

Foraminiferal Record of the Onset of the Middle Miocene Badenian Salinity Crisis in Central Paratethys*

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Abstract

The isolation of some parts of the Paratethys Sea (Middle East, Red Sea, Carpathian Foredeep, Transylvania) at the end of late Langhian resulted in the “Middle Badenian” salinity crisis. The scenario of events leading to the deposition of widespread evaporites in the Badenian shows great similarities to the onset of the Messinian salinity crisis in the Mediterranean. Isotopic studies of Badenian foraminifers occurring below evaporites in the Carpathian Foredeep basin suggest that the interrupted communication of the Paratethys with the ocean was a consequence of eustatic sealevel fall, possibly related to climatic cooling, and it was coupled with a tectonic closure of connection with the Tethys. Badenian evaporites are underlain by deep-water deposits, and the previous interpretation assumed that the onset of evaporite deposition was sudden but not synchronous in all facies zones: the evaporites deposited in the basin centre preceded the beginning of evaporite sedimentation in the marginal basin. Giant gypsum intergrowth facies occurring at the base of gypsum section in the northern Carpathian Foredeep originated from density-stratified brines. This density stratification possibly started during the deposition of the Ervilia Bed, a thin limestone layer containing fauna almost exclusively composed of two mollusk species particularly adapted to an increased salinity and low oxygenation. Recently clays underlying a major gypsum unit in the Borków gypsum quarry (southern Poland), one of the best studied Badenian gypsum outcrops, have been exposed. The study of foraminiferal microfauna occurring in those clays shows that benthic foraminiferal assemblage is very well preserved and moderately diversified; it is dominated by infaunal morphogroups represented mainly by thin-walled, delicate, elongate, smooth, and serial-shaped genera. Planktonic foraminifera are rare. The recorded foraminifera indicate marine environment where bottom waters were oxygen deficient but of normal marine salinity. The foraminiferal assemblage immediately below the gypsum is moderately diversified and shows different taxonomic composition, possibly due to increased salinity. In any case, the transition from normal marine to evaporite deposition was rapid and this implies a roughly synchronous onset of evaporite deposition in the entire Carpathian Foredeep basin.

Selected References

Ilyina, L.B., I.G. Shcherba, S.O. Khondkarian, and I.A. Goncharova, 2004, Map 6: Mid Middle Miocene *in* S.V. Popov, F. Rogl, A.Y. Rozanov, F.F. Steininger, I.G. Shcherba, and M. Kovac (eds.) Lithological-Paleogeographic maps of Paratethys 10 maps Late Eocene to Pliocene: Courier Forschungsinstitut Senckenberg, p. 250.

Peryt, T.M., 2006, The beginning, development and termination of the middle Miocene Badenian salinity crisis in central Paratethys: *Sedimentary Geology*, v. 188-189, p. 379-396.

Picha, F.J., 1996, Exploring for hydrocarbons under thrust belts; a challenging new frontier in the Carpathians and elsewhere: *AAPG Bulletin*, v. 80/10, p. 1547-1564.

van der Zwan, G.J., F.J. Jorissen, and H.C. de Stigter, 1990, The depth dependency of planktonic/benthic foraminiferal ratios; constraints and applications: *Marine Geology*, v. 95/1, p. 1-16.

van Hinsbergen, D.J.J., E. Hafkenscheid, W. Spakman, .E. Meulenkaamp, and R. Wortel, 2005, Nappe stacking resulting from subduction of oceanic and continental lithosphere below Greece: *Geology*, v. 33/4, p. 325-328.

FORAMINIFERAL RECORD OF THE ONSET OF THE MIDDLE MIOCENE BADENIAN SALINITY CRISIS IN CENTRAL PARATETHYS

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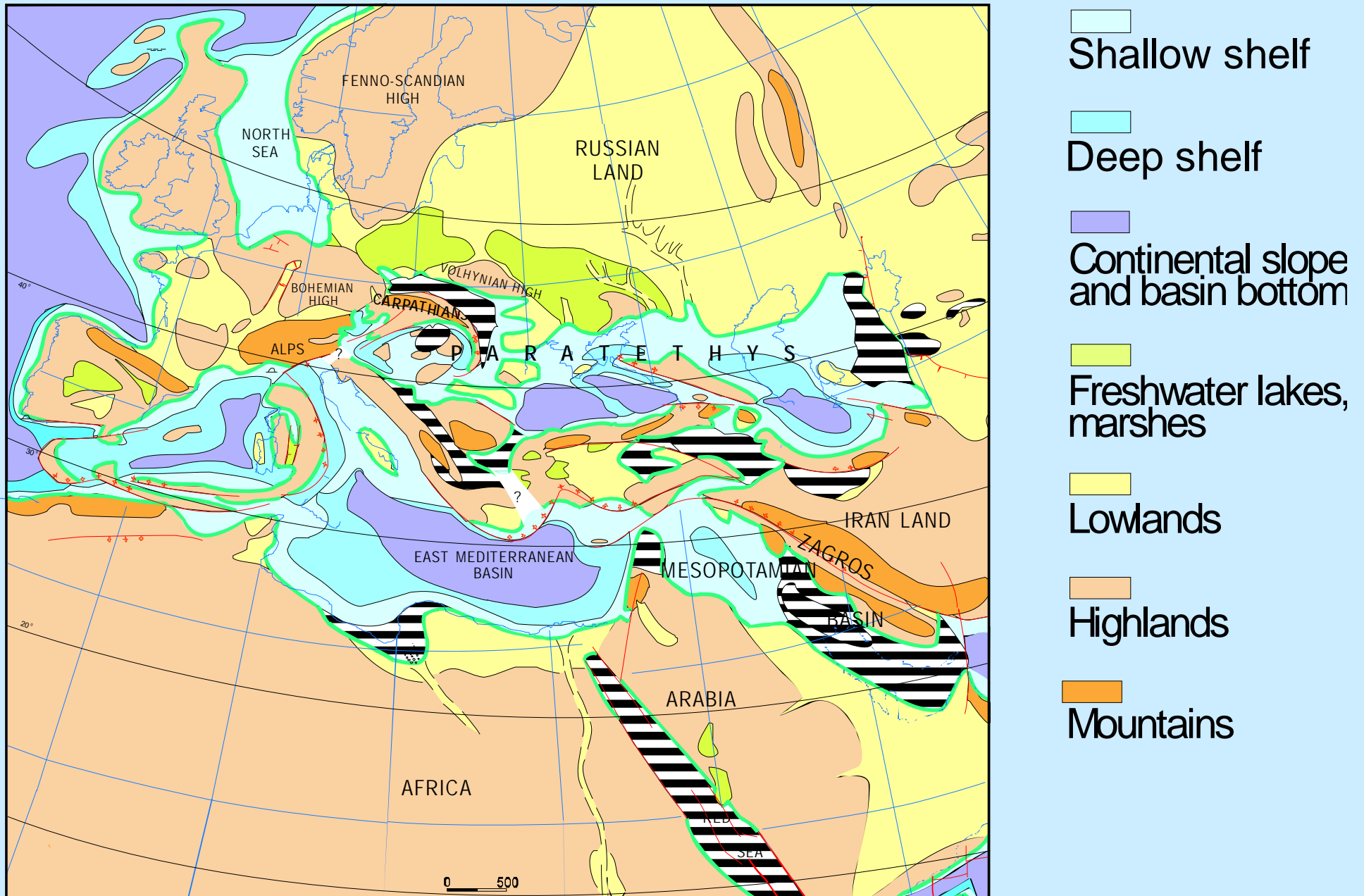


New Orleans, April 14, 2010



Middle Middle Miocene 14 -13 Ma

After Ilyina, Shcherba, Khondkarian & Goncharova (2003)



POLISH & UKRAINIAN CARPATHIAN FOREDEEP IN THE ALPINE-CARPATHIAN SYSTEM (after Picha, 1996)



Geological setting

The Carpathian Foreland Basin system is one of the biggest sedimentary basins in Central Europe. It stretches from Austria to Romania and was formed in front of the advancing Carpathians. The Carpathian Foreland Basin system was generated on the interior side of a collision zone during lithospheric flexure of the East European Platform in response to a northward-stepping thrust load. The Carpathian Basin shows a large-scale offlap and thickness increase towards the east along the convergent margin, reflecting an increased accommodation in that direction.

The Miocene fill (locally more than 5 km thick) consists of deep-water, shallow-marine, and deltaic siliciclastic sediments and evaporites.

12	Middle Miocene	Serravallian	Sarmatian	NN6	Machów Formation	clays
13			Badenian			
14	Ma	Langhian		NN5	Baranów Beds	clays, silts, sands, coralline algal limestones

gypsum

coralline algal limestones

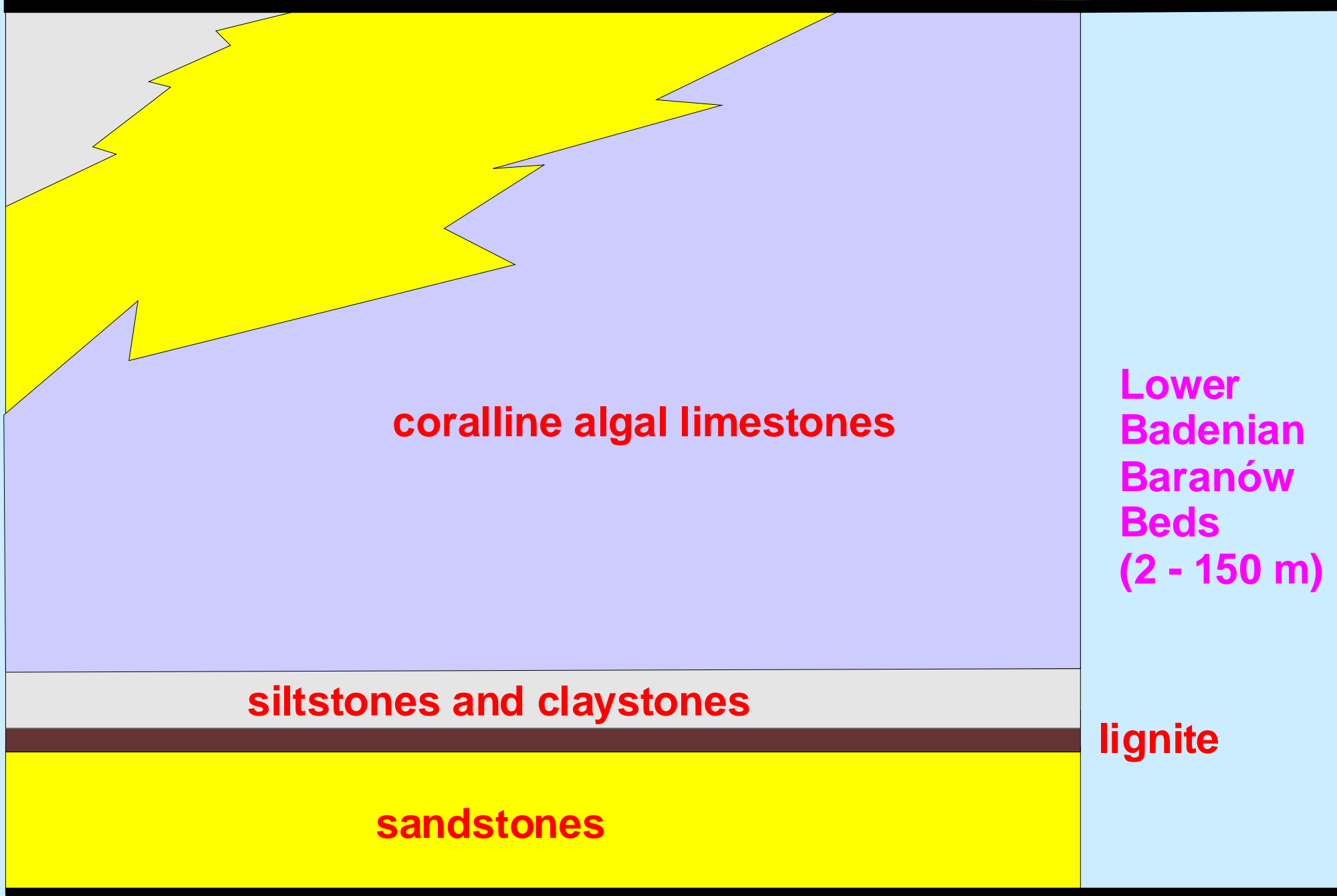
siltstones and claystones

**Lower
Badenian
Baranów
Beds
(2 - 150 m)**

lignite

sandstones

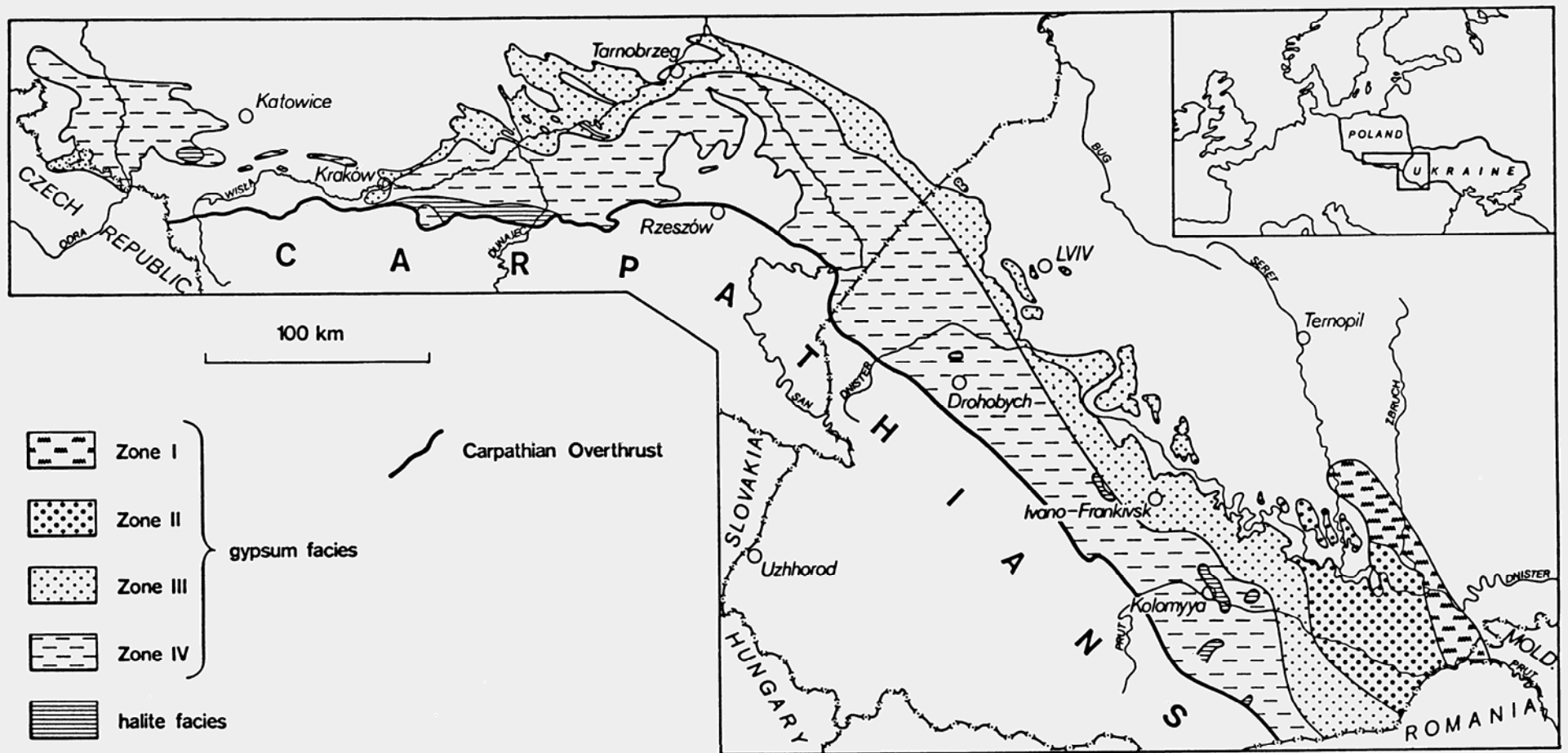
Cretaceous

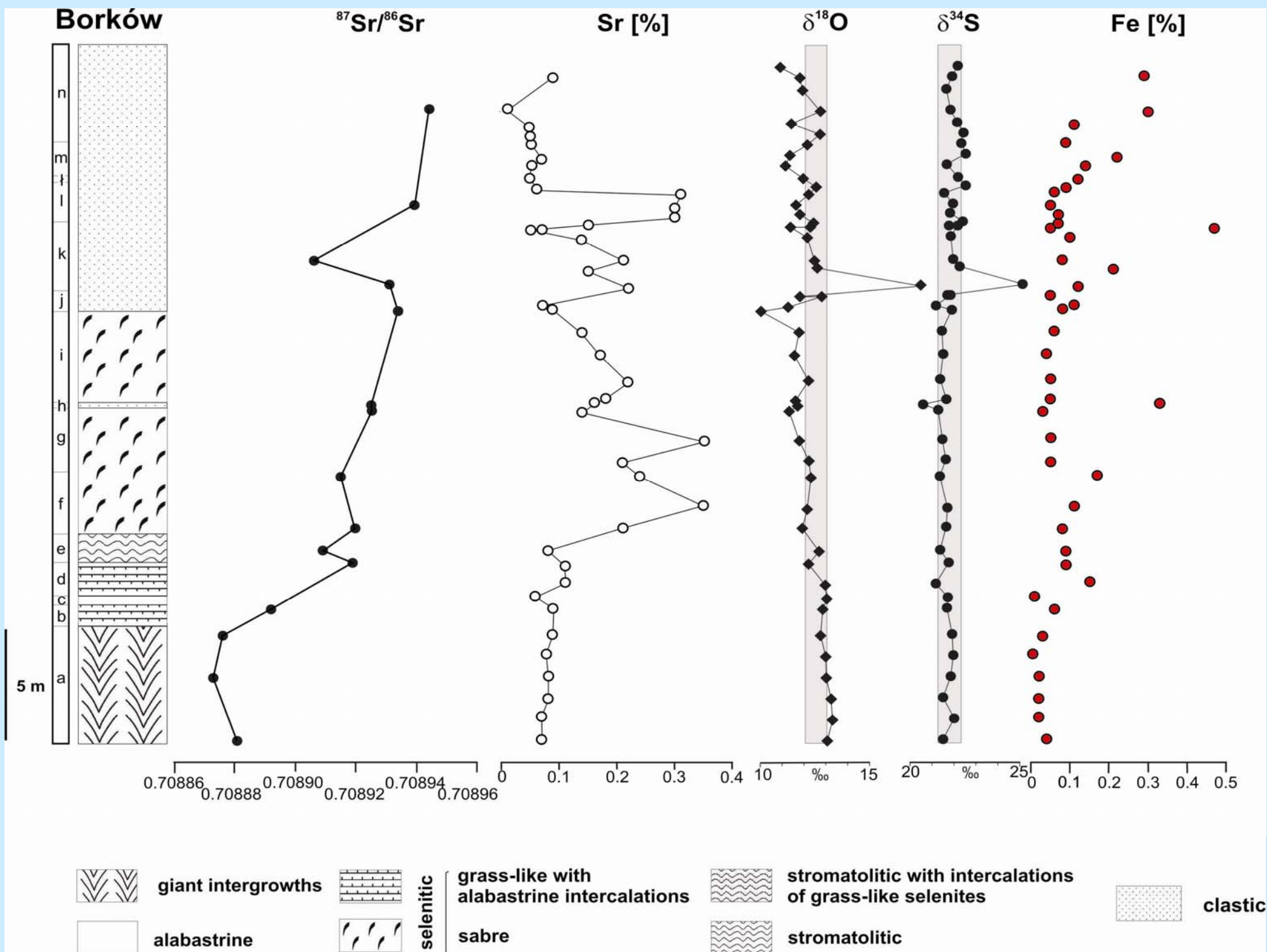


The scenario of events leading to the deposition of widespread evaporites, being a synchronous event, in the Badenian is not established in detail:

- eustatic sealevel fall, possibly related to climatic cooling?
- tectonic closure of connection with the Tethys?

BADENIAN EVAPORITE FACIES (CARPATHIAN FOREDEEP BASIN), after T.M. Peryt (2006)





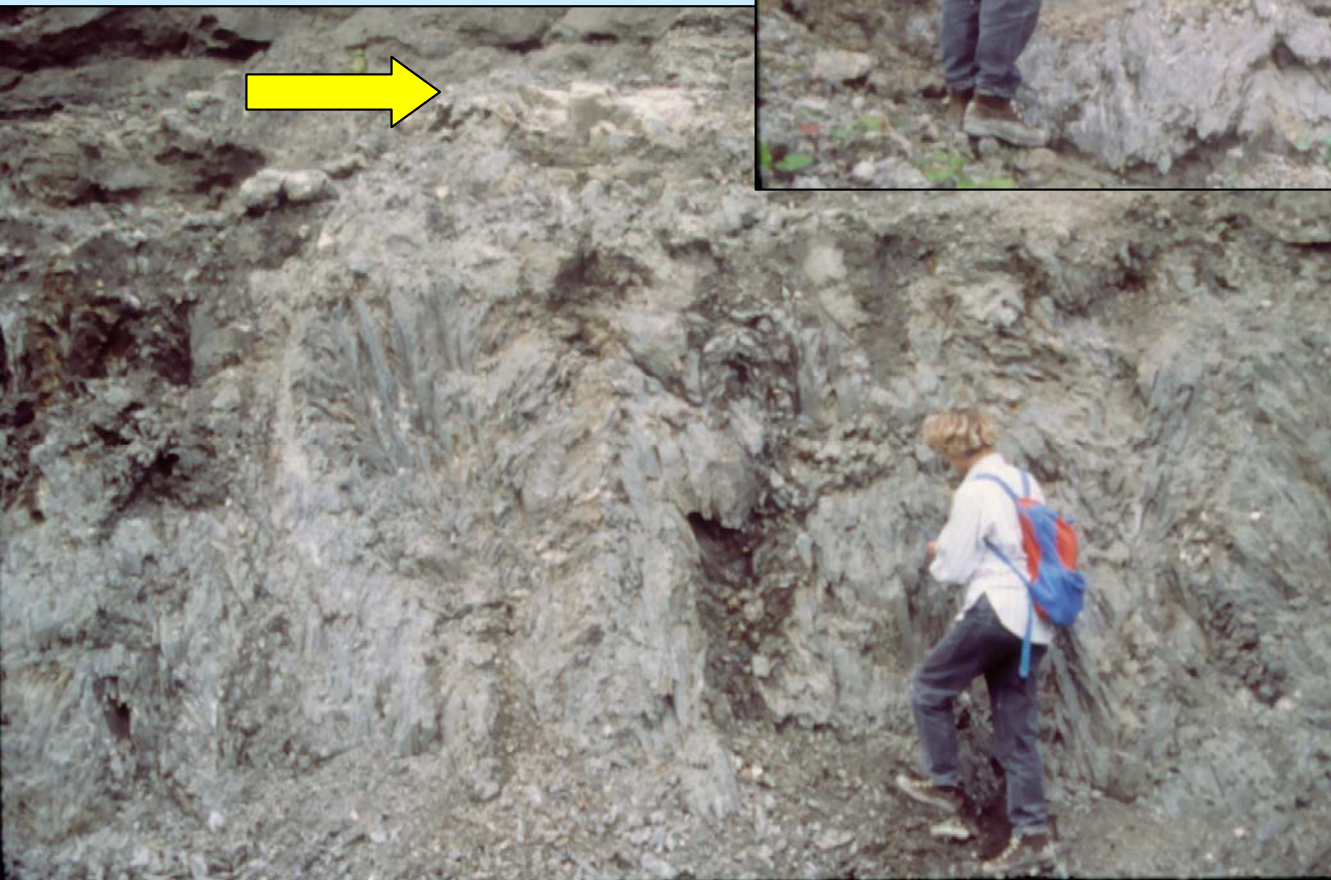
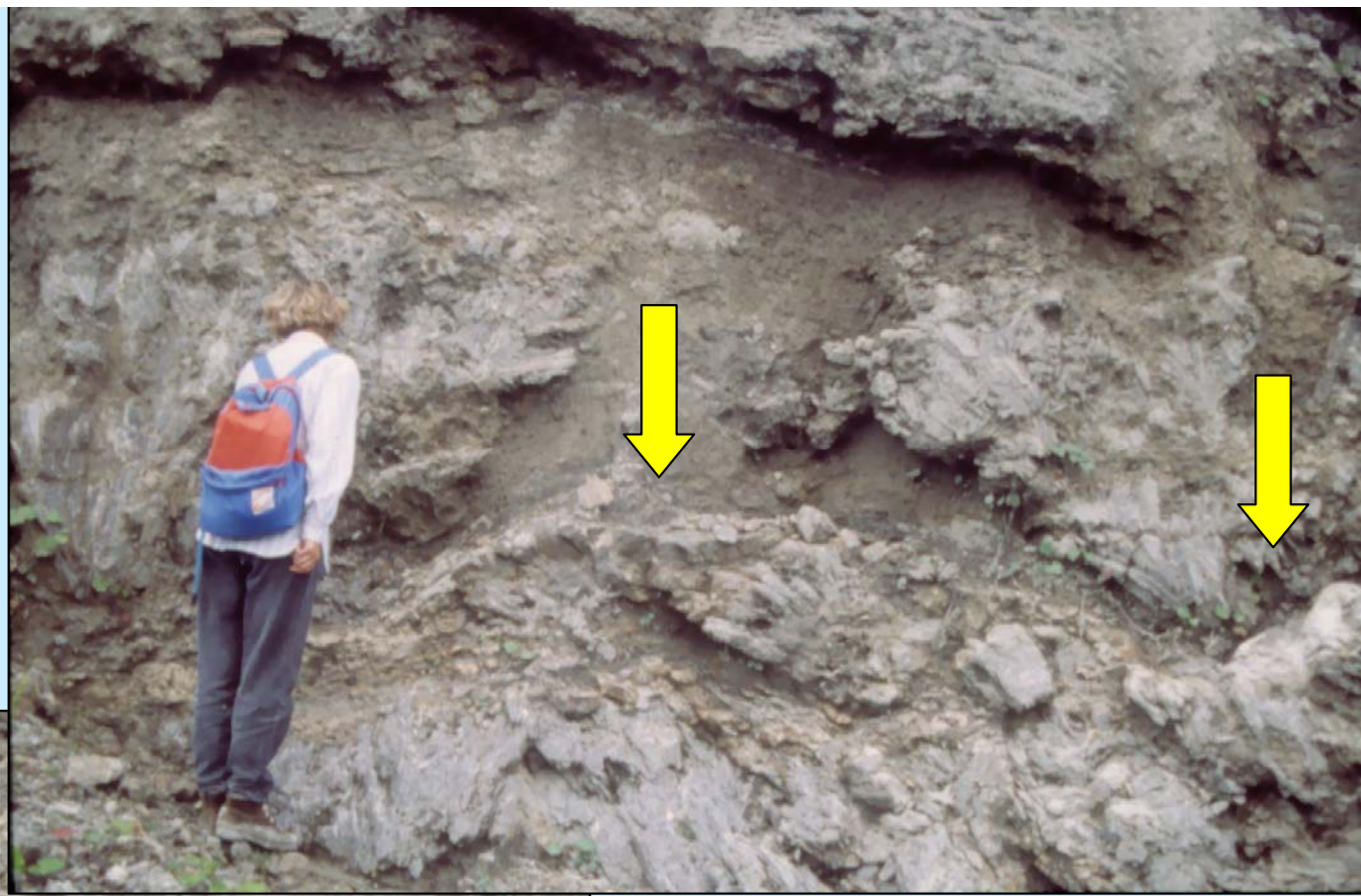


upper part



lower part

Kobeřice (CZ)







5 m

Borków (June 2009), dewatering dig



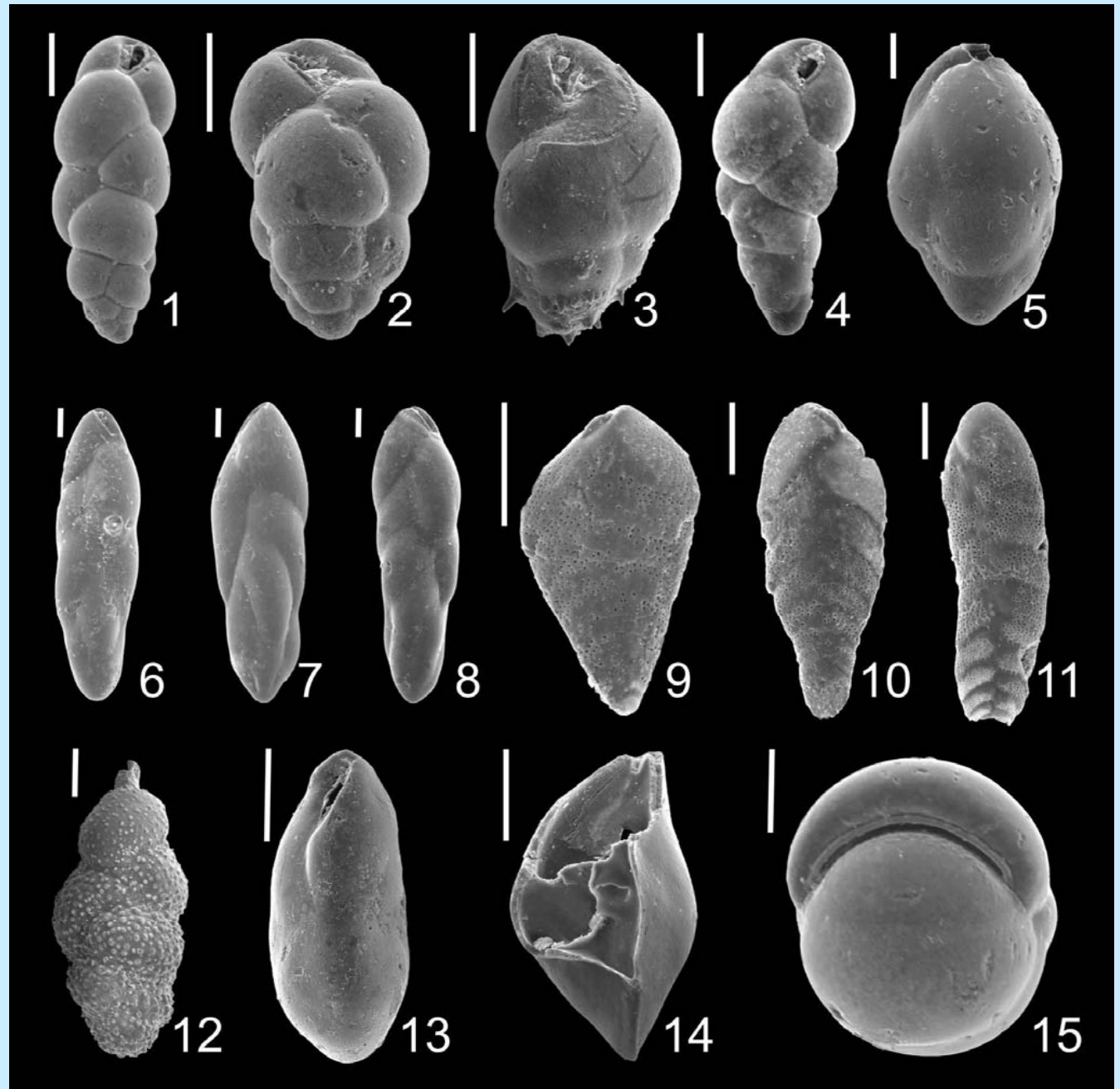
scale bar = 0.1 mm

Deep infauna:

- 1, 4. *Bulimina elongata*
- 2. *Bulimina insignis*
- 3. *Bulimina aculeata*
- 5. *Praeglobobulimina pyrula*
- 6, 8. *Fursenkoina acuta*
- 9. *Bolivina dilatata*
- 10. *Bolivina spathulata*
- 11. *Bolivina* sp.
- 12. *Uvigerina hispida*
- 13. *Globocassidulina oblonga*

Shallow infauna:

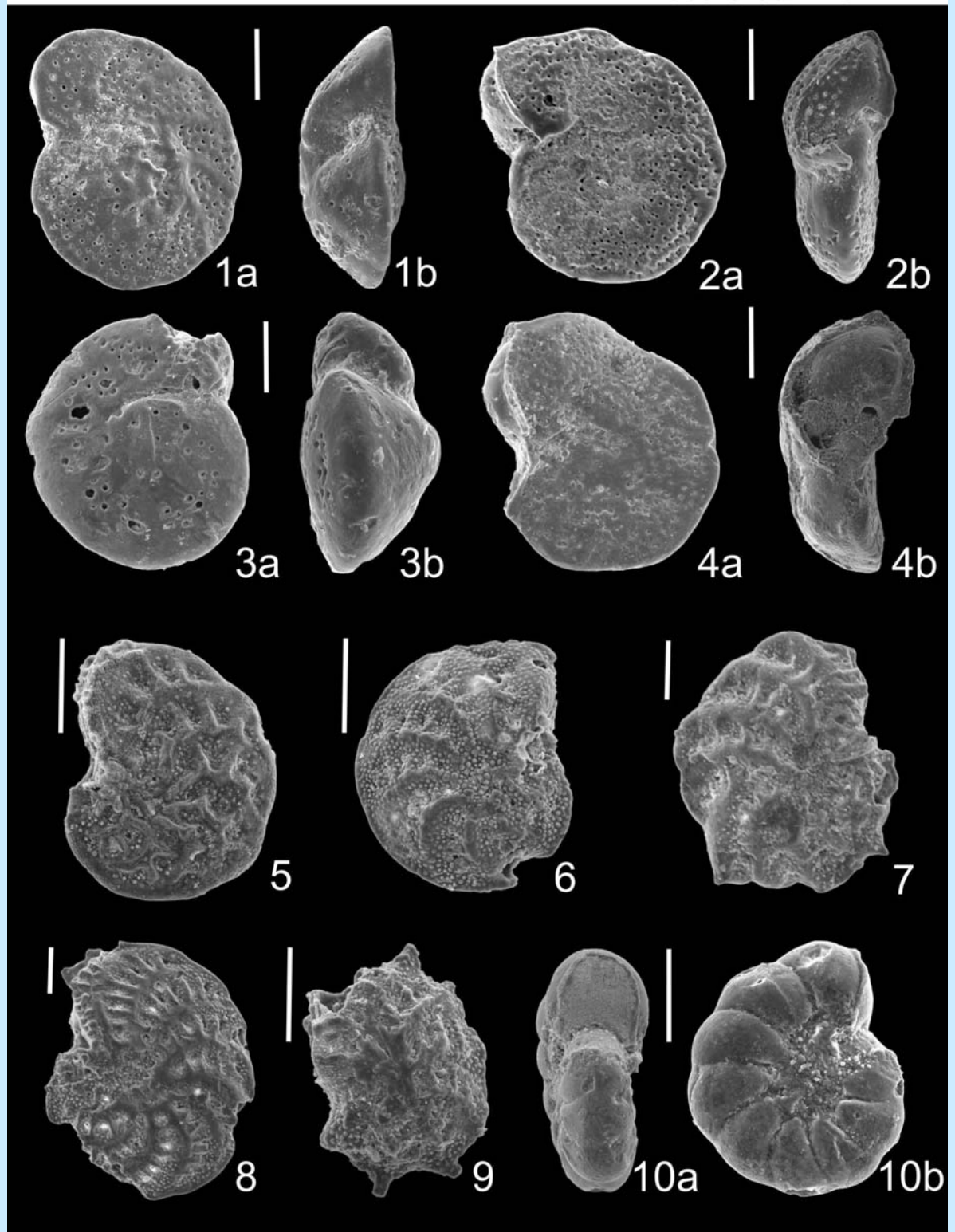
- 14. *Hoeglundina elegans*
- 15. *Pullenia bulloides*



Benthic foraminifera – infaunal taxa

Benthic foraminifera – epifaunal taxa

1. *Cibicides ungerianus*
- 2, 4. *Lobatula lobatula*
3. *Cibicidoides* sp.
5. *Elphidium* sp.
6. *Elphidium argenteum*
7. *Elphidium aculeatum*
8. *Elphidium macellum*
9. *Elphidium josephinum*
10. *Porosononion martkobi*



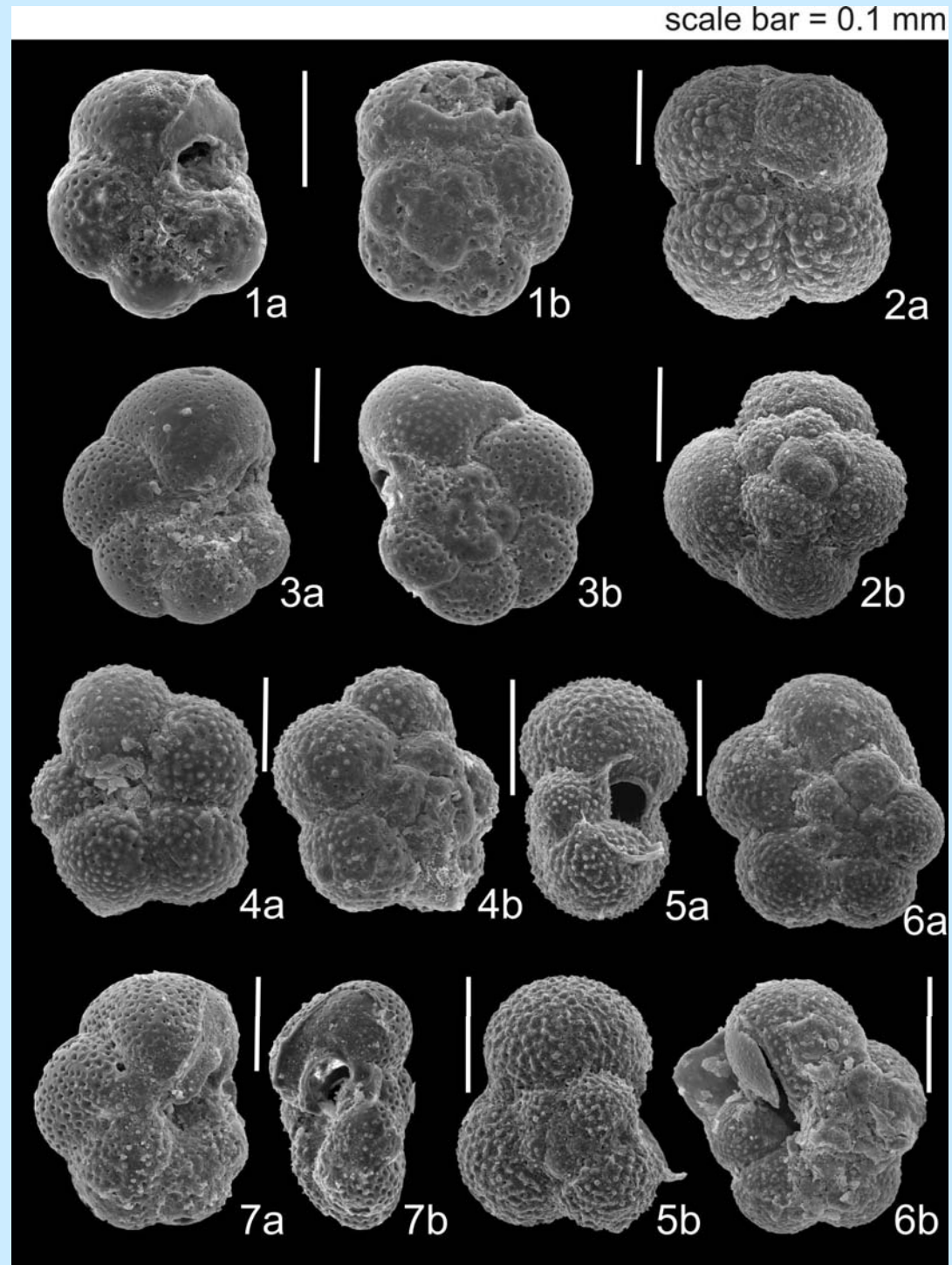
Planktonic foraminifera

Cool-temperate indices:

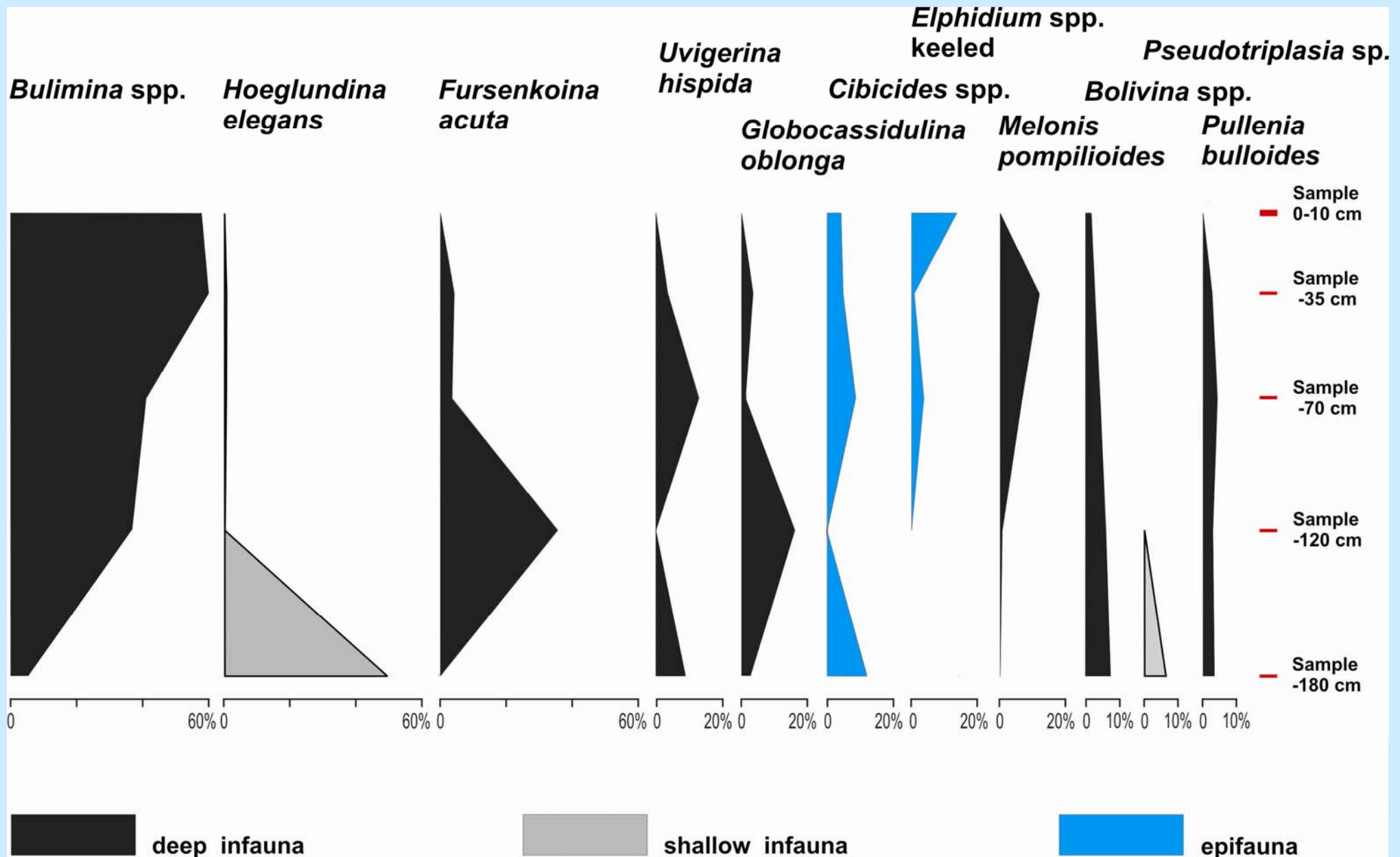
- 1, 7. *Globorotalia bykovae*
- 3. *Globorotalia scitula*

Cool indices:

- 2. *Globigerina tarchanensis*
- 4, 6. *Globigerina concinna*
- 5. *Globigerina praebulloides*



Relative abundance pattern of benthic foraminifera at Borków



Van der Zwaan et al. (1990) determined a regression for the relationship between bathymetry and the percentage of planktonic foraminifera with respect to the total fossil foraminiferal population ($\%P$), based on present-day bathymetric transects:

$$\text{Depth (m)} = e^{3.58718 + (0.03534 * \%P)}$$

where $\%P$ = percentage planktonics in the total foraminiferal association, calculated as $100 * P / (P + B)$, P = number of planktonic specimens and B = number of benthic specimens.

Van Hinsbergen et al. (2005) suggested the modification of the calculation of the plankton fraction $\%P$ as

$$\%P = 100 * (P / (P + B - S))$$

where S = number of stress markers (deep infauna)

Sample [m]	P/B	Shannon-Weaver diversity index H(S)	Depth (m)
0-10	3.5%	2	59
-35	9%	2	112
-70	32%	2	320
-125	17%	1.9	601
-180	75%	1.8	612

CONCLUSIONS

Foraminiferal assemblages at Borków indicate up-section depth decrease and increased oxygen deficit in bottom waters due to decreased bottom water circulation.

The increasing content of keeled forms of *Elphidium* spp. suggests increased salinity during deposition of the upper part of marls underlying gypsum.

It is still difficult to discriminate the individual effects of tectonics, climate, global sealevel changes but in any case, the transition from normal marine to evaporite deposition was rapid, and this implies a roughly synchronous onset of evaporite deposition in the entire Carpathian Foredeep basin.

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Thank you for coming

