Foraminiferal Micropaleontology in the Oligo-Miocene of the North Alpine Foreland Basin*

Patrick Grunert[1], Werner E. Piller[2], Mathias Harzhauser[3], Hanns Sperl[4] and Ralph Hinsch[4]

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Abstract

The North Alpine Foreland Basin (NAFB) comprises one of the main depositional areas of the vanished Paratethys Sea by forming a deep-water trough in front of the northward moving Alpine nappes. Its Oligocene-Early Miocene marine infill contains important source and reservoir rocks. Currently, the Rohöl-Aufsuchungs AG (RAG) is facing new ventures of oil and gas exploration in the southern NAFB. This area adjacent and below the Alps is heavily tectonised and imbricated. To assure efficient drilling, exploration will have to rely on the means of micropaleontology to unravel the relations between these highly deformed and dislocated deposits and their connection to the undisturbed northern part of the basin.

A three-year project co-funded by the RAG and the Commission for the Paleontological and Stratigraphical Research of Austria (Austrian Academy of Sciences) intends to provide a high-resolution micropaleontological analysis for three N-S-oriented wells from the late Oligocene - Early Miocene in the NAFB. The evaluation of the foraminiferal, dinoflagellate and nannoplankton assemblages will reveal crucial information on biostratigraphy, facies distribution and past productivity. The micropaleontological data will be backed up by geochemical proxies (total organic carbon, sulphur and carbonate contents), geophysical logs and seismic images.

In a first step a depositional model for the Hall Fm. (upper Aquitanian-lower Burdigalian) will be established. These widespread offshore sediments from the NAFB in Austria and Germany comprise mainly turbiditic sequences at the base which are overlain by a thick package of silts and sands. Initial foraminiferal investigations on samples from the basal Hall Fm. at the Hochburg drilling site revealed assemblages dominated by Uvigerina spp. passing into associations dominated by the agglutinated foraminifera Bathysiphon and Cyclammina. The overall composition indicates an upper-middle bathyal setting. High proportions of damaged and abraded Ammonia spp. in the respective samples document intense transport. Preliminary results for the geochemical proxies revealed rather low values of TOC (0.33-0.86%) in the lower Hall Fm. in contrast to higher TOC content in the upper Hall Fm. (1.18-1.44%). S (0.1-0.4%) and calculated carbonate content (30-50%) vary constantly throughout the formation. These and future results will contribute to an improved reconstruction of the paleoceanographic and paleogeographic setting in the NAFB.

Selected References

Corliss, B.H., T.C.E. van Weering, 1991, Living (stained) benthic foraminifera from the Skagerrak region of the North Sea: Eos Transactions American Geophysical Union , v. 72/17, p. 156.

Hubbard, B. and S. Clemmens, 2008, Recent high-resolution surface velocities and elevation change at a high-altitude, debris-covered glacier; Chacraraju, Peru: Journal of Glaciology, v. 54/186, p. 479-486.

Van den Akker, T.J.H.A., M.A. Kaminski, F.M. Gradstein, and J. Wood, 2000, Campanian to Palaeocene biostratigraphy and palaeoenvironments in the Foula Sub-basin, west of the Shetland Islands, UK: Journal of Micropalaeontology, v. 1, p. 23-43.

Foraminiferal micropaleontology in the Oligo-Miocene of the North Alpine Foreland Basin

An example from the Hall Fm. in Upper Austria

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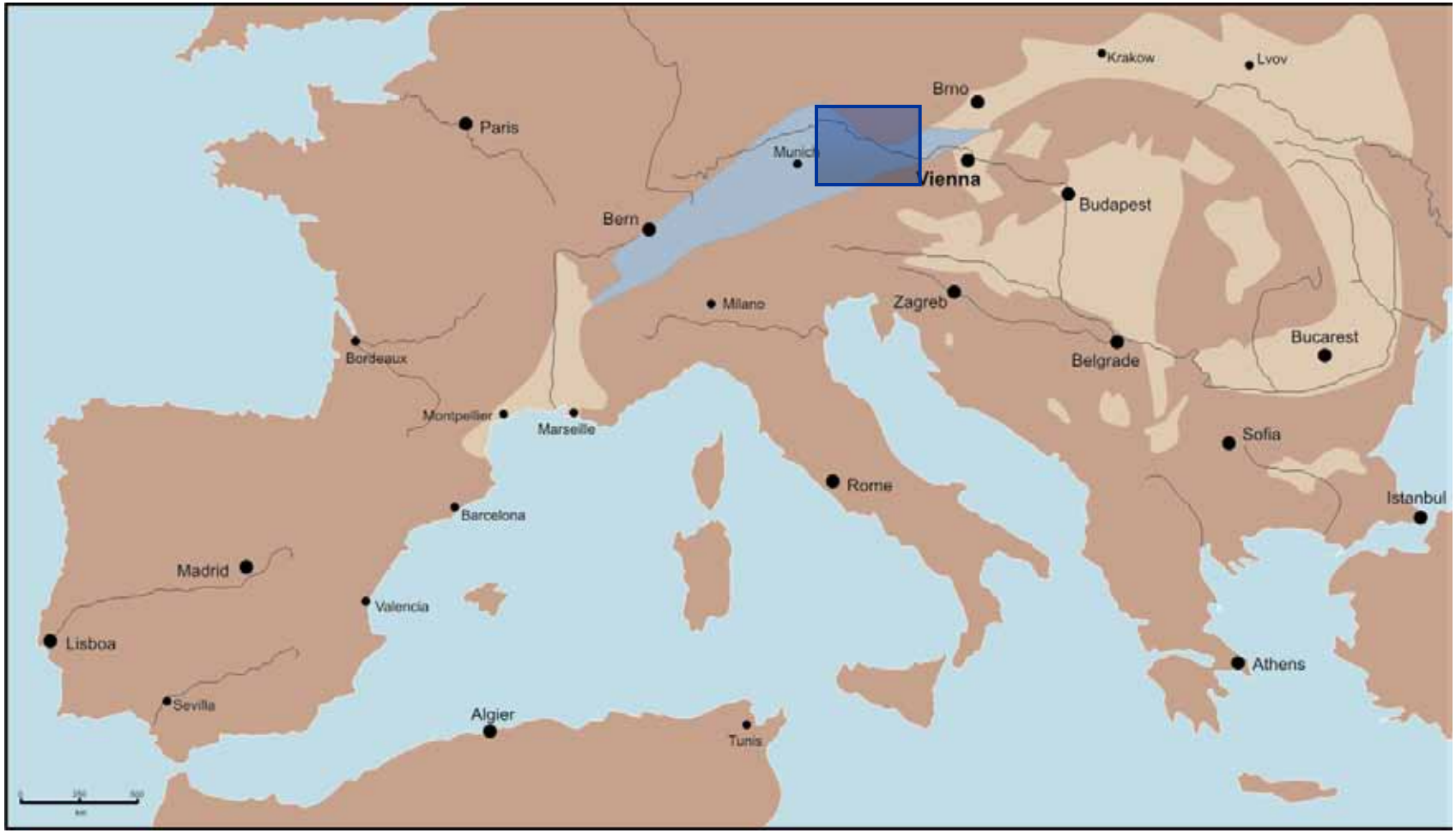
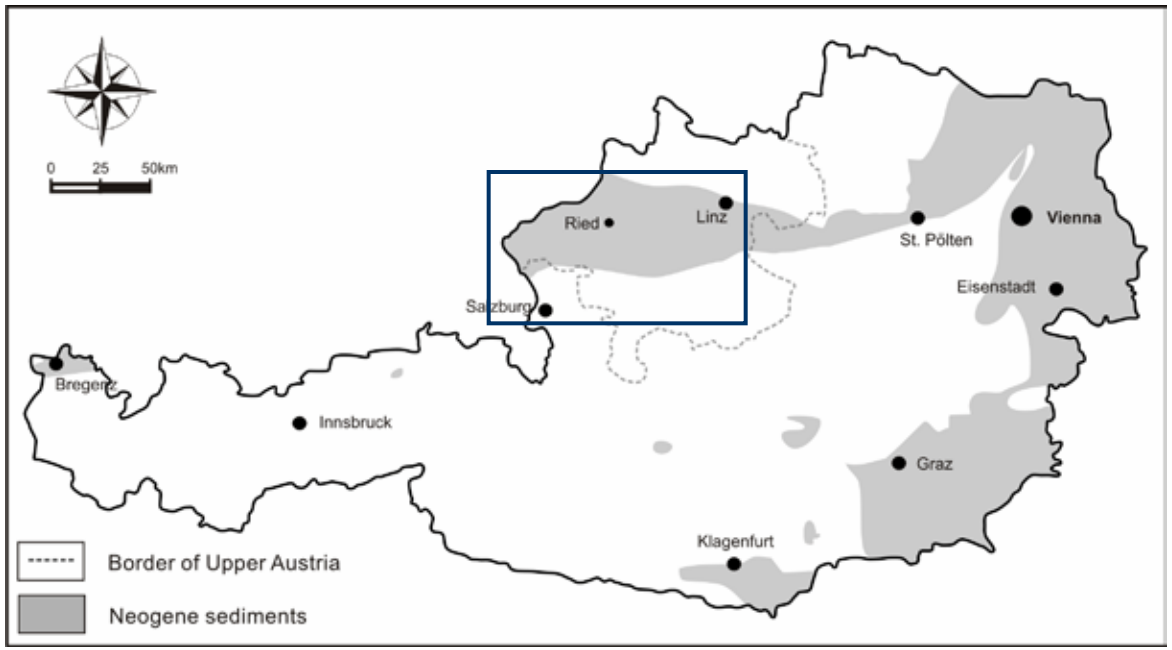
[2] *Natural History Museum Vienna, Burgring 7, A-1010 Vienna*

[3] *Rohöl Aufsuchungs-AG, Schwarzenbergplatz 16, A-1015 Vienna*

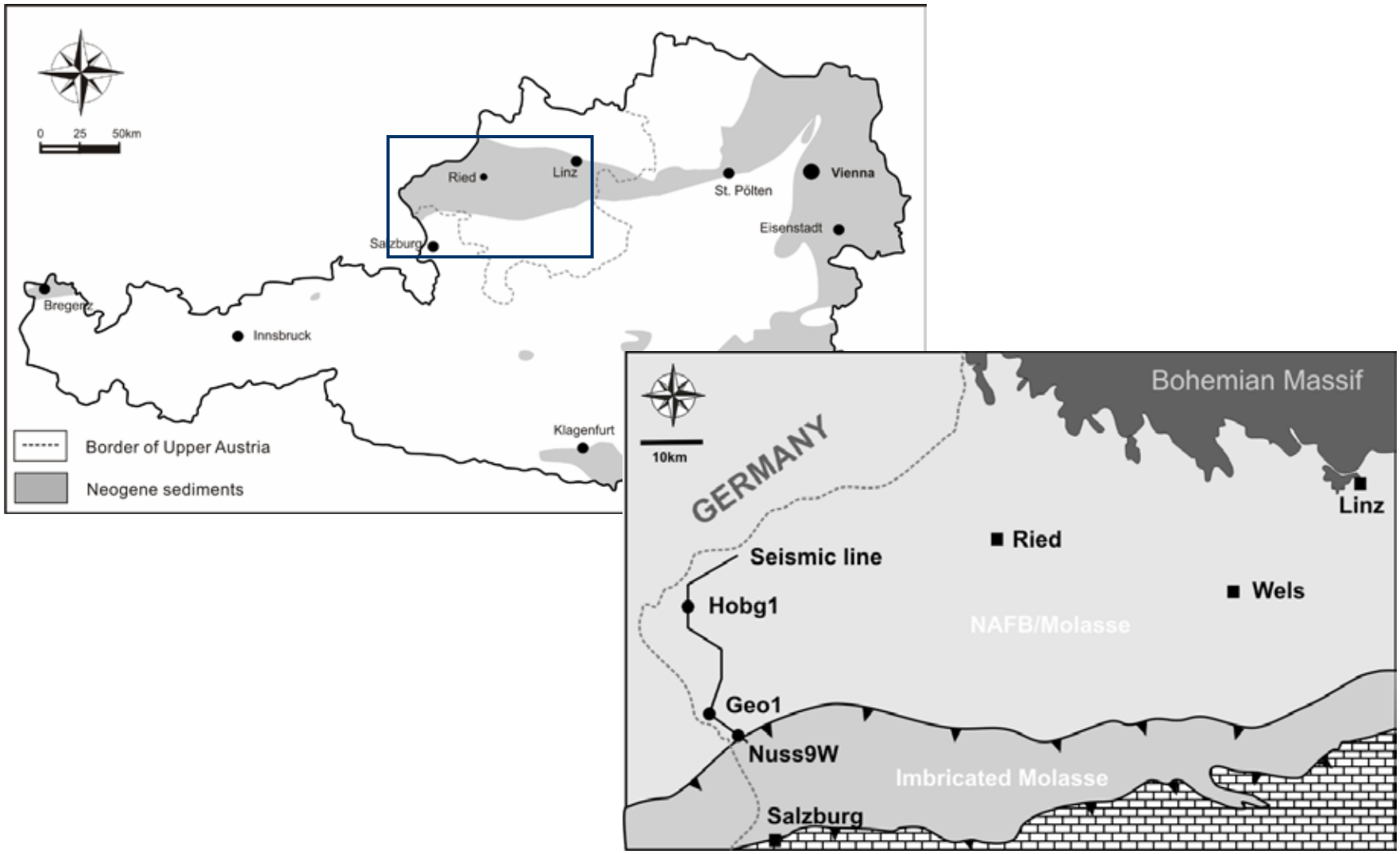
North Alpine Foreland Basin



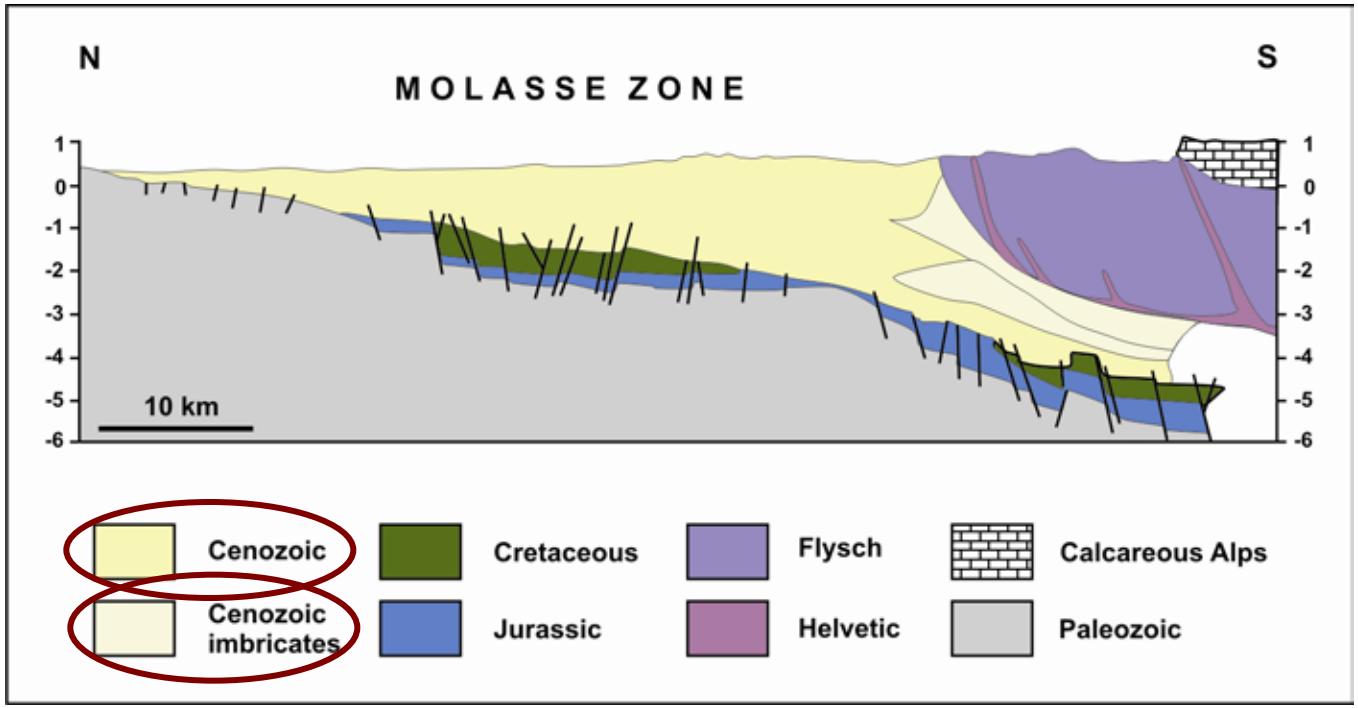
Study area


0 25 50km
Ried
Linz
St. Pölten
Vienna
Eisenstadt
Salzburg
Bregenz
Innsbruck
Graz
Klagenfurt
Border of Upper Austria
Neogene sediments

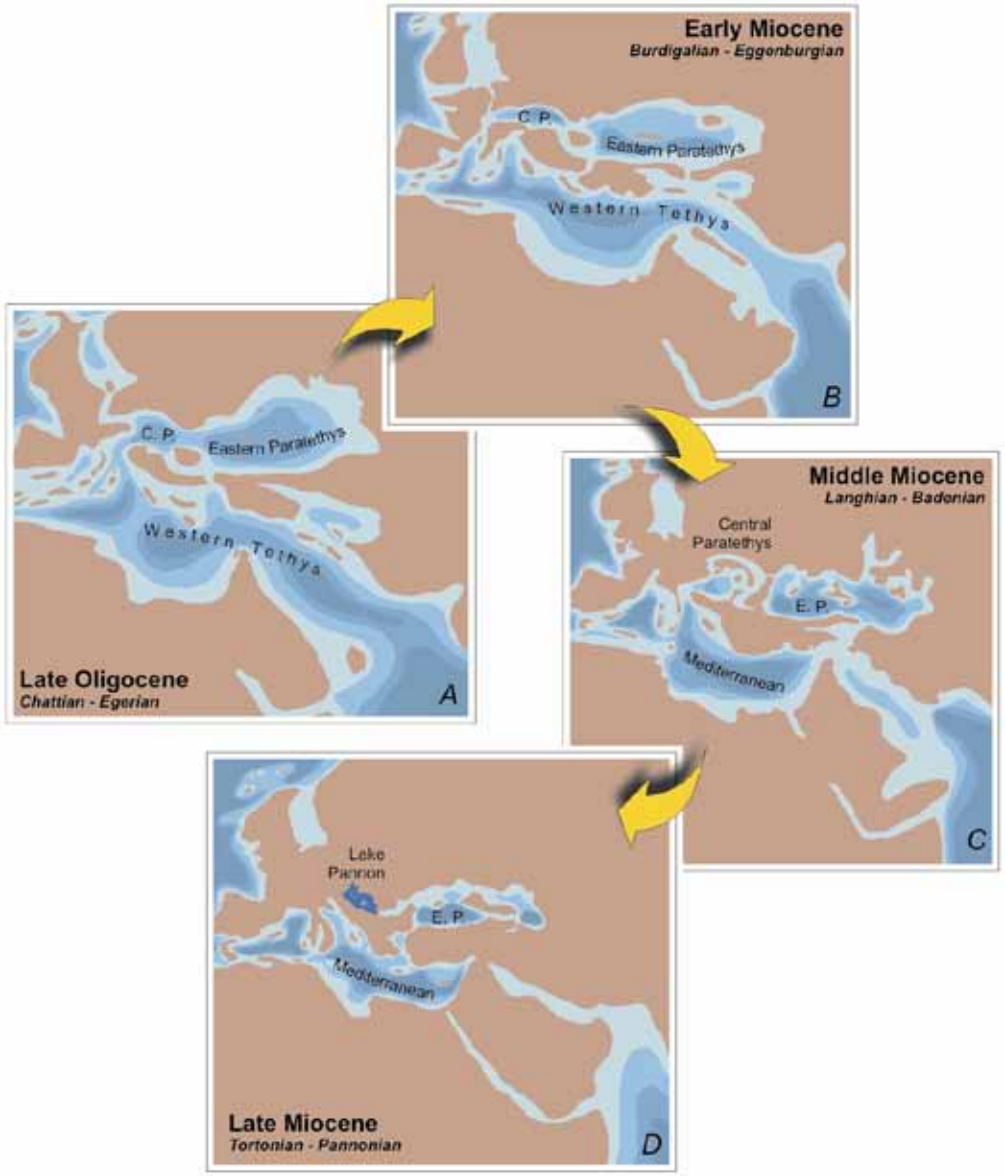
Study area


0 25 50km
Ried
Linz
St. Pölten
Vienna
Eisenstadt
Salzburg
Bregenz
Innsbruck
Klagenfurt
Border of Upper Austria
Neogene sediments
10km
GERMANY
Bohemian Massif
Linz
Ried
Seismic line
Wels
Hobg1
NAFB/Molasse
Geo1
Nuss9W
Imbricated Molasse
Salzburg

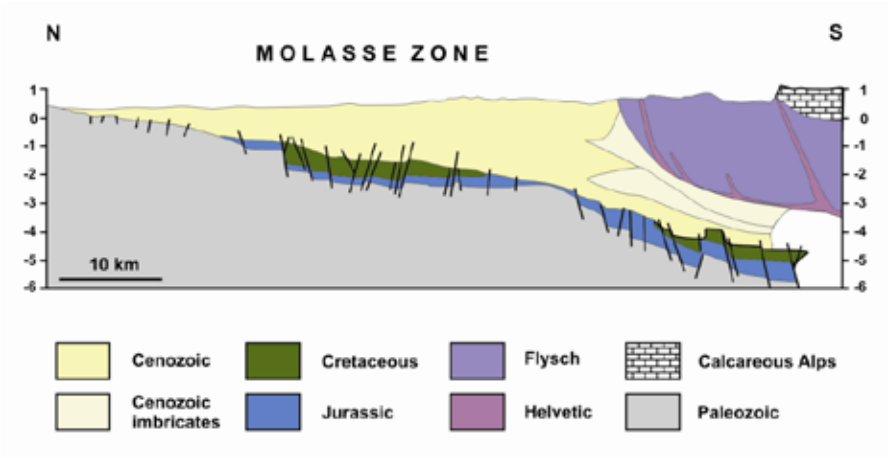
Mesozoic and Cenozoic infill = ***Molasse***



Central Paratethys



Joint ventures...



RAG

ÖAW Austrian Academy of Sciences

CPSA

UNI GRAZ

Natural History Museum Vienna

Geologische Bundesanstalt

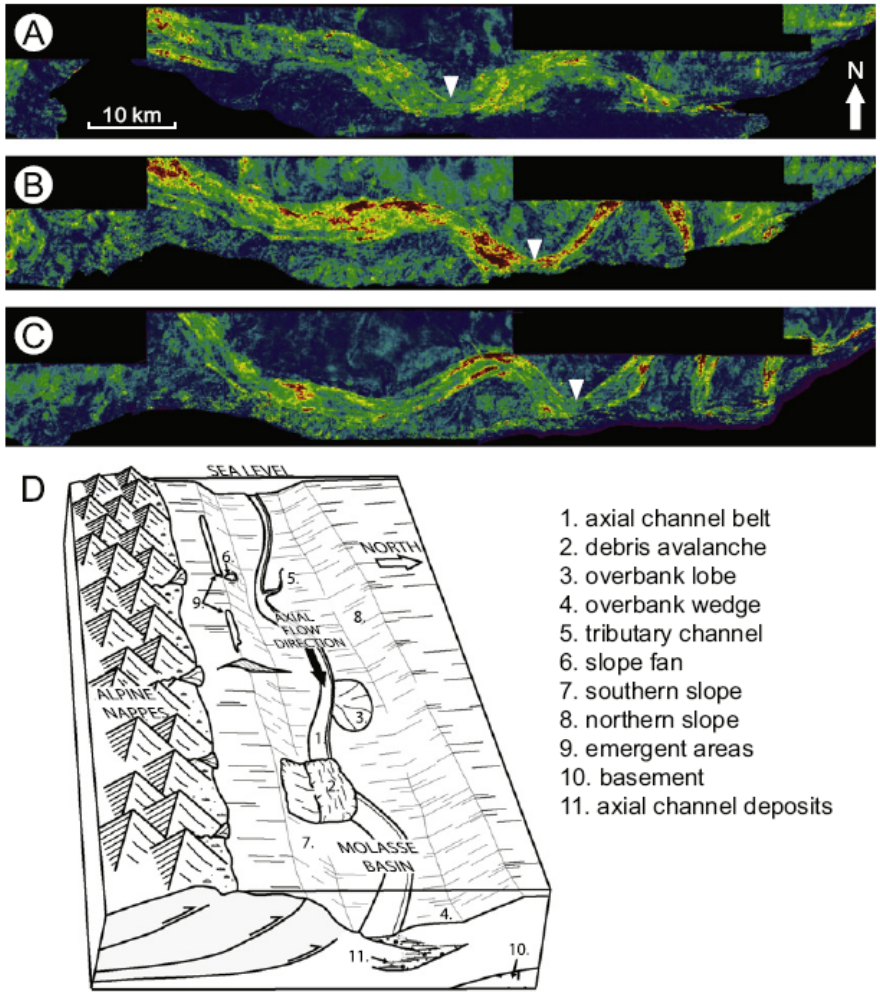
MONTAN UNIVERSITÄT WWW.UNILEOBEN.AC.AT

VIENNENSIS S. SAPIENTIAE STUDII

BERGAKADEMIE FREIBERG TECHNISCHE UNIVERSITÄT

UNIVERSITY OF CALGARY

LELAND STANFORD JUNIOR UNIVERSITY 1891



Hubbard et al., 2008

Still missing:

1. ***Reliable age-model***

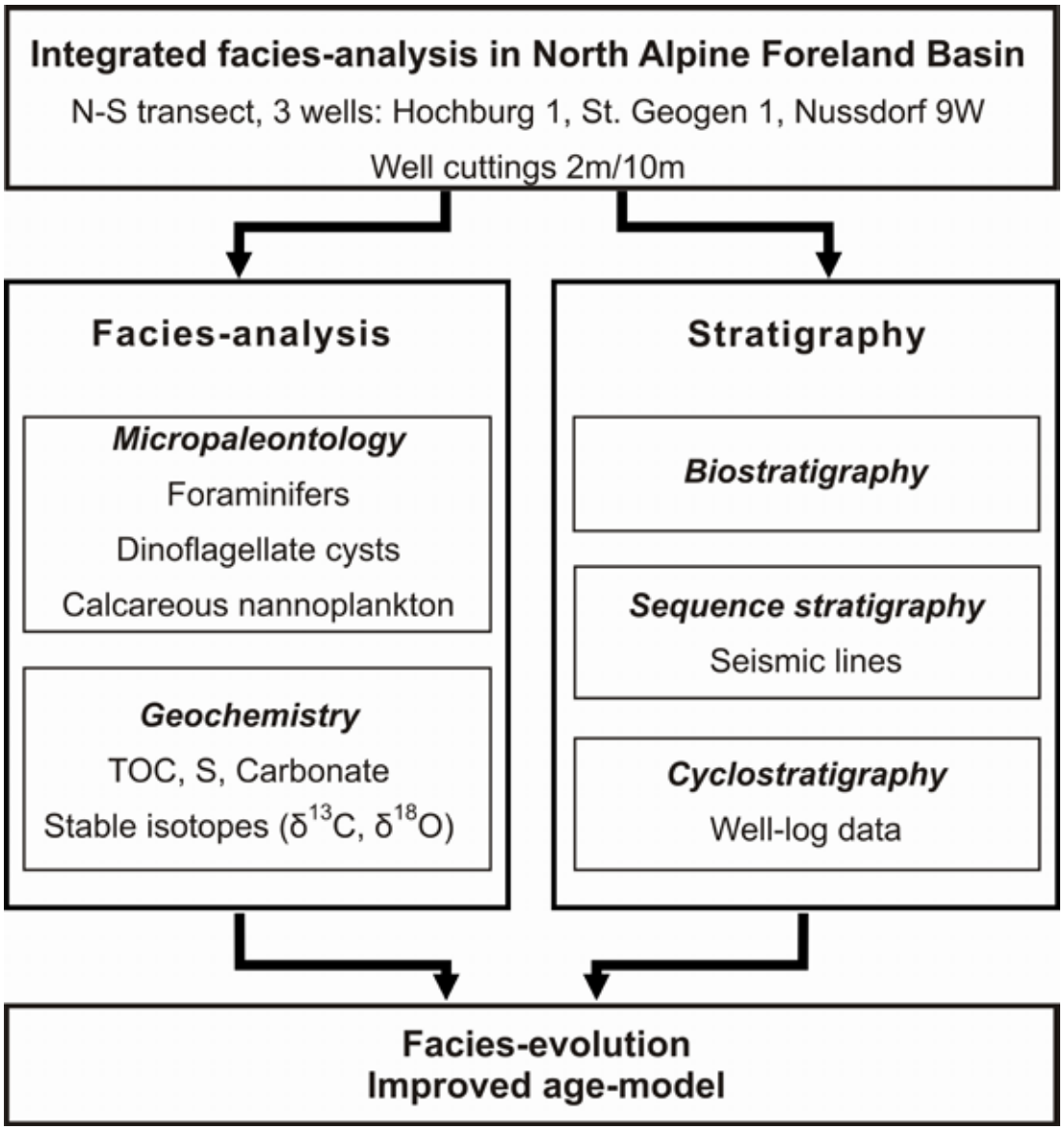
   Correlation to GTS

   Modern approaches

2. ***Integrative facies-model***

   based on different proxies

Project outline



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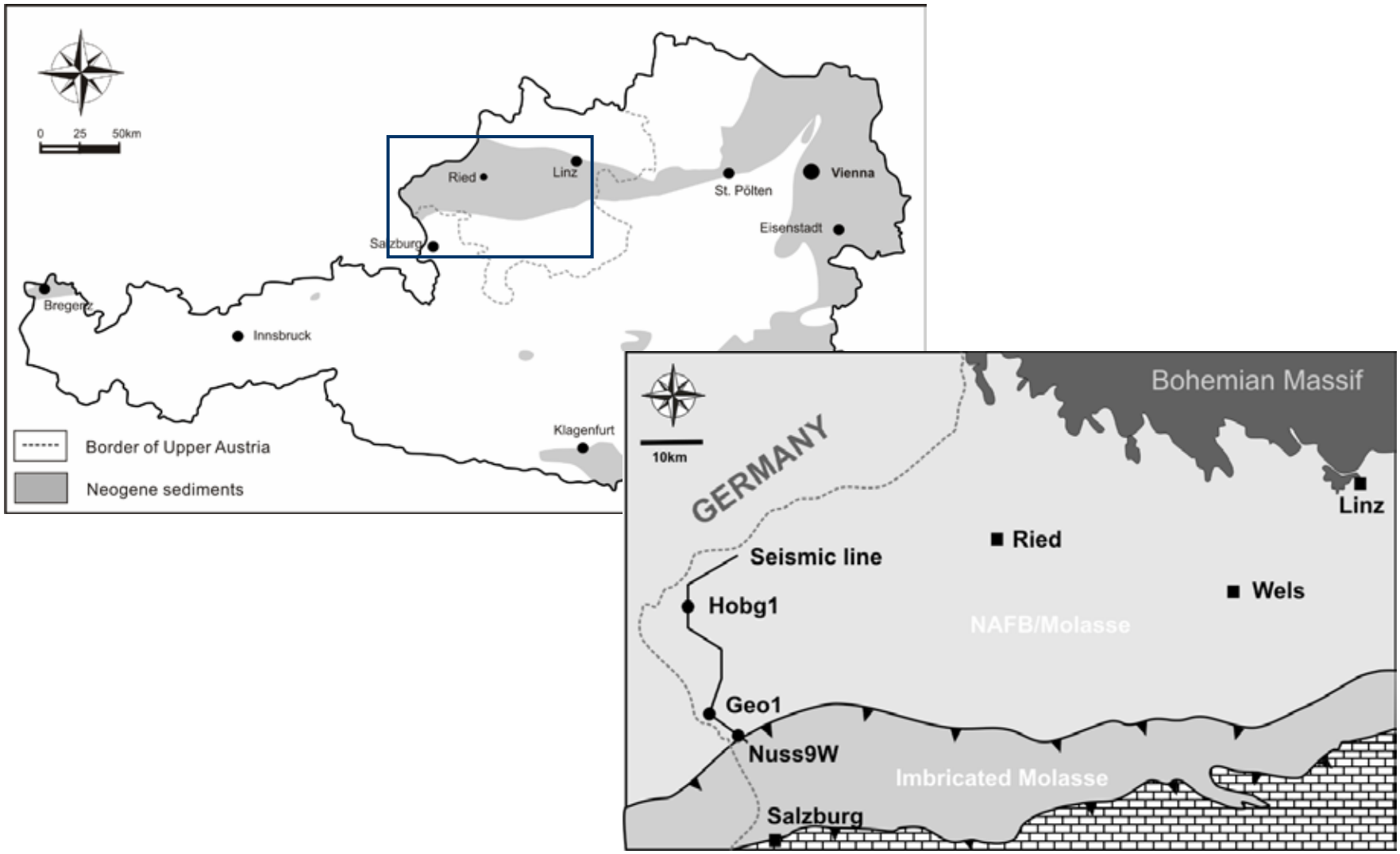
Study area


0 25 50km
Ried
Linz
St. Pölten
Vienna
Eisenstadt
Salzburg
Bregenz
Innsbruck
Klagenfurt
Border of Upper Austria
Neogene sediments
10km
GERMANY
Bohemian Massif
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Ried
Seismic line
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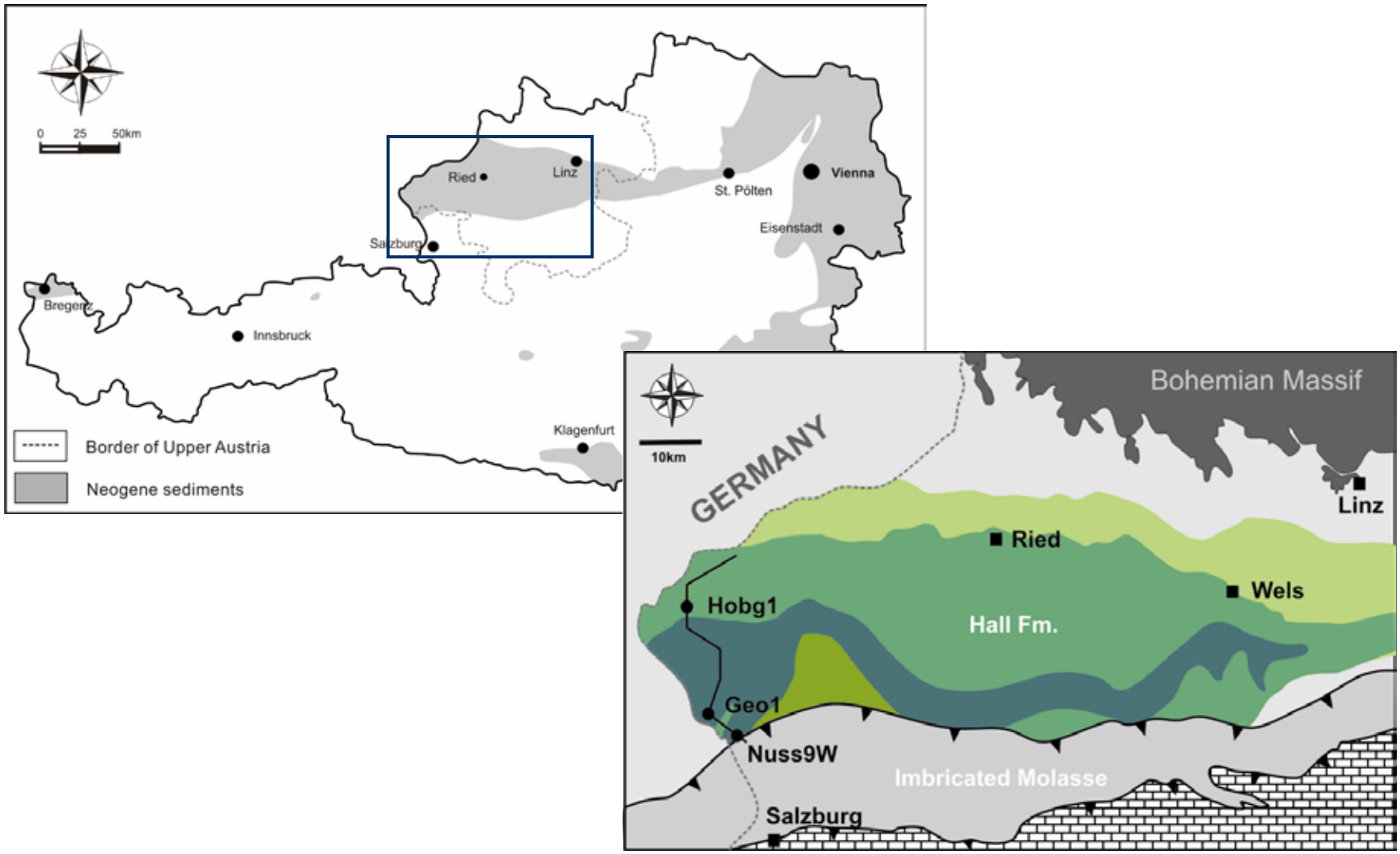
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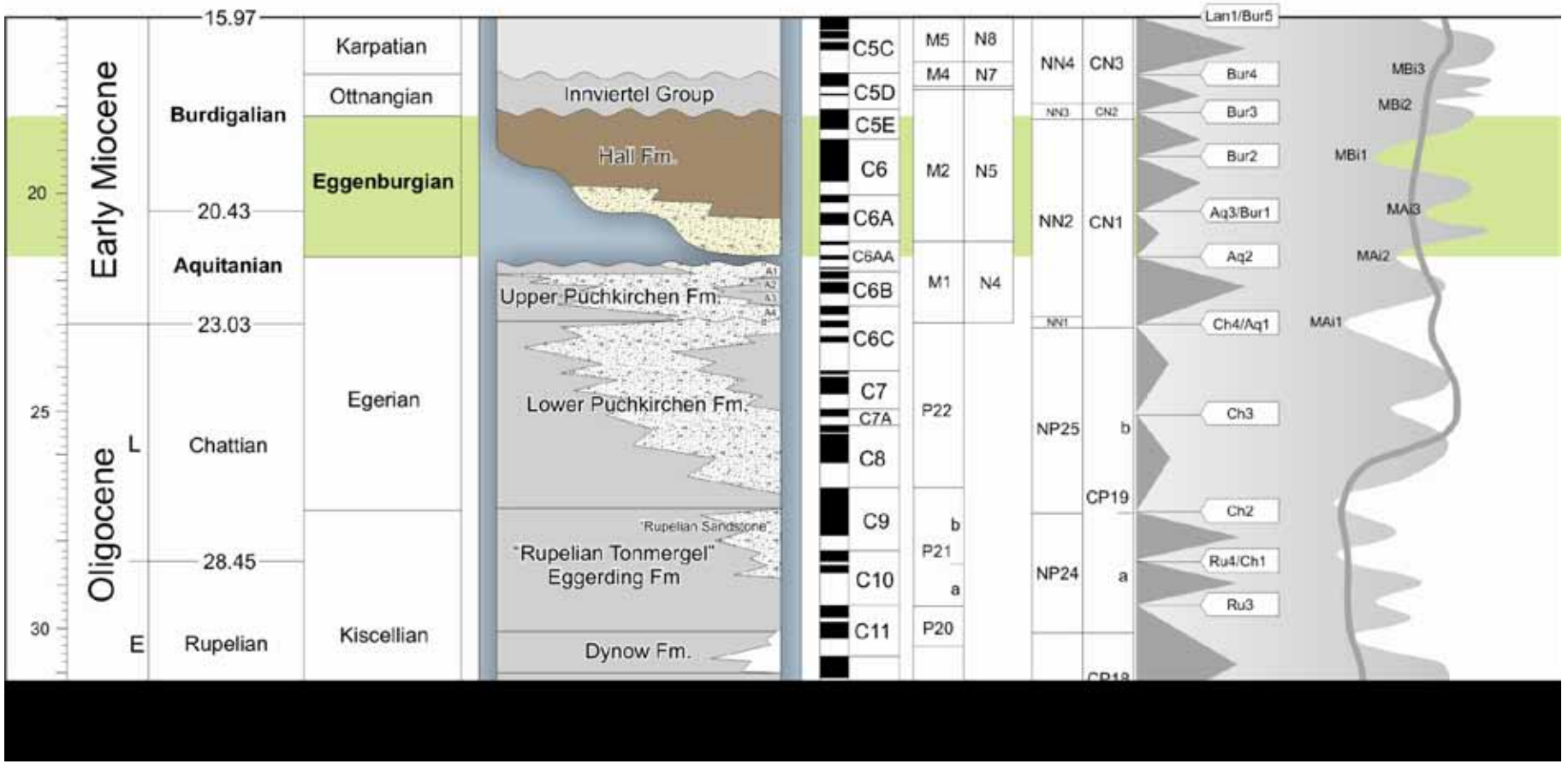
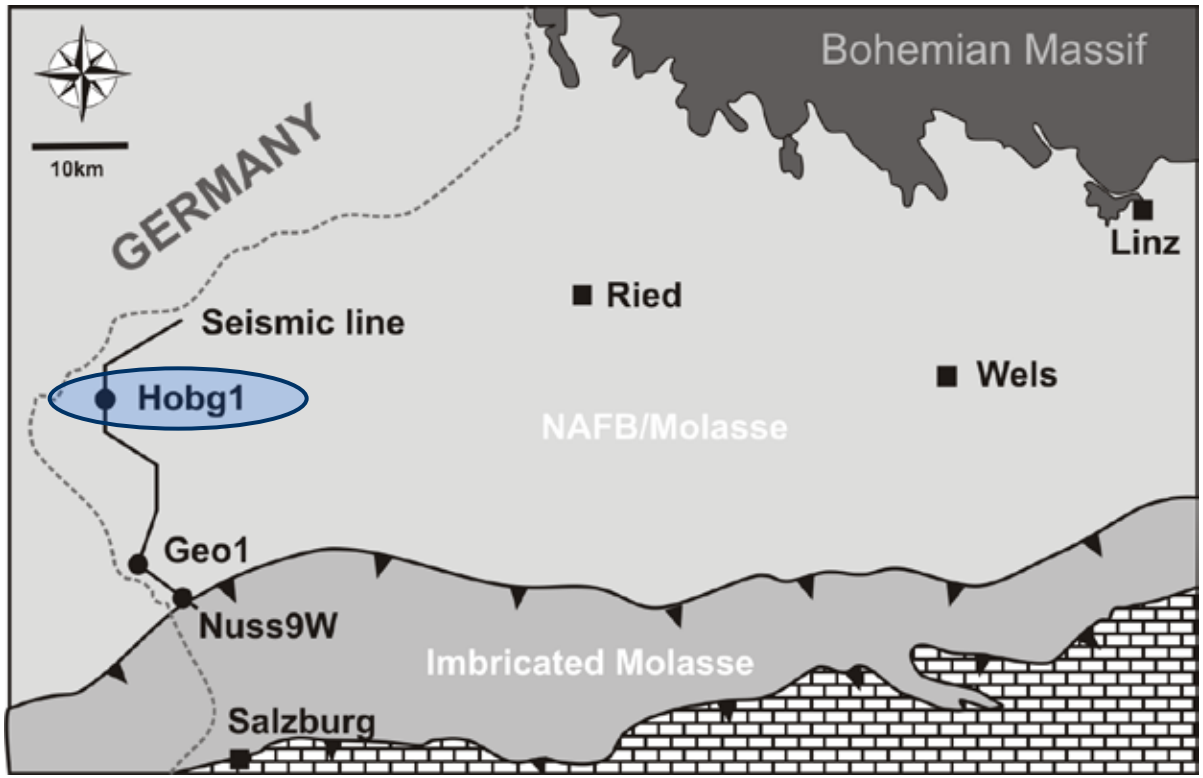
Salzburg

Regional vs. global stratigraphy



Facies analysis

Hochburg 1


Bohemian Massif
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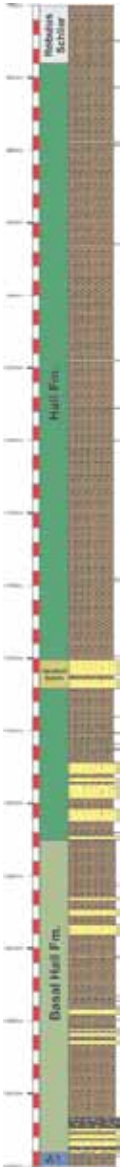
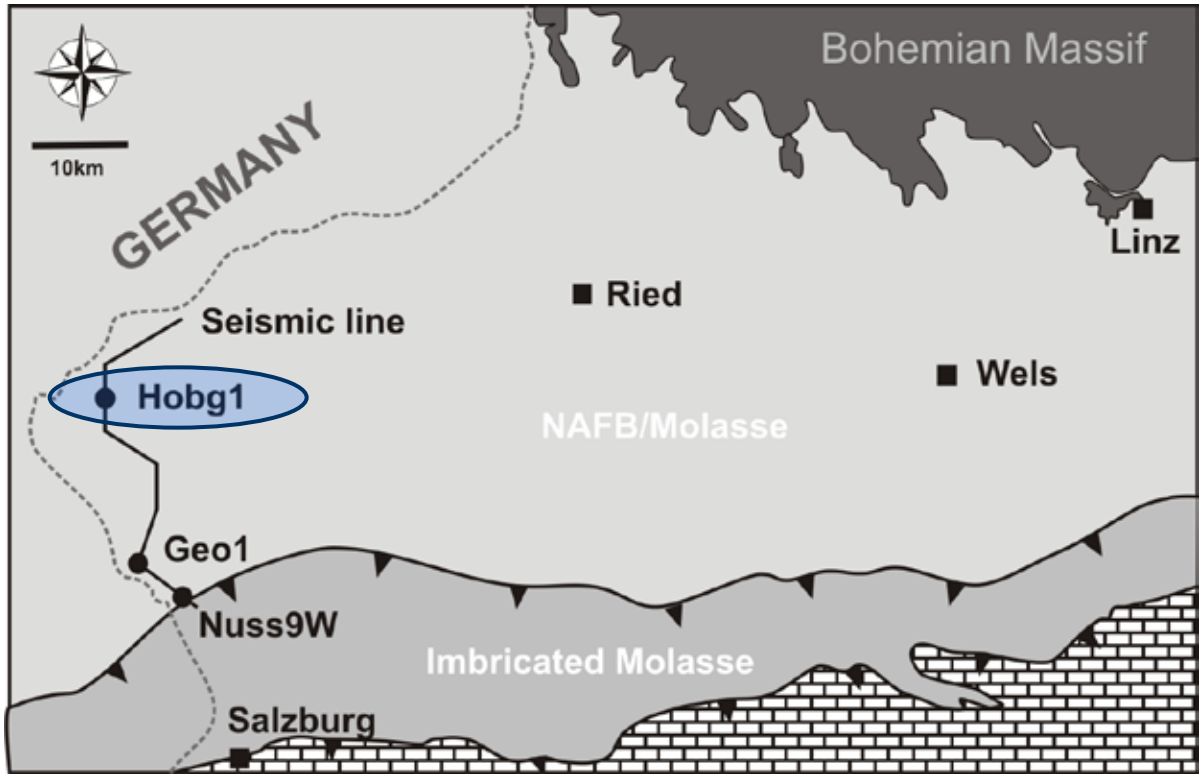
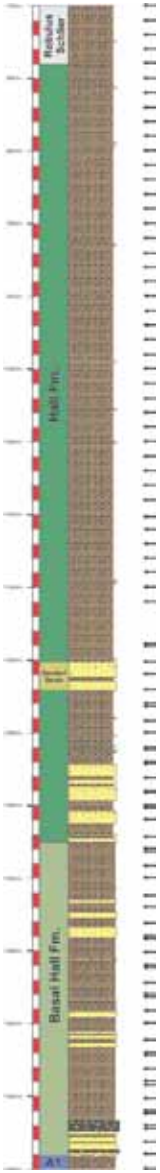


Hall Fm.: 790-1540m (thickness: 750m)

Basal Hall Fm.: 1330-1540m

Gendorf Sands: 1201-1221m





Hall Fm.: 790-1540m (thickness: 750m)

Basal Hall Fm.: 1330-1540m

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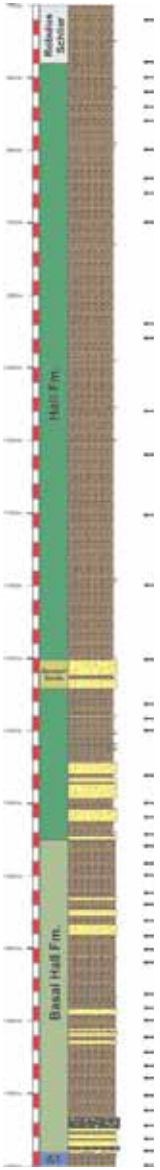
Analyses include

- 1 sample from Upper Puchkirchen Fm.
- 65 samples from Hall Fm.
- 4 samples from „Robulus Schlier“

- Benthic foraminifera
- TOC, S, $CaCO_3$, $\delta^{18}O$, $\delta^{13}C$



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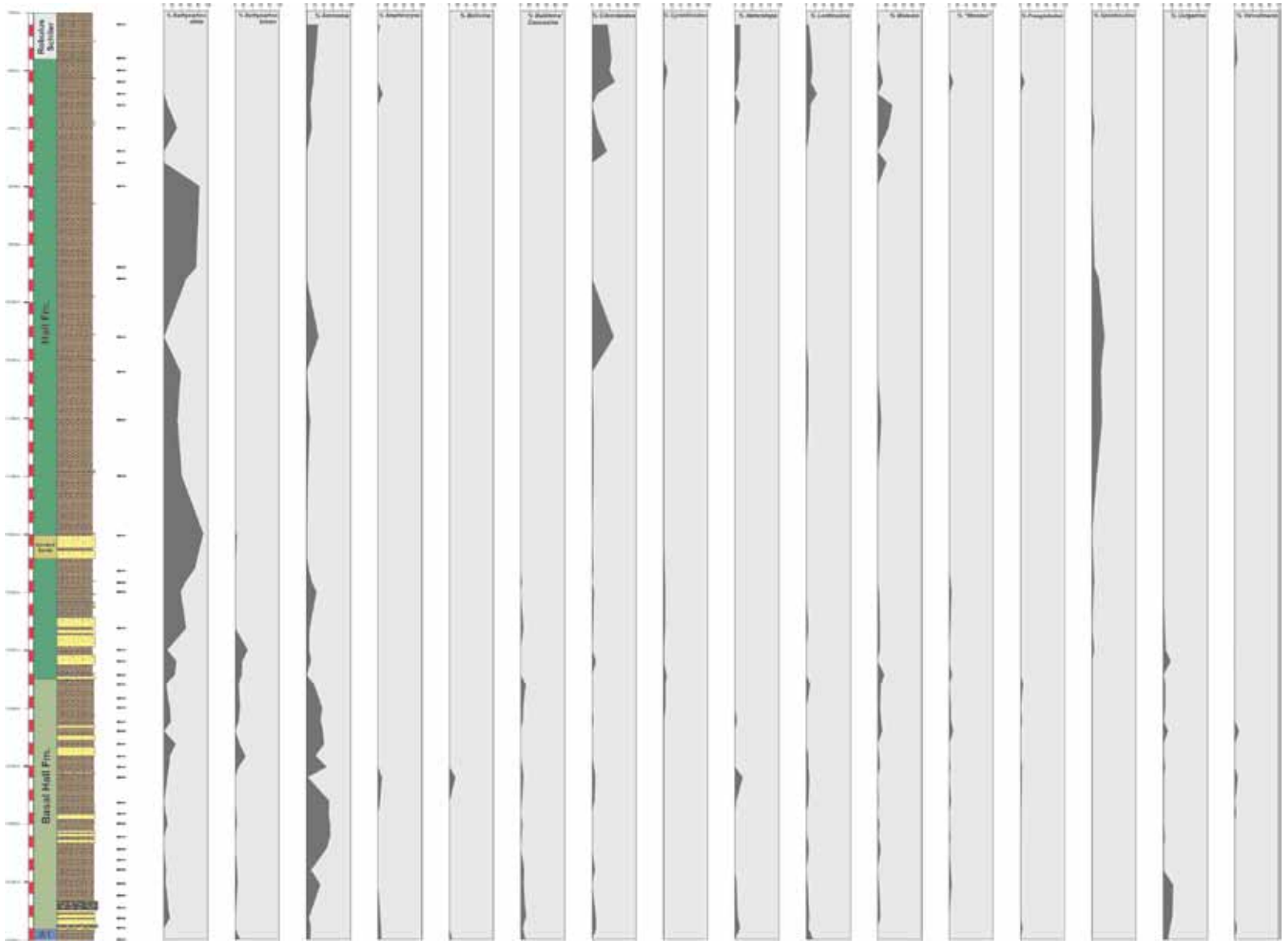
- **Benthic foraminifers**
- TOC, S, $CaCO_3$, $\delta^{18}O$, $\delta^{13}C$

Hochburg 1 – Benthic foraminifera



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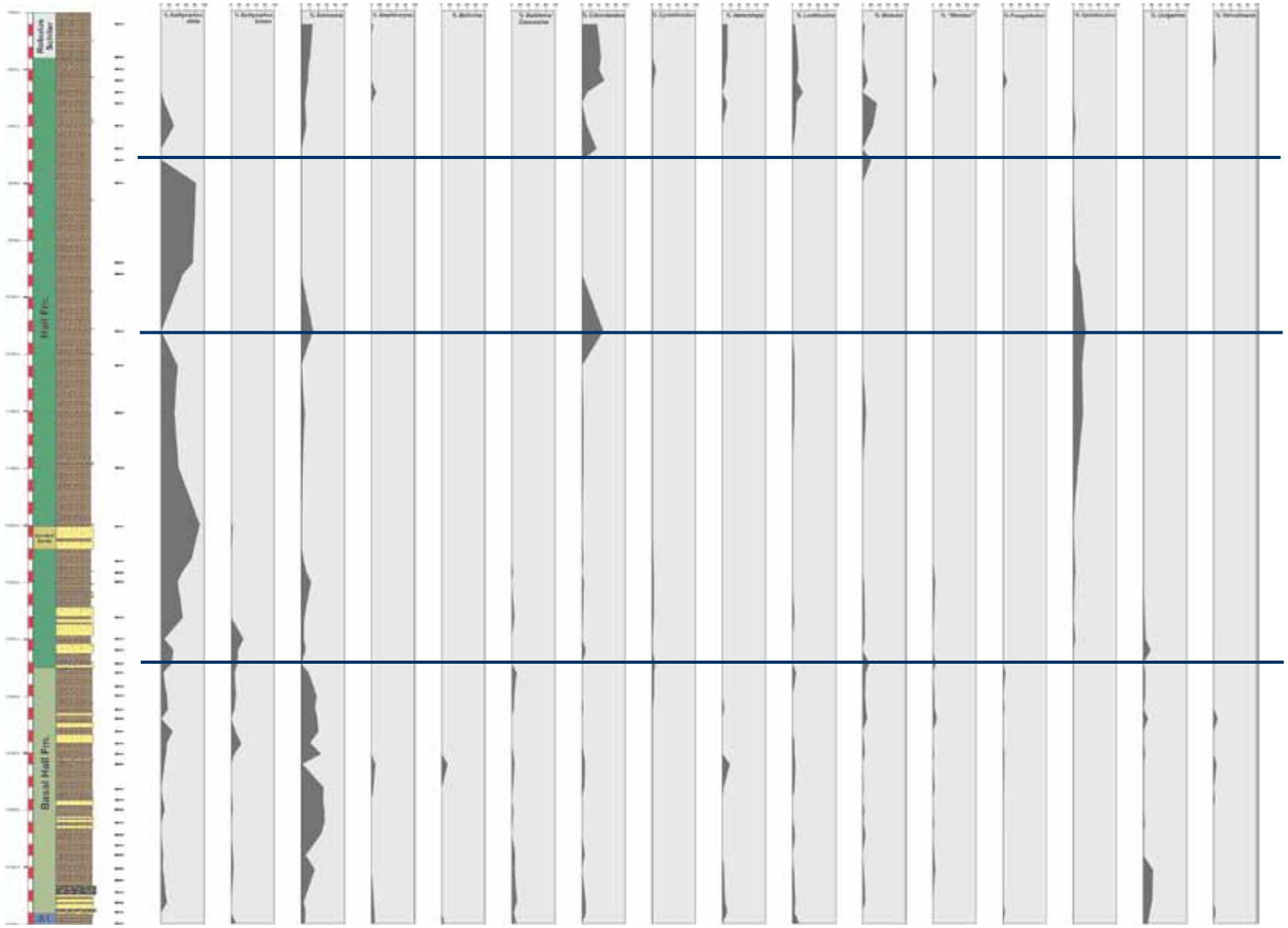
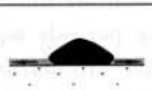
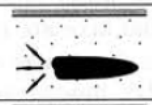
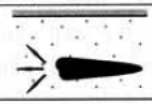


Morphotypes – Agglutinated benthos

Test-morphology of foraminifera is related to environment

Morphotypes are defined that reflect specific environmental parameters

- Feeding strategies
- Organic matter flux
- Bottom-water oxygenation
- Water depth

MORPHOTYPE	TEST SHAPE	MORPHO-GROUP	LIFE POSITION	FEEDING HABIT	ENVIRONMENT
	tubular	M 1	erect epifauna	suspension feeding	tranquil bathyal and abyssal with low organic matter flux
	globular	M 2 a	shallow infauna	suspension feeding - passive deposit feeding	bathyal and abyssal
	rounded trochospiral and streptospiral	M 2 b	surficial epifauna	active deposit feeding	shelf to marginal marine
	planoconvex trochospiral				
	elongate keeled	M 2 c	surficial epifauna	active deposit feeding	shelf to marginal marine
	flattened trochospiral	M 3 a	surficial epifauna	active and passive deposit feeding	high energy lagoon and estuary
	flattened planispiral and streptospiral				
	flattened irregular	M 3 b	surficial epifauna	passive deposit feeding	upper bathyal to abyssal
	rounded planispiral	M 4 a	surficial epifauna - shallow infauna	active deposit feeding	inner shelf to upper bathyal
	elongate subcylindrical	M 4 b	deep infauna	active deposit feeding	inner shelf to upper bathyal with increased organic matter flux
	elongate tapered				

Van den Akker et al. (2000)

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	planoconvex trochospiral				
	elongate keeled	M 2 c	surficial epifauna	active deposit feeding	shelf to marginal marine
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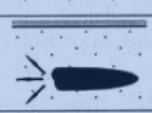
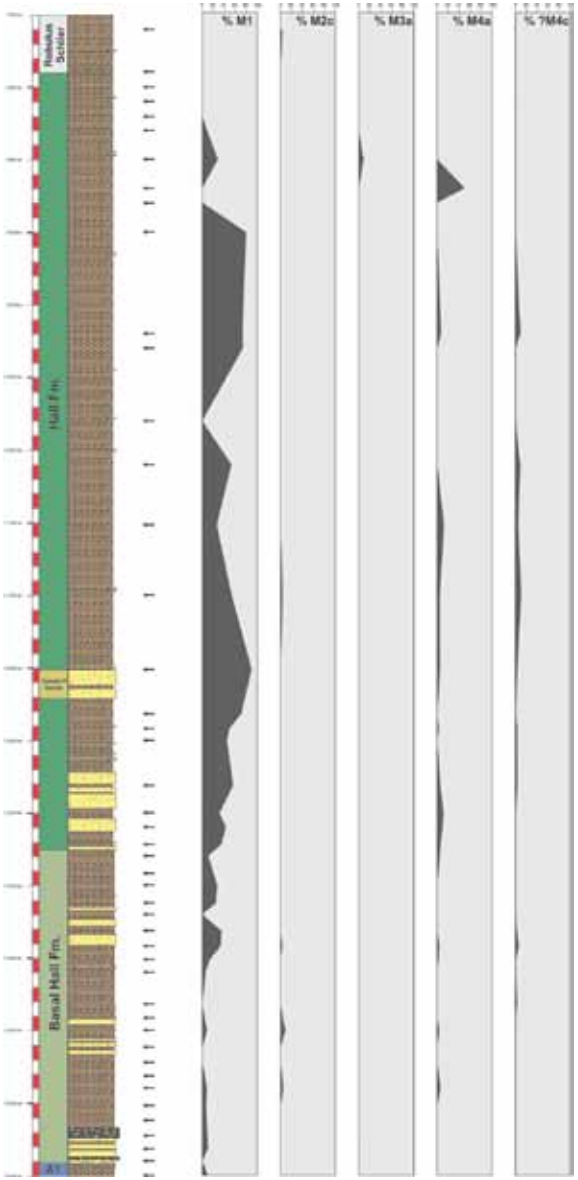
	elongate subcylindrical	M 4 b	deep infauna	active deposit feeding	inner shelf to upper bathyal with increased organic matter flux
	elongate tapered				

Van den Akker et al. (2000)

Morphotypes – Agglutinated benthos



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	elongate tapered				

Van den Akker et al. (2000)

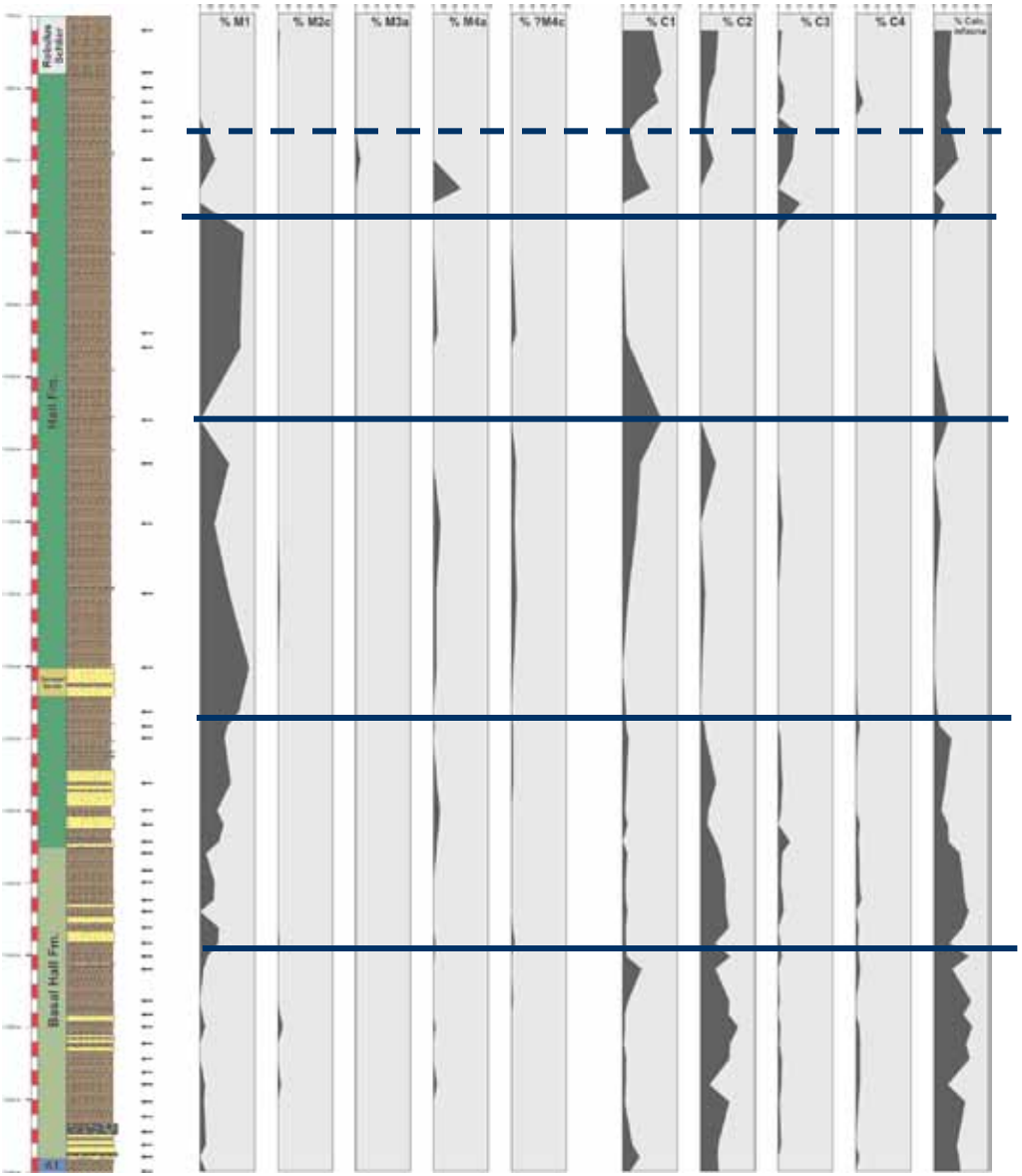
Epifaunal taxa are dependent on oxygen

Infaunal taxa can deal with low oxygen conditions

Groups C1 – C4 (~ morphogroups of Corliss et al., 1991):

- C1: Epifaunal (0-1cm)
- C2: Shallow infaunal (0-2cm)
- C3: Intermediate infaunal (1-4cm)
- C4: Deep infaunal (> 4cm)

Morphotypes – Benthos



Calcareous taxa replace agglutinated taxa, epifauna dominates

Calcareous epifaunal taxa vanish, agglutinated epifauna dominates;

suspension feeders

Epifauna dominates, trend agglutinated to calcareous taxa;

suspension feeders

Agglutinated epifauna and suspension feeders increase

Calcareous infauna decreases

Calcareous infauna dominates

Software: **PAST** (version 1.82b), University of Oslo

Ranked distance calculated by chosen index (e.g. Bray-Curtis Index)

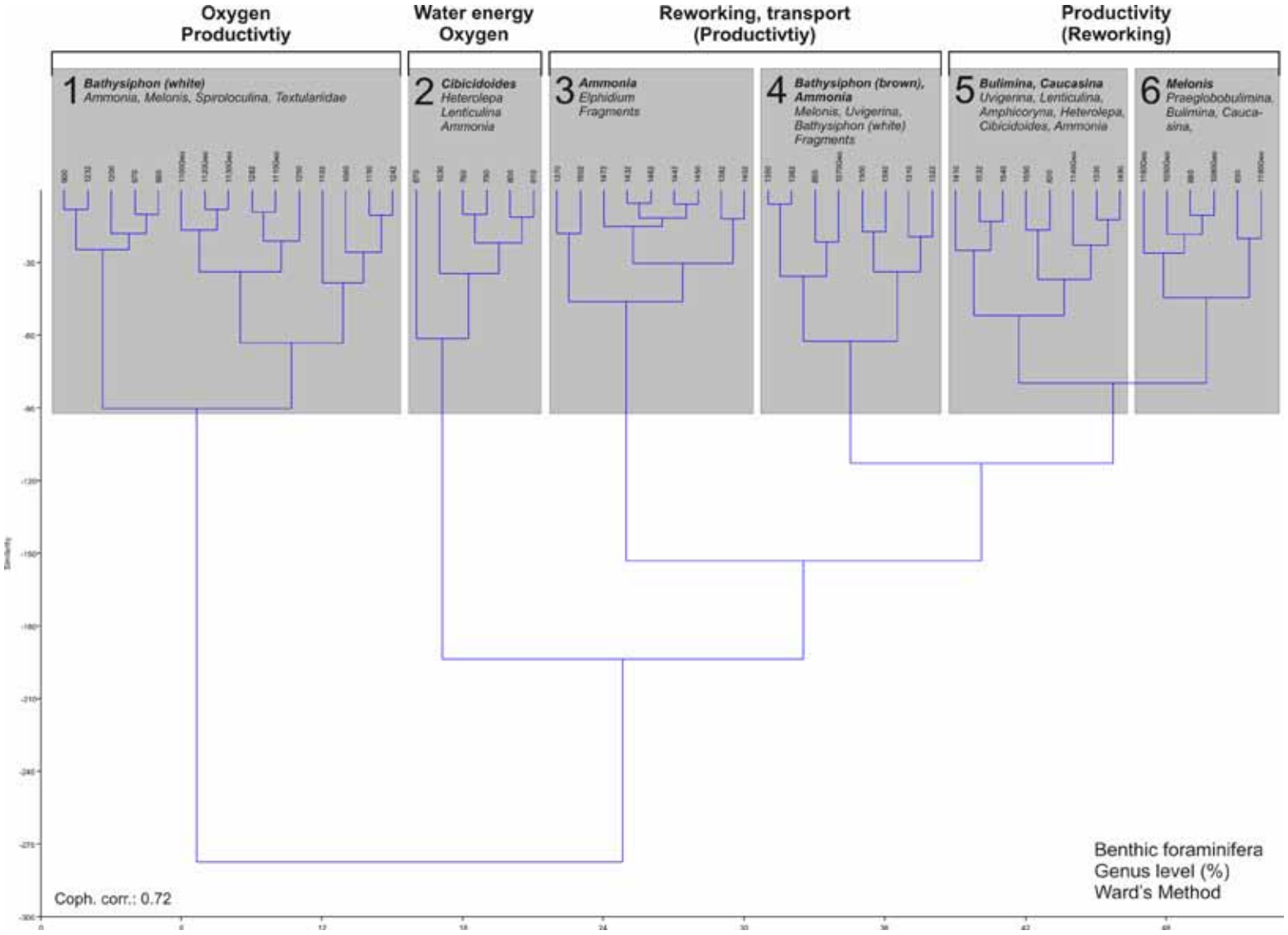
1. Cluster analysis

- Distance between samples visualized in dendrograme

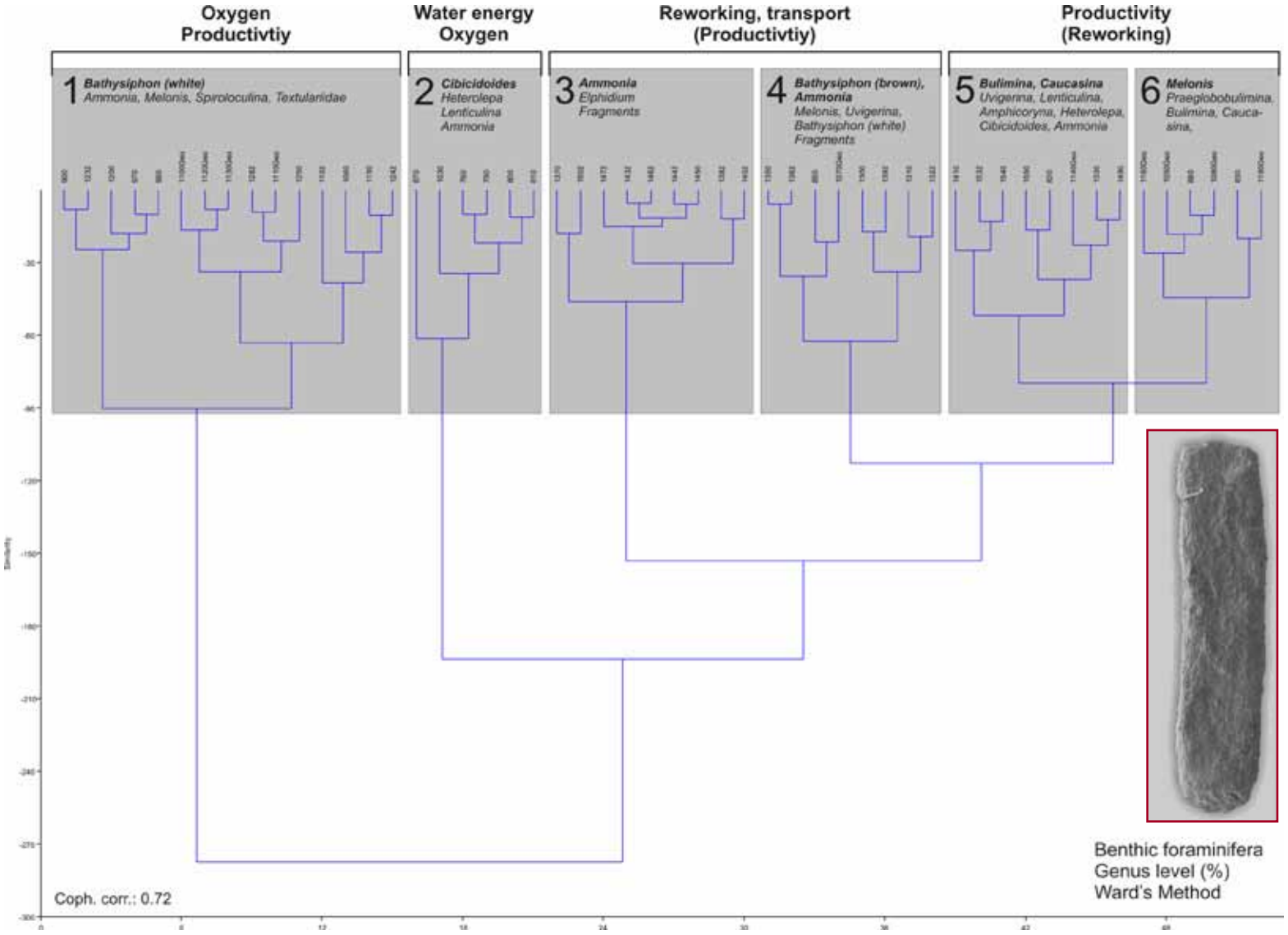
2. Non-metric mutlidimensional scaling (NMDS)

- Distance between samples visualized in two-dimensional coordinate system

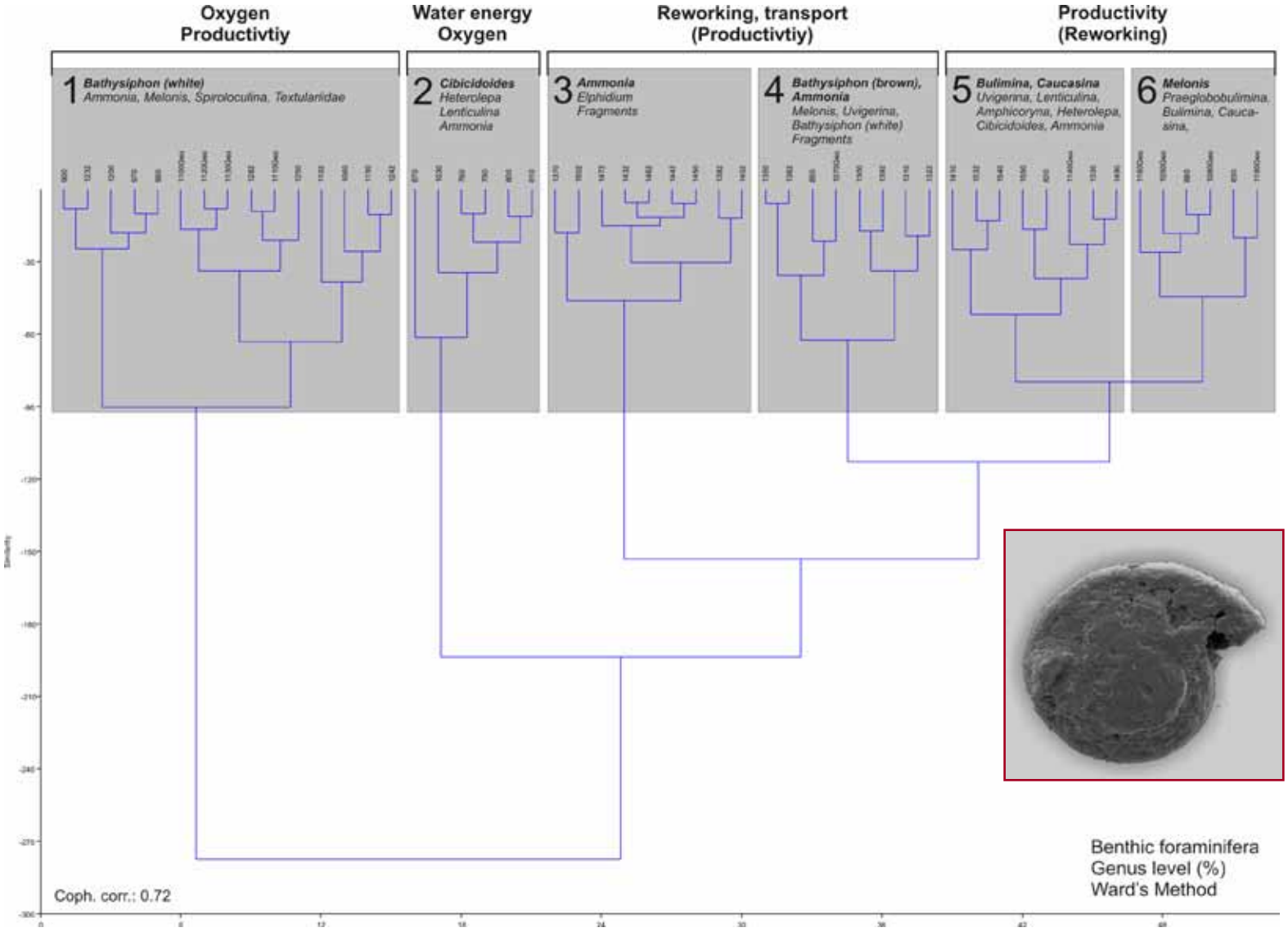
Cluster Analysis



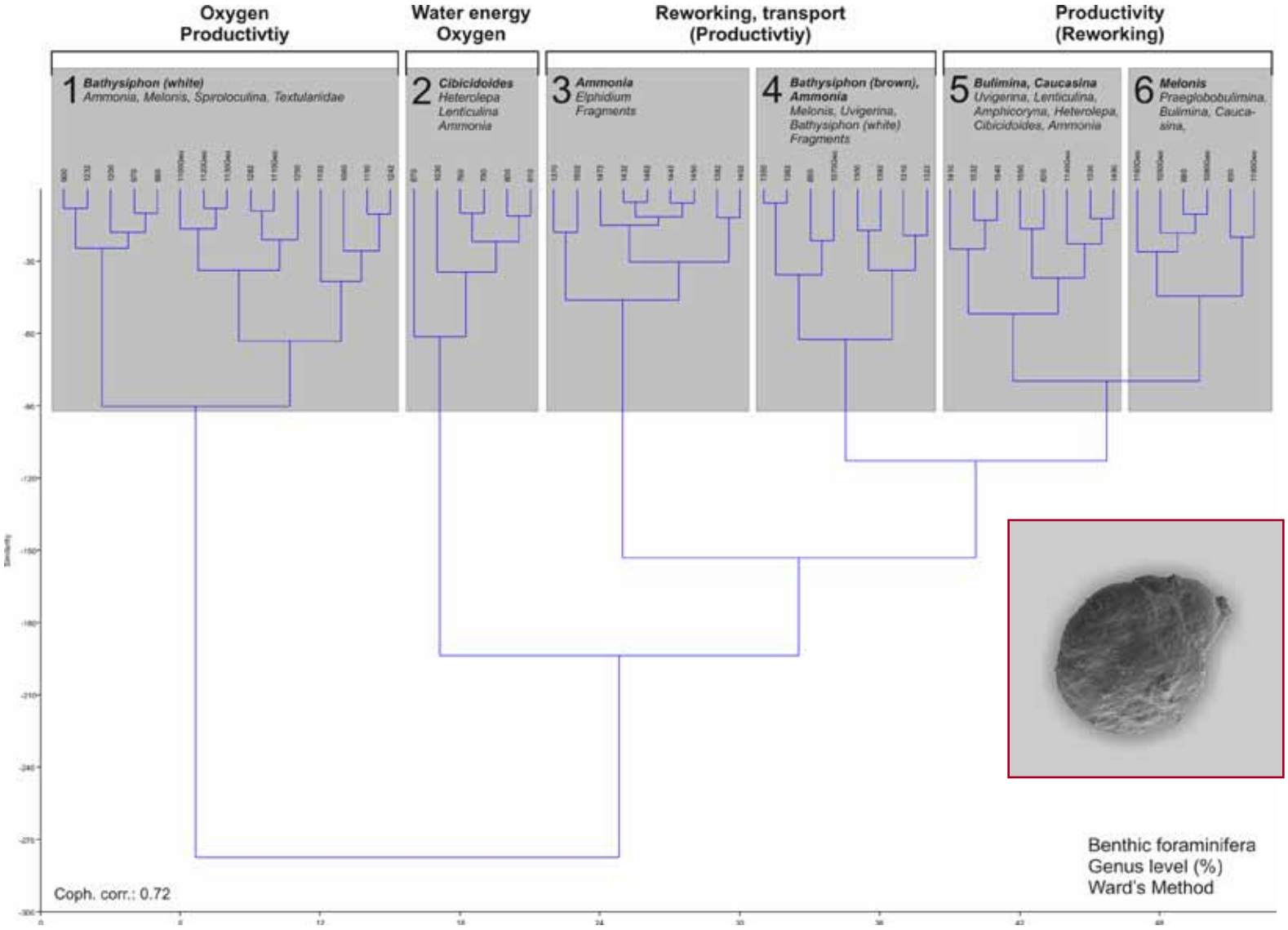
Cluster Analysis



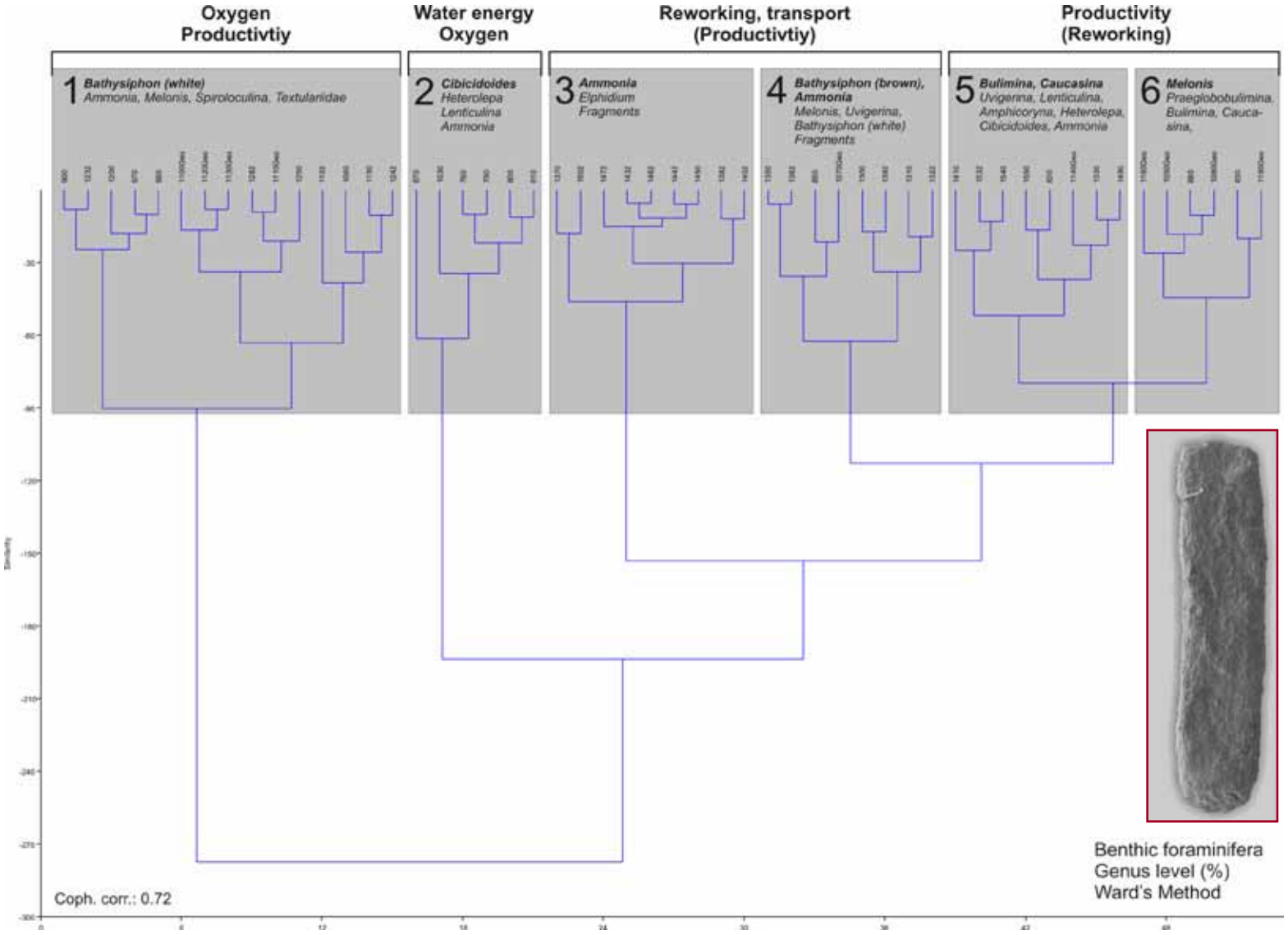
Cluster Analysis



Cluster Analysis



Cluster Analysis



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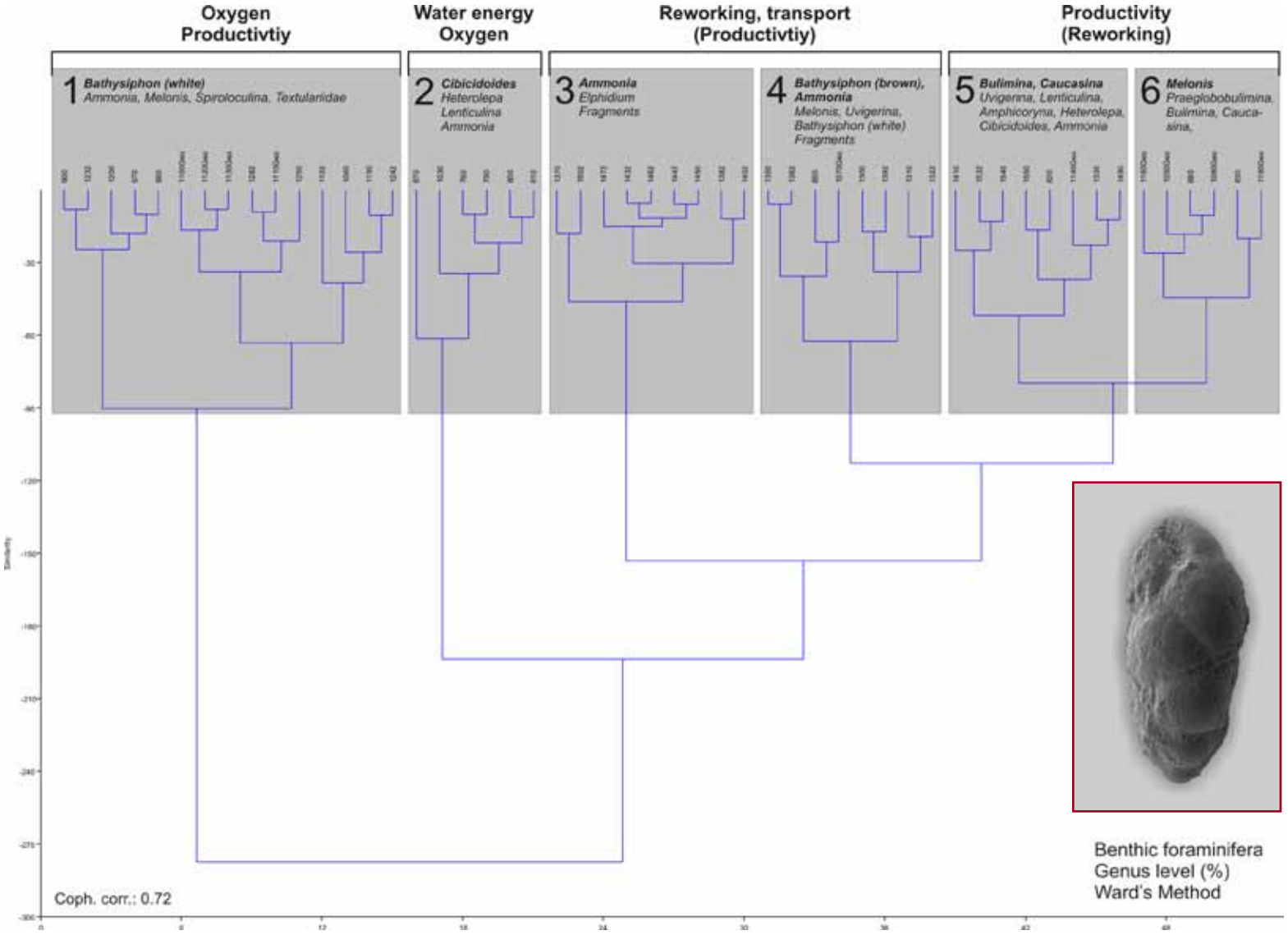
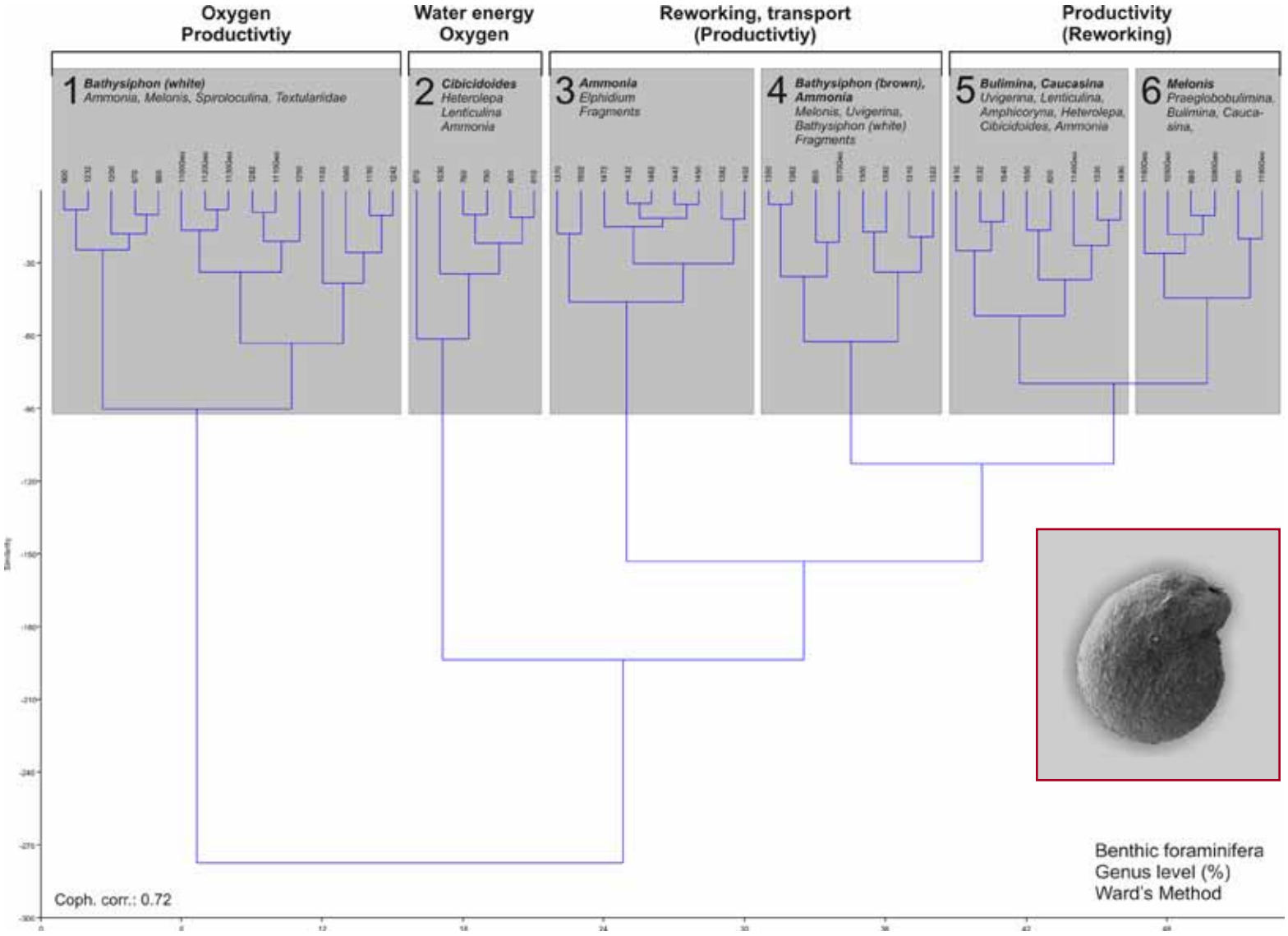
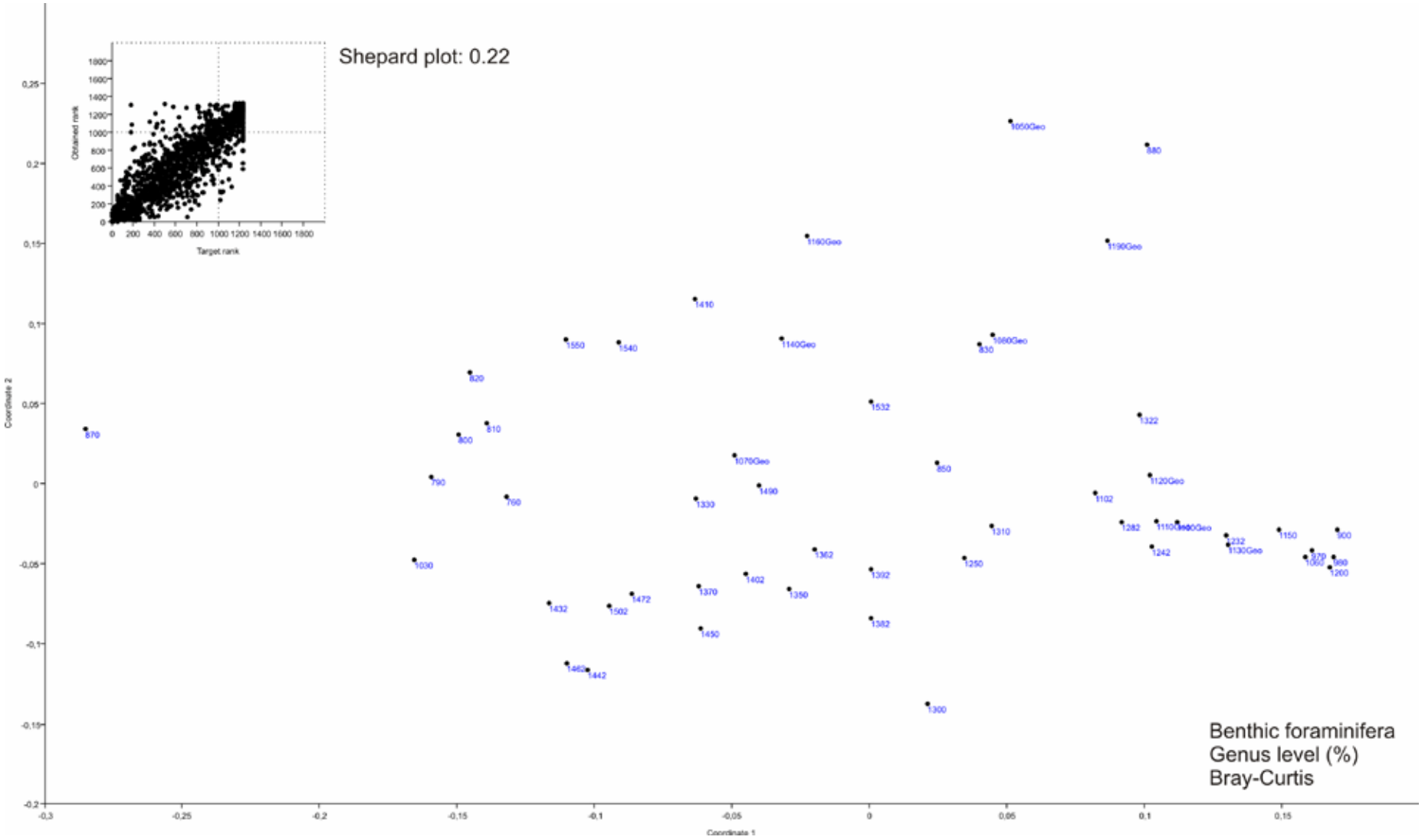


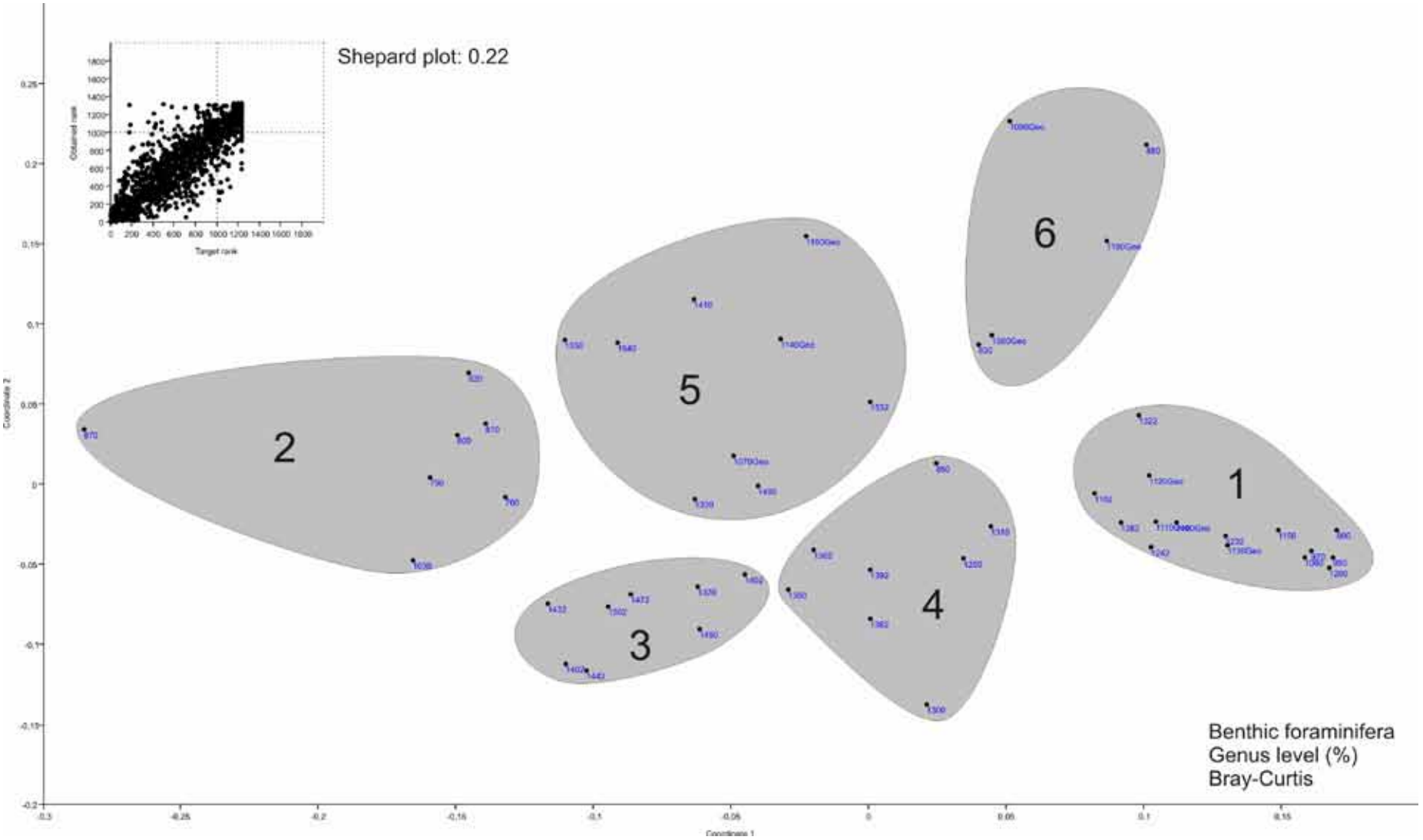
Cluster Analysis



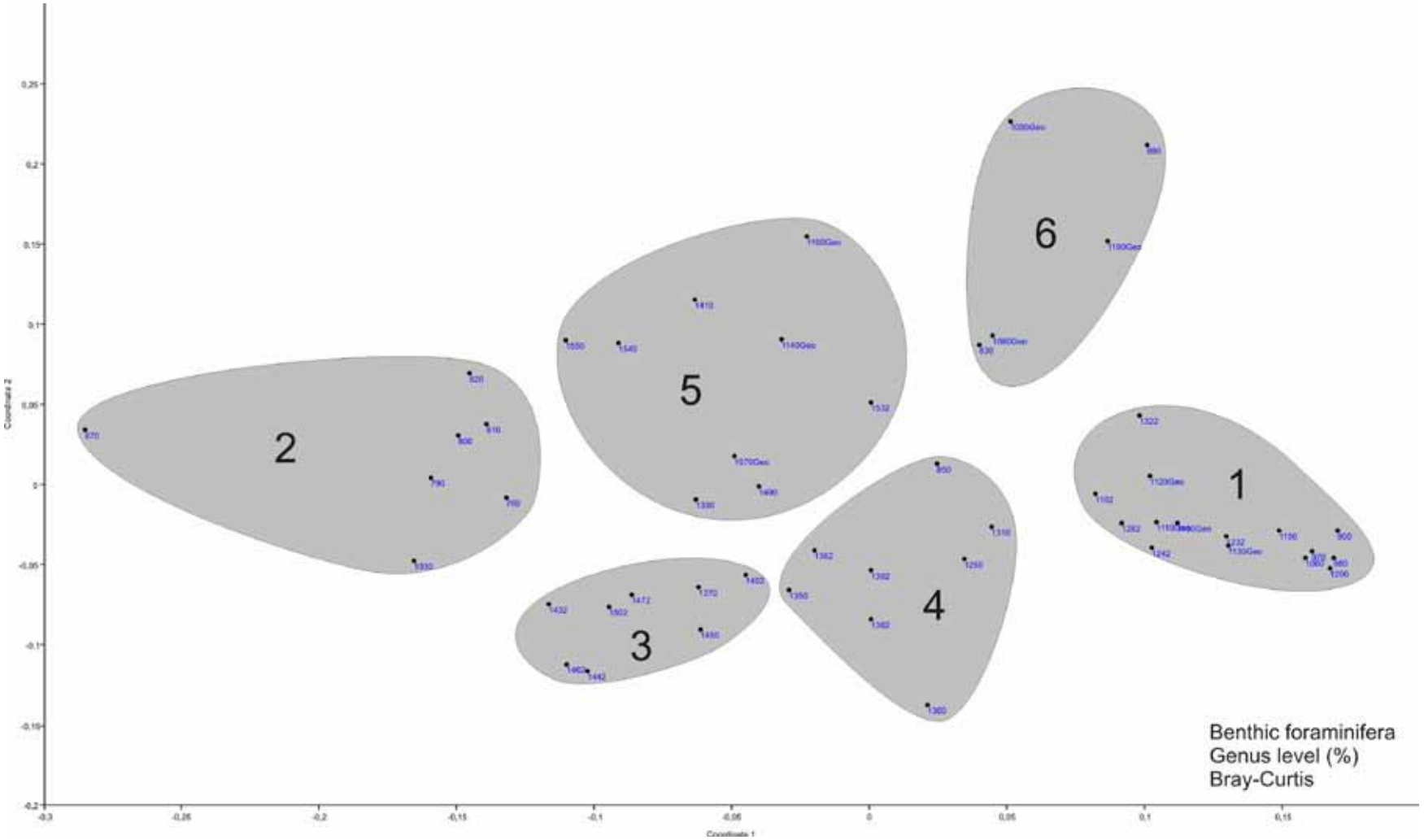
Nonmetric Multidimensional Scaling



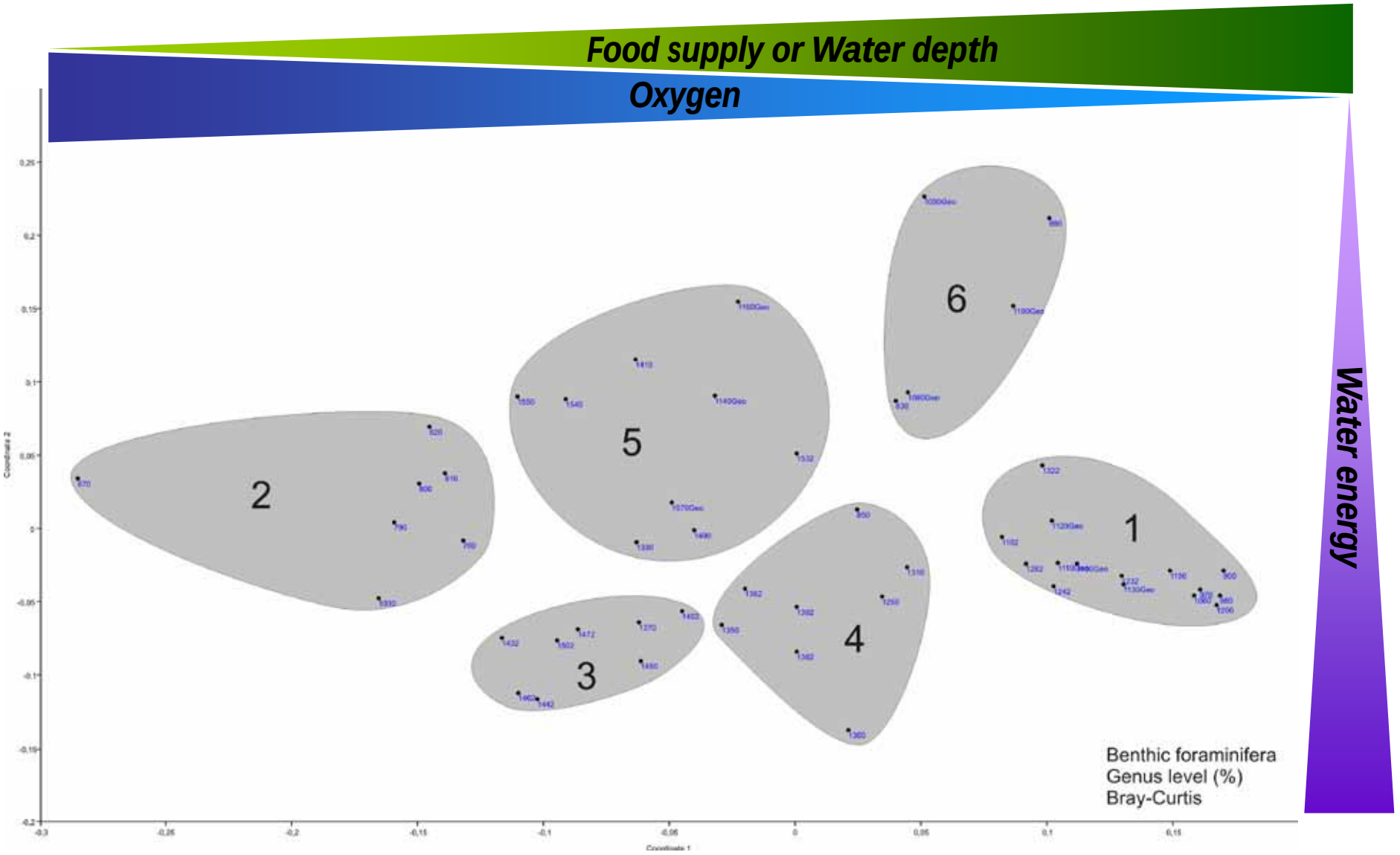
Nonmetric Multidimensional Scaling



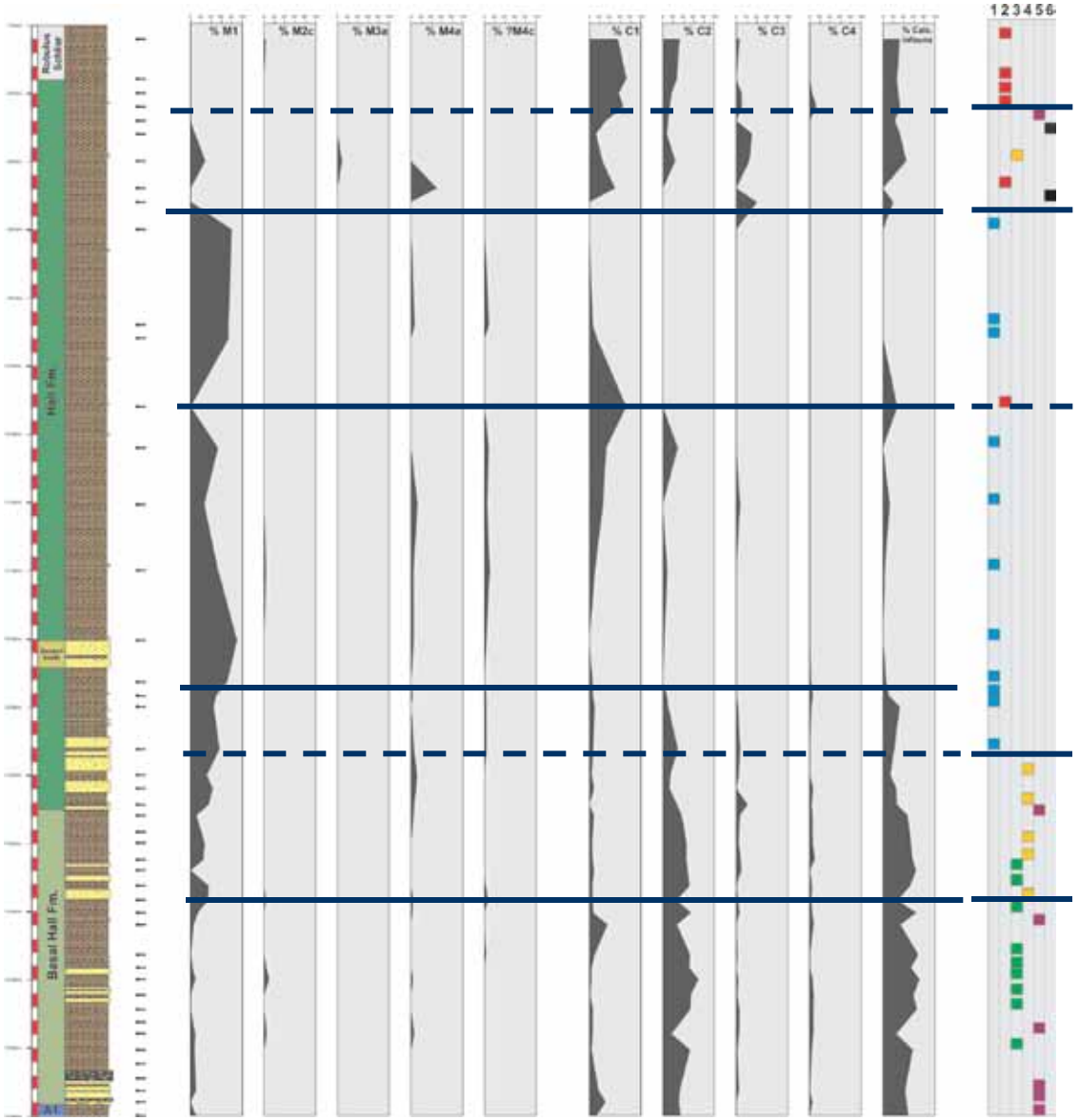
Nonmetric Multidimensional Scaling



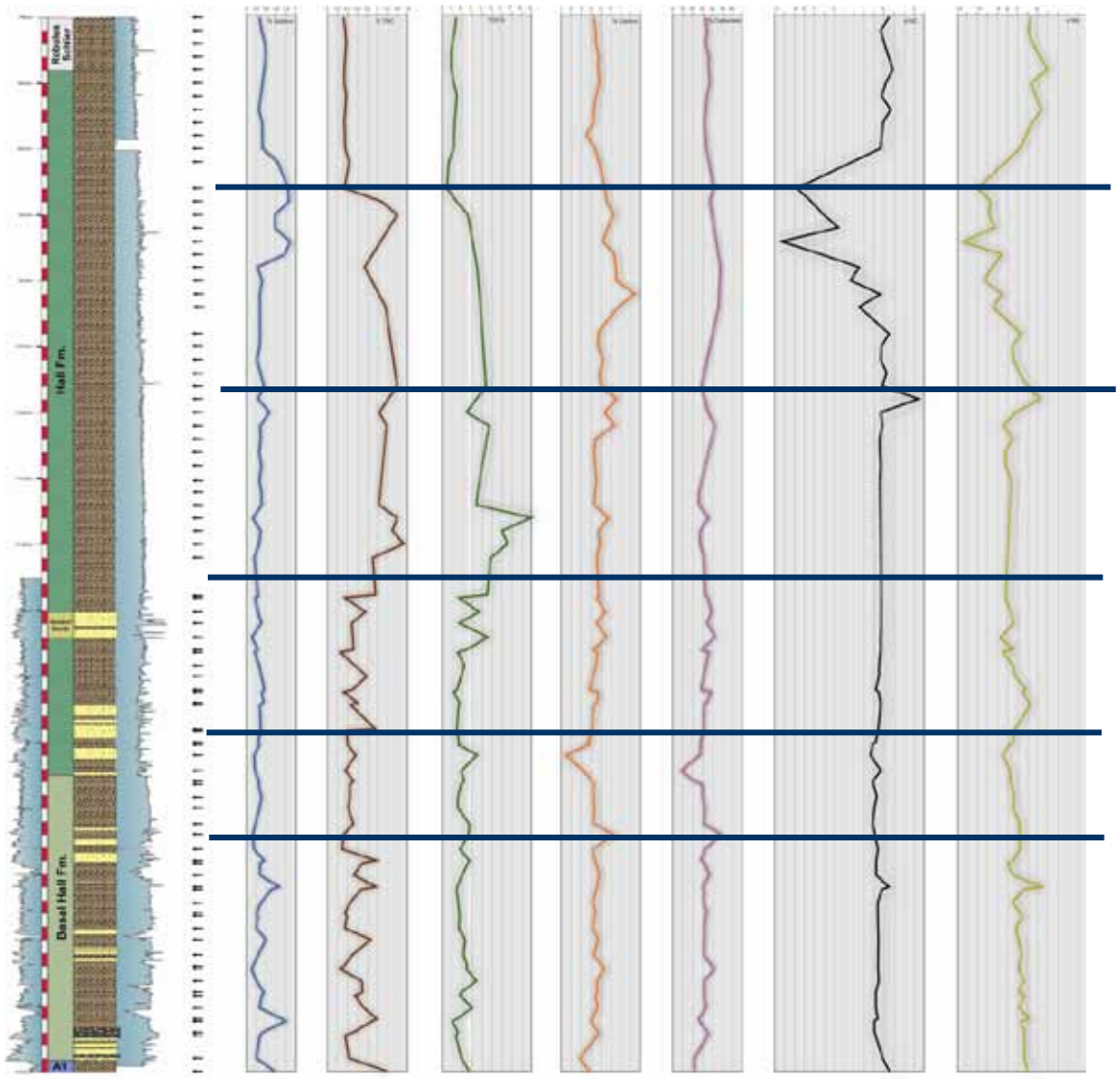
Nonmetric Multidimensional Scaling



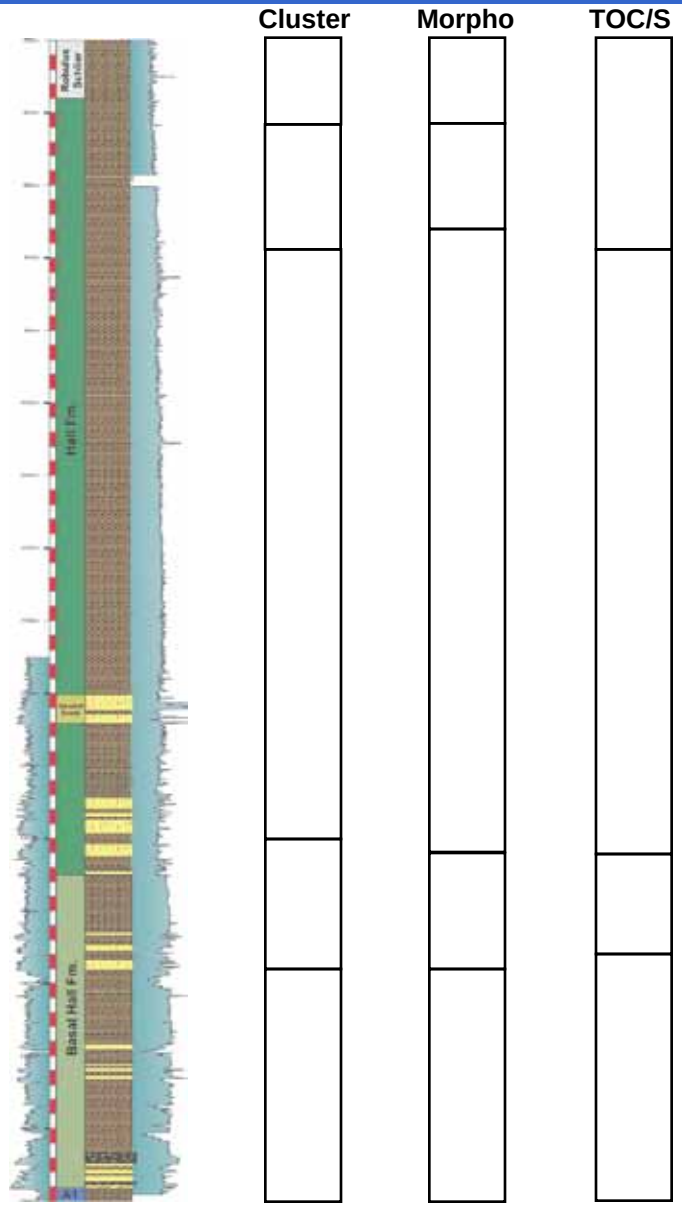
Hochburg 1 – Benthos



Hochburg 1 – Geochemistry

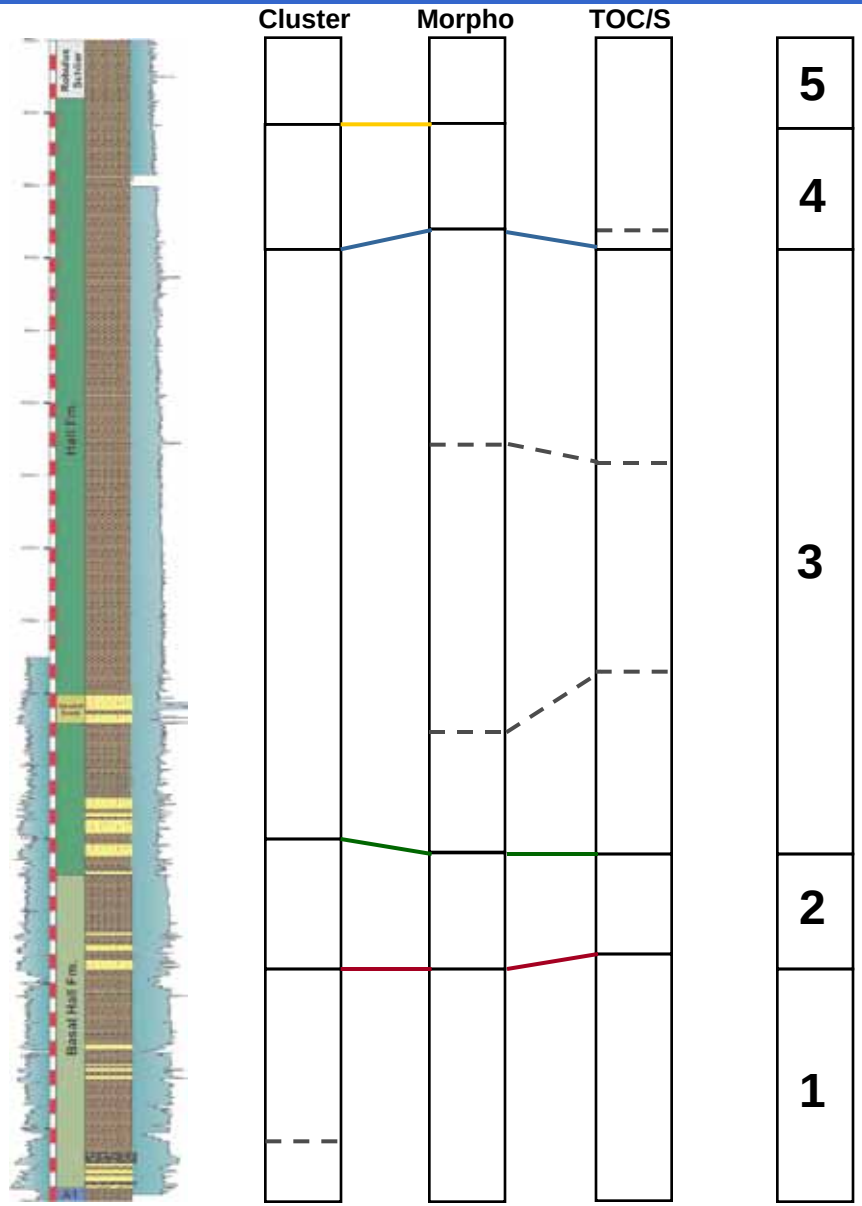


Hochburg – Facies evolution



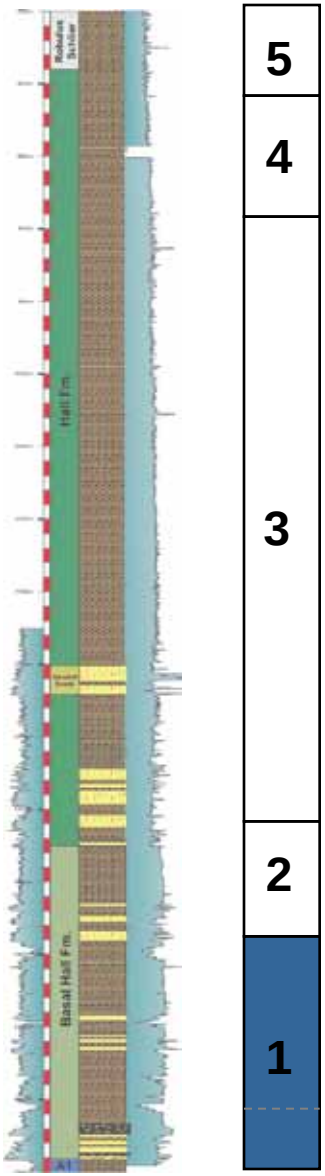
Integration of all available data to reconstruct paleoenvironment

Hochburg – Facies evolution



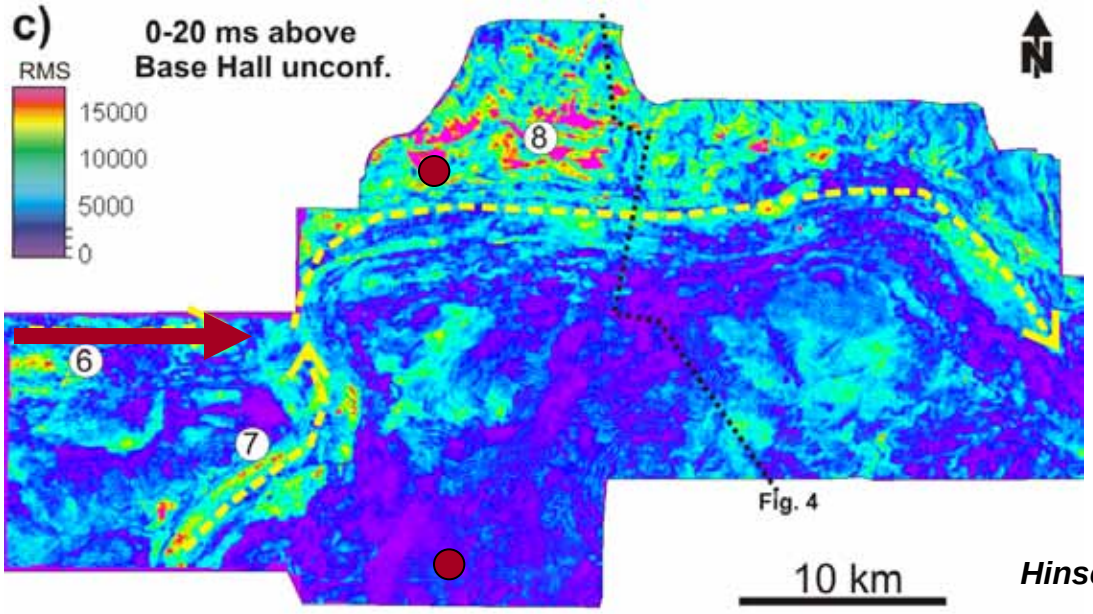
Integration of all available data to reconstruct paleoenvironment

Resolution not good enough to resolve trends within facies 3!

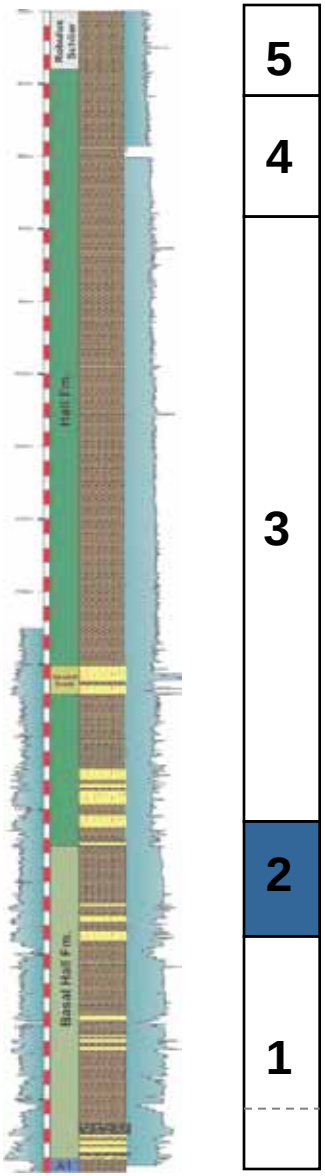


Facies 1: Channel depositon (1390-1540m)

- High abundance of reworked *Ammonia* and *Elphidium*
- 1510-1540m: Reworked Egerian (UPF?) foraminifera
- Variable high TOC and S à transport!
- Source: shelf sediments (feeder from W?)

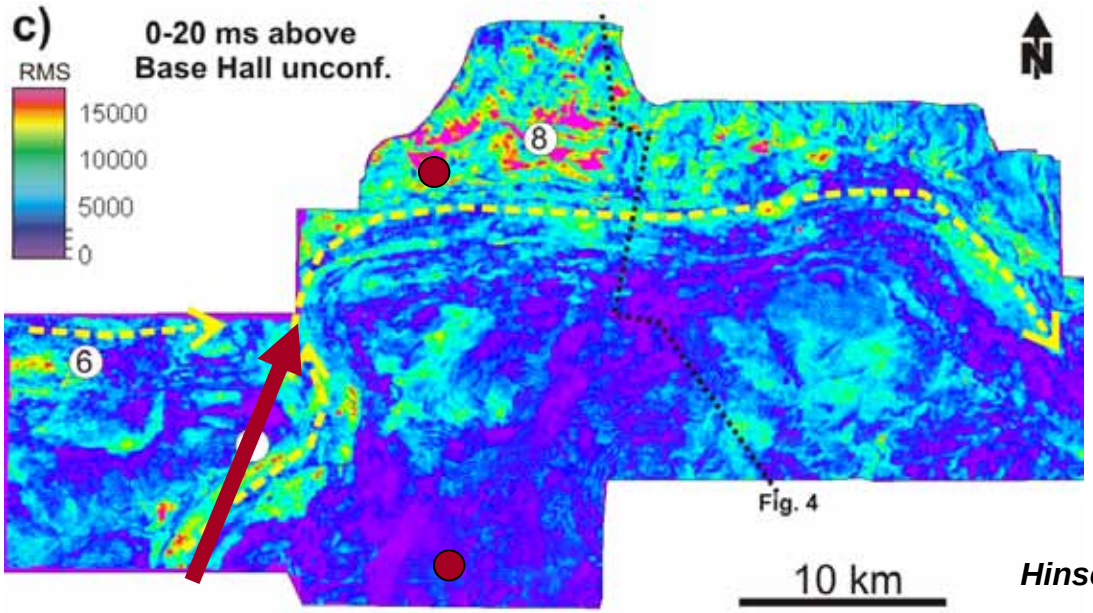


Hinsch, 2008

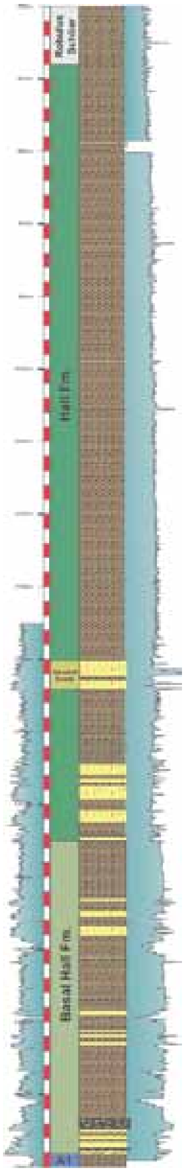


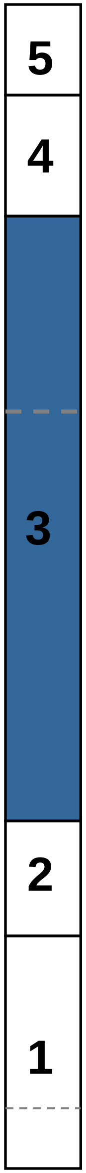
Facies 2: Channel depositon (1310-1390m)

- High abundance of brown *Bathysiphon* (reworked?)
- Fauna with *Uvigerina, Melonis* and white *Bathysiphon*
  à episodes of decreased transport?
- Rather constant TOC and S
- Source: slope sediments (feeder from SW?)



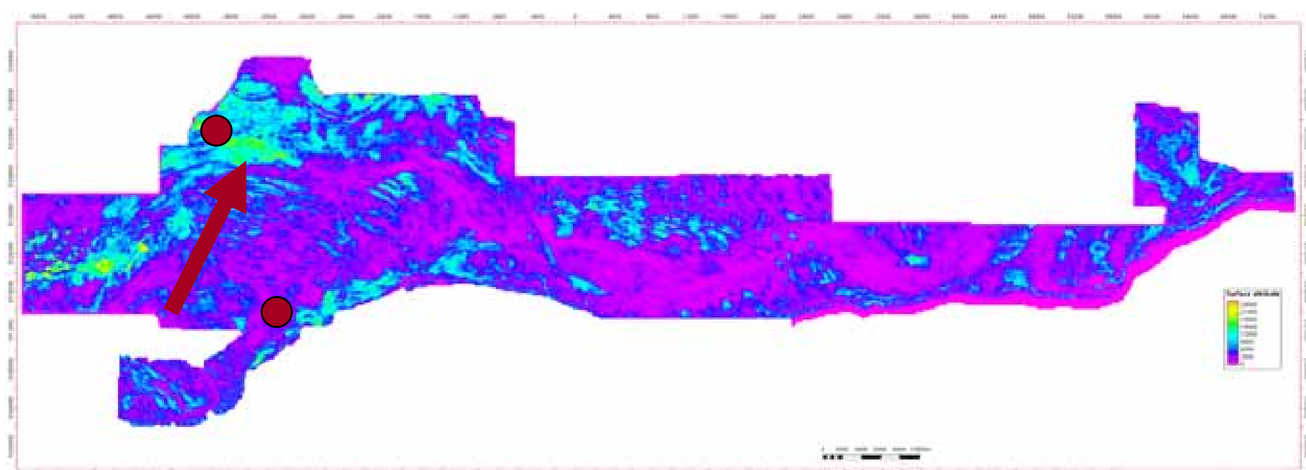
Hinsch, 2008

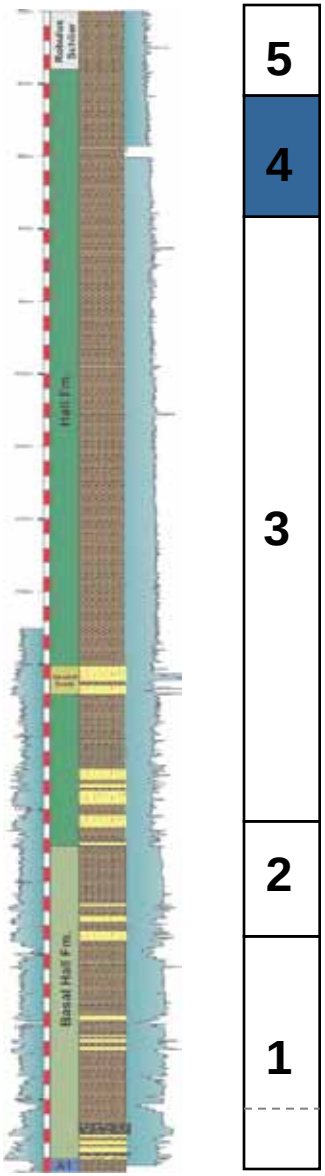




Facies 3: High productive, oxic pelagic facies (890-1310m)

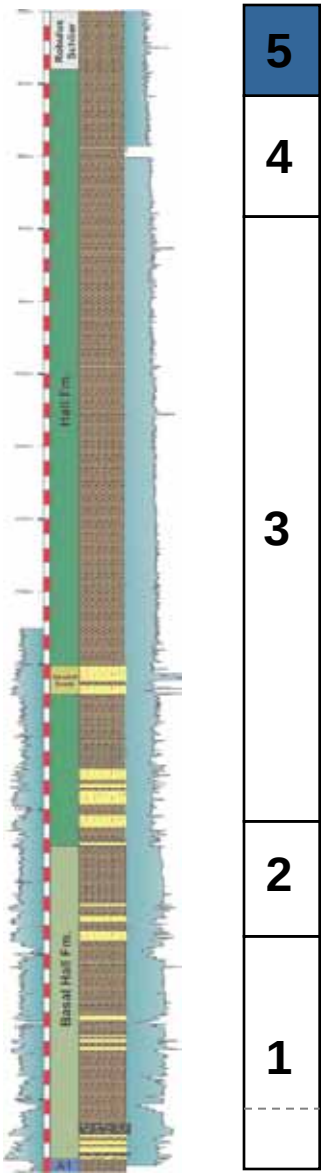
- High abundance of white *Bathysiphon*
- Input of *Ammonia*, miliolids and coal à adjacent coast
- Increasing, high TOC, constant S
- Source: prograding delta front from SW
- ***Higher resolution will show trends within this facies!***





Facies 4: High productive anoxic pelagic facies (810-890m)

- Decreasing abundance of agglutinated foraminifera
- Increasing abundance of infaunal calcareous taxa
- Increasing abundance of high-productivity taxa
- Low TOC, high S
- Change in sediment composition (mica)
- Source: Paleozoic rocks of northern coast?



5
4
3
2
1

Facies 5: High energy outer neritic facies (760-810m)

- Agglutinated foraminifera vanish
- Increased abundance of epifaunal calcareous taxa
- Increased abundance of clinging taxa
- Low TOC, low S
- Source: Paleozoic rocks of northern coast?
- Ottnangian base at 810m

Facies development – Hochburg 1

- ***Foraminifers*** show clear assemblage changes that are well correlated with geochemical proxies

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- ***Change channel deposition à delta deposition à slope à shelf***

- ***Basal Hall Fm***. shows heavy reworking and indicates change of sediment input from shelf to slope

- most of ***Hall Fm***. dominated by *Bathysiphon*-assemblages reflecting nutrient-rich, oxic deep-water environment

- in upper part of ***Hall Fm***. change towards calcareous fauna and change from dysoxic à oxic

Thank You!

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