

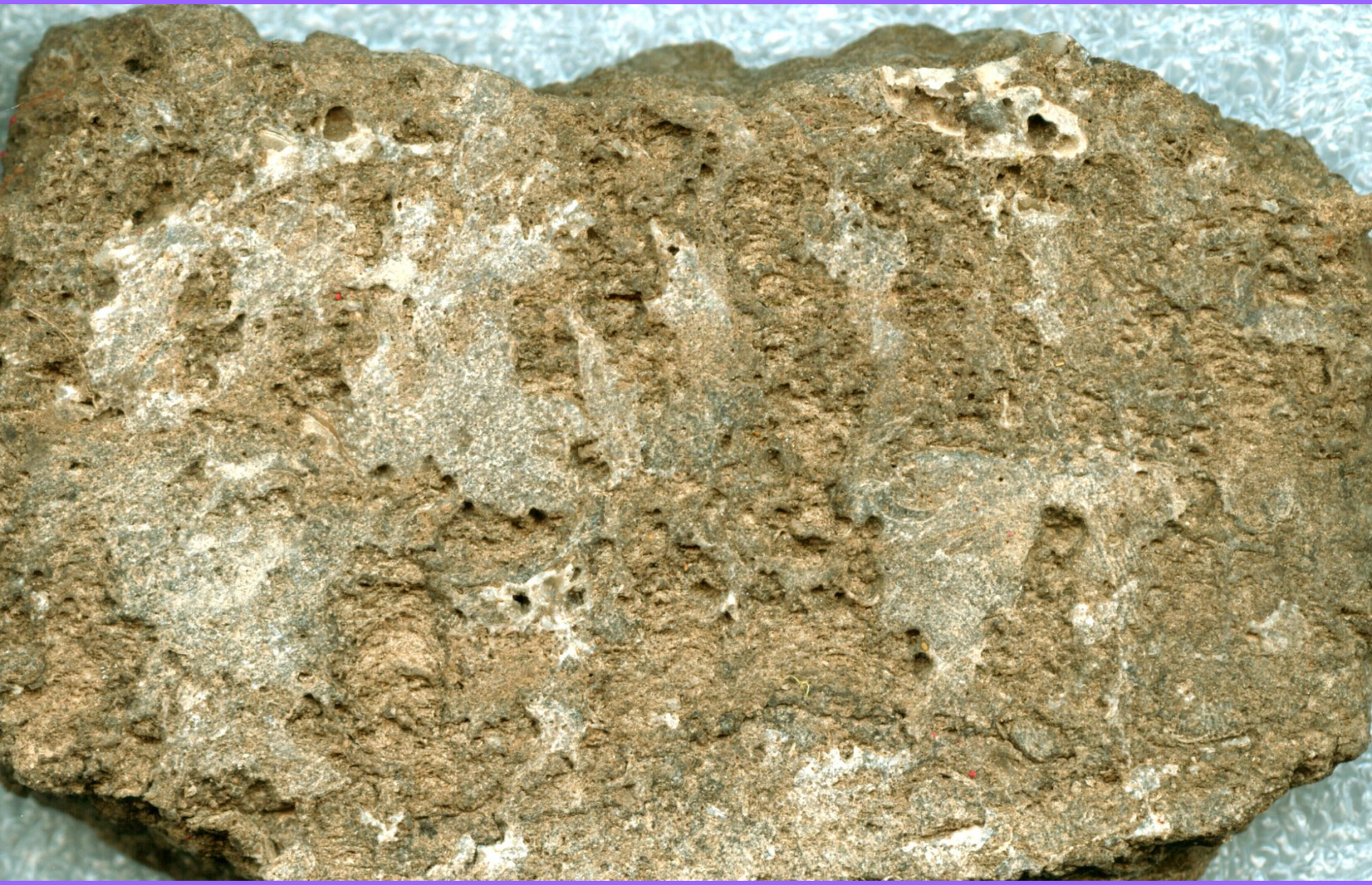
- breccia;
- bioclastic grainstones with extraclasts,
- bioclastic grainstones and packstones with abundant anhydrite;
- bioclastic wackestones-grainstones with intraclastic breccia and carbonate crusts;
- stromatolitic-pisolitic carbonates.

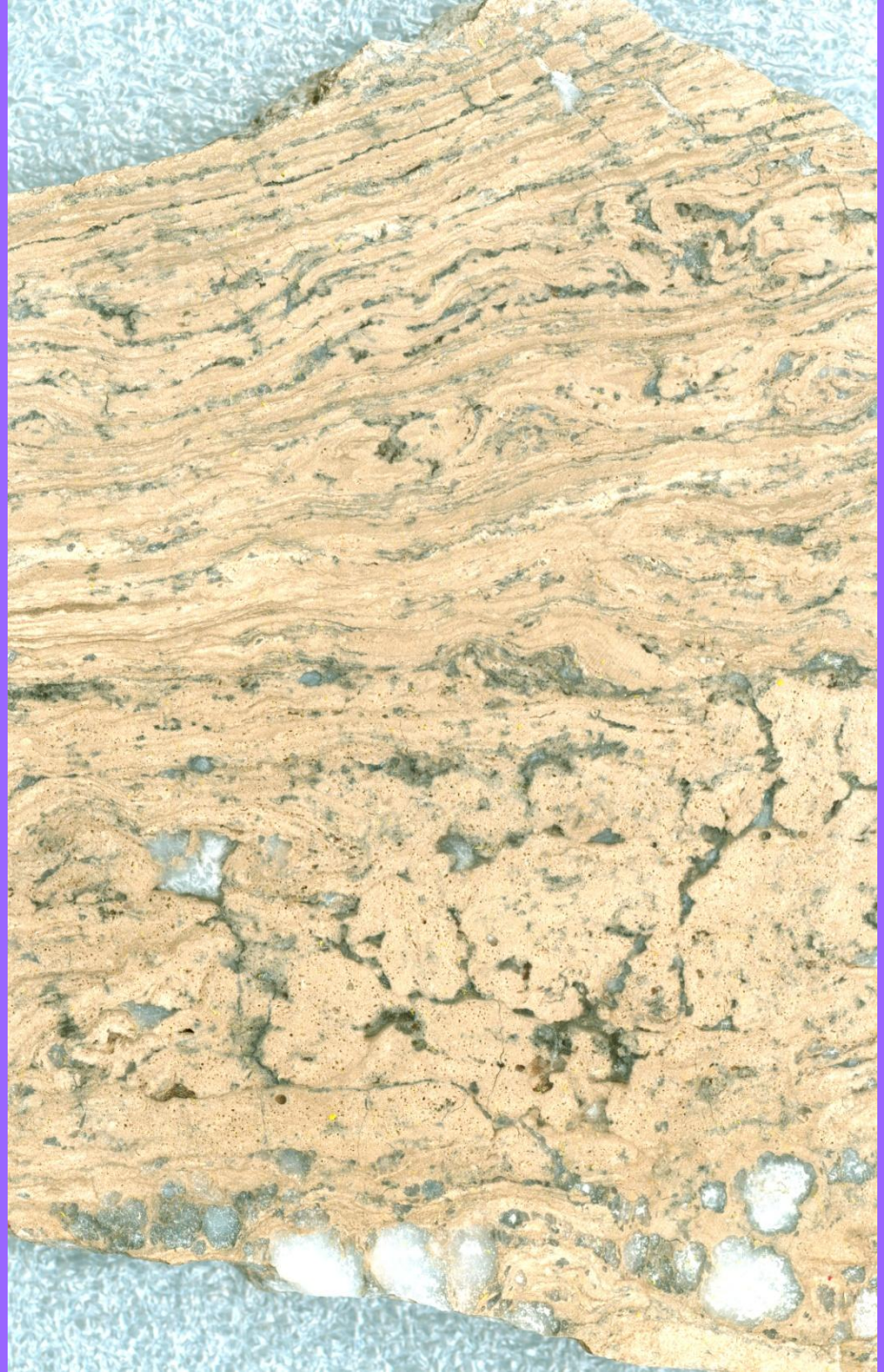
Units (i)-(iv) in general reflect deposition in subaqueous environments, and unit v originated in very shallow water or a temporarily subaerial environment. Unit (i) is interpreted as a TST, units (ii)–(iv) as a HST, and unit (v) as a LST. In places where units (iii) and (iv) are absent and deposits of unit (v) lie directly on those of unit (ii), units (iii) and (iv) either were not deposited or were eroded.

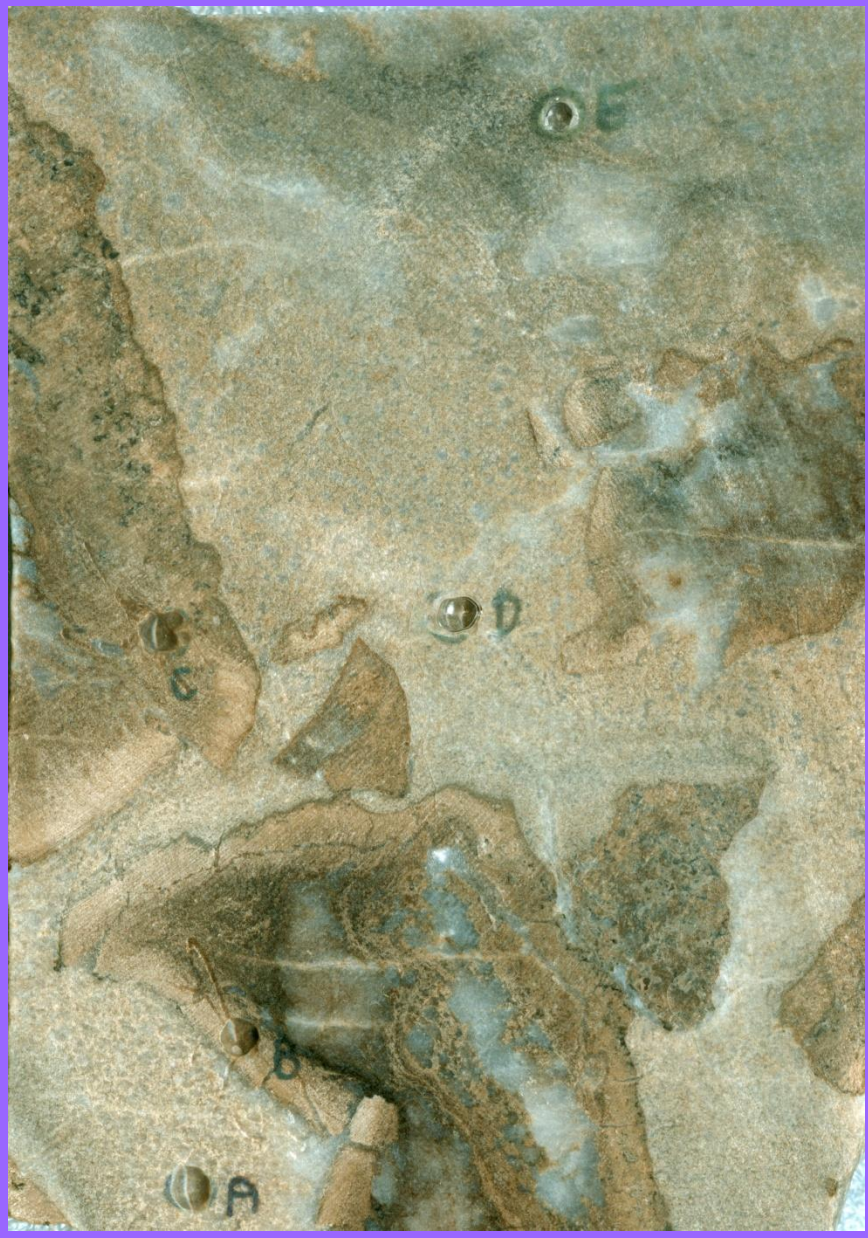

Kościan 20
Kokorzyn 1
Reńsko 1
Racot 1
10 m
microbial crusts and grains (stromatolite biofacies)
intraclastic breccia (clasts of mostly stromatolite and Fenestella/Kingopora biofacies)
carbonates with strophomenid brachiopods and reticulate/narrow conical bryozoans (Fenestella/Kingopora biofacies)
carbonates with common crinoids (reef talus)
bioclastic carbonates (reef talus)
carbonates with common bivalves (Bakevellia/Liebea biofacies)
carbonates with dendroid bryozoans (Acanthocladia biofacies)
Horridonia carbonates (Horridonia biofacies)
lithoclastic breccia (transgressive sediments)


1cm

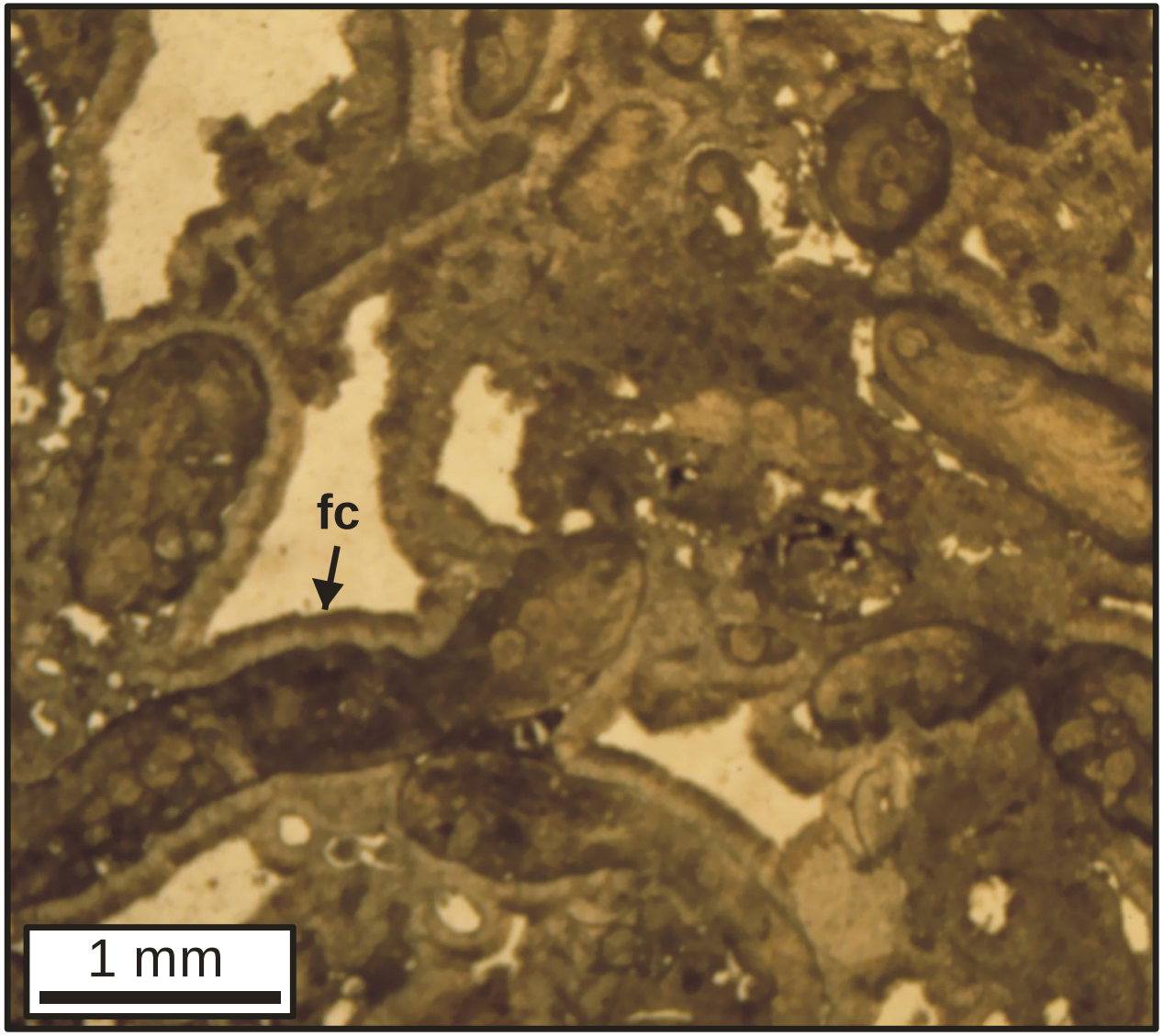

1cm



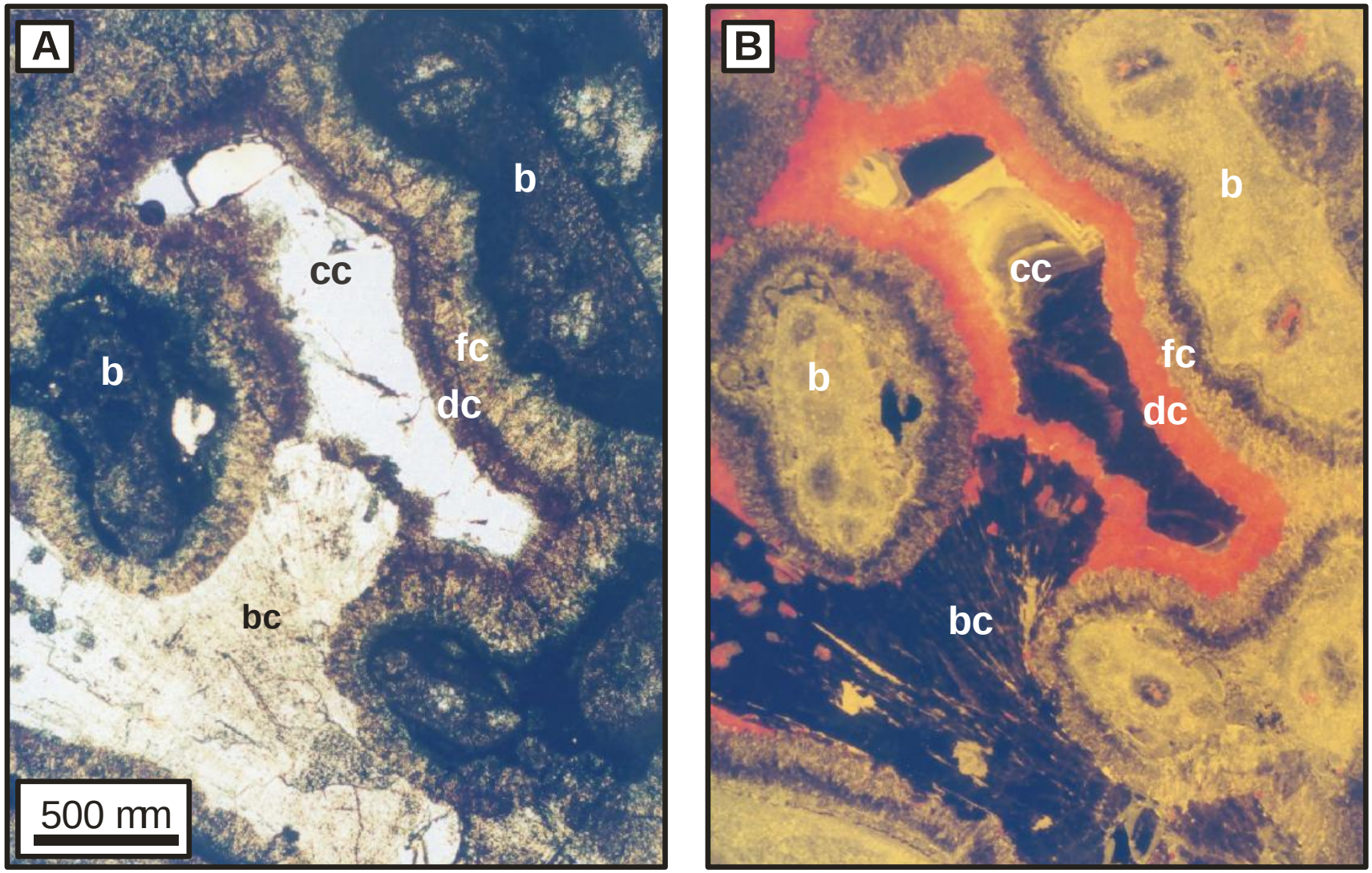



E
D
C
B
A

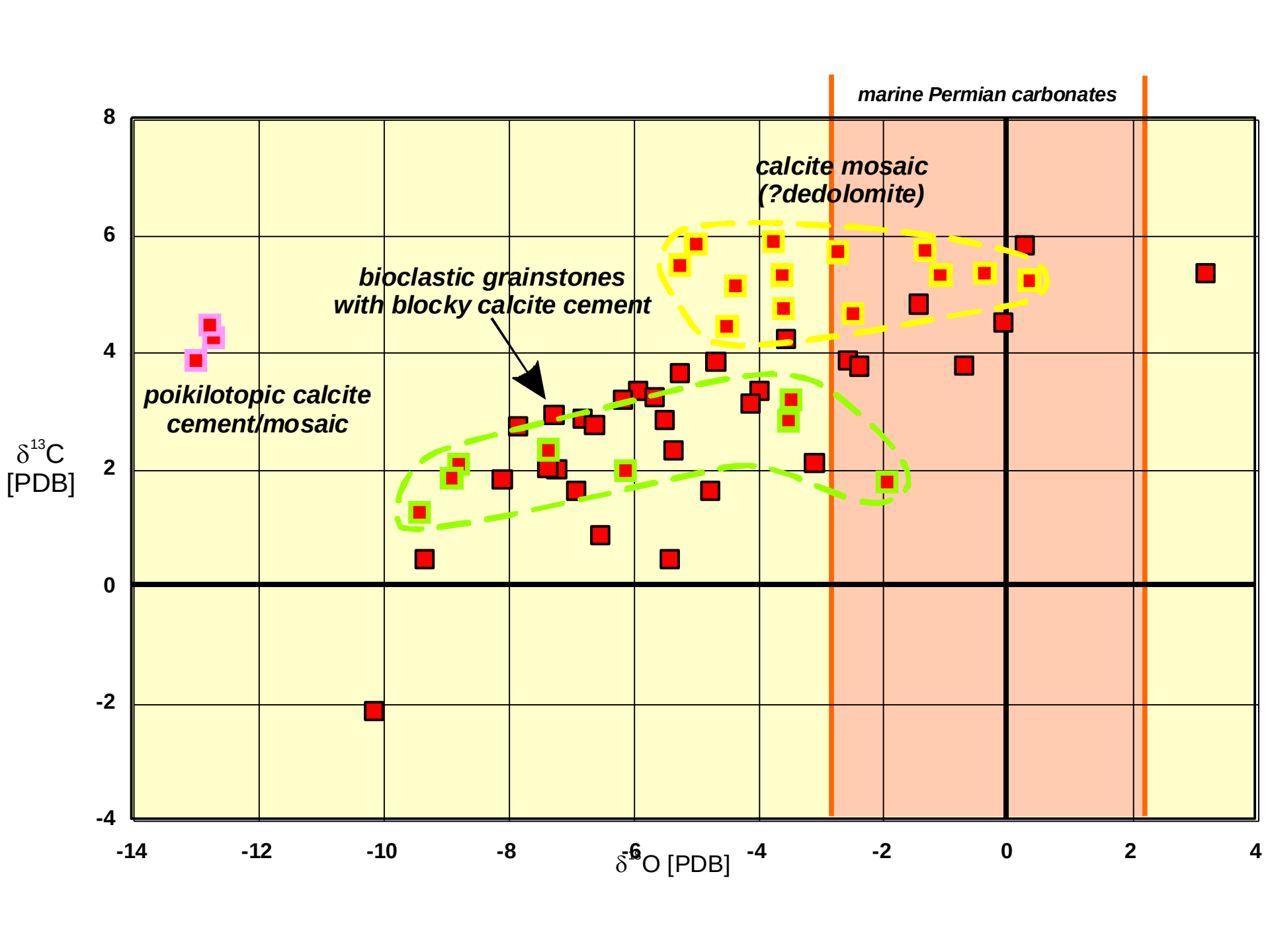
The reefs show variable diagenetic alterations including dolomitization and dedolomitization, multiphase carbonate (calcite and dolomite) and/or anhydrite cementation and recrystallization.

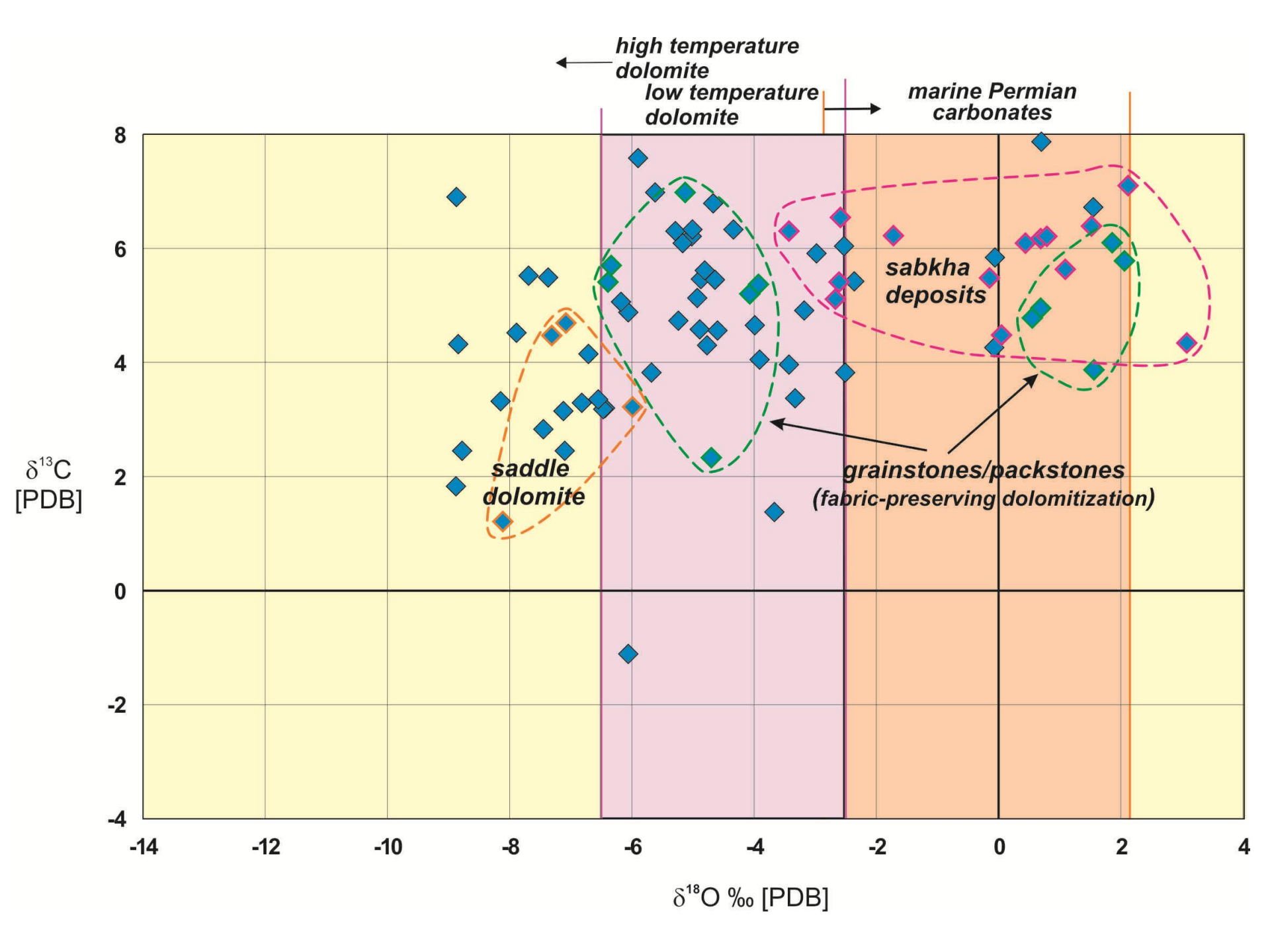


Completely dolomitized (fabric-preserving dolomitization) bryozoan grainstone with fibrous cement rims (fc). Preserved high primary intergranular porosity. Paproć 21.



Bryozoan (b) grainstone. Porosity infilled with marinefibrous ispachous and botryoidal (bc) (originally aragonite) calcite cements followed by isopachous dolomite cement (dc). The last cement generation is coarse-crystalline burial calcite (cc). A- parallel polars, B - CL. Kościan 10.


marine Permian carbonates
calcite mosaic
(?dedolomite)
bioclastic grainstones
with blocky calcite cement
poikilotopic calcite
cement/mosaic
δ13C
[PDB]
δ18O [PDB]
8
6
4
2
0
-2
-4
-14
-12
-10
-8
-6
-4
-2
0
2
4


high temperature dolomite
low temperature dolomite
marine Permian carbonates
sabkha deposits
saddle dolomite
grainstones/packstones
(fabric-preserving dolomitization)
δ13C [PDB]
δ18O ‰ [PDB]
8
6
4
2
0
-2
-4
-14
-12
-10
-8
-6
-4
-2
0
2
4

In West Poland, isolated reefs have originated, and were growing, on the topmost edges of tilted blocks and/or on the top of uplifted horsts in the basin facies. They are sealed by evaporites and are important gas reservoirs. The reef biota are typical bryonoderm associations indicating cool-water and cold-water environments. The Zechstein Limestone basin was sourced by temperate to cool water from the Boreal Sea when the Rotliegend basin lay well below the contemporaneous sea level due to flooding in mid or late Wuchiapingian times. The sequence of lithofacies and biofacies includes deposition of a coarse coquina and subsequent establishment of a diverse, stenohaline bryozoan community followed by start of reef growth with aggradational geometries by a stenohaline fauna including bryozoans, brachiopods, and various encrusters. Later on, bryozoan community changed to encrusting reef-builders, and the depositional geometries changed from aggradation to progradation until sea level falls resulted in subaerial exposure of the reefs.

The main part of reefs is built of rudstones, and only stromatolitic crusts form massive construction. Astonishing is the mechanism of origin of clearly separate morphological reef constructions from remains with relatively low potential for fossilization. Zones built of crushed remains clearly dominate over parts representing massive constructions. The Zechstein Limestone reefs abound in the hemispheroid aragonitic cement which is otherwise common for the reefs elsewhere in the Zechstein basin. The abundance of the cement recorded in Permian reefs is interpreted as the result of an unusually high saturation state of surface seawater because of a number of factors. The occurrence of reefs at the base of the Zechstein Limestone indicates that, locally and very quickly after the onset of Zechstein deposition, the environmental conditions were favorable for local carbonate production. However, over a large area in the region the regime was hostile for much carbonate production, and hence condensed sequences were deposited.