Lithology and Hydrocarbon Potential of Lower Oligocene Successions in the Alpine Foreland Basin: Model for Source Rocks in the Paratethys?*

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Abstract

The Lower Oligocene succession in the Paratethys contains many important petroleum source rocks including the Menilite Formation in the Carpathian Foreland (Central Paratethys) and the Maykop Formation in the Eastern Paratethys. In our contribution we present results from a study of the organic-rich, Lower Oligocene deep-water succession in the Alpine Foreland Basin (AFB), based on core analysis, well logs and 3D seismic data. It is shown that the architecture of the Lower Oligocene succession and its source potential are mainly controlled by basin-wide processes. Thus, the Lower Oligocene of the AFB may serve as a model for source rock deposition in the entire Paratethys.

The Lower Oligocene succession in the AFB is about 60 m thick and comprises, from bottom to top, the Schöneck, Dynow, and Eggerding formations. Log patterns, which can be traced over more than 150 km in a W-E direction, emphasize the high lateral continuity of the succession. In contrast, there is a significant vertical variation of both lithology and source potential. TOC contents in the Lower Oligocene strata vary from 1.5% to more than 10.0% and HI values ranging from 350 to 600 mgHC/gTOC. Whereas

relatively low TOC contents occur in bright marls deposited during NP 23 (Solenovian event), the best source rock potential exists in shales underlying these marls (unit c of the Schöneck Formation).

Major mass movements occurred during the late stages of deposition of the Eggerding Formation at the northern slope of the basin and locally removed the entire Lower Oligocene succession. The eroded material became redeposited at the basin floor, in the area of the present-day oil kitchen. Thus redeposition increased the hydrocarbon potential of the basin!

Investigations in the western Black Sea area (offshore Bulgaria) show that at least the Solenovian event had a similar effect on source rock quality compared to that in the AFB.

References

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Lithology and HC potential of L.-Oligocene successions in the Alpine Foreland Basin

Model for source rocks in the Paratethys?

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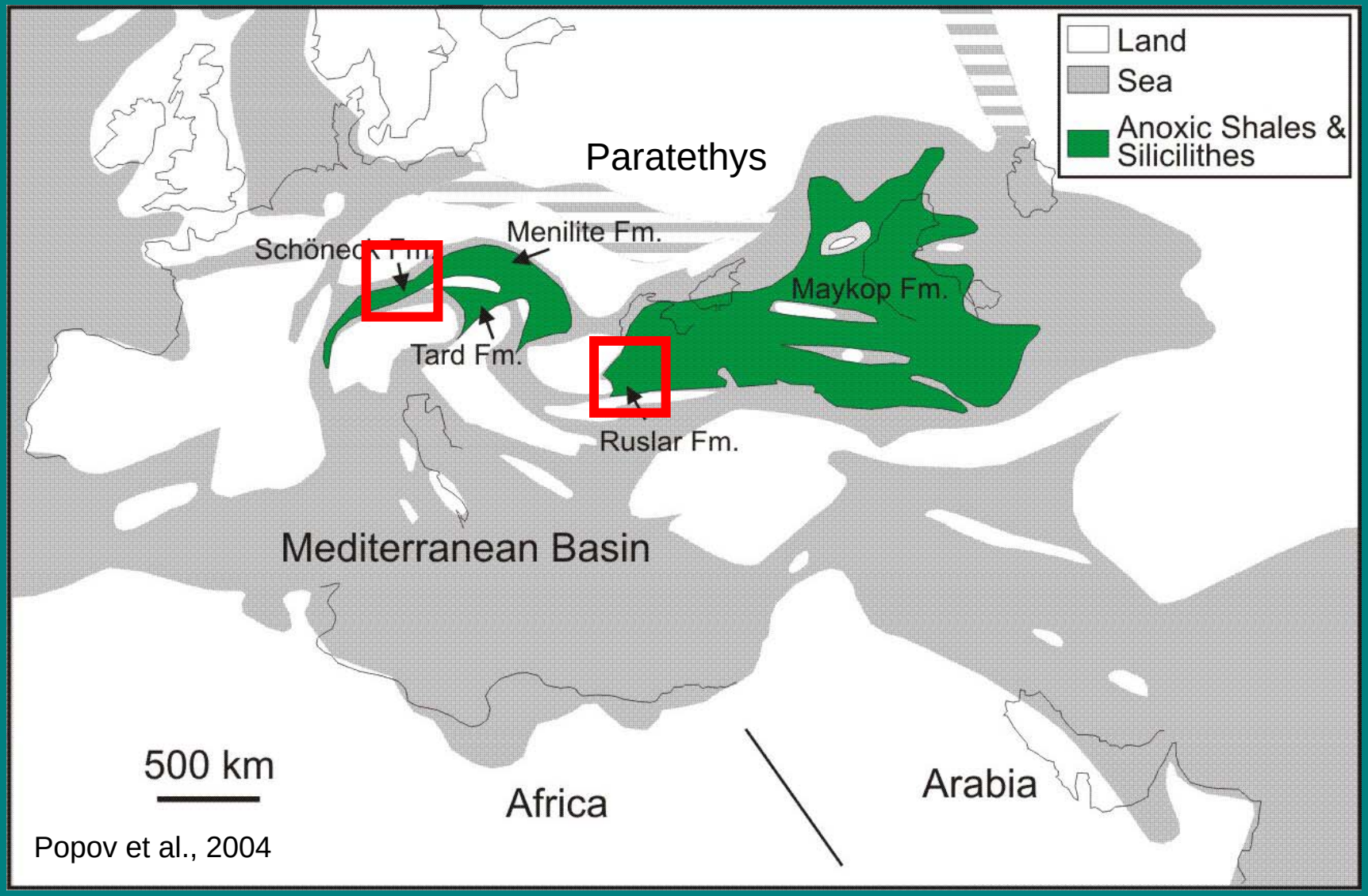
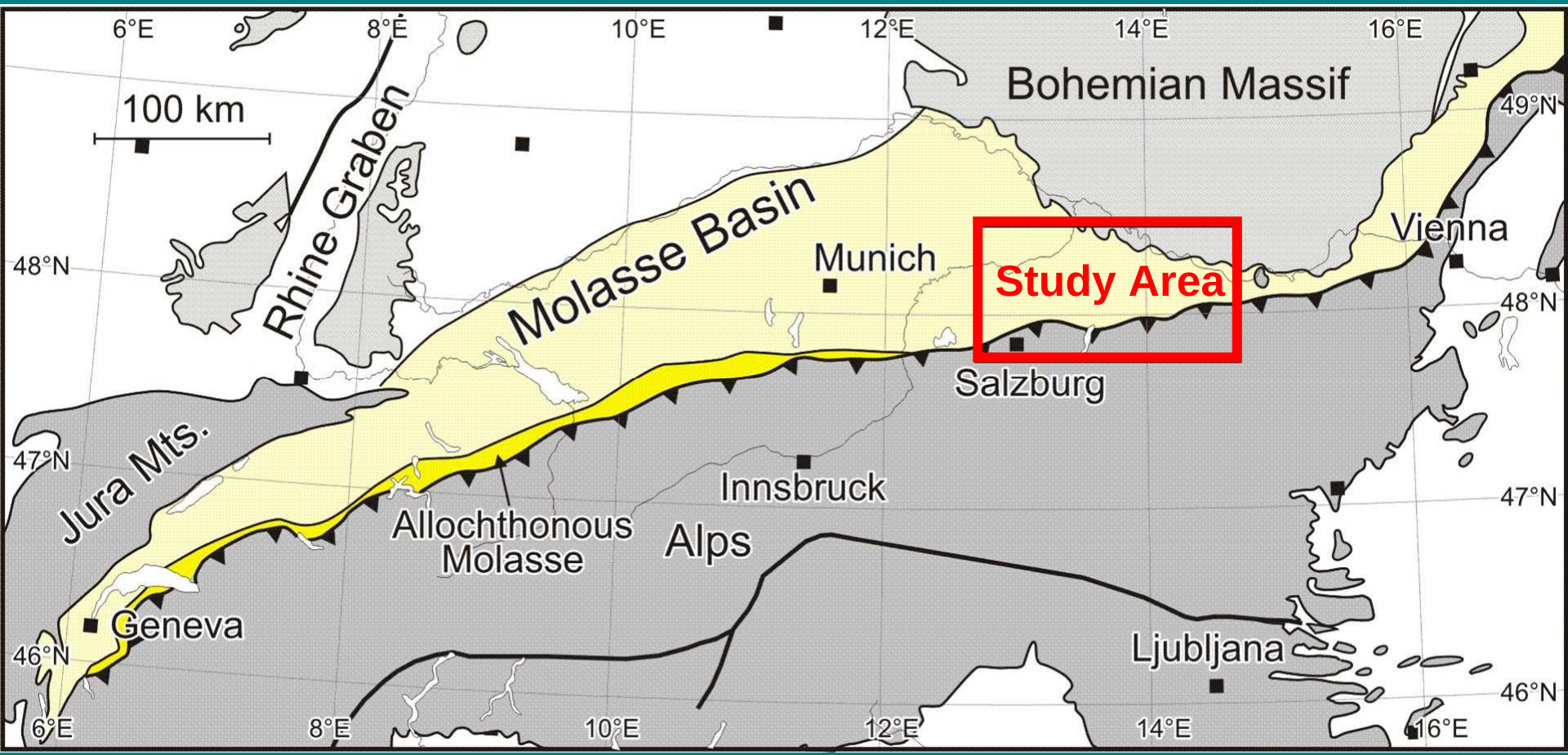
Lower Oligocene Source Rocks

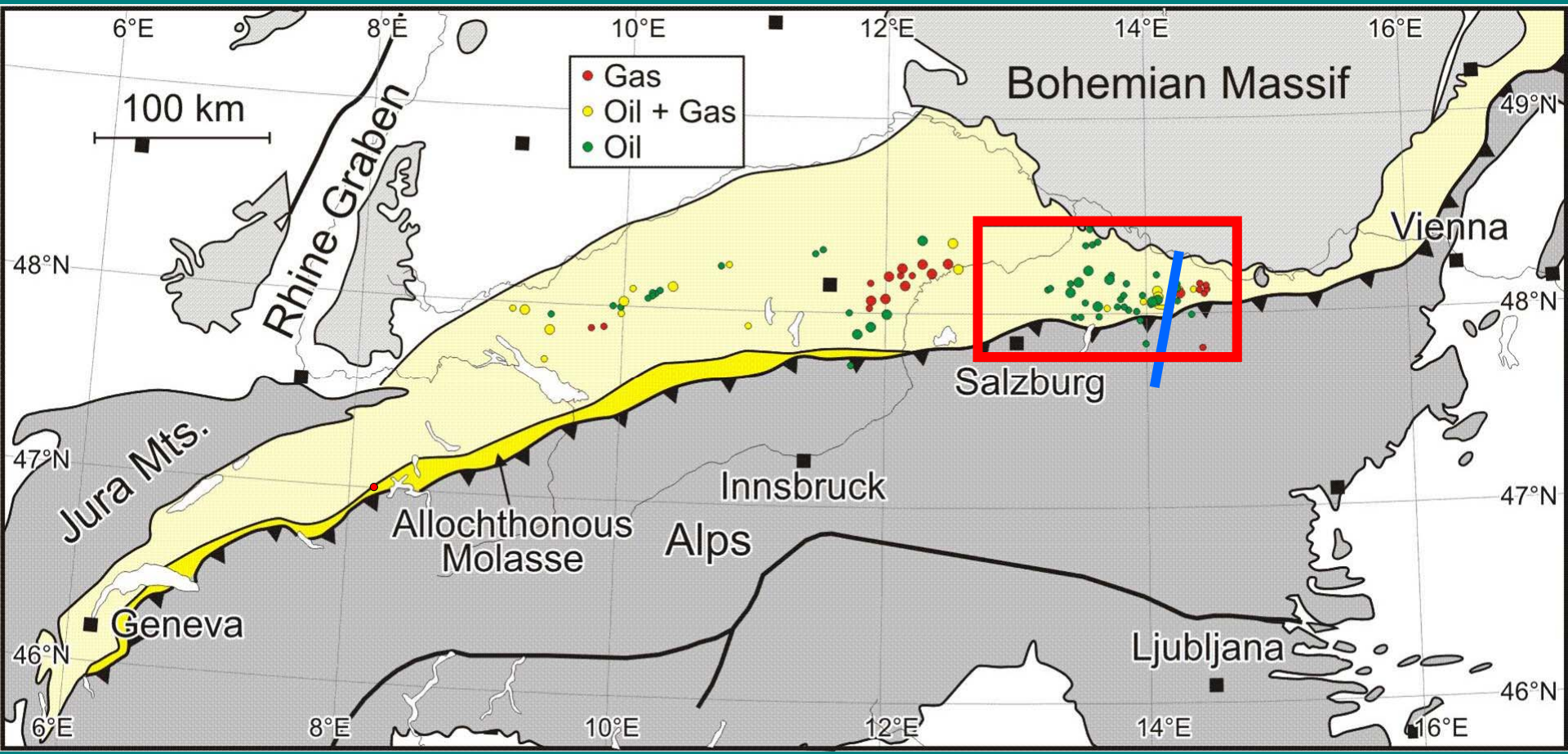


Popov et al., 2004

Study Area

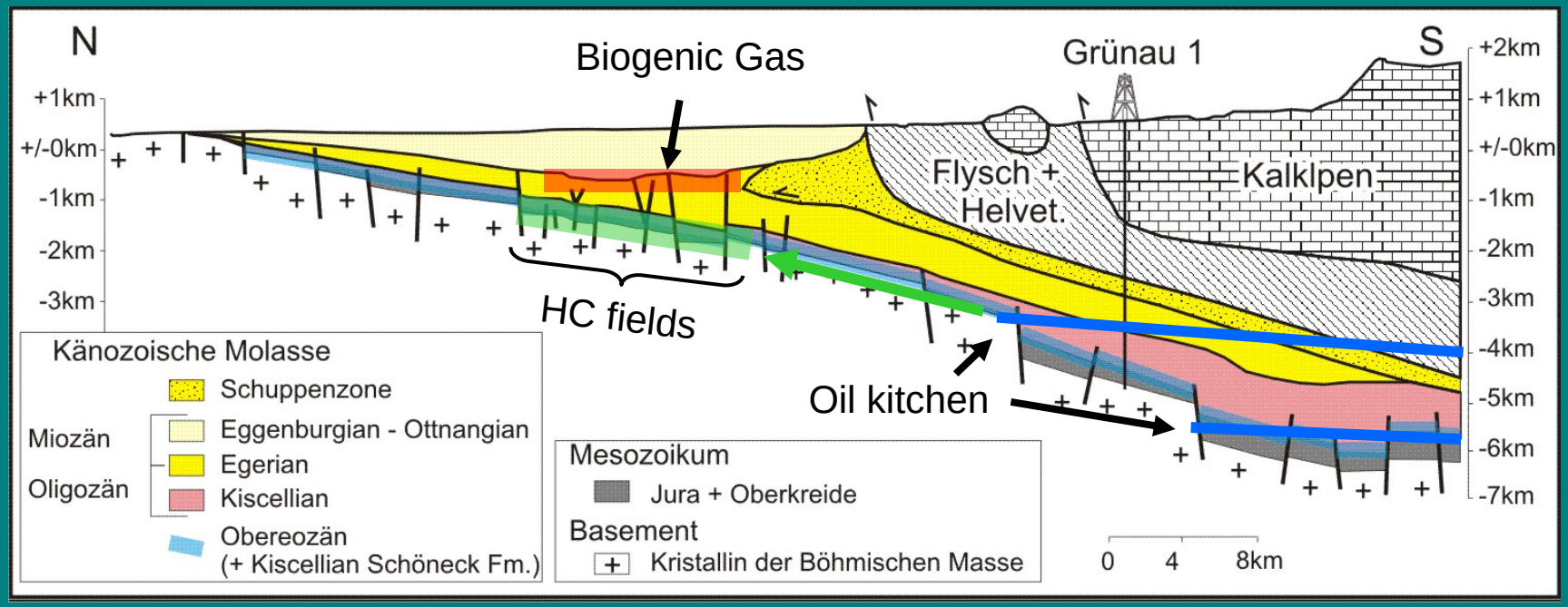

6°E
8°E
10°E
12°E
14°E
16°E
100 km
Bohemian Massif
49°N
Rhine Graben
Molasse Basin
Munich
Study Area
Vienna
48°N
48°N
Salzburg
47°N
Jura Mts.
Innsbruck
47°N
Allochthonous
Molasse
Alps
Geneva
46°N
Ljubljana
46°N
6°E
8°E
10°E
12°E
14°E
16°E

Hydrocarbon Fields (Oil + Thermal Gas)

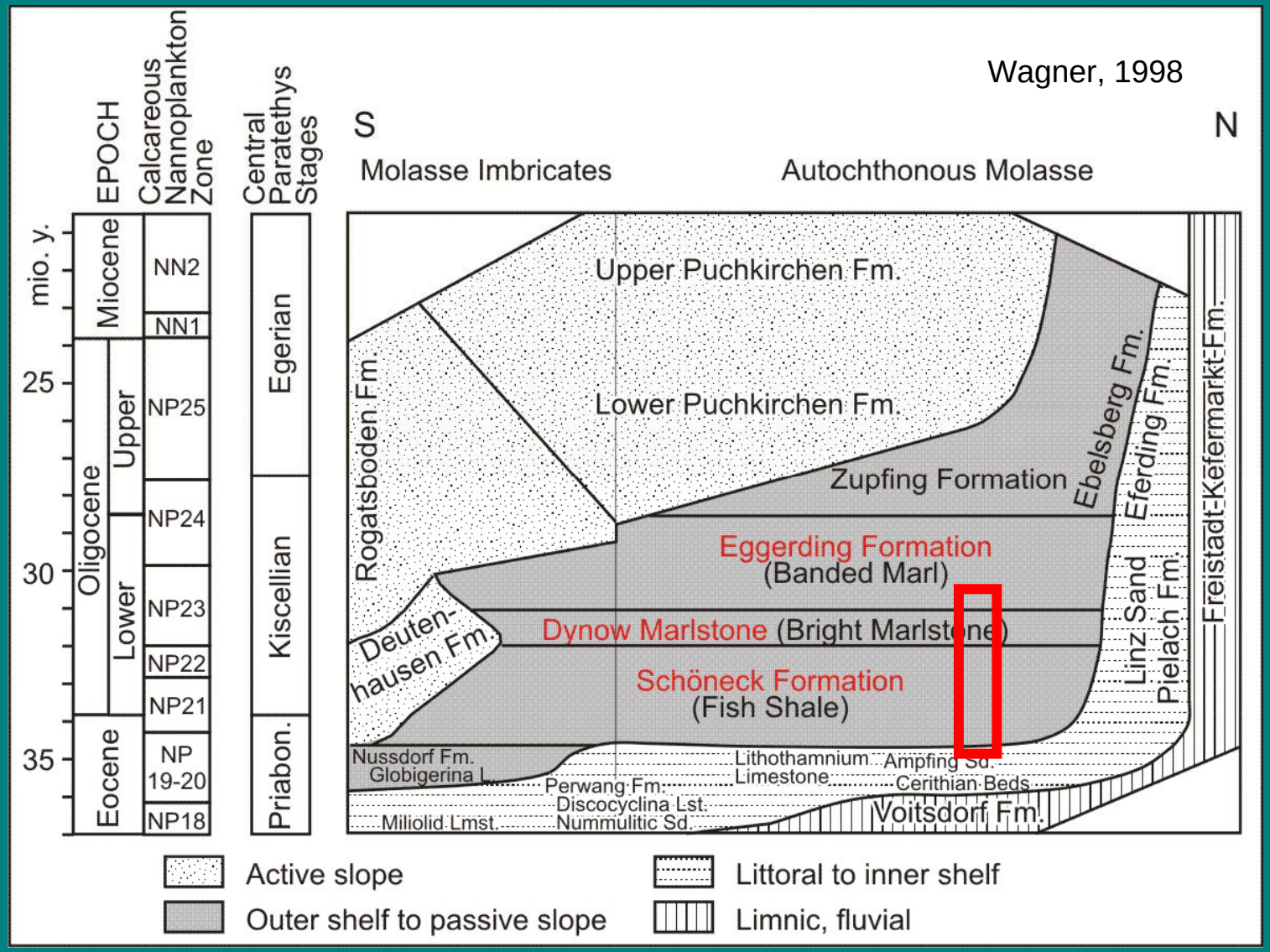


Petroleum Systems

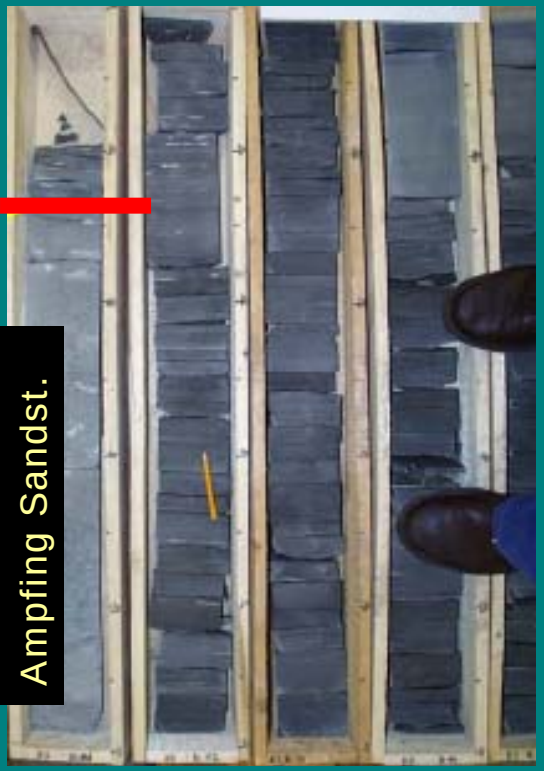
Source Rock	–	Reservoir Rock		
Oligocene	–	Cretac./Paleogene	PS	Thermogenic HCs
Puchkirchen/Hall	–	Puchkirchen/Hall	PS	Bacterial(?) Gas

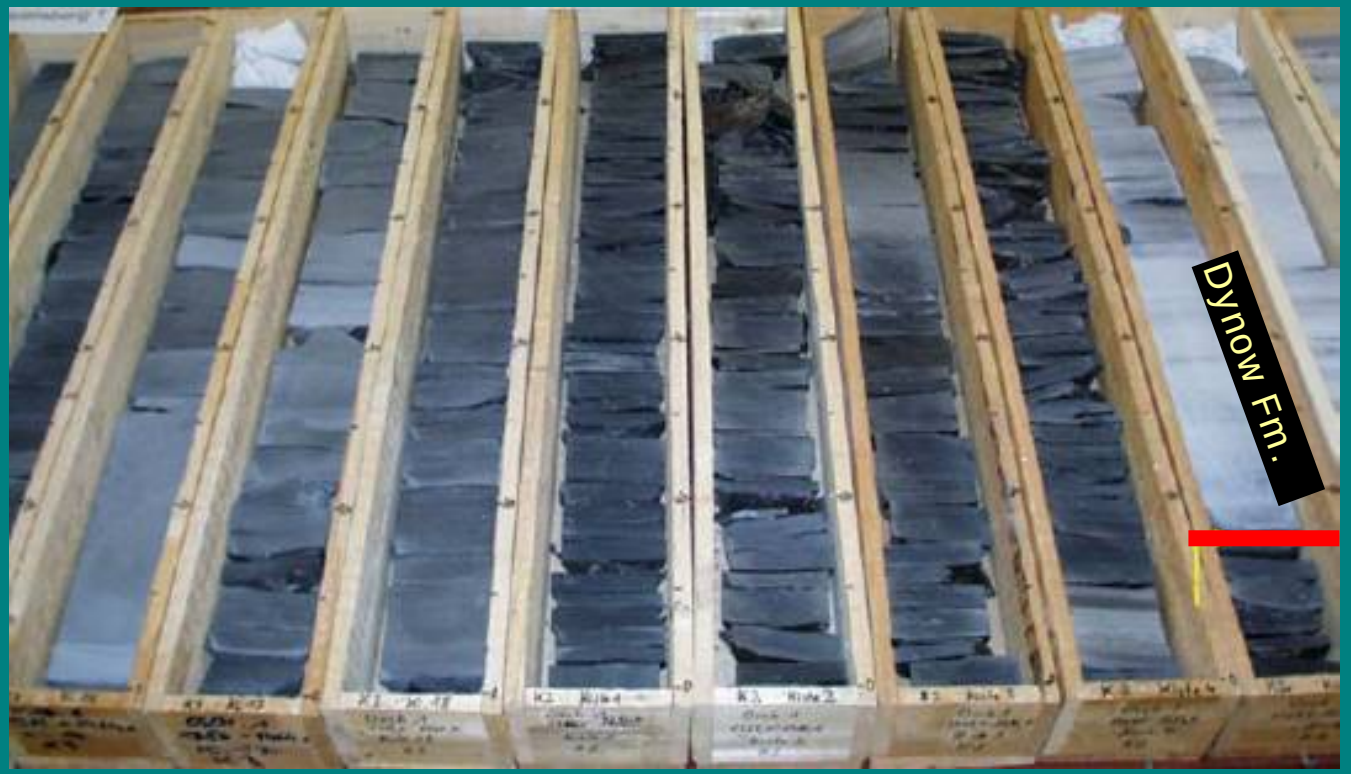


Stratigraphy



Lithology, Schöneck Fm. (Fish Shale)

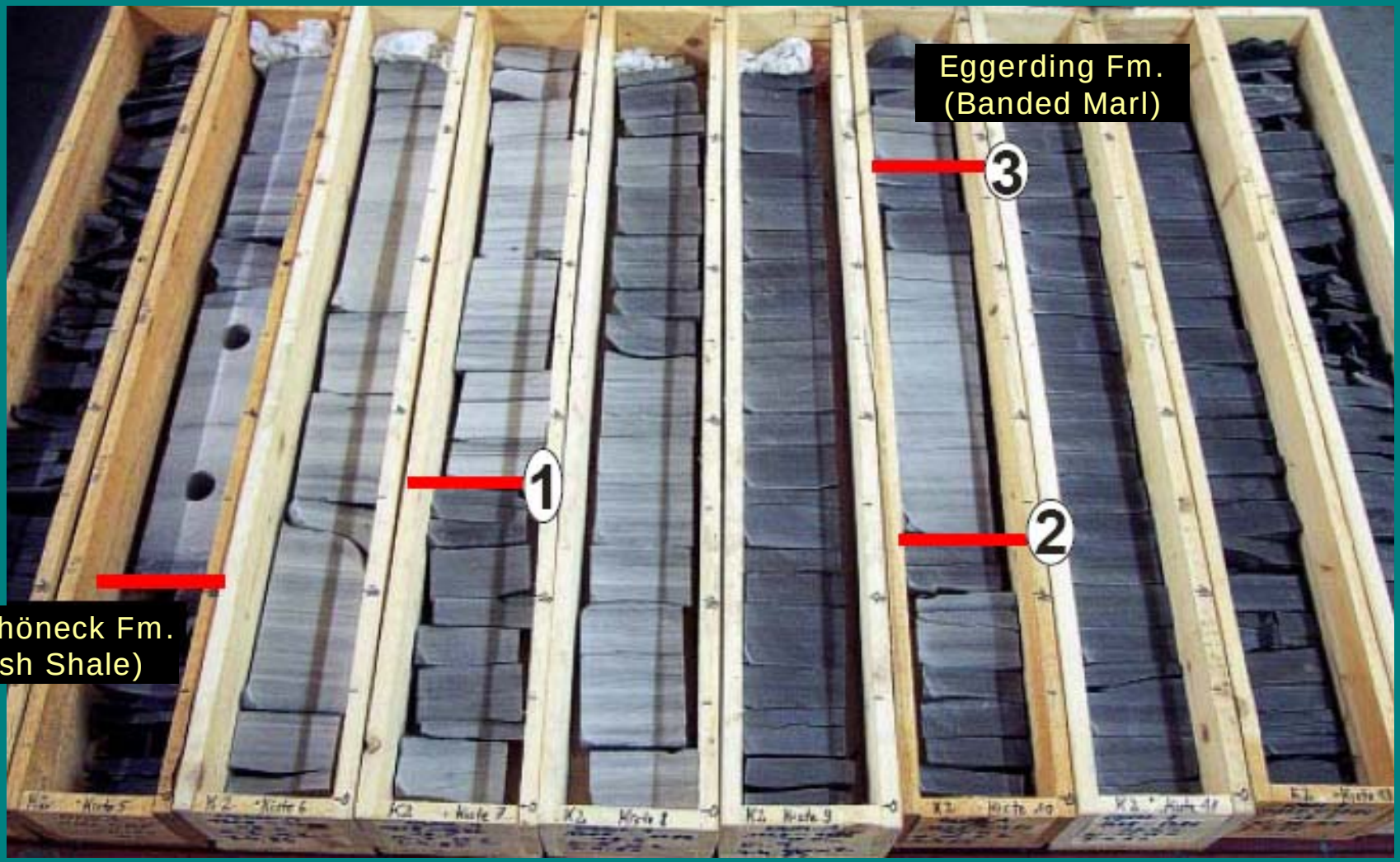




bottom → top

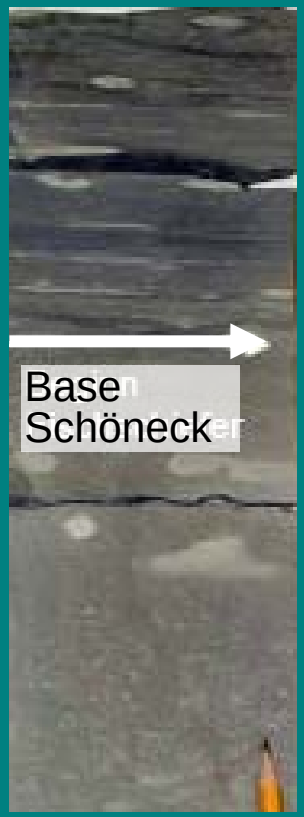
Oberschauersberg 1

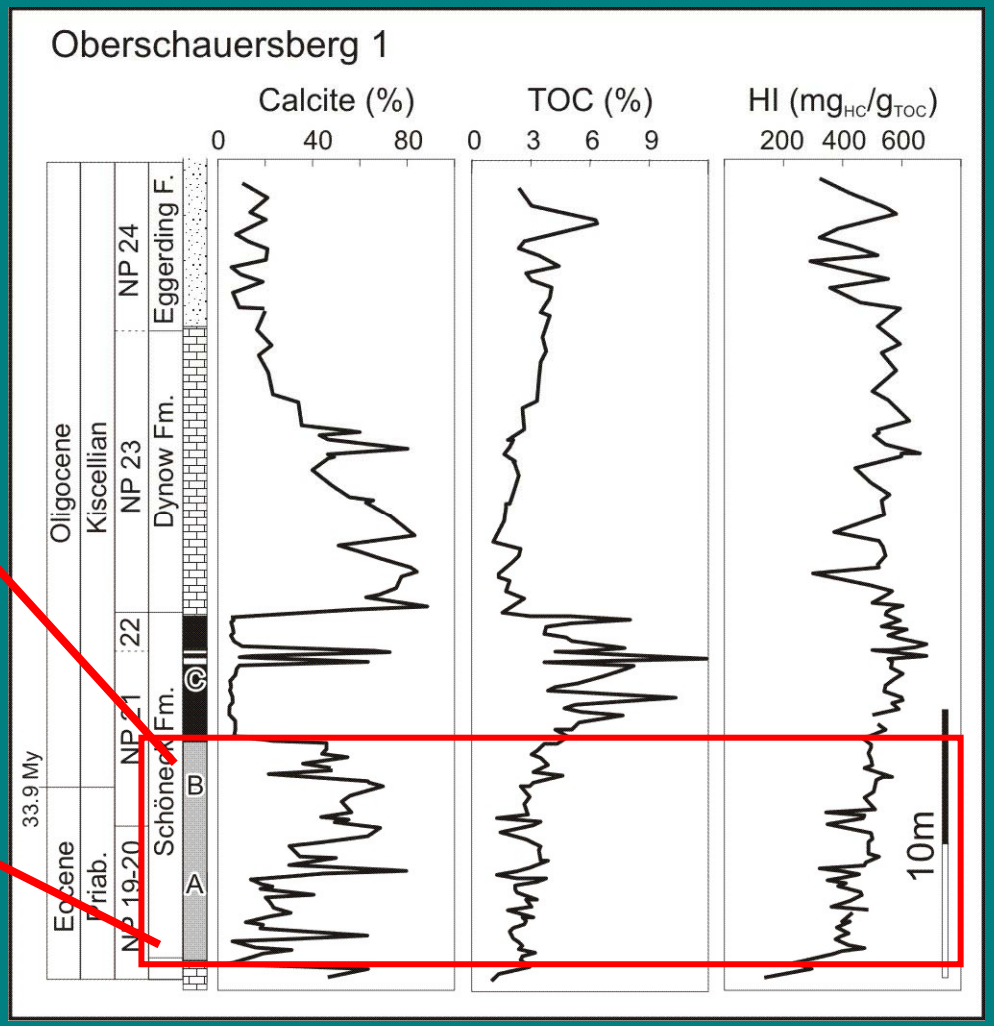
Lithology, Dynow Fm. - Eggerding Fm. (Bright Marlstone, Banded Marl)



bottom → top

Tuff layer

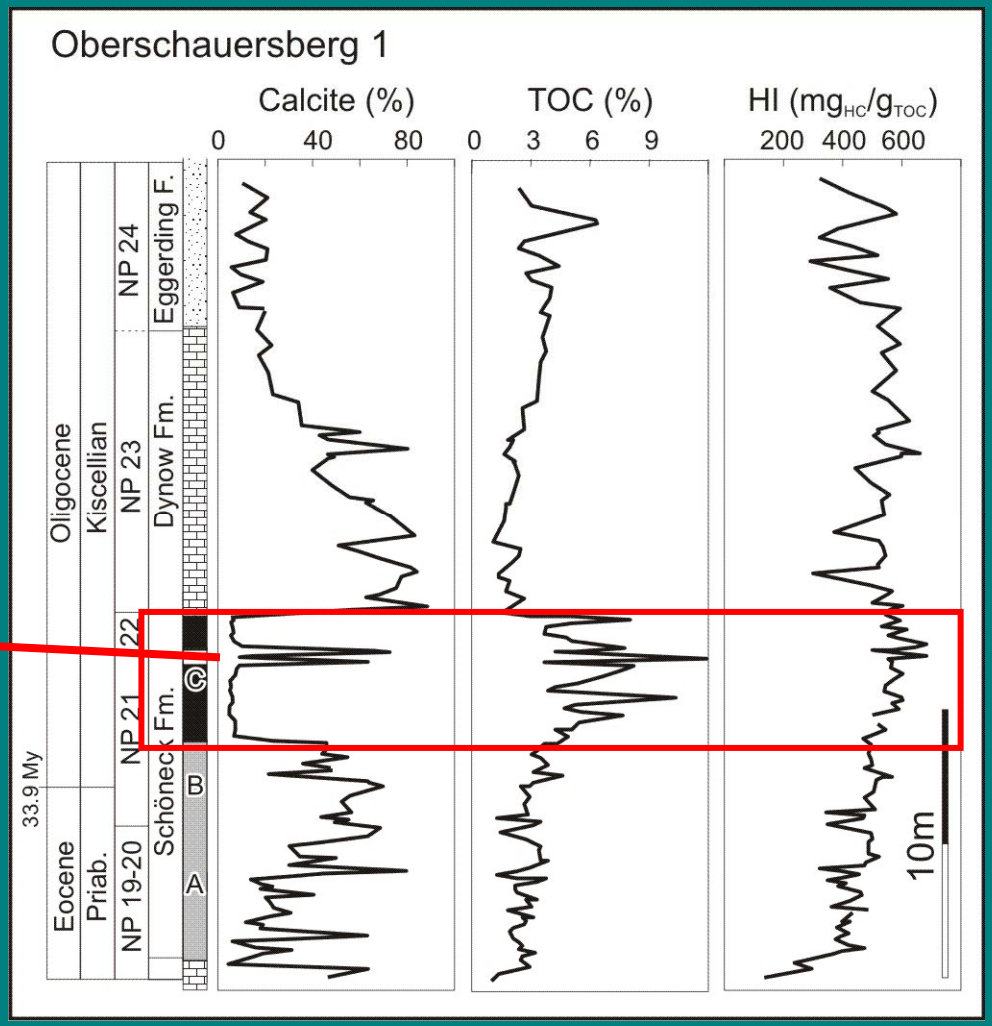

Base
Schöneck

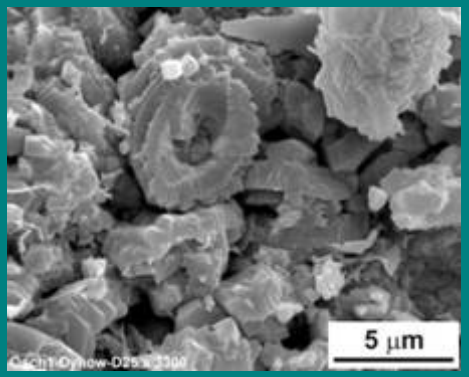

Oberschauersberg 1
Calcite (%)
0
40
80
TOC (%)
0
3
6
9
HI (mgHC/gTOC)
200
400
600
Oligocene
Kiscellian
Eocene
Priab.
NP 24
NP 23
NP 22
NP 21
NP 19-20
Eggerding F.
Dynow Fm.
Schöneck Fm.
C
B
A
33.9 My
10m

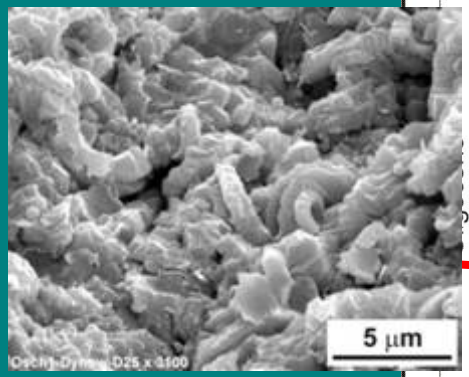
Bright marlstone in „unit c“

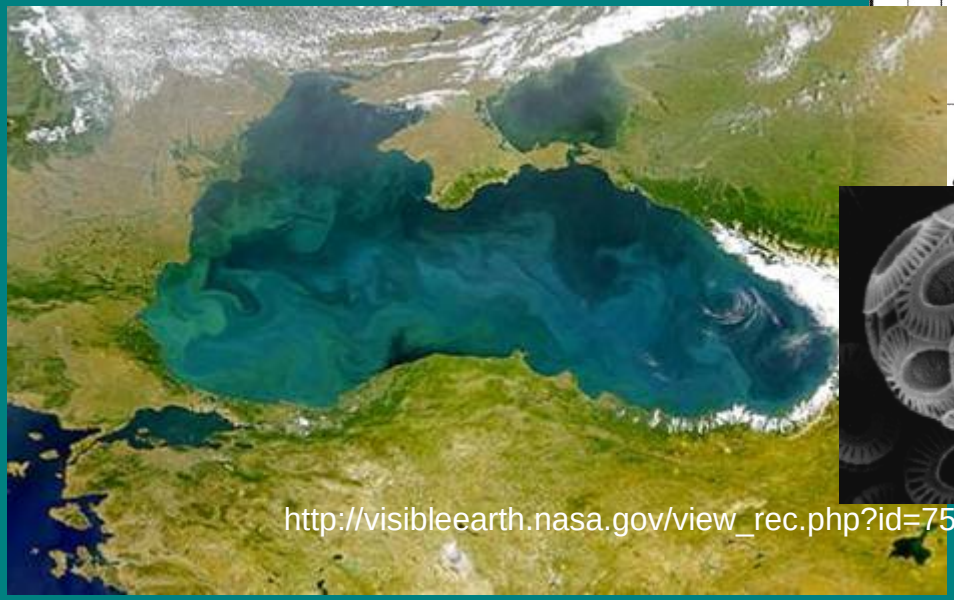
Zooplankton faecal pellets:

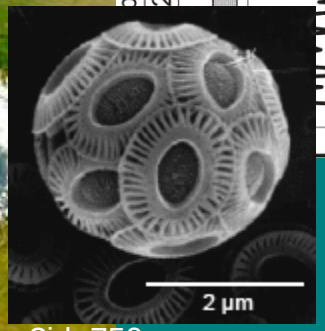
made up of coccolith debris from planktonic copepods



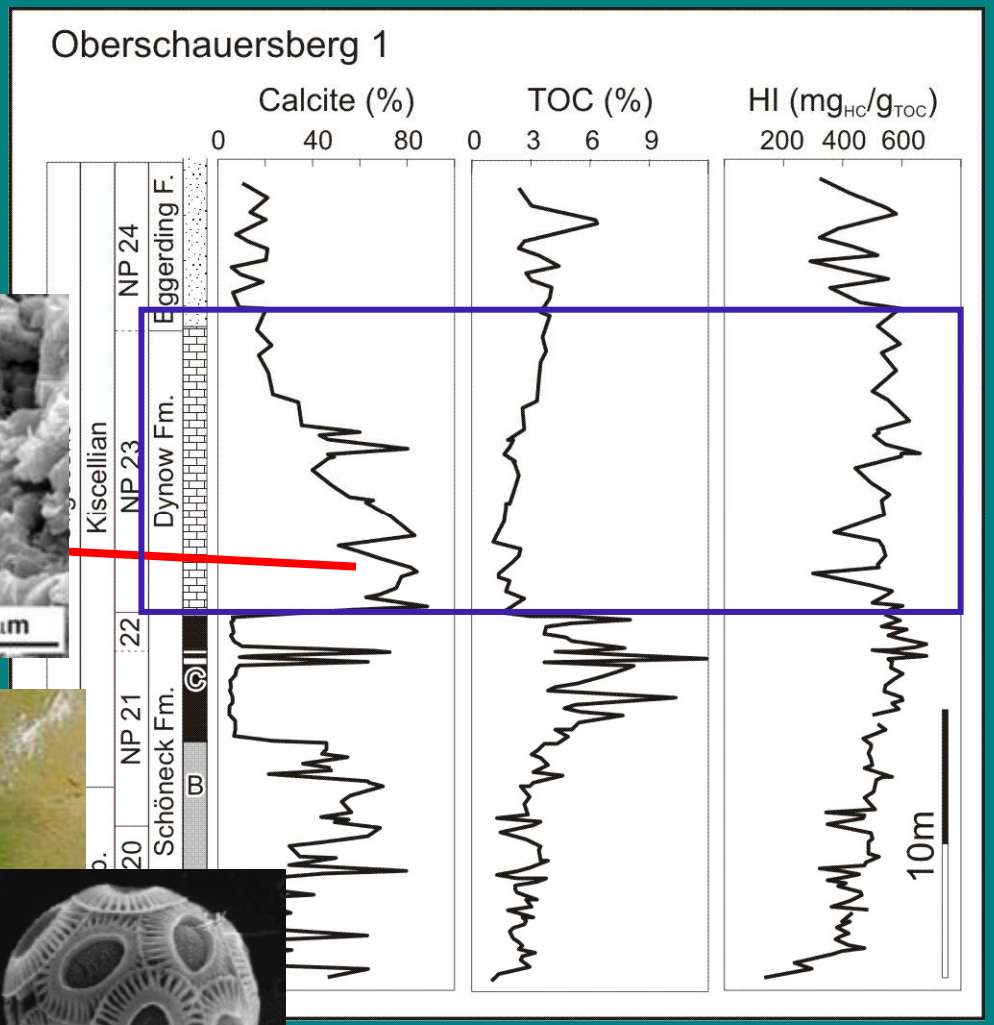


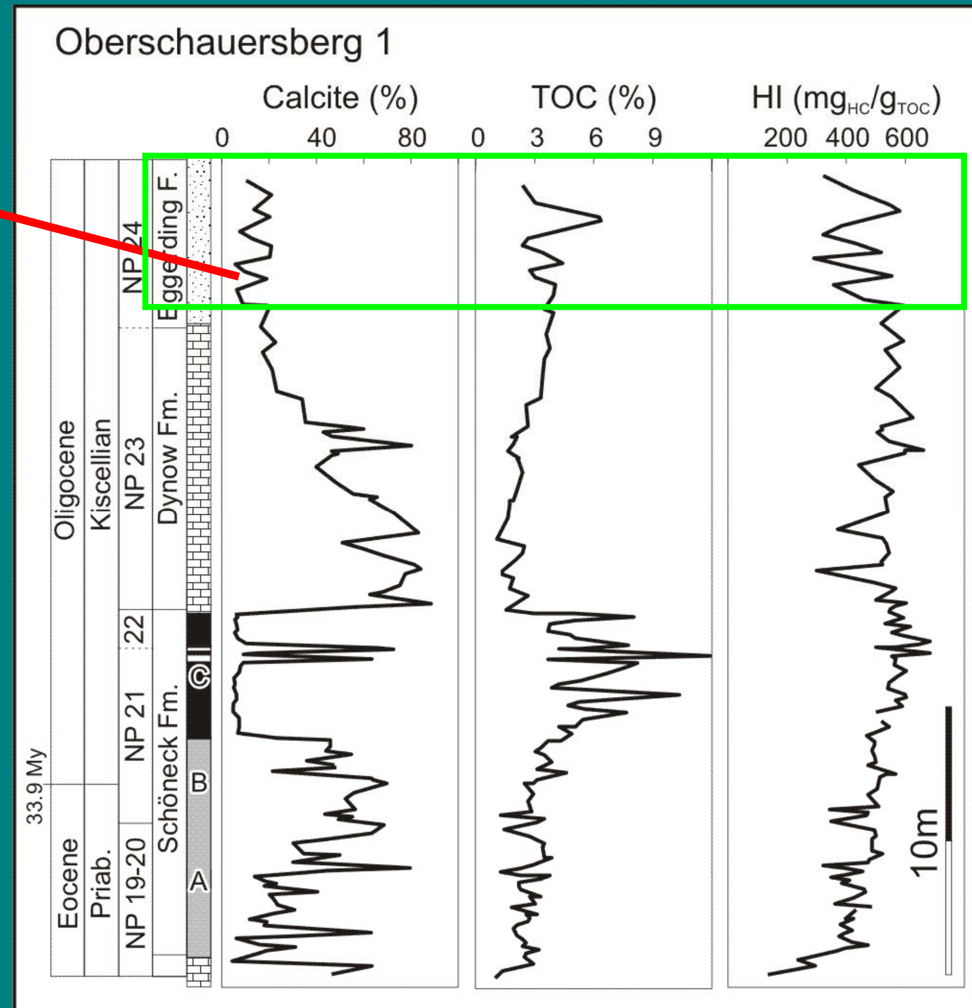




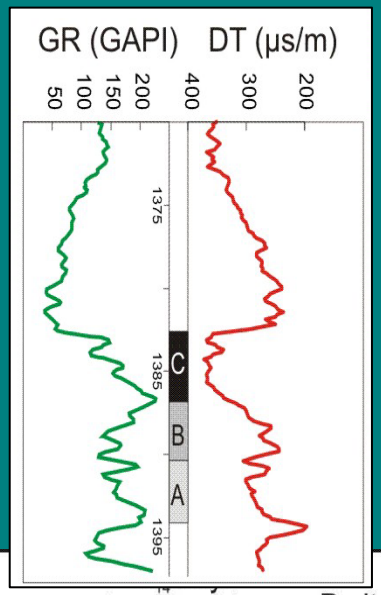


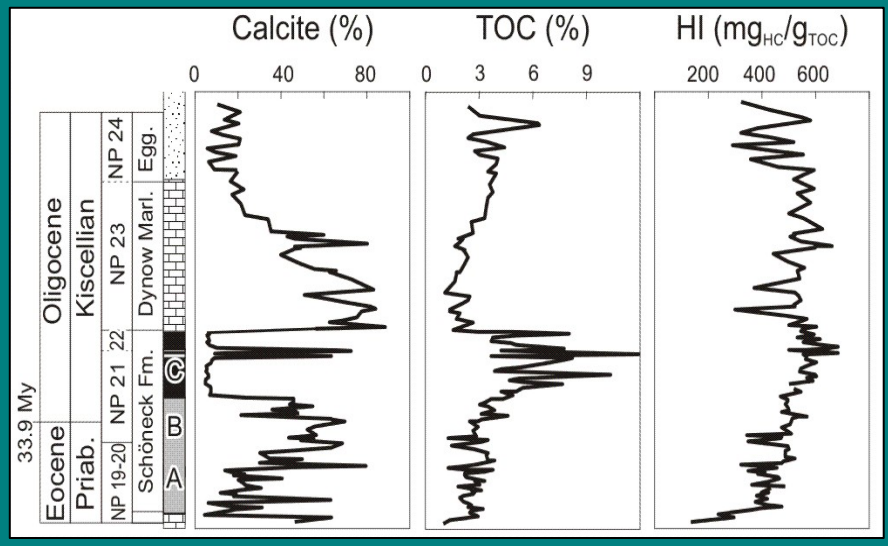
http://visibleearth.nasa.gov/view_rec.php?id=750

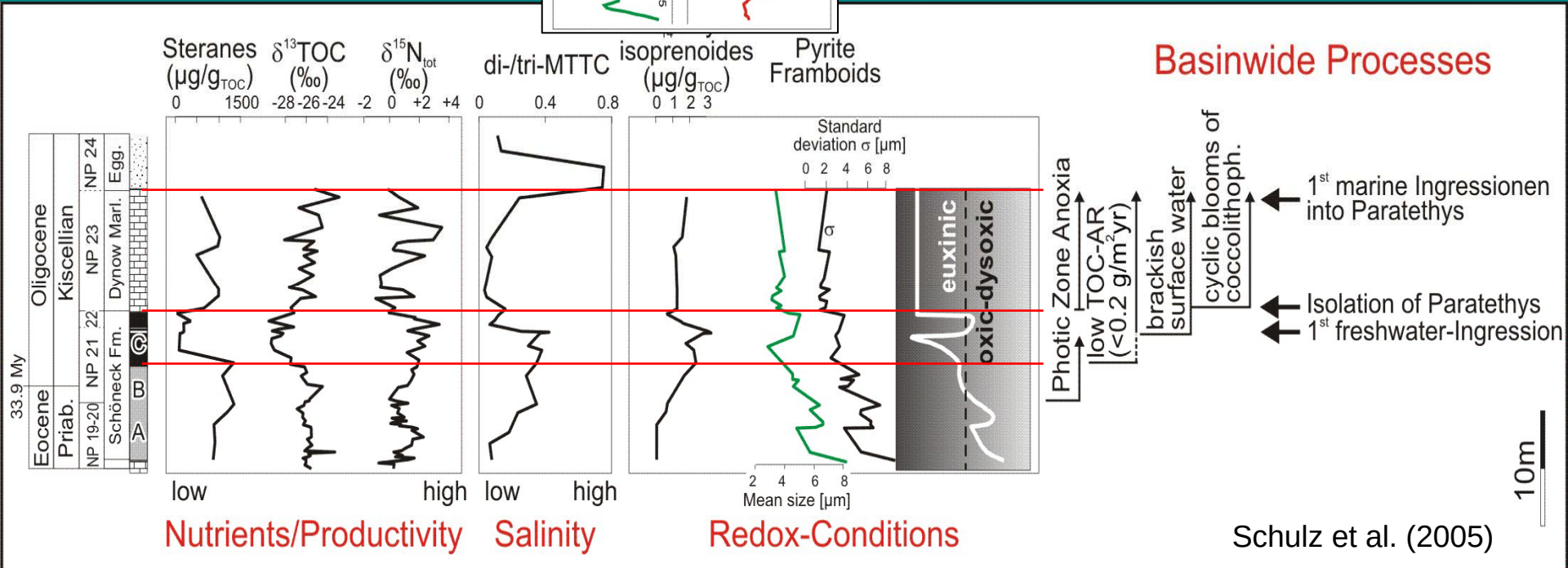



Oberschauersberg 1
Calcite (%)
0 40 80
TOC (%)
0 3 6 9
HI (mgHC/gTOC)
200 400 600
Oligocene
Eocene
Kiscellian
Priab.
33.9 My
NP 24
NP 23
22
NP 21
NP 19-20
Eggerding F.
Dynow Fm.
Schöneck Fm.
C
B
A
10m

Depositional Environment (Biomarker, Isotopy)

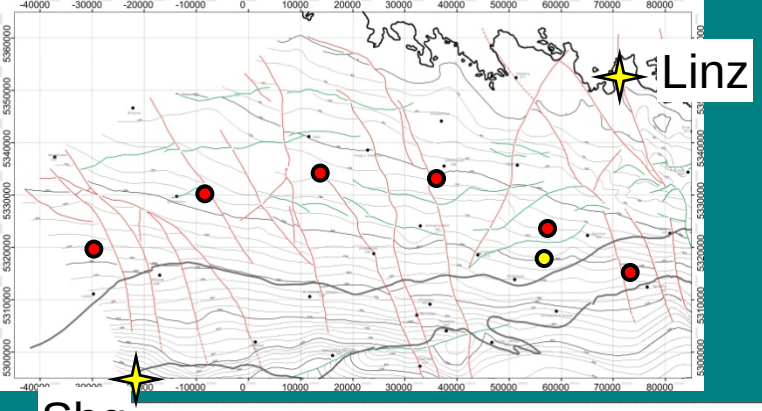


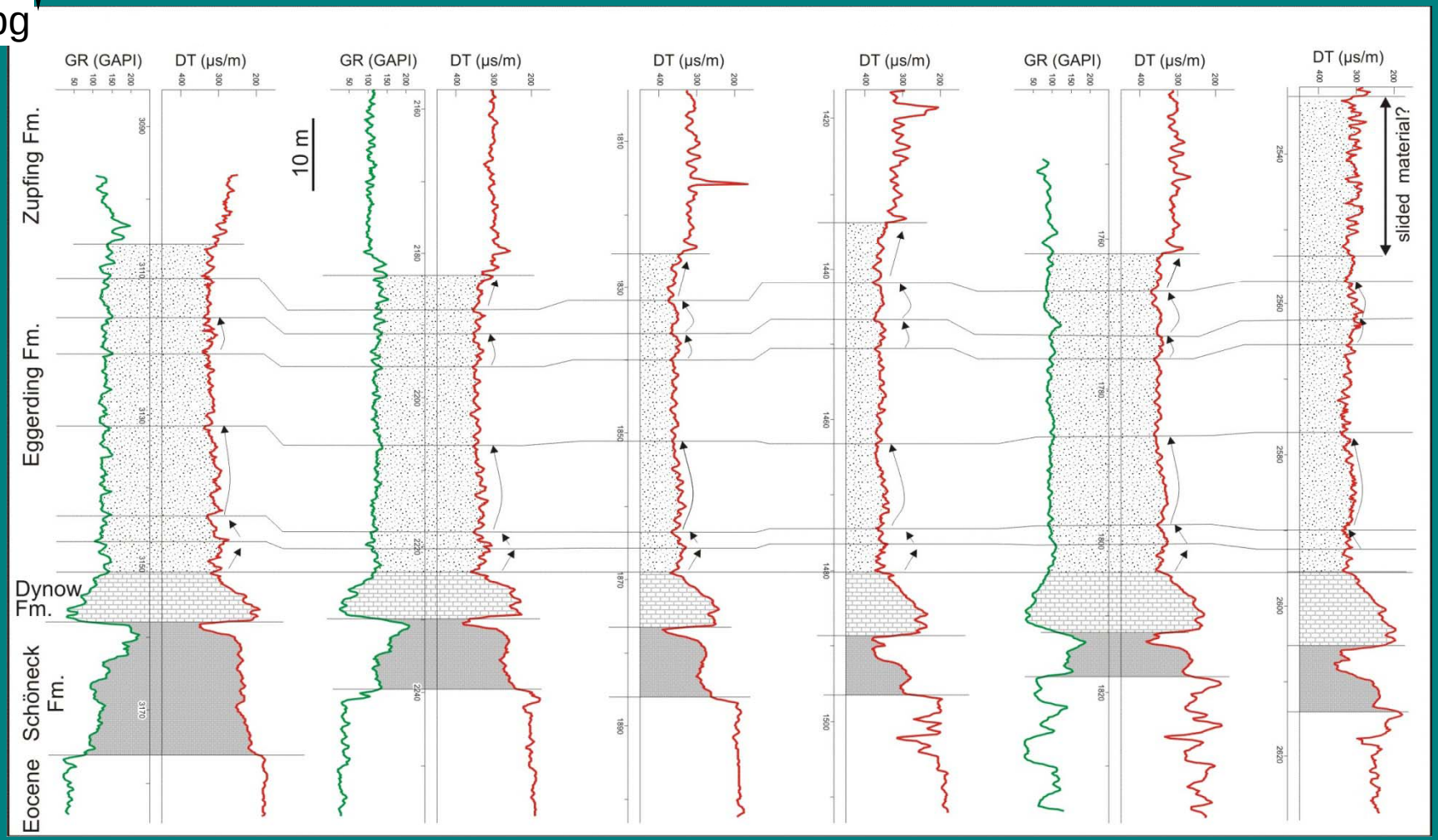




Schulz et al. (2005)

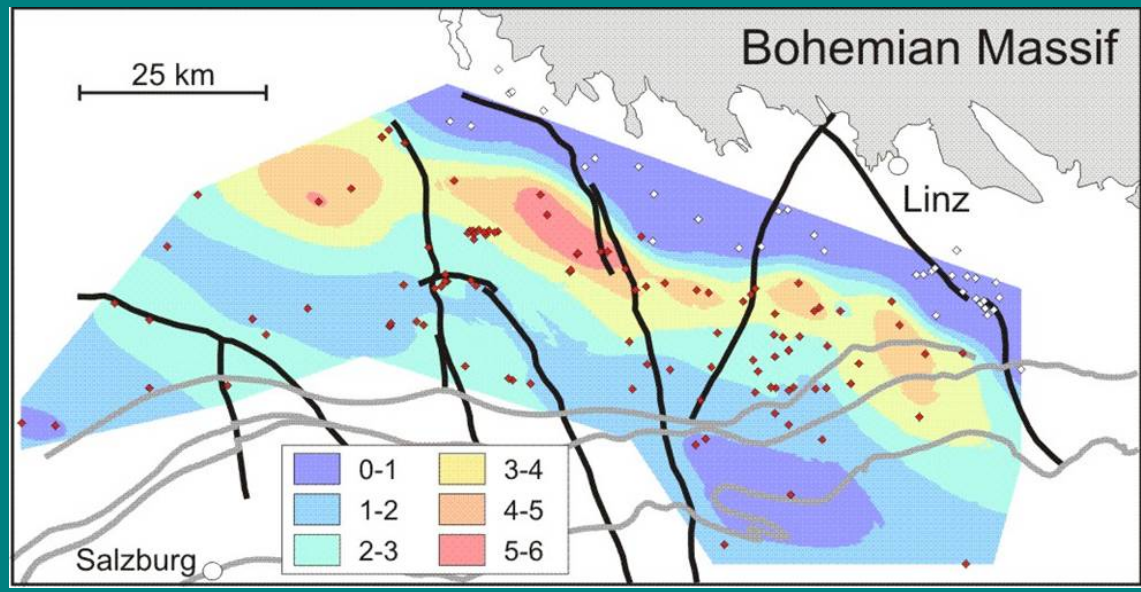
Log facies


Linz
Sbg


GR (GAPI)
DT (µs/m)
10 m
Zupfing Fm.
Eggerding Fm.
Dynow Fm.
Schöneck Fm.
Eocene
slided material?

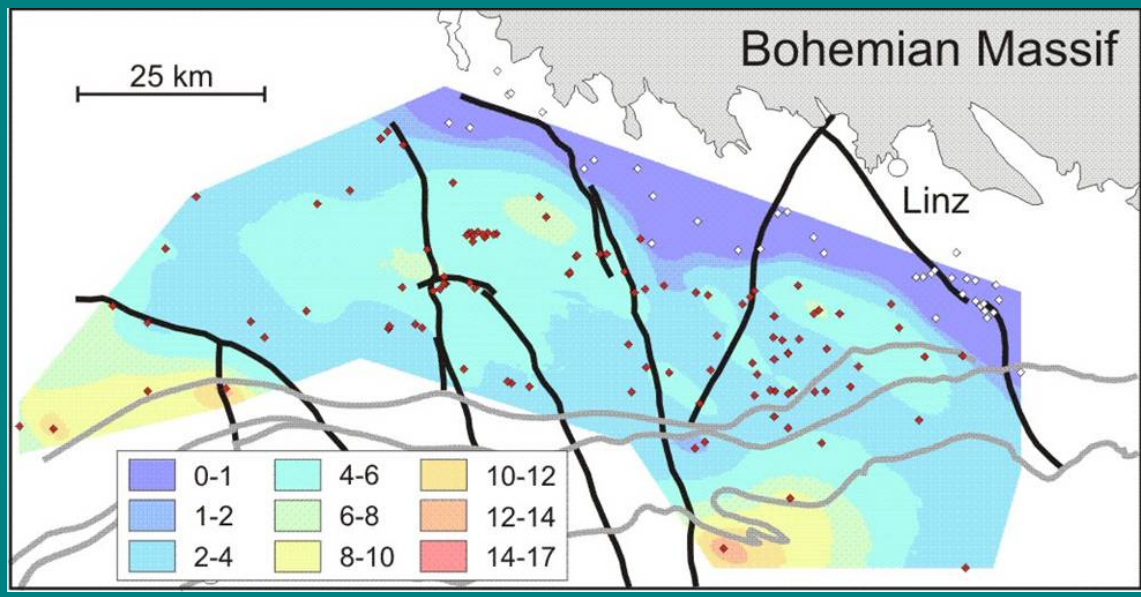
Original thickness
(before submarine erosion)

Schöneck Fm.
(shale Unit „C“)

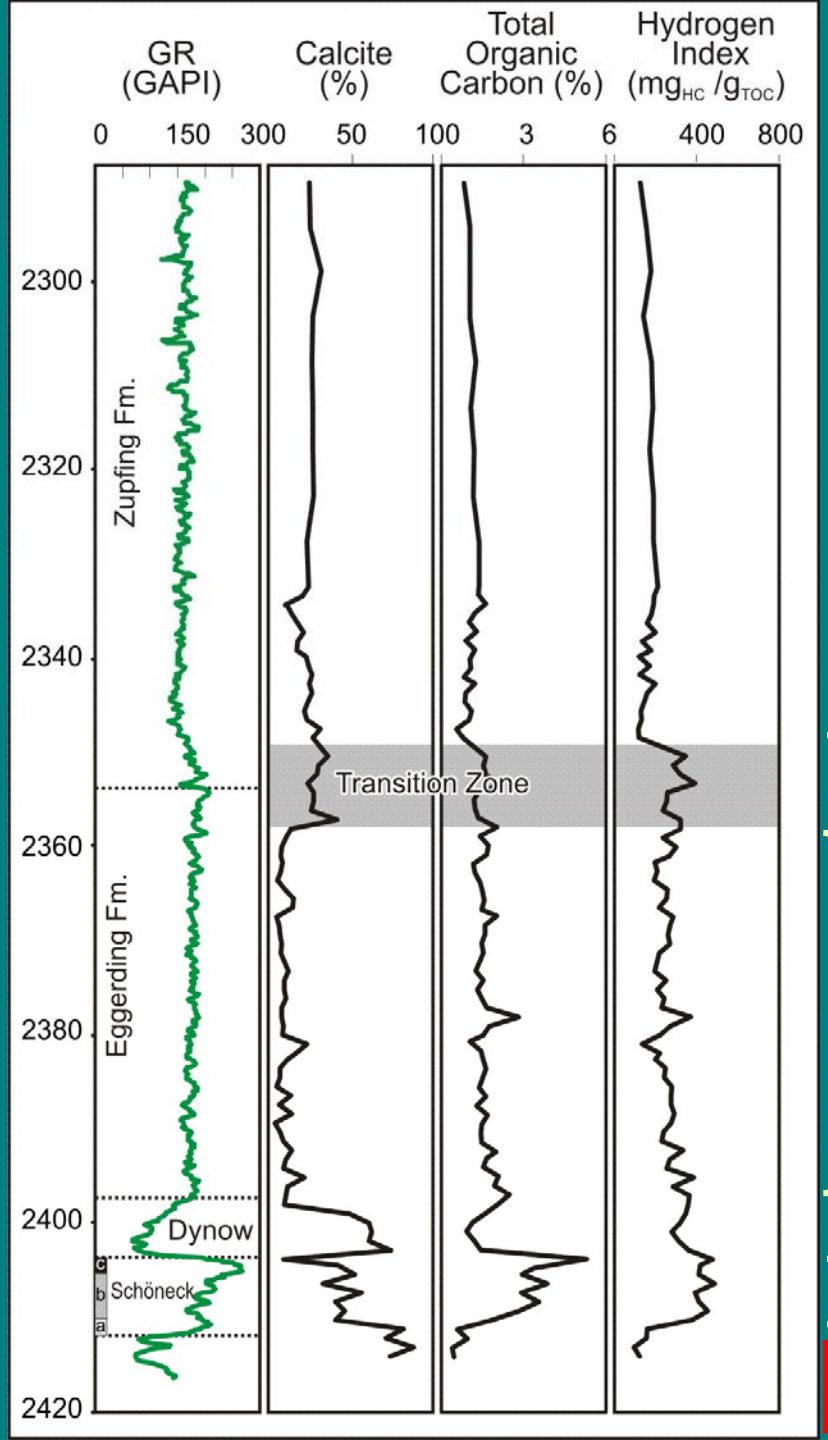


Thickness max. parallel to shoreline

Schöneck Fm.
(marl Unit „B“)



Uniform thickness distribution



HC potential

Quantity of HCs generated within a column of SR beneath 1 m² of surface area

$$SPI = \frac{h\,(S1+S2)\rho}{1000}$$

(t_{HC}/m^2)

0.04

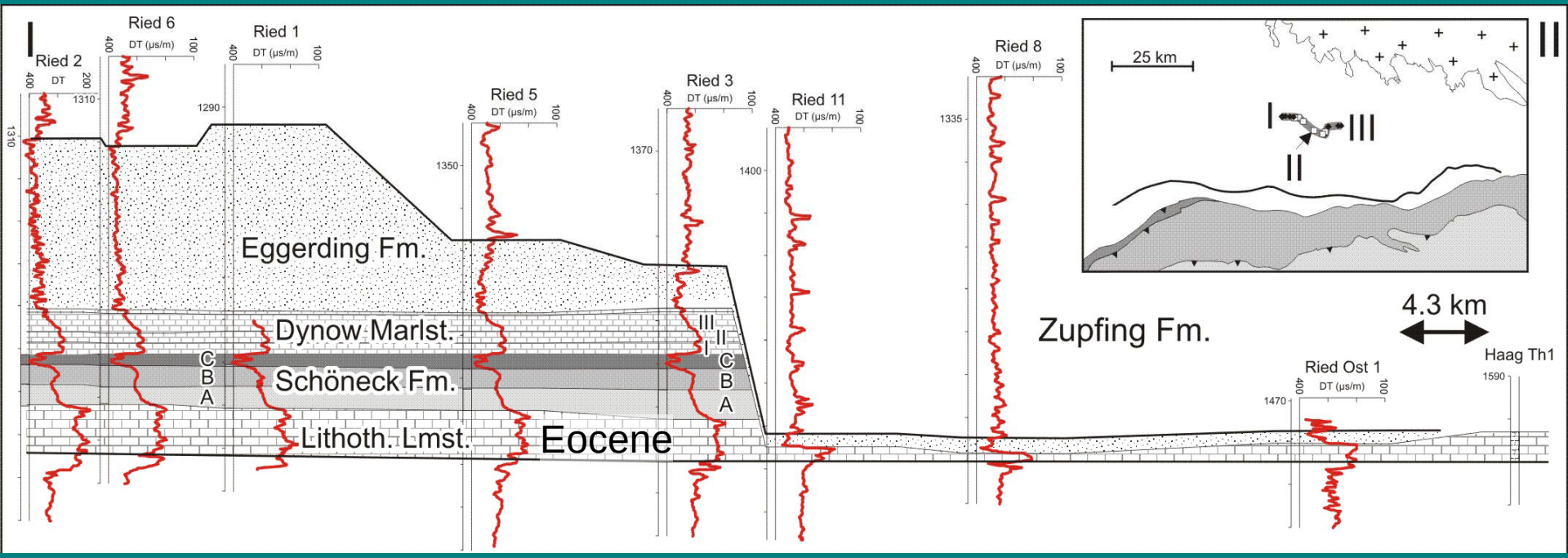
0.54

0.16

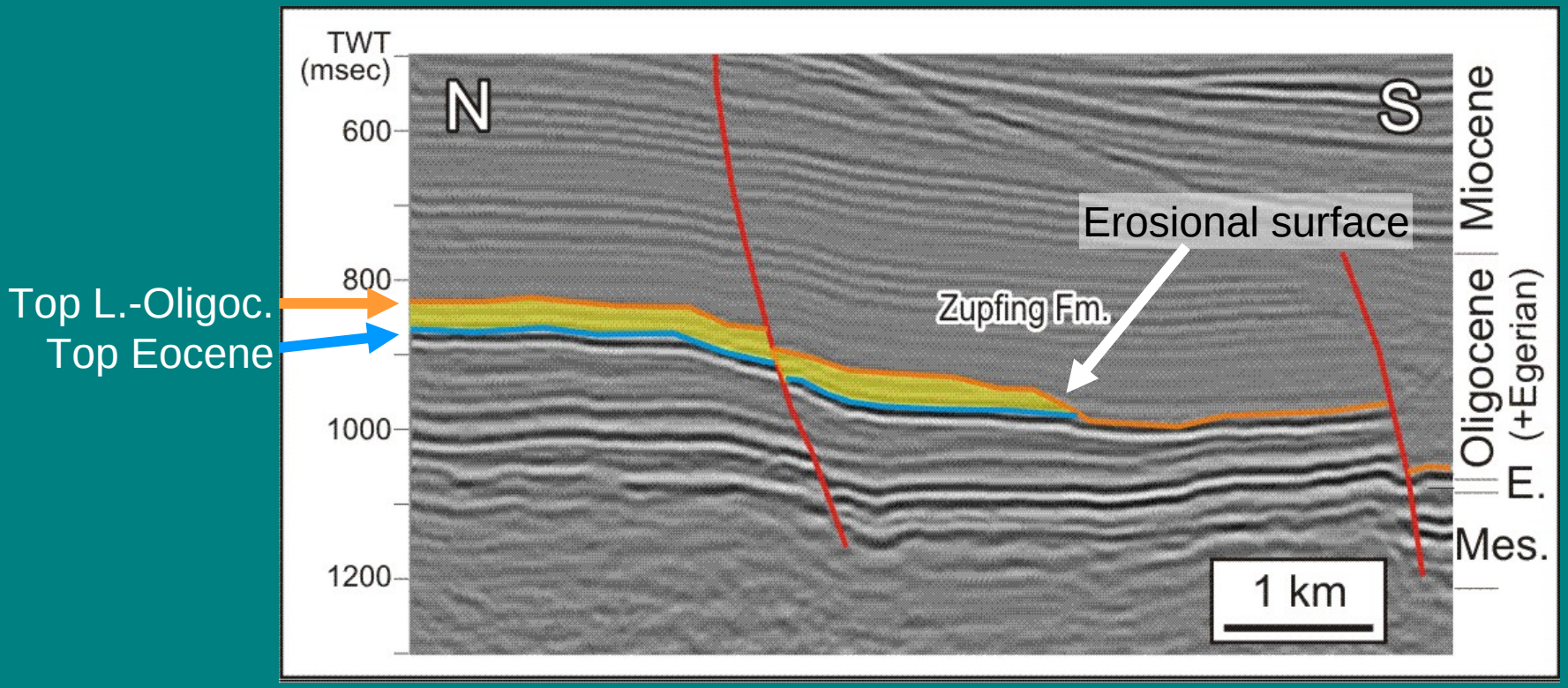
0.37

Σ 1.09

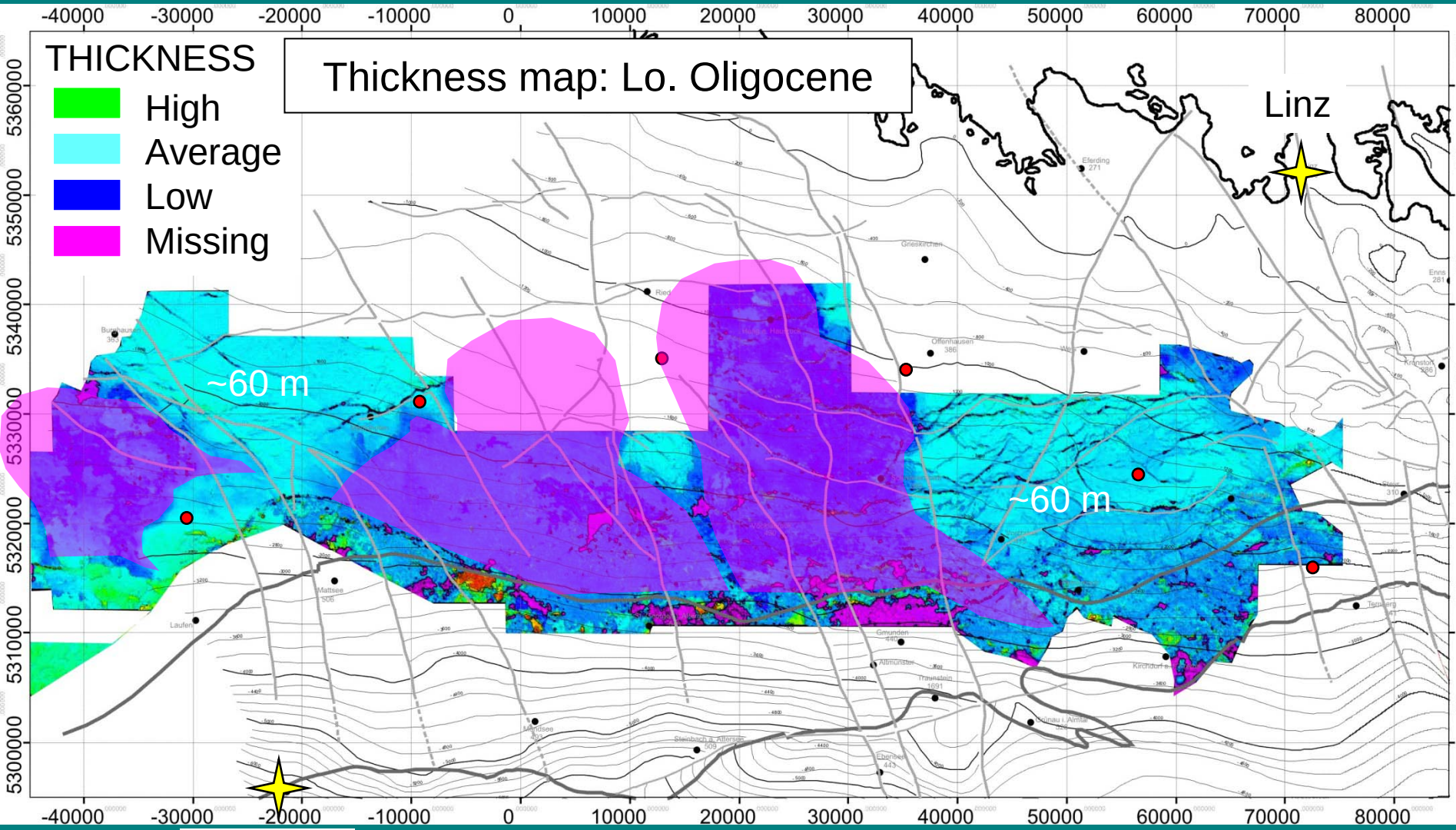
Mass Movements

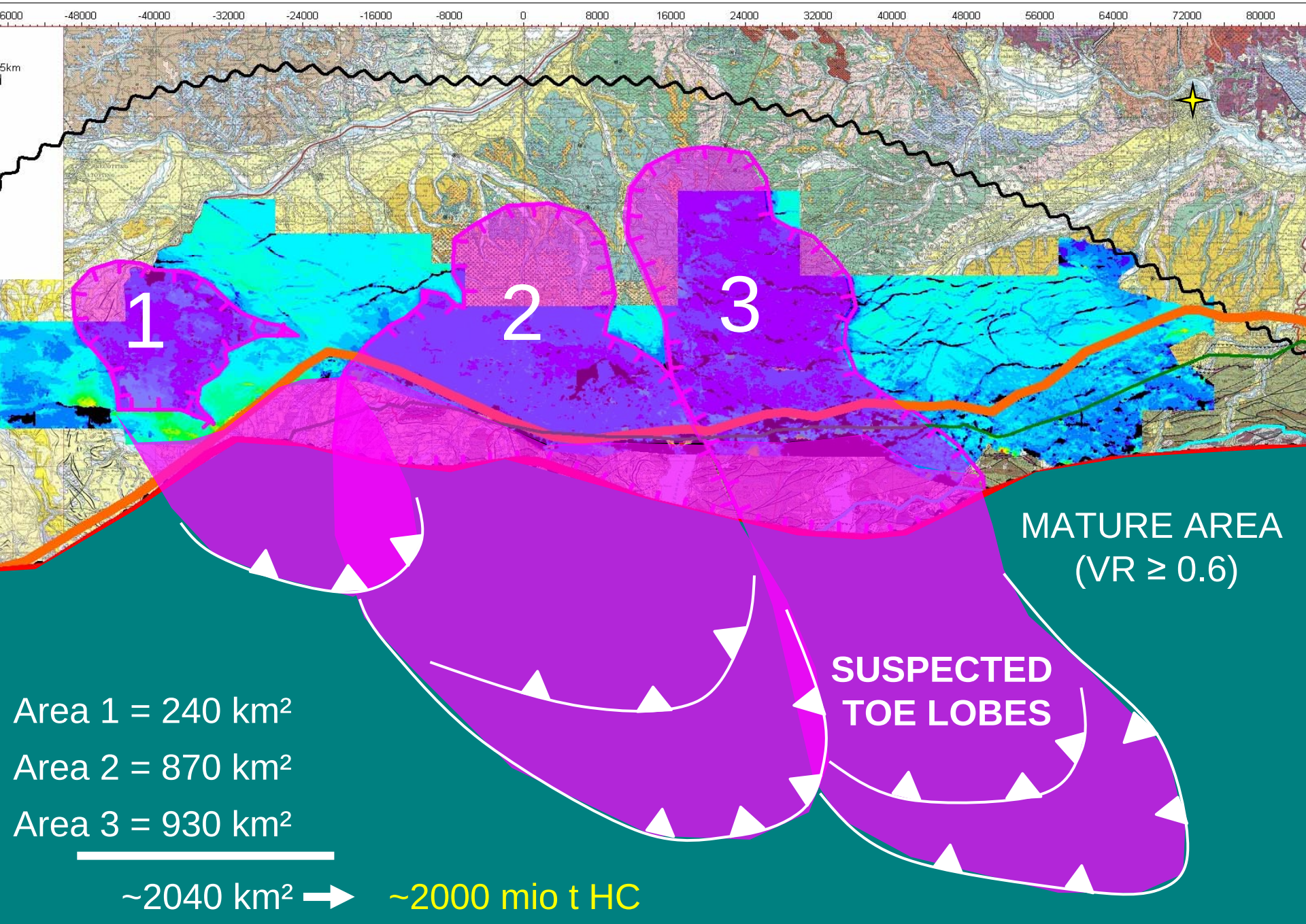


Mass Movements

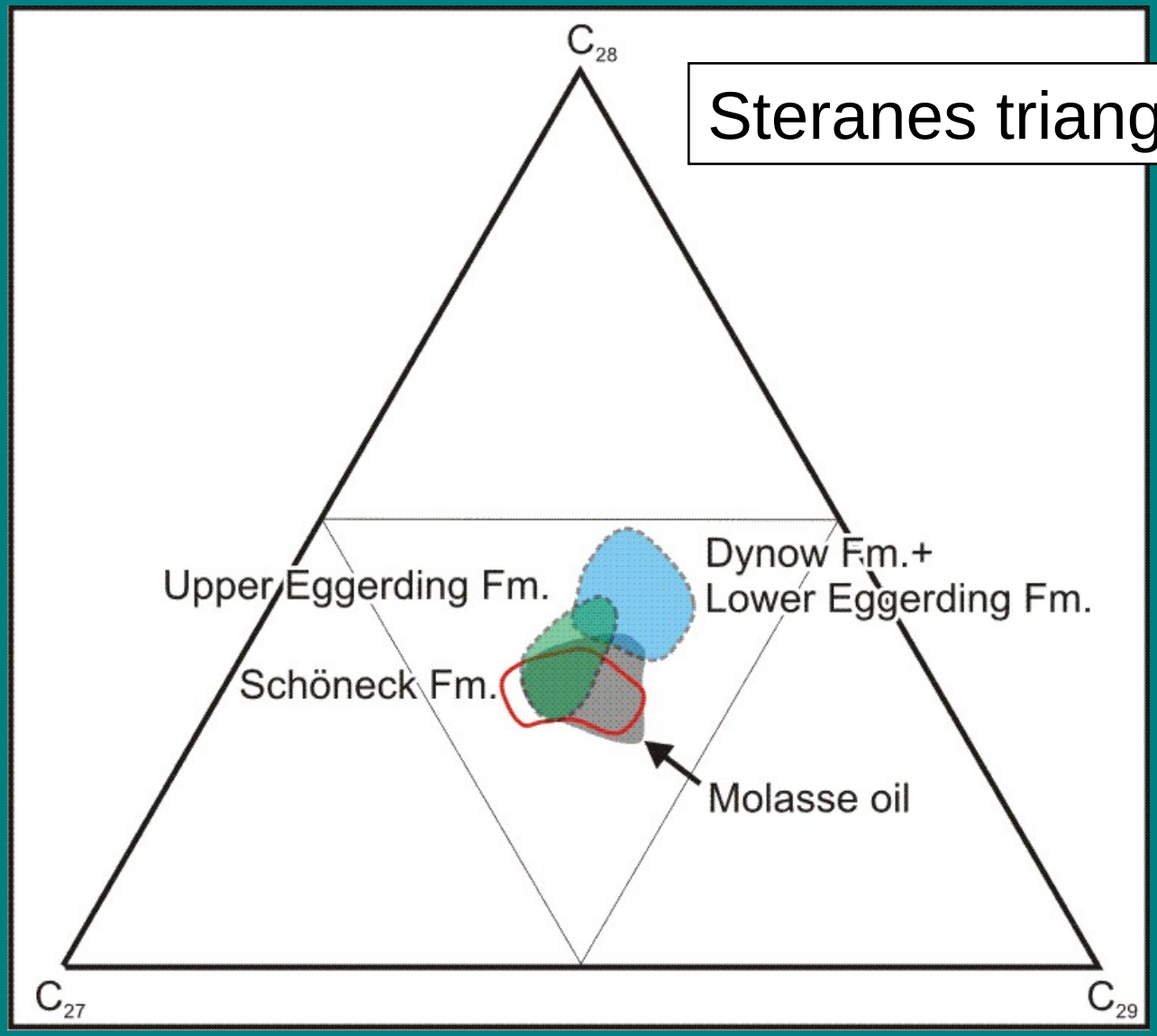


Mass Movements

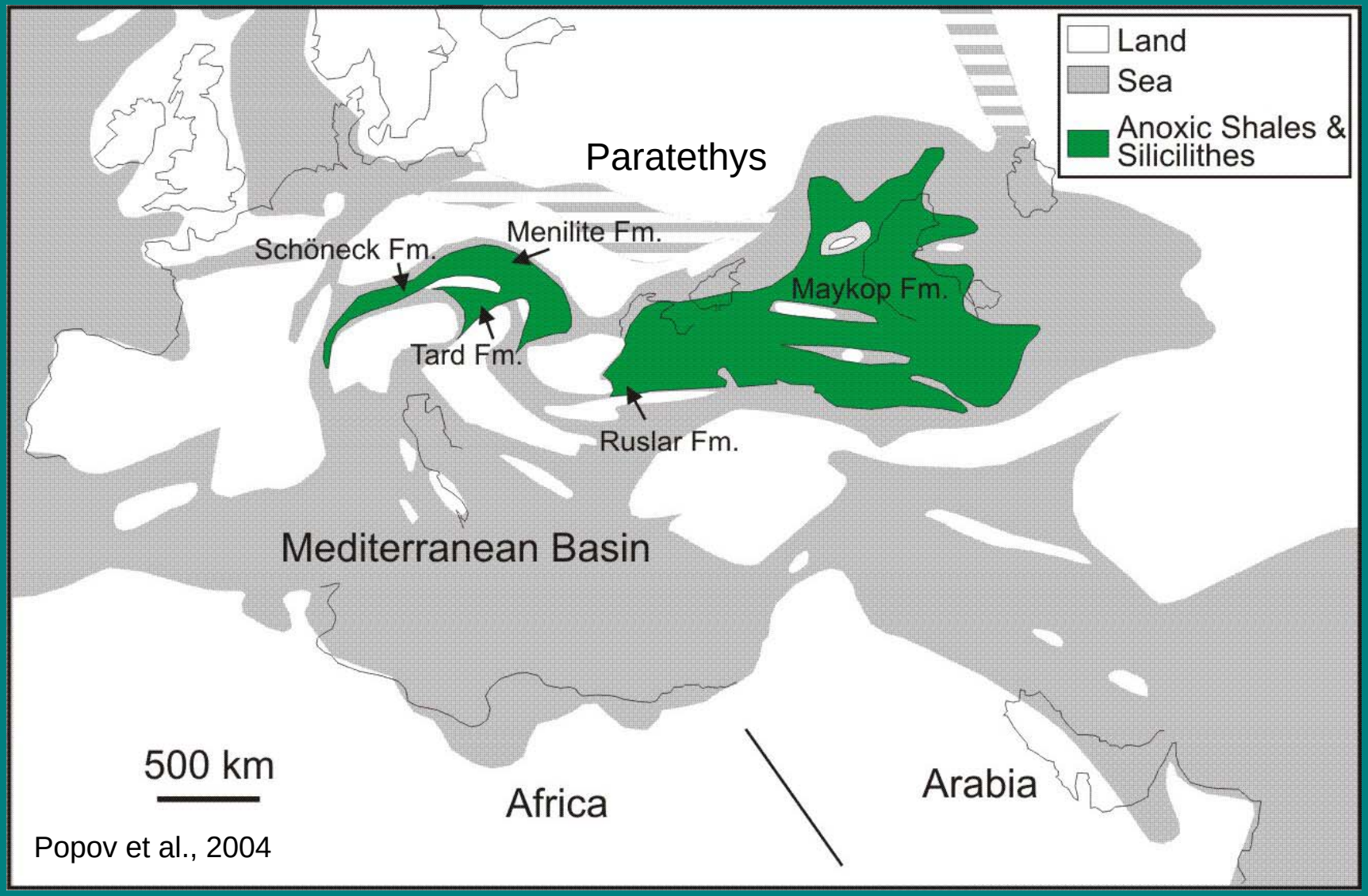



-48000
-40000
-32000
-24000
-16000
-8000
0
8000
16000
24000
32000
40000
48000
56000
64000
72000
80000
1
2
3
MATURE AREA
(VR ≥ 0.6)
SUSPECTED
TOE LOBES
Area 1 = 240 km²
Area 2 = 870 km²
Area 3 = 930 km²
~2040 km² → ~2000 mio t HC

Oil-source correlation

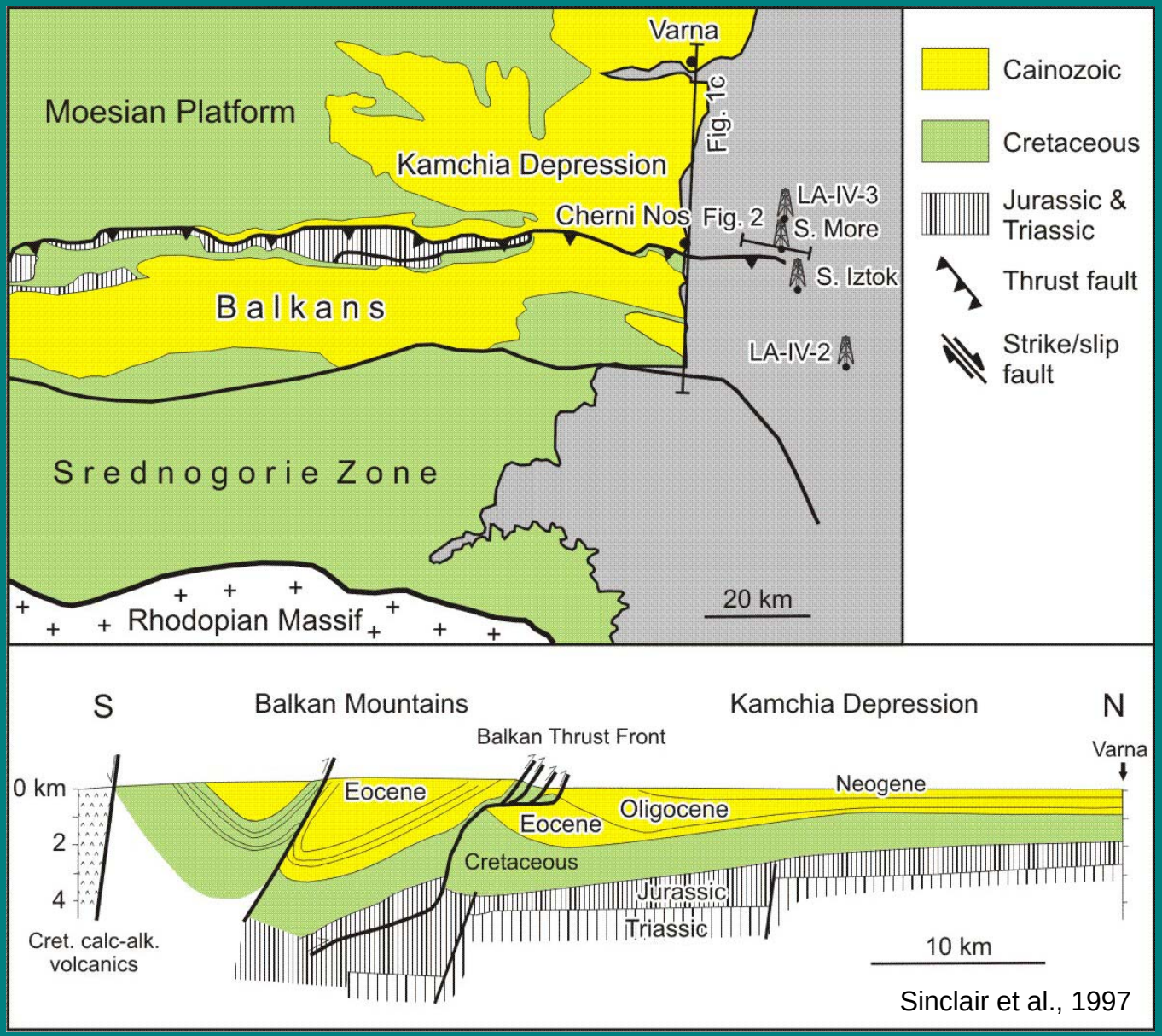


Lower Oligocene Source Rocks



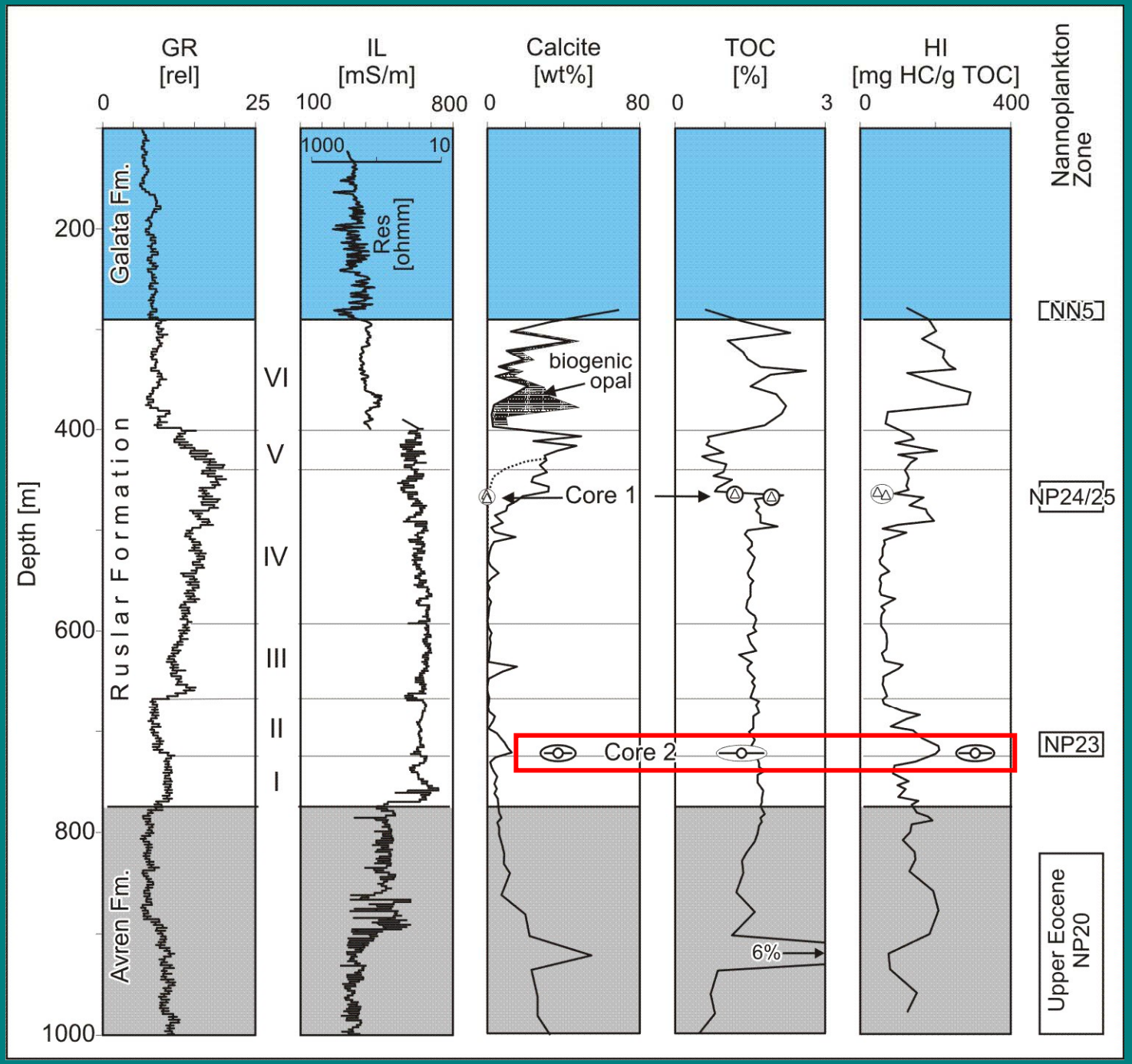
Popov et al., 2004

Ruslar Fm.



Sinclair et al., 1997

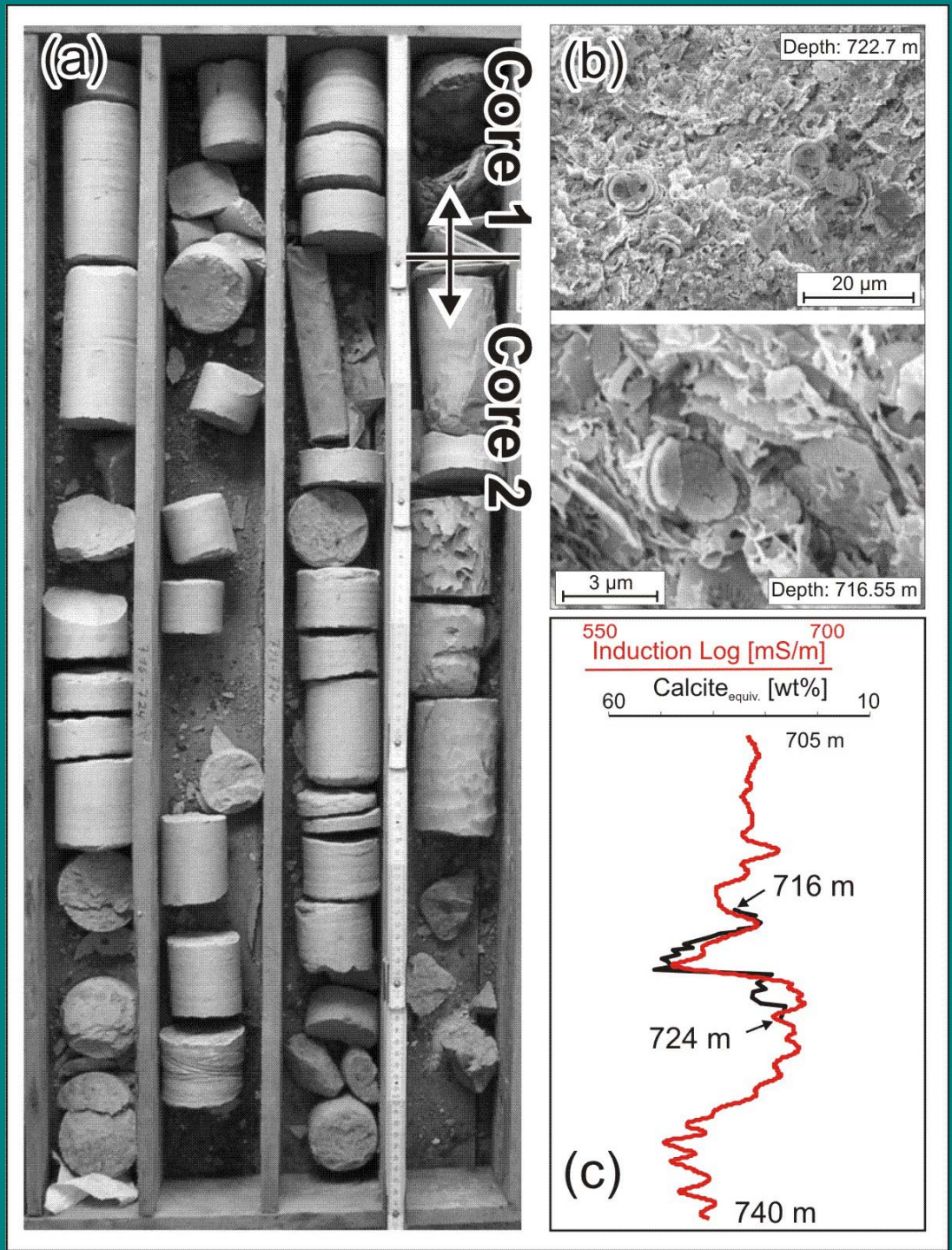
Ruslar Fm.



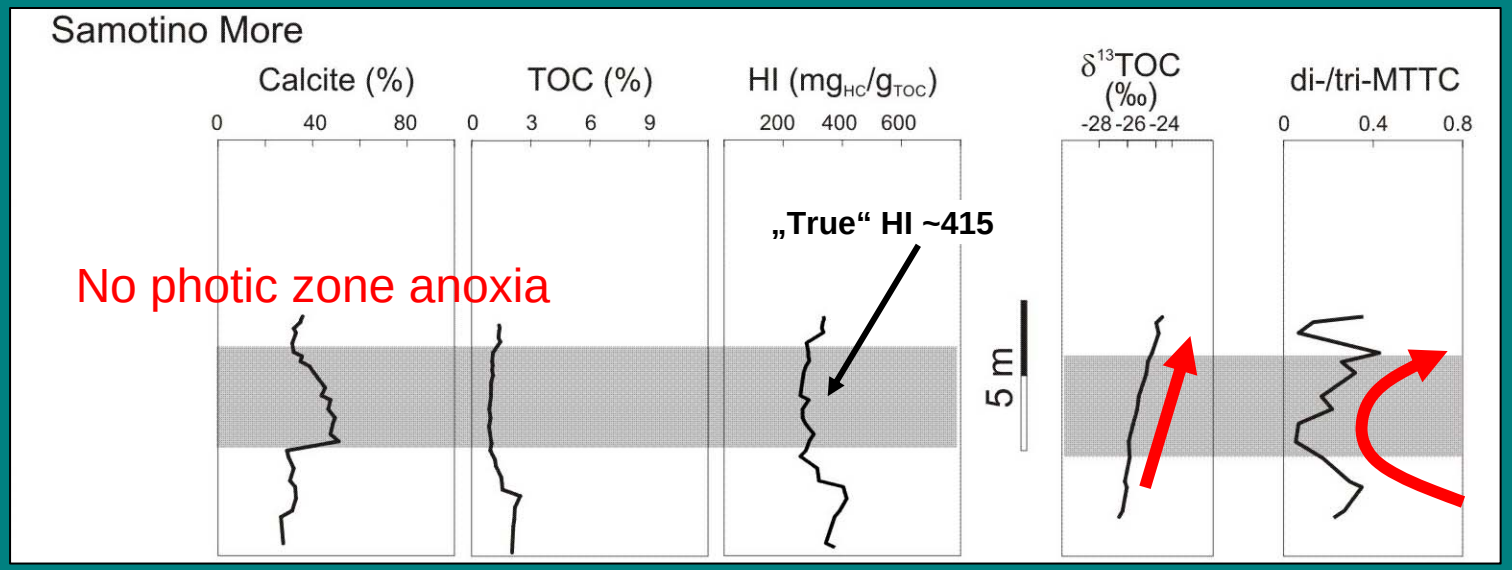
Lower Oligocene

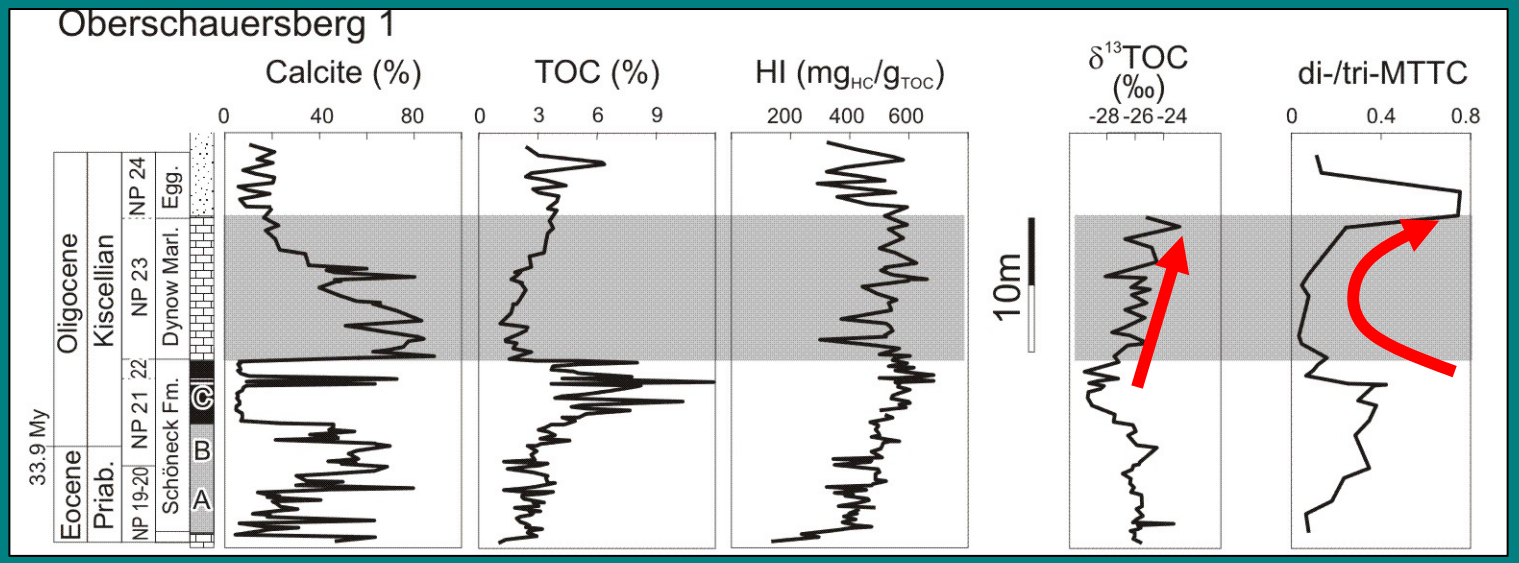
Sachsenhofer et al., 2009

Solenovian Event (Equ. Dynow Fm.?)

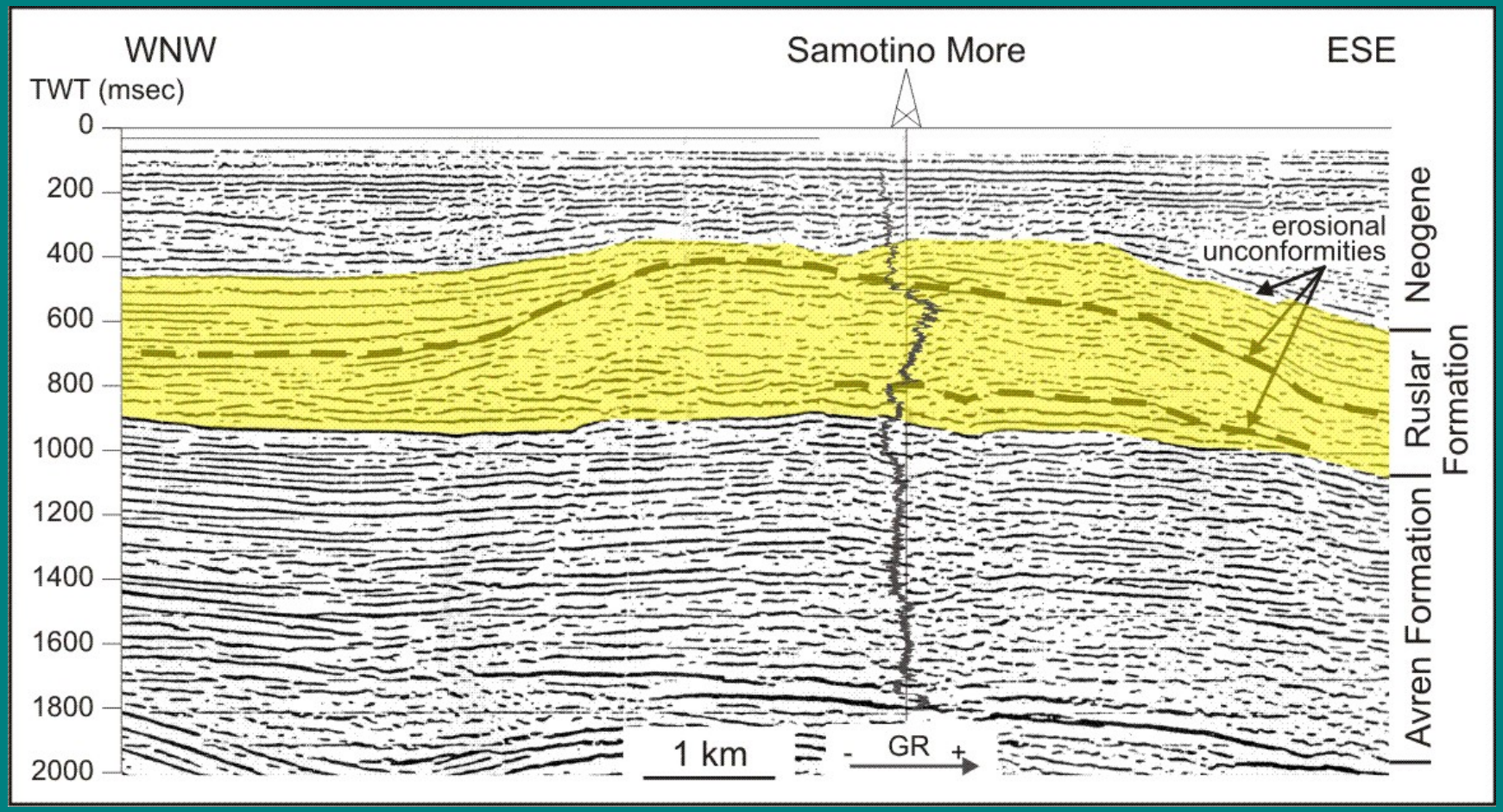


Solenovian Event: Comparison





Ruslar Fm.: Submarine(?) Erosion



Conclusions

- The original SR facies in the AFB is lateral uniform
- Later variability of source potential is due to submarine mass movements
- Strong vertical variability of source potential is controlled by basinwide processes (changes in salinity, nutrients,..)

- High resolution studies (incl. biomarker) of Lower Oligocene deposits in different parts of the Central and Eastern Paratethys will yield interesting results concerning both, paleogeography and source potential