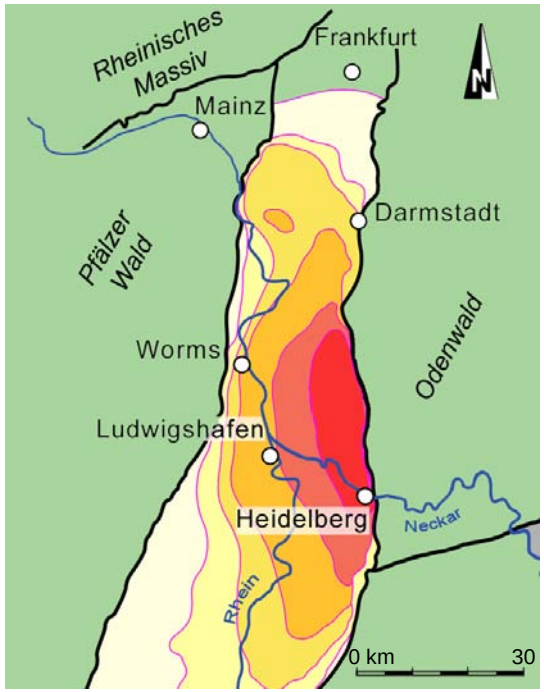
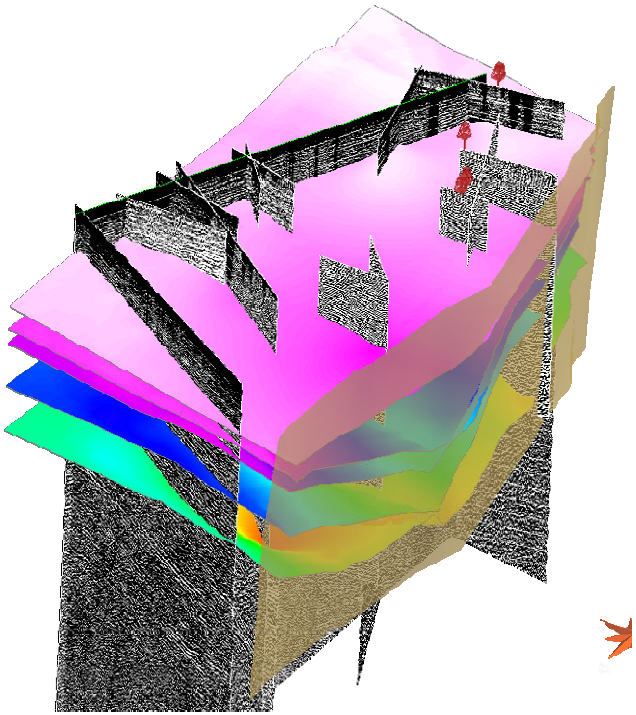
Three-dimensional basin analysis of the Heidelberg Basin, Upper Rhine Graben





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Leibniz Institute for Applied Geophysics

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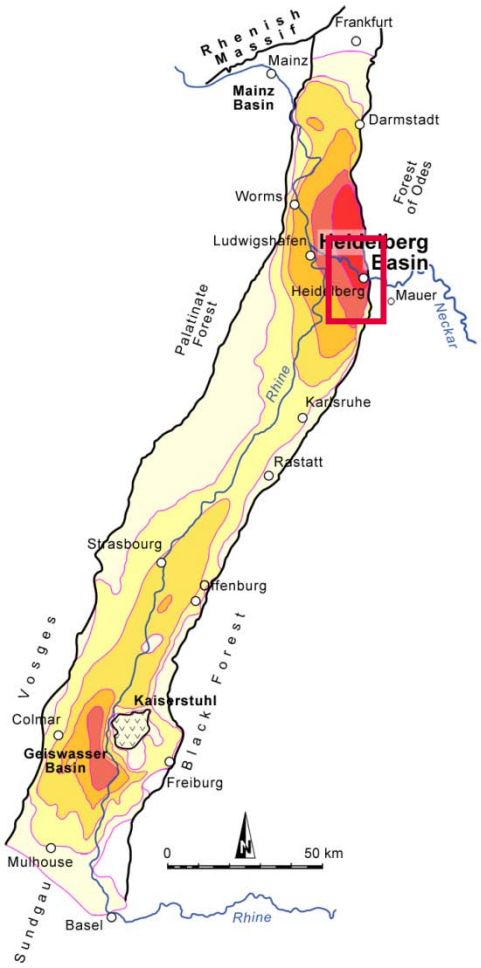
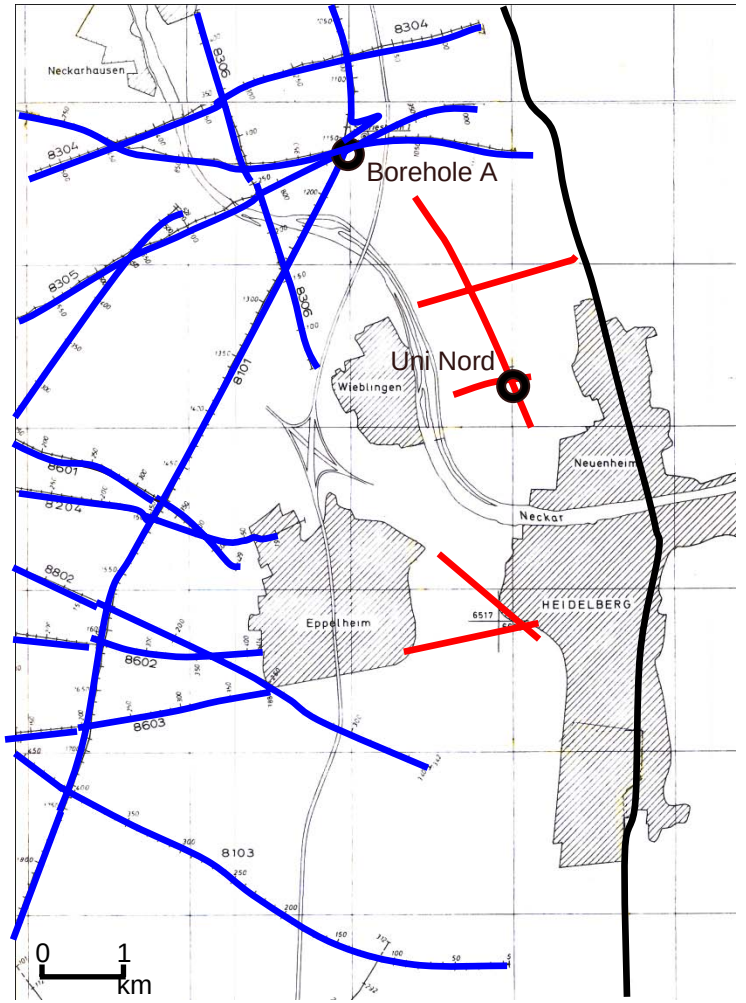
Contents

- Location
- New and old reflection seismics of the Heidelberg Basin
- Stratigraphy
- 3D Geometrical Model (GoCAD)
- Decompaction and Subsidence Analysis (3Dmove)
- Conclusions

Location / Database



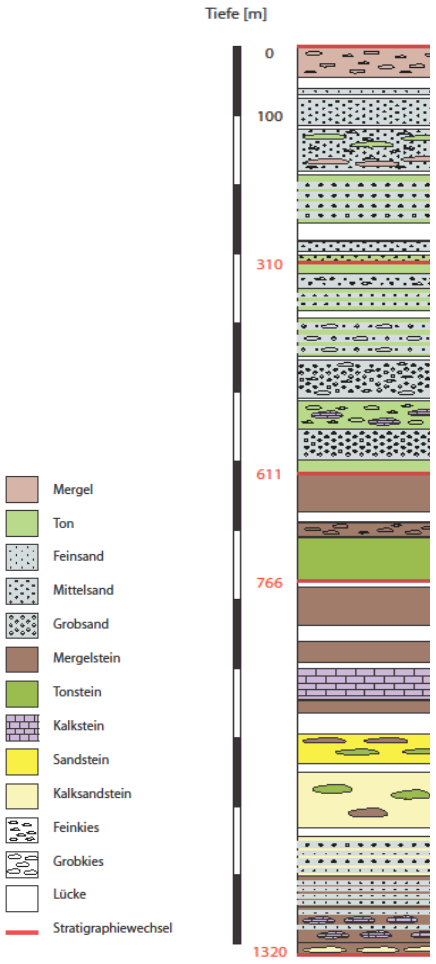


Quarternary thickness in the URG after Bartz 1974

Location of reflection seismics in the Heidelberg Basin

Stratigraphy

Borehole A



Base Quaternary

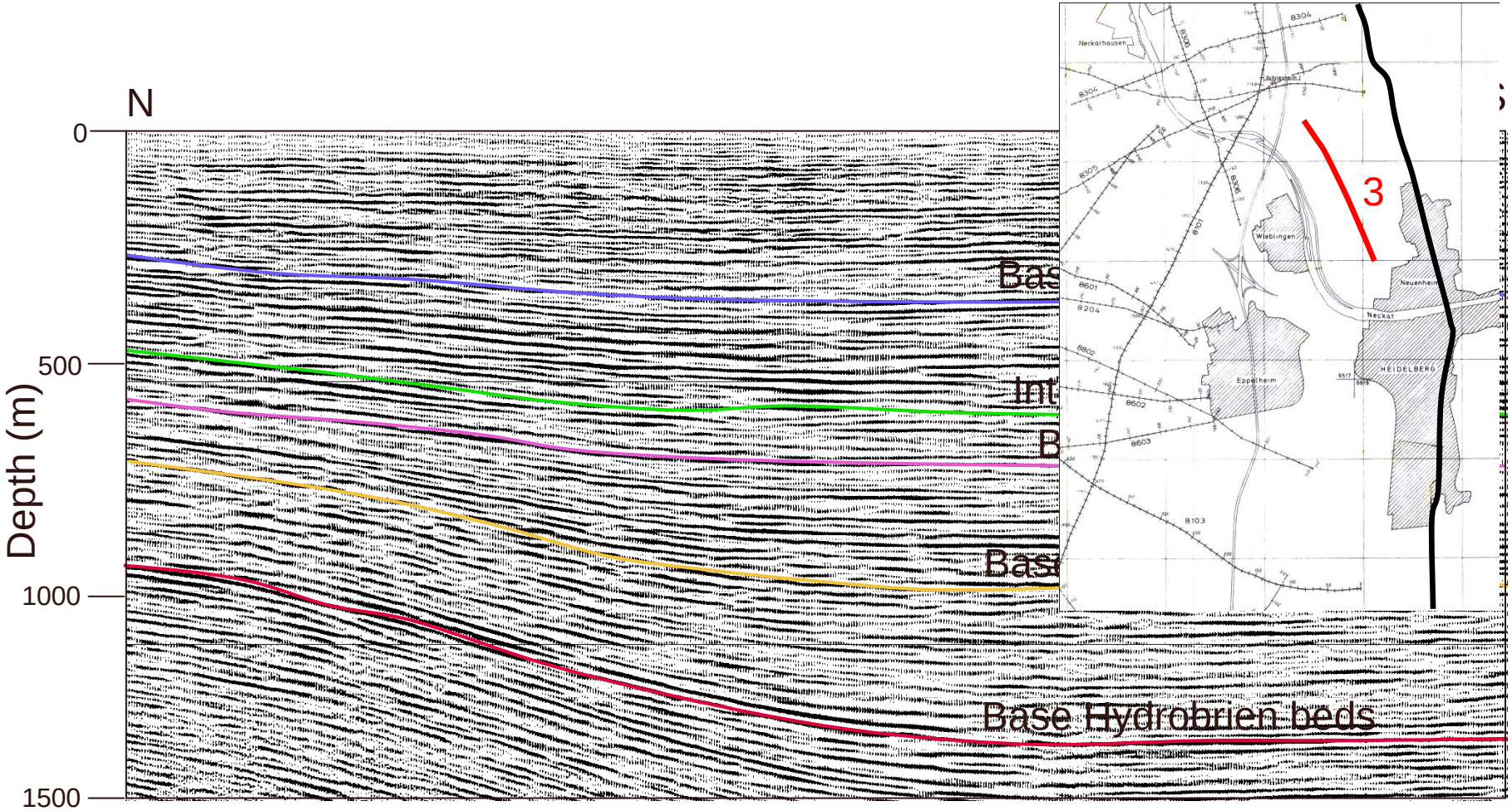
Internal Pliocene

Base Pliocene

Base Upper Miocene

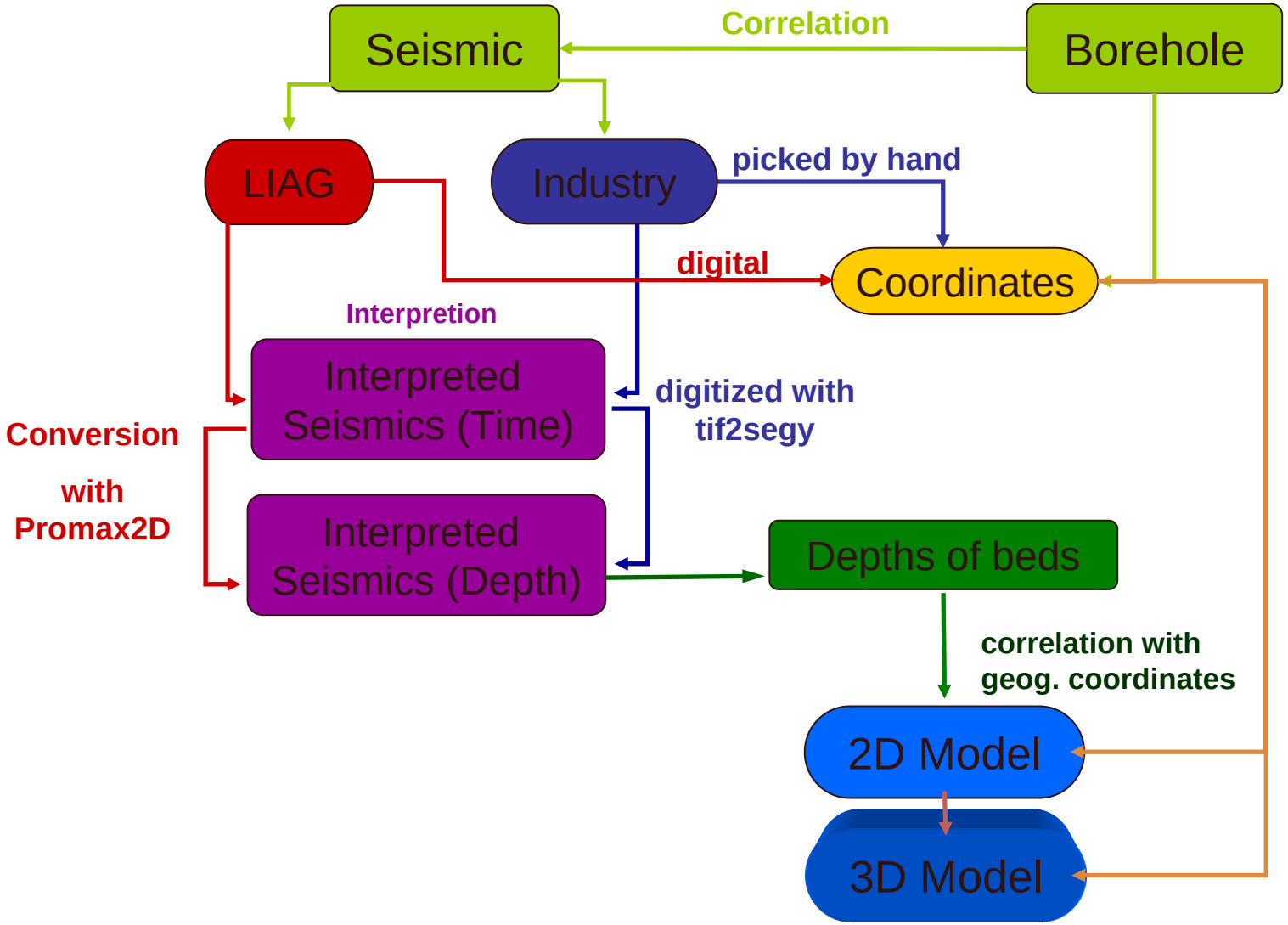
Base Hydrobien beds (Lower Miocene)

Reflection Seismics

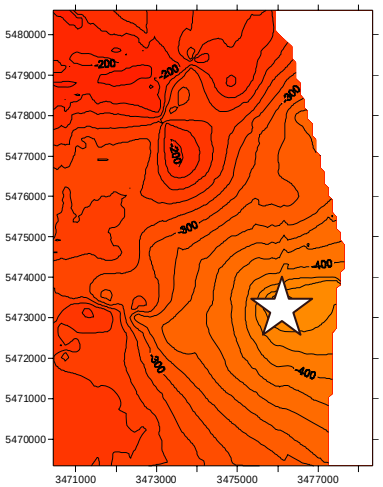


LIAG P-wave profile 3, Heidelberg, Depth section (Buness et al., 2008)

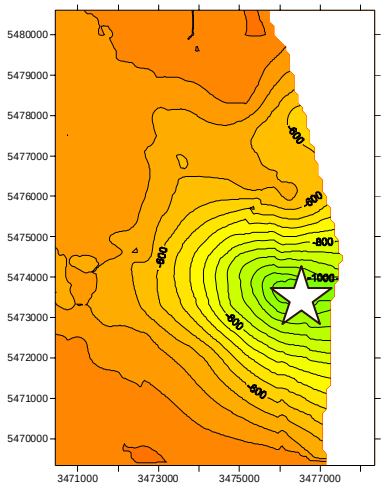
Method


Seismic
Correlation
Borehole
LIAG
Industry
picked by hand
digital
Coordinates
Interpretion
Interpreted Seismics (Time)
digitized with tif2segy
Conversion with Promax2D
Interpreted Seismics (Depth)
Depths of beds
correlation with geog. coordinates
2D Model
3D Model

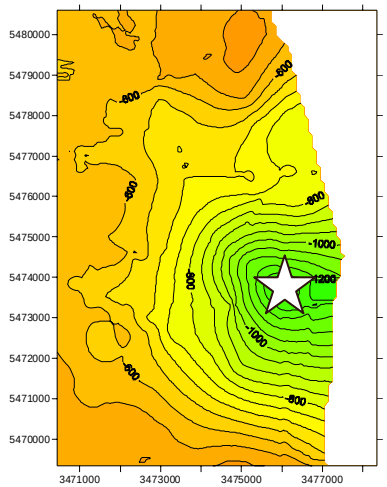
Depth surfaces - Depocentre



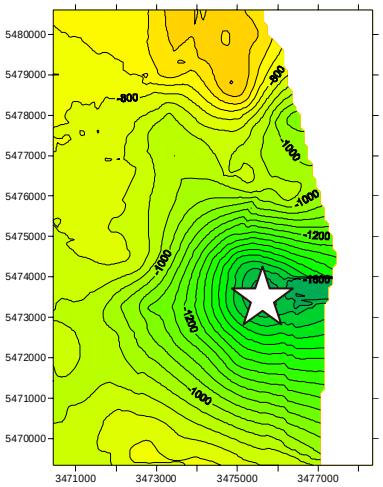
Base Quaternary



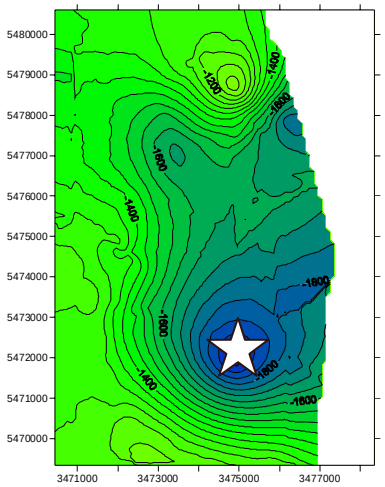
Internal Pliocene



Base Pliocene

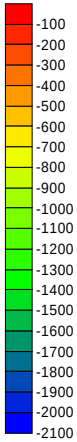


Base Upper Miocene



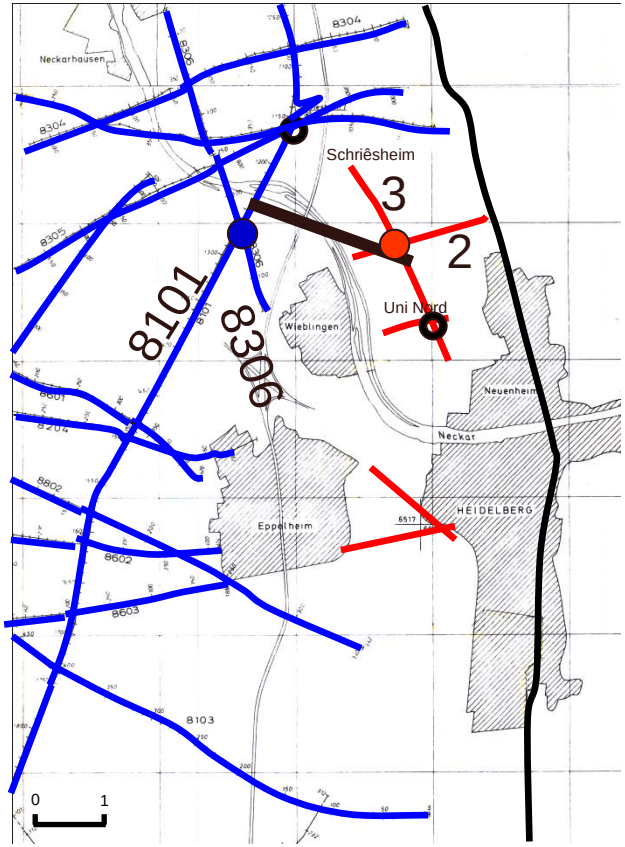
Base Hydrobien beds

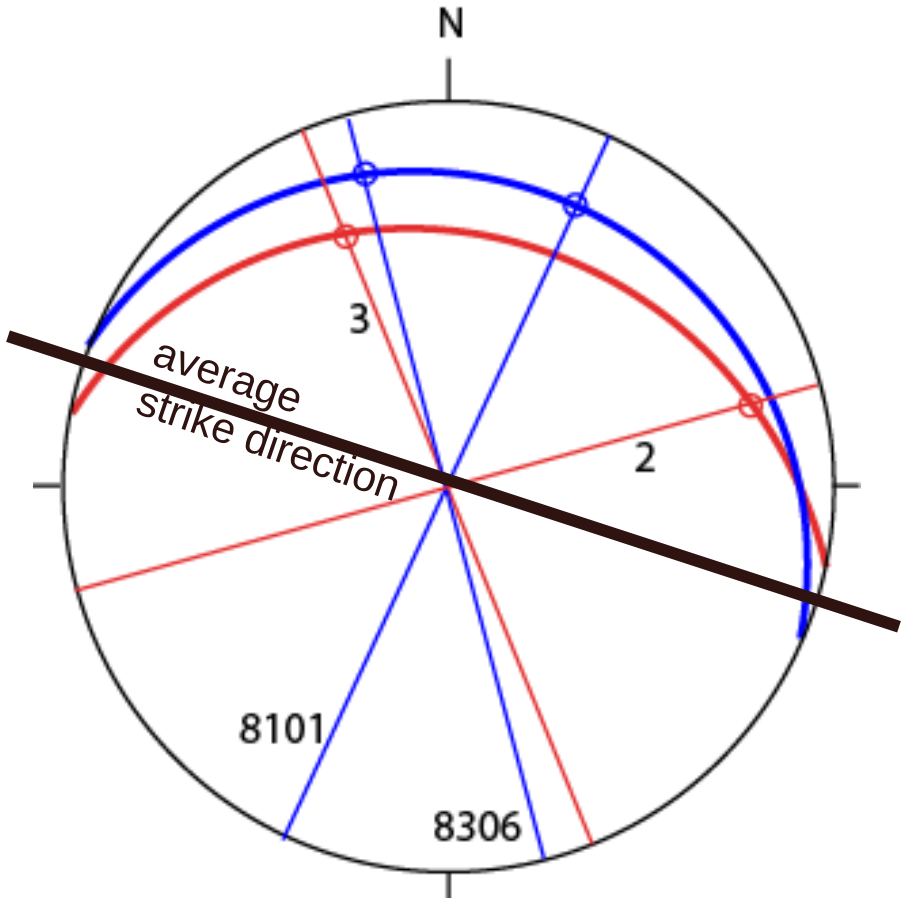
Depth (m)



Method of Correlating Seismics

- **Problem:** No connection between LIAG (red) and industry (blue) seismic lines
- **Solution:** Strike projection

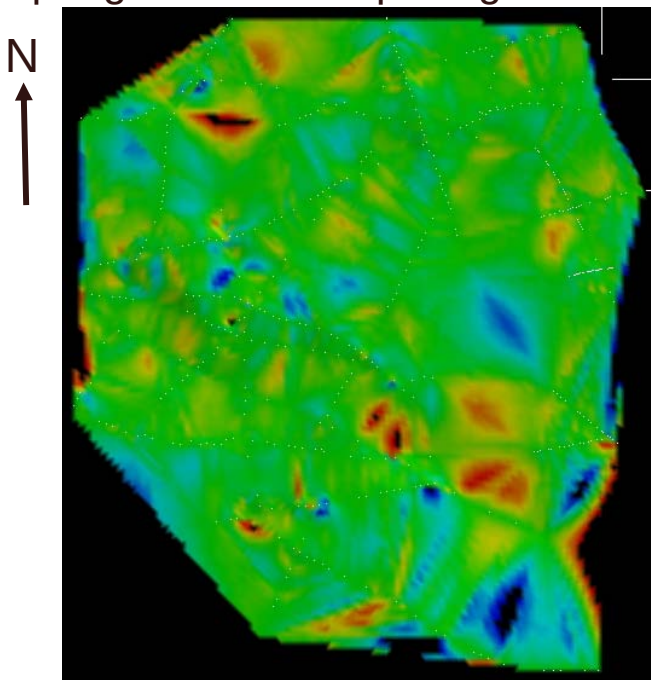


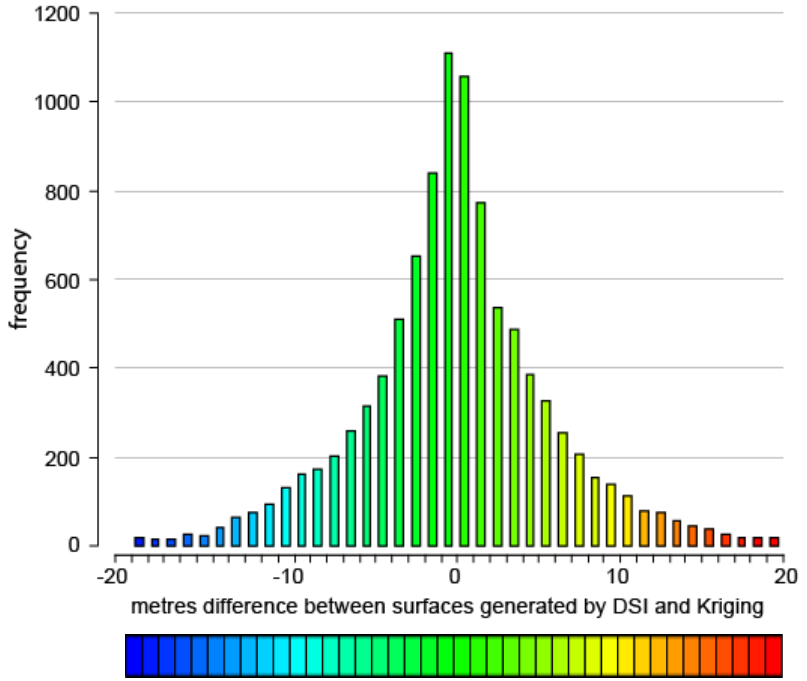


Stereographic projection

Method of Gridding Surfaces

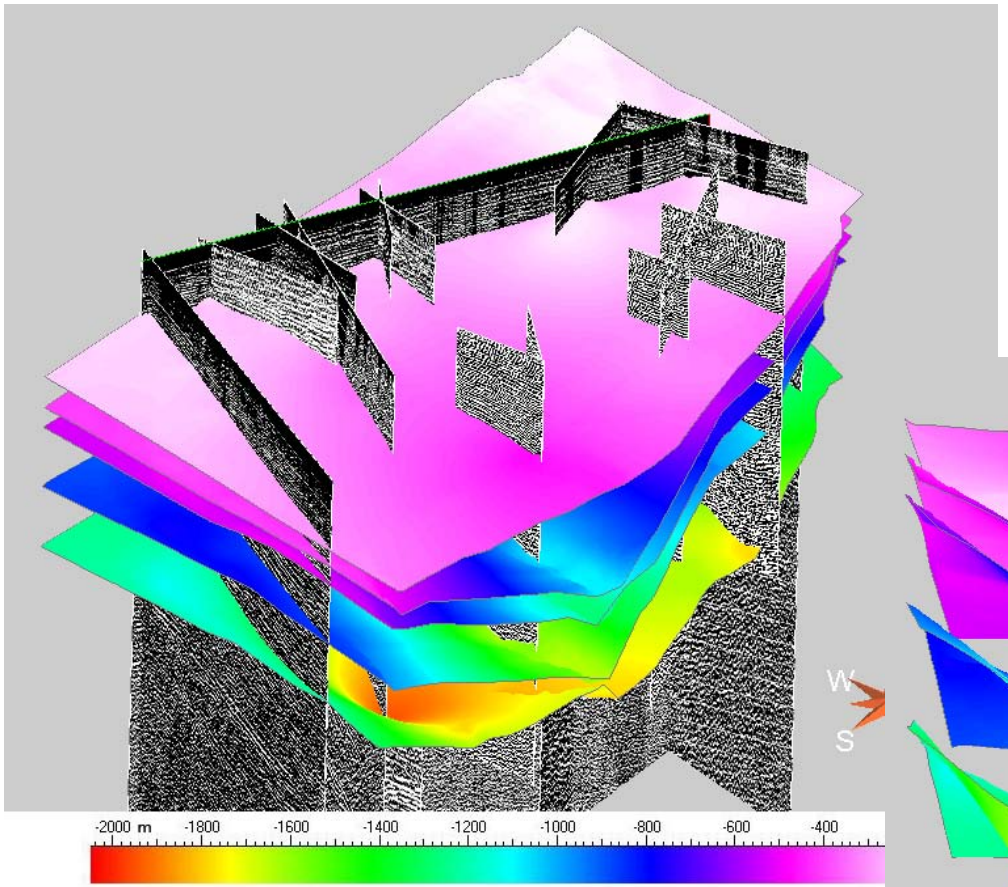
- Original data
  - Seismic interpretation @ every 10th CMP
  - ca. 900 points per surface
- Data were gridded using *Discrete Point Interpolation* (GOCAD) and the *Point Kriging* algorithm (Surfer)
  - Output grid with X Y spacing of 100 m.



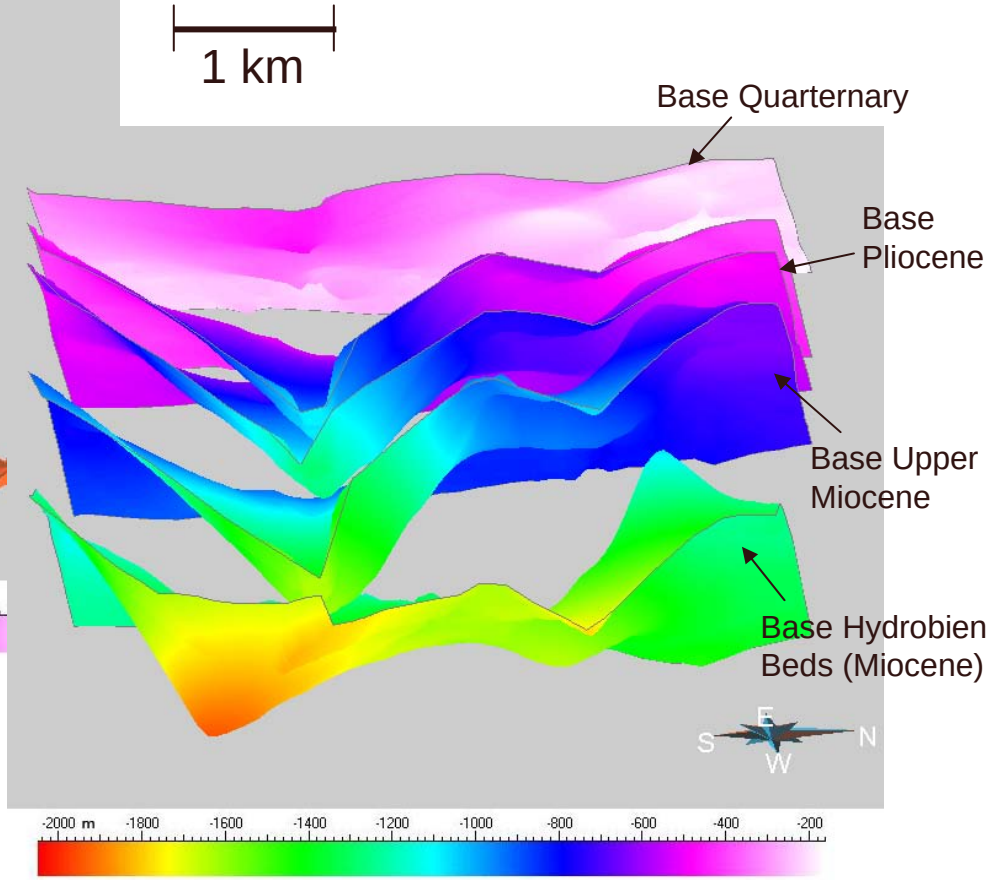


Difference between DSI and Kriging
(e.g. Base Quaternary)

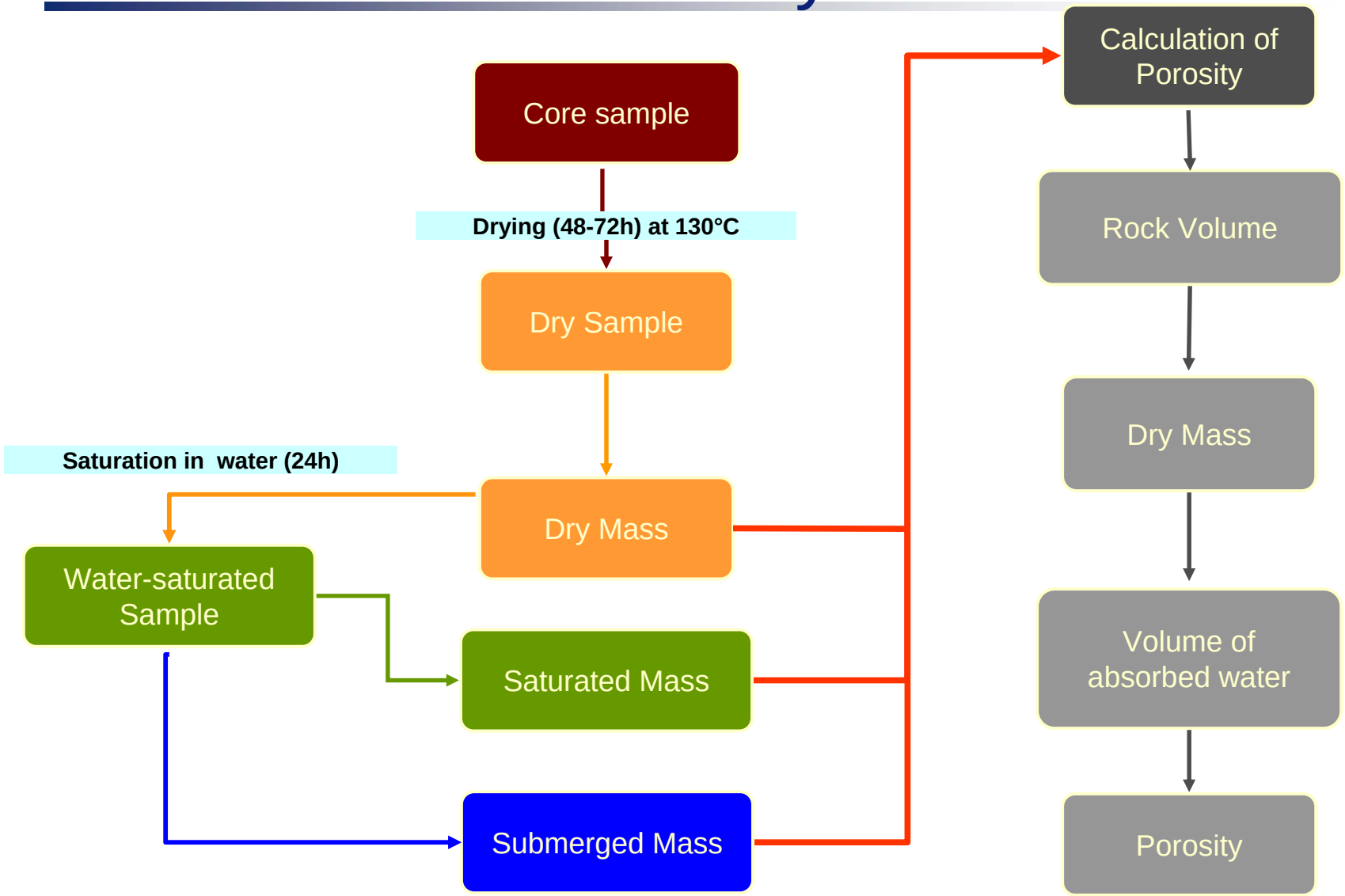
3D Model



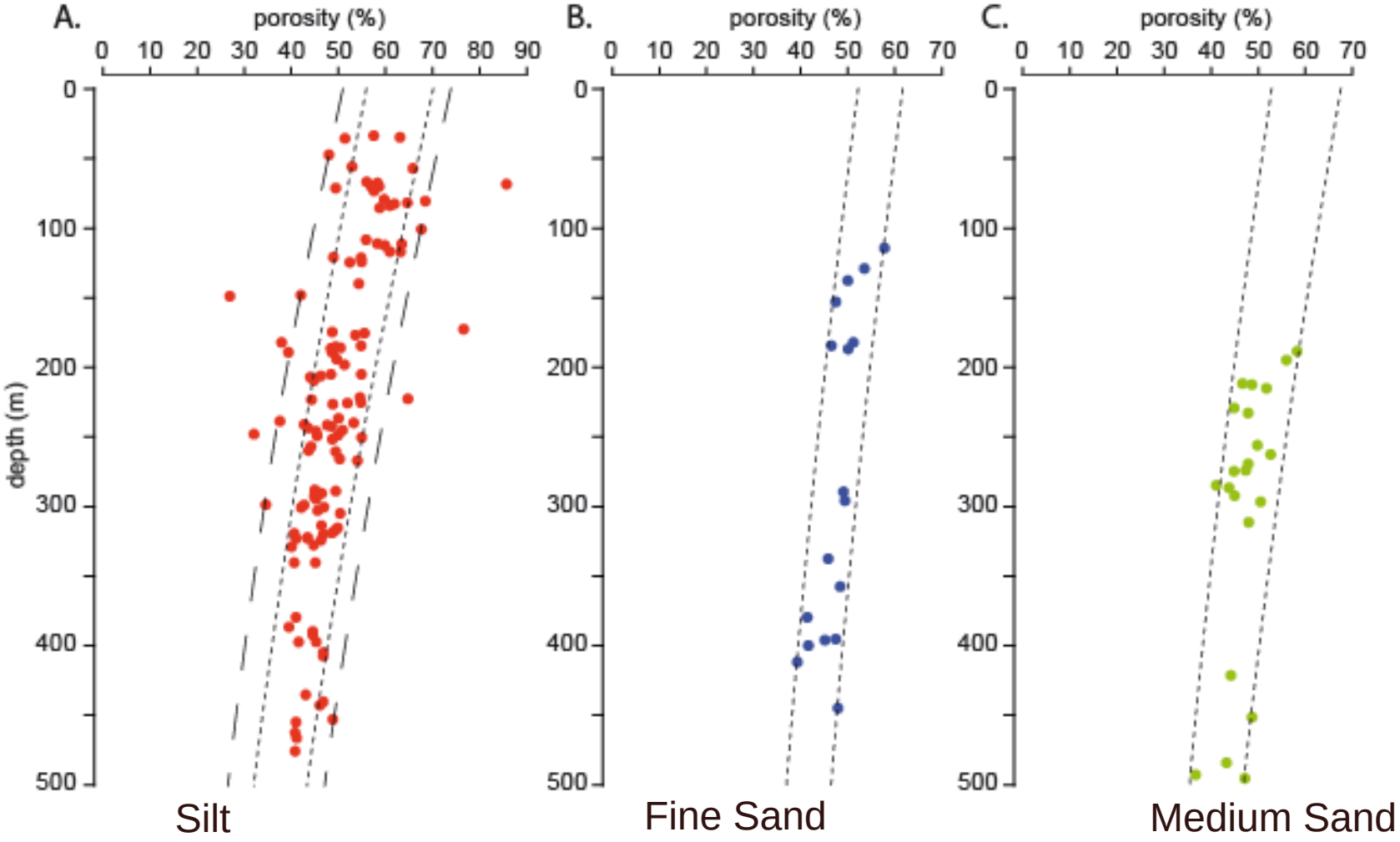
GoCAD model,
5x vertical exaggeration



Calculation of Porosity



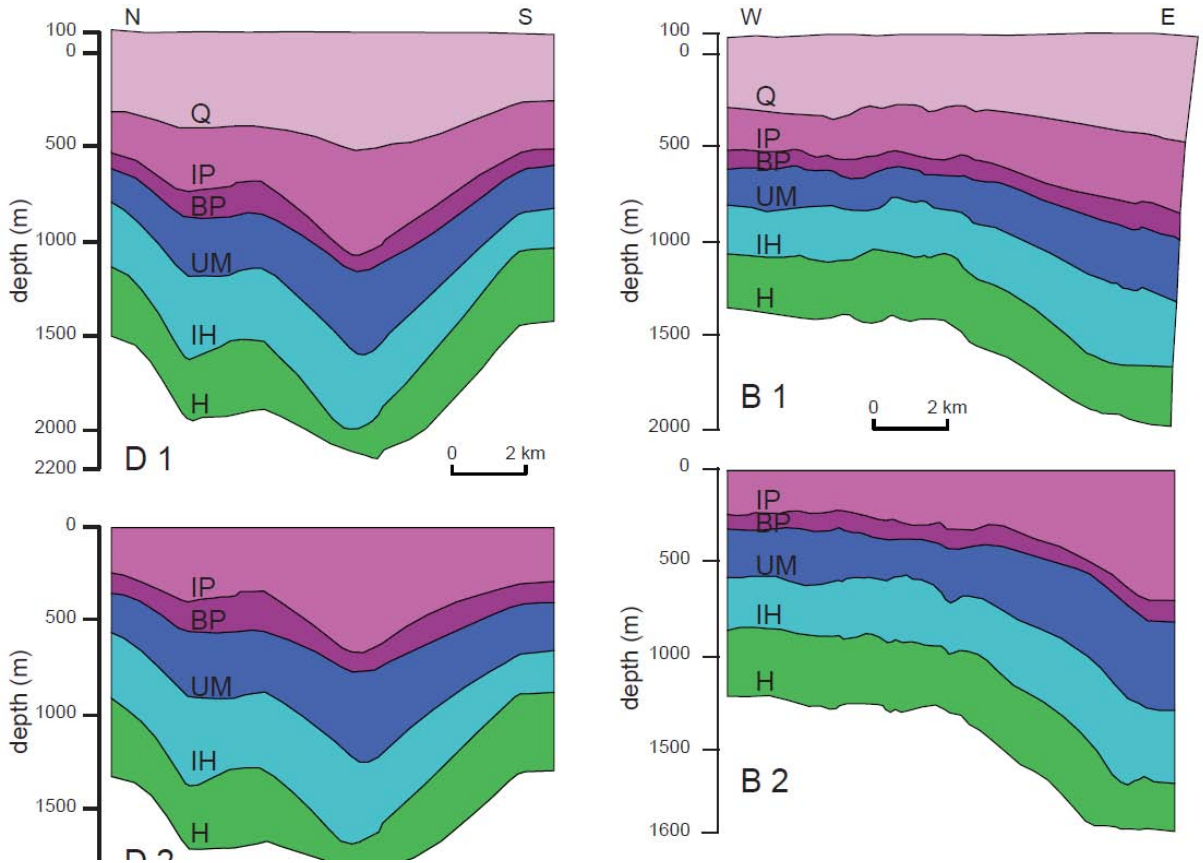
Porosity change with depth



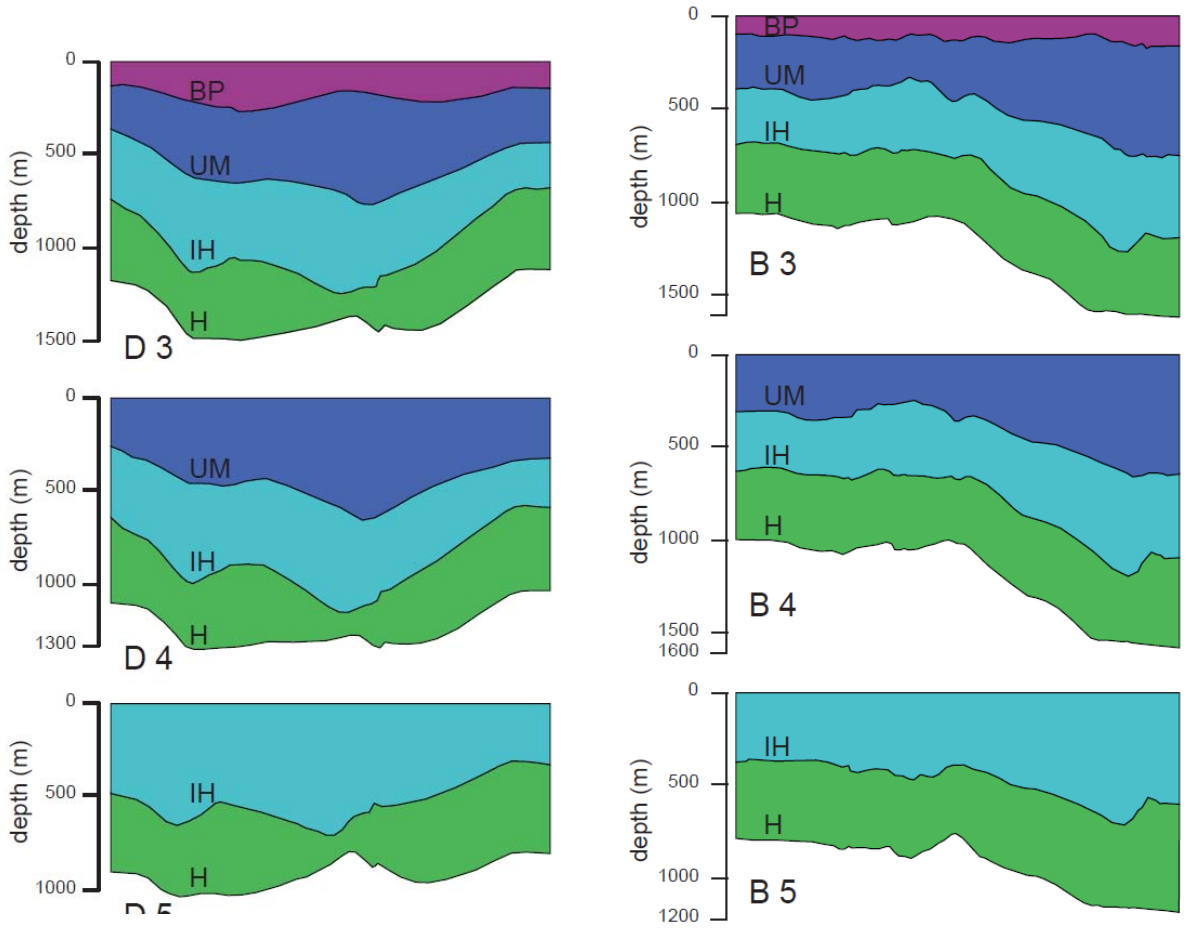
Uni Nord borehole

$$\phi_z = \phi_0 \, e^{-cz}$$ Athy, 1930

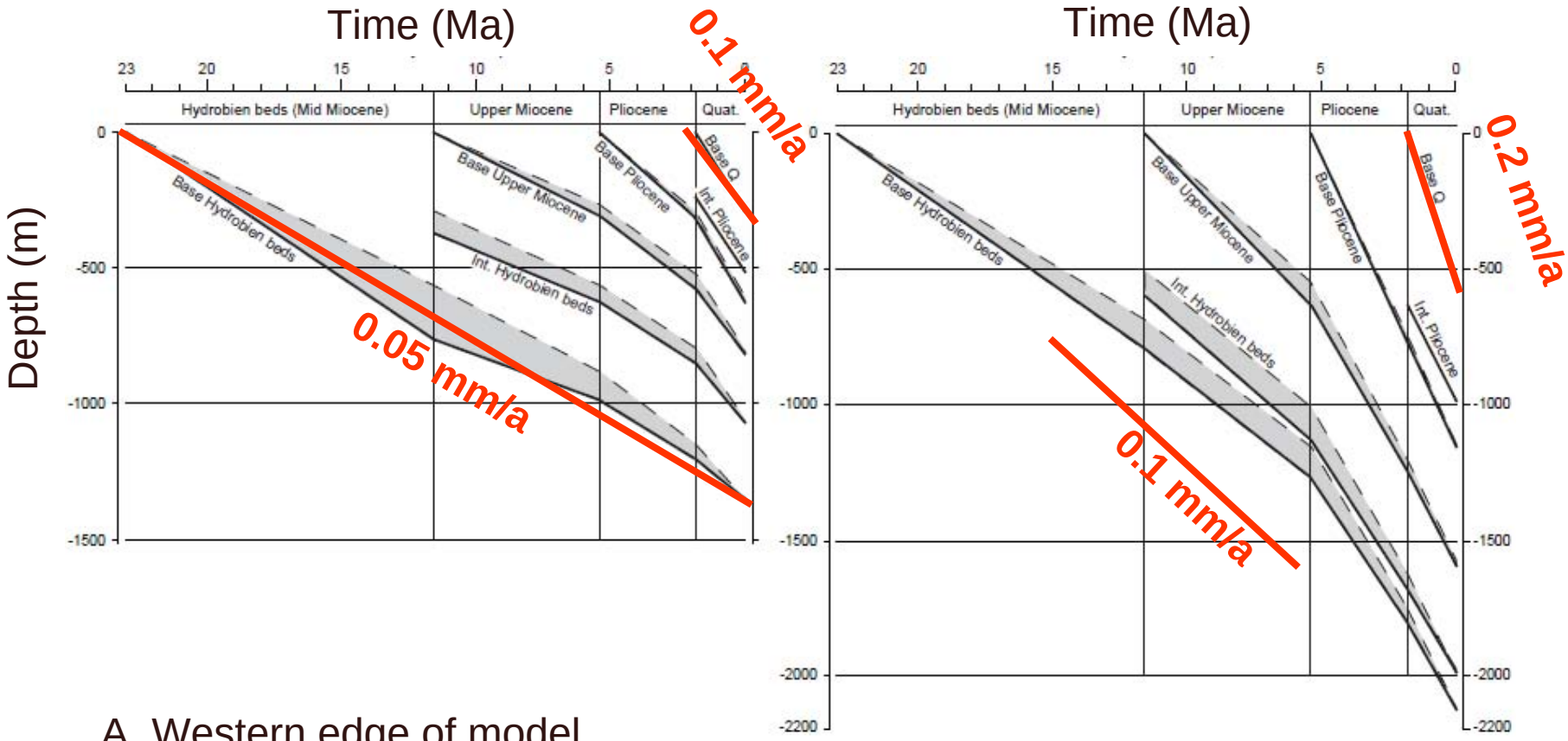
Decompaction and Backstripping I



Decompaction and Backstripping II



Subsidence



A. Western edge of model, towards graben centre

B. Depocentre of the Heidelberg Basin

Conclusions

1. We interpreted reflection seismics to produce a 3D model of the Heidelberg Basin, with 5 stratigraphic horizons.
2. The model shows the depth of the (mini) basin, and movement of the depocentre.
3. We suggest that the basin is pull-apart basin, centered on a „breached“ relay zone.
4. The porosity of the Quaternary sediments decreases exponentially with depth. We used this information to incrementally decompact the Heidelberg Basin, to examine the true changes in basin morphology.
5. Subsidence of the Heidelberg Basin was fast (twice as fast as the average in the URG); average rates are 0.1 mm a^{-1} and rise to 0.2 mm a^{-1} during the Quaternary.

References

- Tanner, D.C., Martini, N., Buness, H., Gabriel, G. & Krawczyk, C.M. (2010). Three-dimensional basin analysis of the Heidelberg Basin, Upper Rhine Graben. GeoDarmstadt 10-13th October 2010. Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften 68, 548-549.
- Tanner, D.C., Martini, N., Buness, H., Gabriel, G. & Krawczyk, C.M. (2010). The Heidelberg Basin Drilling Project - basin analysis. European Geosciences Union General Assembly, Vienna 2nd-7th May 2010.
- Athy, L.F. (1930) Density, Porosity and Compaction of Sedimentary Rocks. AAPG Bulletin Volume 14: 1–24.
- Buness, H., Gabriel, G. & Ellwanger, D. (2008) The Heidelberg Basin drilling project: Geophysical pre-site surveys. Quaternary Science Journal (Eiszeit und Gegenwart) 2008, 57/3–4: 338-366.
- Ellwanger, D., Gabriel, G., Hoselmann, C., Lämmermann-Barthel, J., Weidenfeller, M. (2005) The Heidelberg Drilling Project (Upper Rhine Graben, Germany). Quarternaire 2005, 16/3: 191–199.
- Martini, N. (2009) 3D-Modellierung im Umfeld des Heidelberger Beckens. Diplomkartierung, Universität Hannover, 23 S., unveröffentlicht
- Martini, N. (2010) Retrodeformation des Heidelberger Beckens. Diplomarbeit, Universität Hannover, 88 S., unveröffentlicht