3D Seismic Imaging for a Better Understanding of Deep-Seated Deposits

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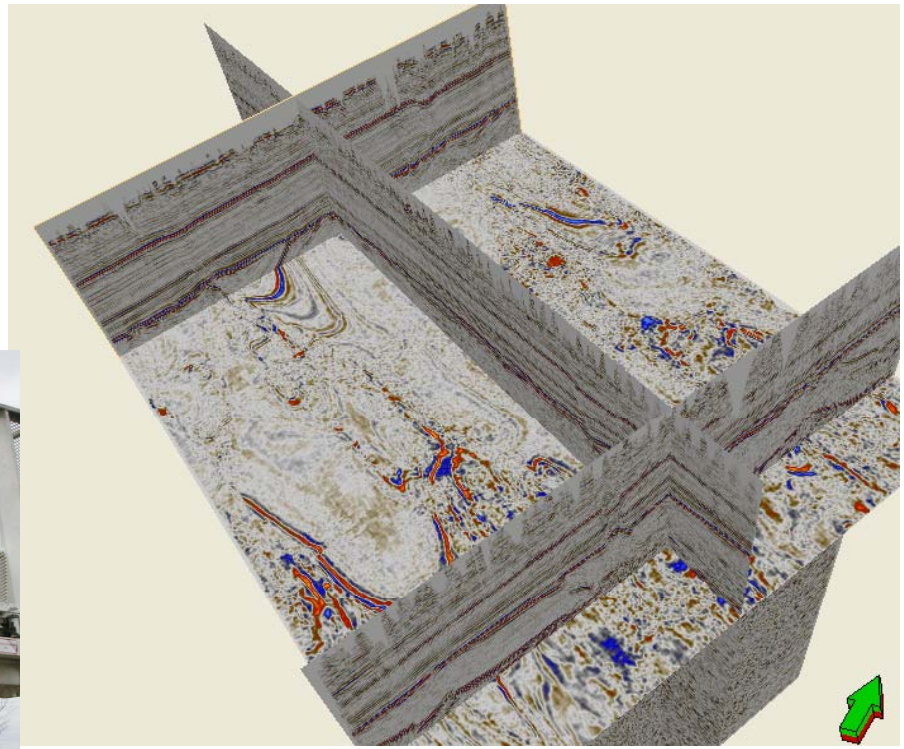


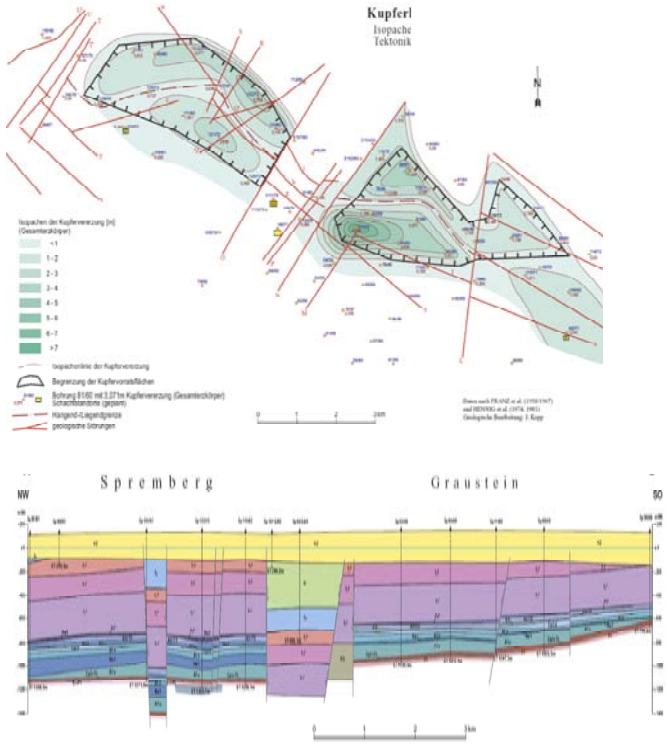
Content

- 3D-seismic Spremberg - Initial geological situation of the survey area and objectives of the 3D-seismic survey
- Phases of the 3D-seismic survey
- Description of the survey; Planning; Parameters; Techniques; Characteristics
- Seismic Data Processing; Special Procedures
- Interpretation of the results

Initial Geological Situation and Objectives of the 3D Seismic Survey

Geological situation

Basis about 80 drill holes



Goals of the seismic survey

- Identification of the Copper Shale horizon in depths between 700 m and 1200 m
- Description of the layering down to a depth of about 1.500 m
- Generation of a detailed geological 3D-model
- Identification of possible fault structures as basis for an optimized mine planning to reduce risks and costs for the construction of shafts and underground roadways.

Phases of 3D Seismics (onshore)

Preparation phase

Planning / public relations work

Permitting

Survey phase

Topographical surveying

Mobilization of survey crew

Field measurements

Interpretation phase

Data processing

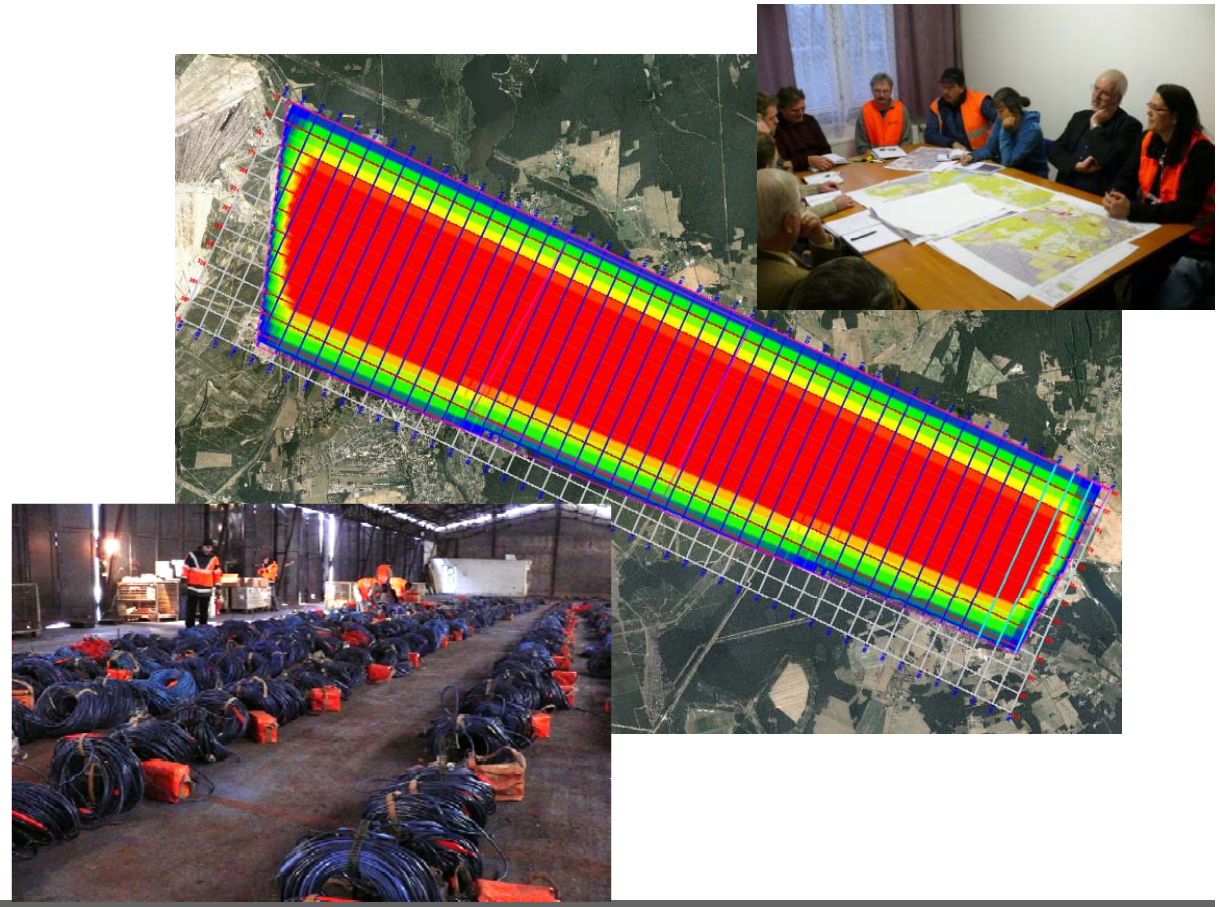
Interpretation

Modeling / Imaging

Preparation Phase

- Planning

- Scouting
- Map material
- Survey program
- Coverage diagrams
- Scheduling
- Equipment needs
- Manpower needs



Preparation Phase

- Public Relations Work

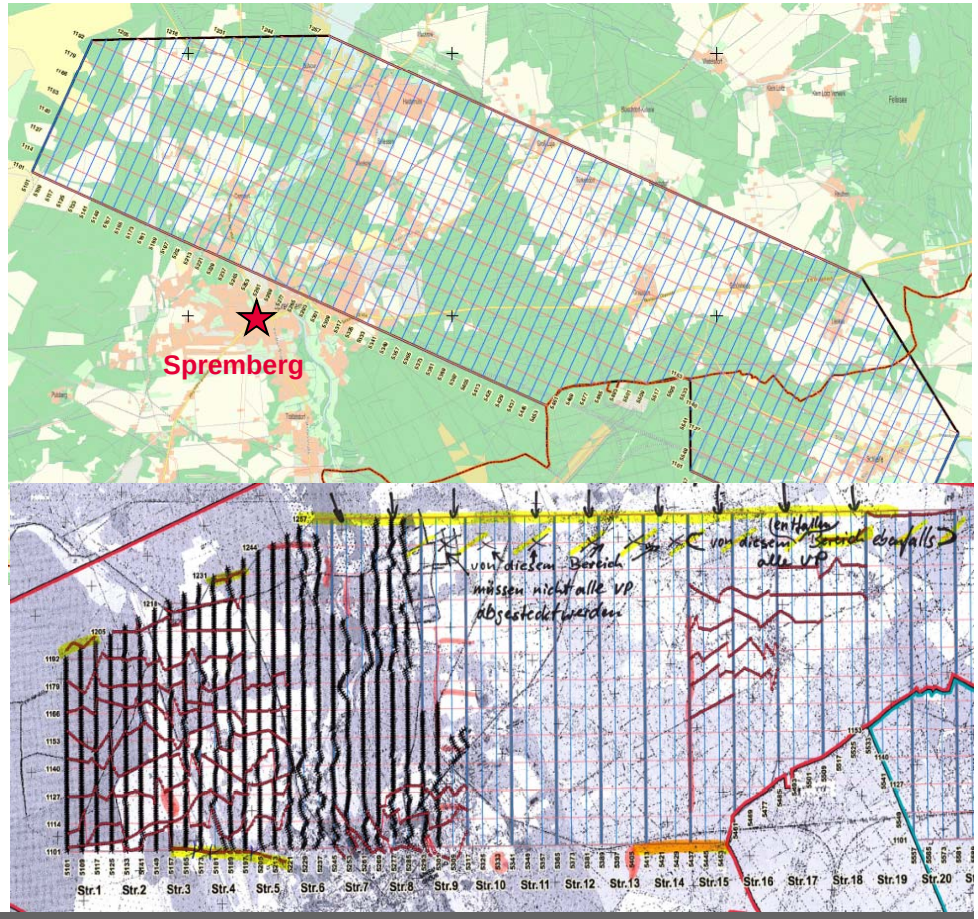
- **Press conferences**
- **Meeting with local inhabitants**
- **Preparation of flyers**
- **Information event**

3D Seismics Spremberg

- Technical Parameters

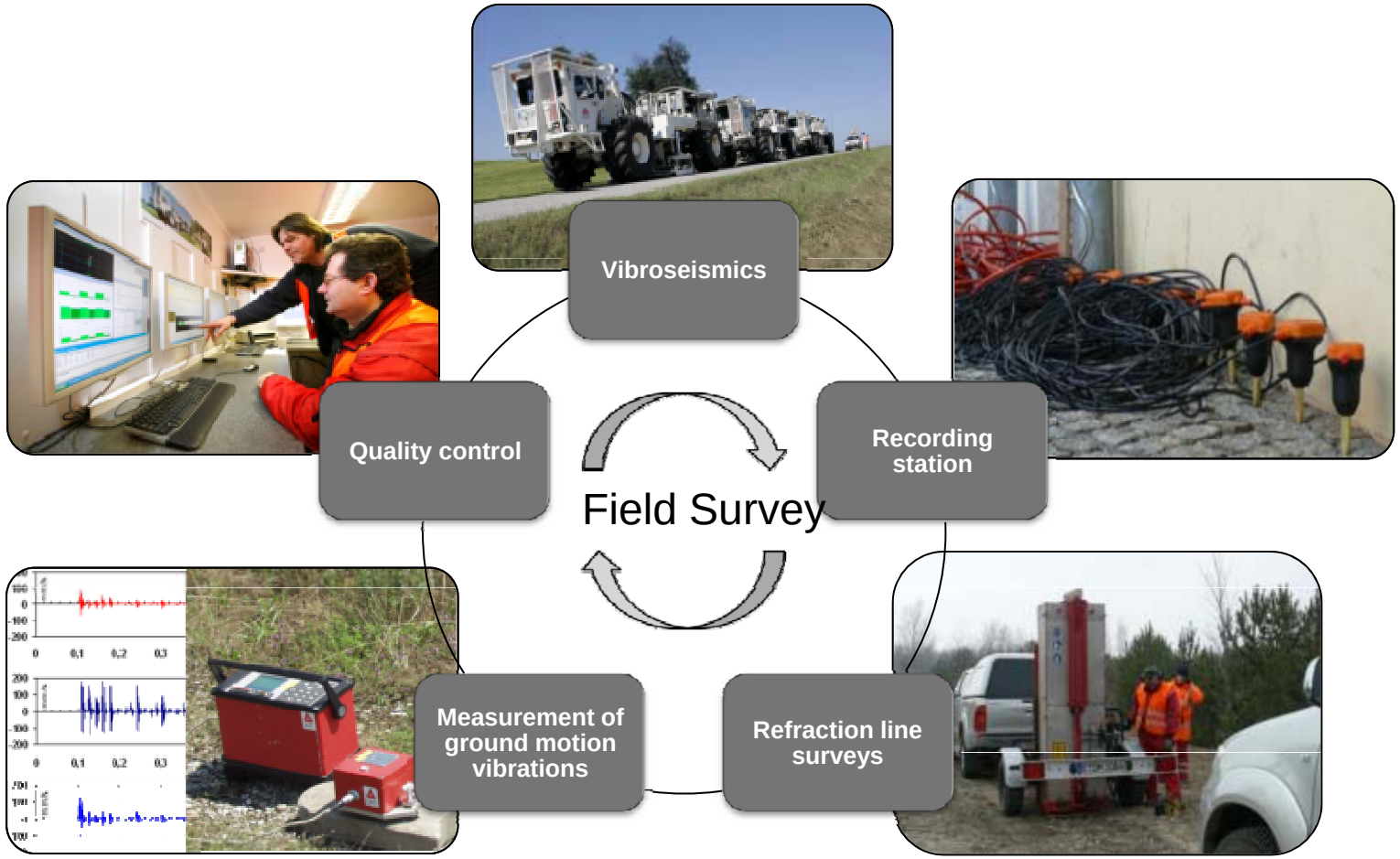
Field parameters

- Area: 75 km²
- Survey: February 11th to March 16th 2011
- Seismic source: 2 Mertz M12 Vibrators; Peak force 30,000 lbs, each
- 12 active geophone lines with1872 active channels, 10.500 recording points, 240 m line distances.
- 6.800 Vibro-points, 390 m line distances
- 10 s sweep length, 10-108 Hz sweep, 3 s recording time, 2 ms sampling rate;
- Bin-size: 15 x 15 m



Survey Phase

- Integrated Field Work



Required Certificates

- QHSE Standard

- SCC certificate
- IAGC Standard
- DIN 9001 / 14001
- Fair Company
- Job & Family
- Top employer for engineers
- Presentation of a safety concept

Impressions from the Survey Site

Vibro Crew

Impressions from the Survey Site

Cable Crew

Impressions from the Survey Site

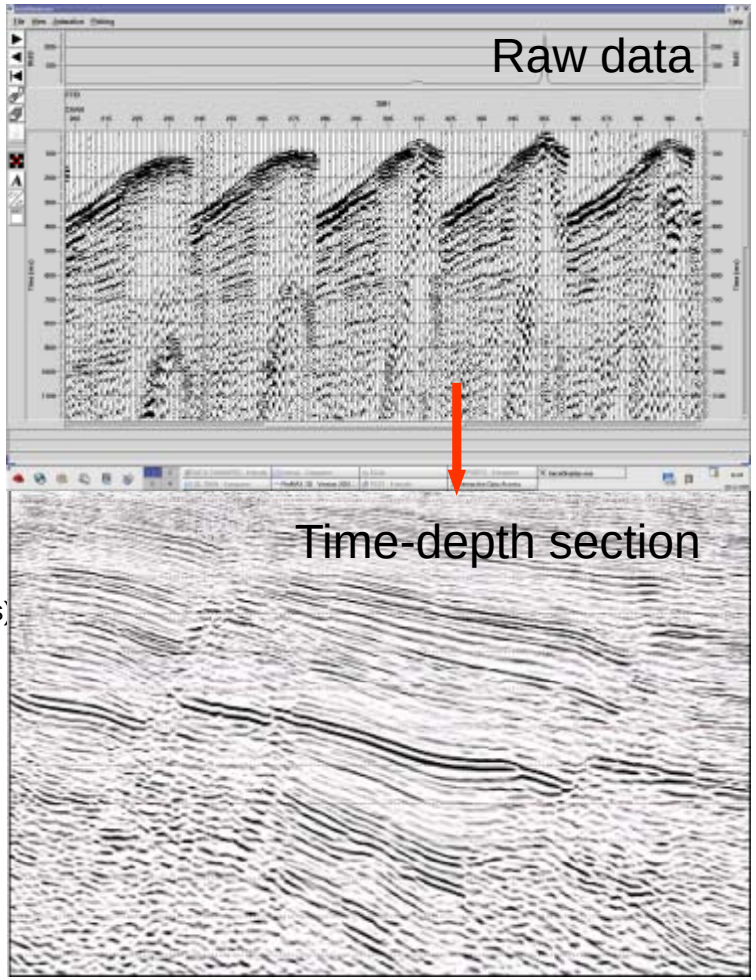
Traffic Regulation

3D Seismic Data Processing

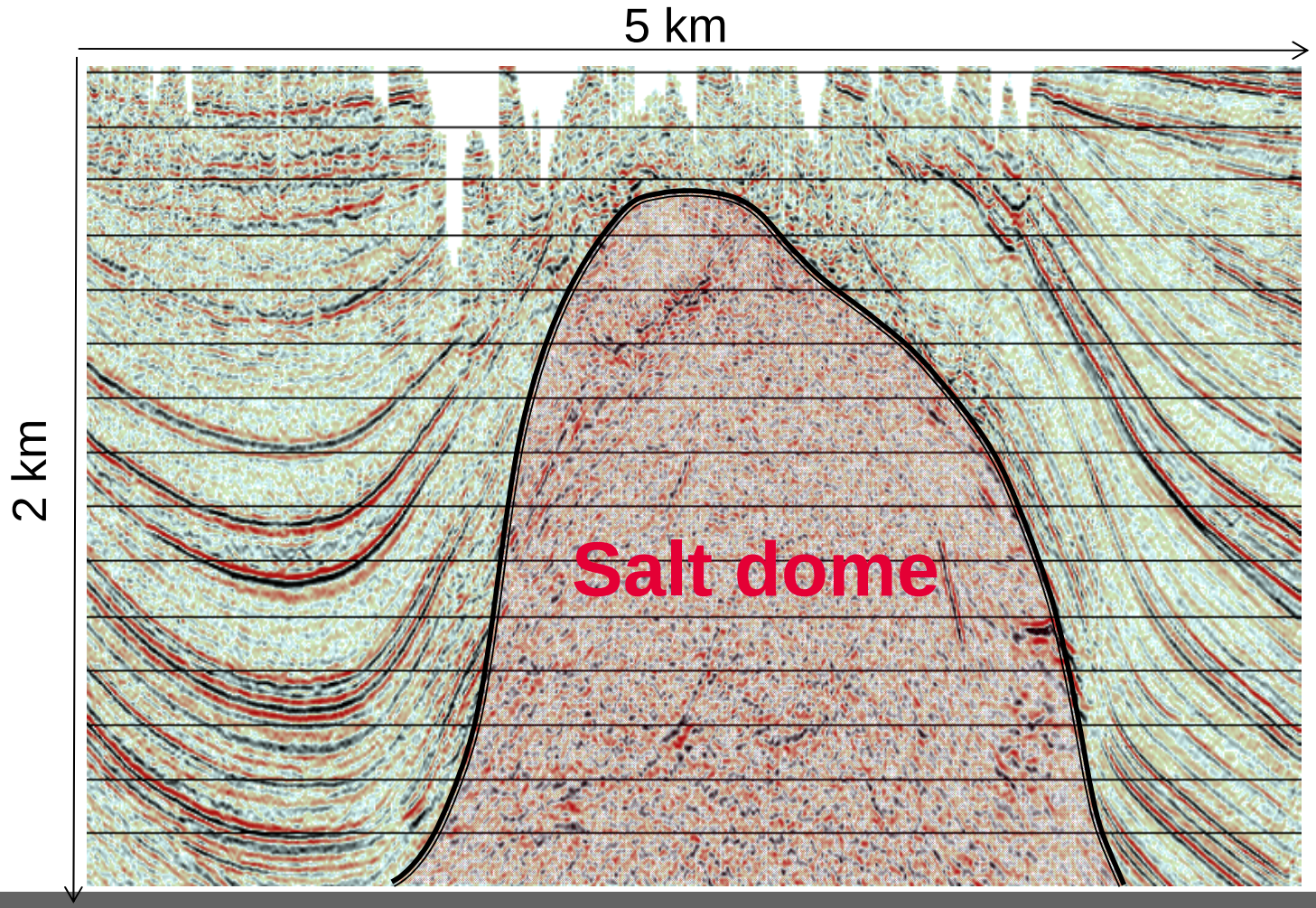
Approx: 75 km² - 14 million data traces
Processing time: several man-months

Data processing processes

1. Transcribe to internal format
2. Geometry setup and application
3. Minimum phase transformation
4. First-break mute
5. Gain recovery
6. Trace editing interactively and/or automatically
7. Suppression of shot domain noise dips by FK filtering + removable AGC
8. Deconvolution, preferably surface consistent, according to test results.
9. Basic static correction (apply to floating datum only)
10. First break picking and refraction statics
11. Preliminary velocity analysis
12. (Interactive QC display of brute stack as final check for bad traces + geometry errors)
13. Computation and application of 2D residual statics, up to 3 passes
14. Improvement of NMO correction and mute
15. Application of AGC, if necessary
16. Removal of NMO correction
17. **CRS processing and/or PSD migration**
18. 2D/ 3D post stack FD time migration
19. SEGY output of raw CRS stack, time migrations
20. Application of zero-phase filter (statistically derived from seismic)
21. Time variant filter and scaling
22. SEGY output of final CRS stack, time migrations
23. Section plot of final CRS stacks and depth migrations

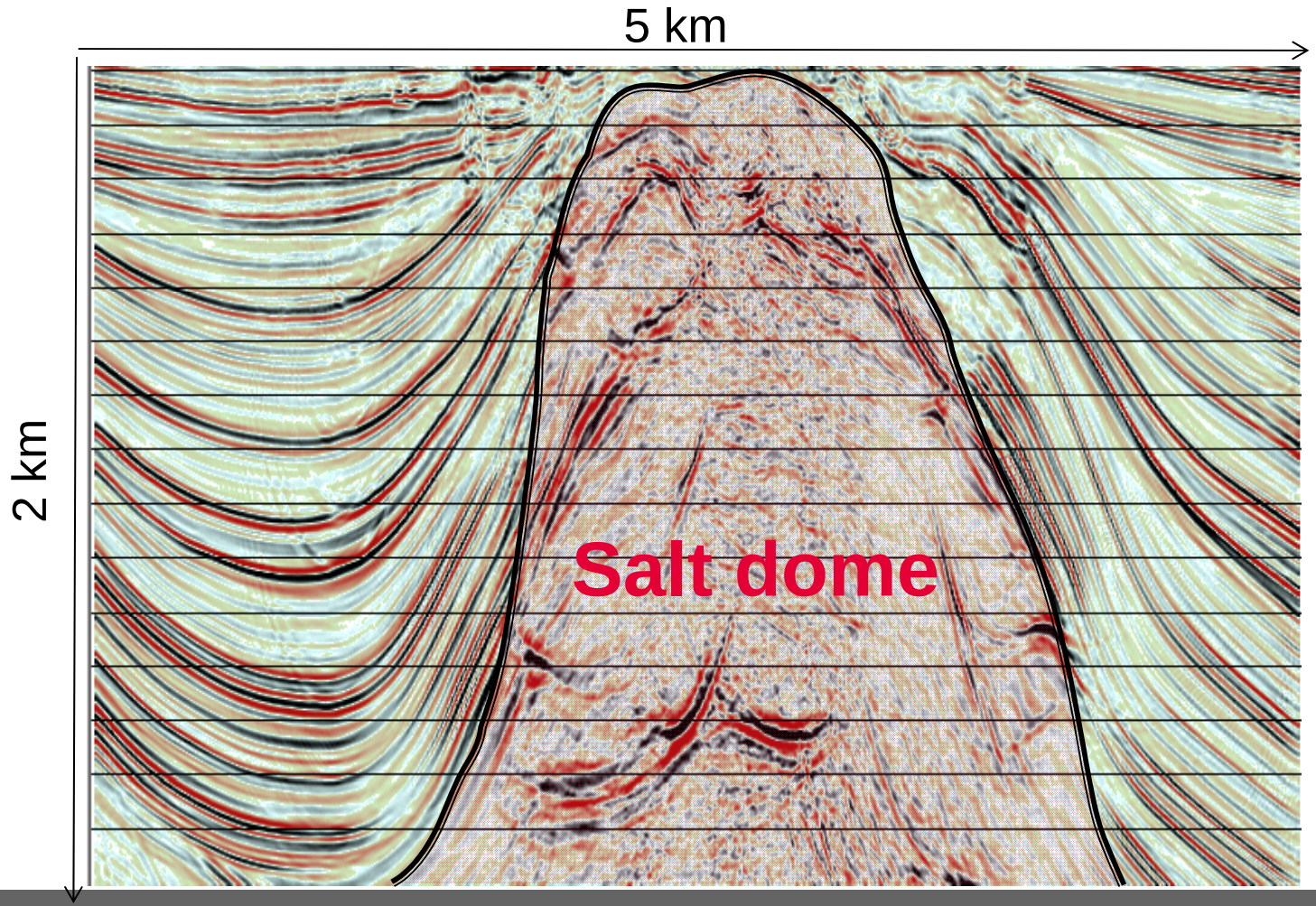


Migration of a Conventional 3D Stack



Migration of a 3D CRS Stack

CRS = Common Reflection Surface



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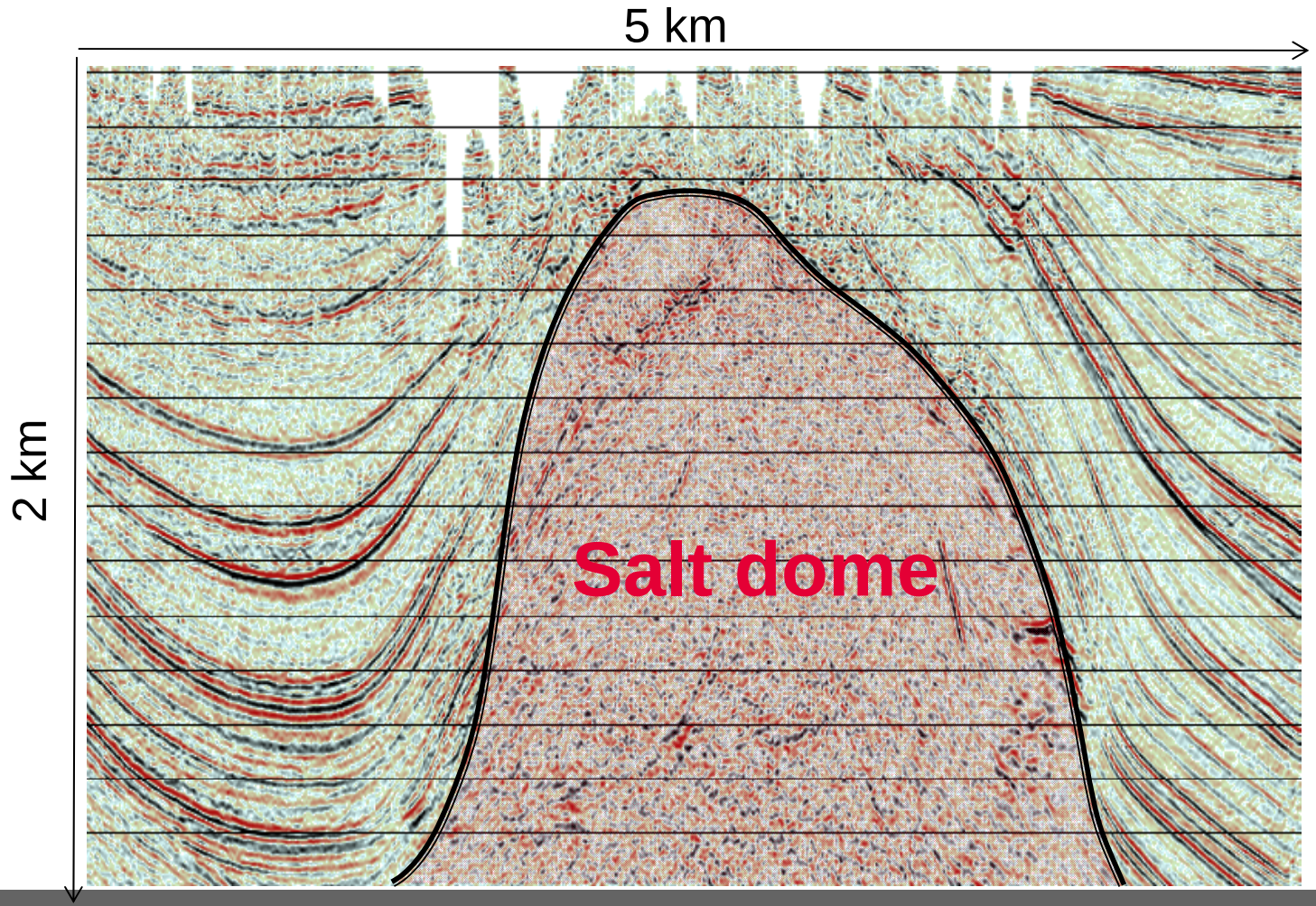

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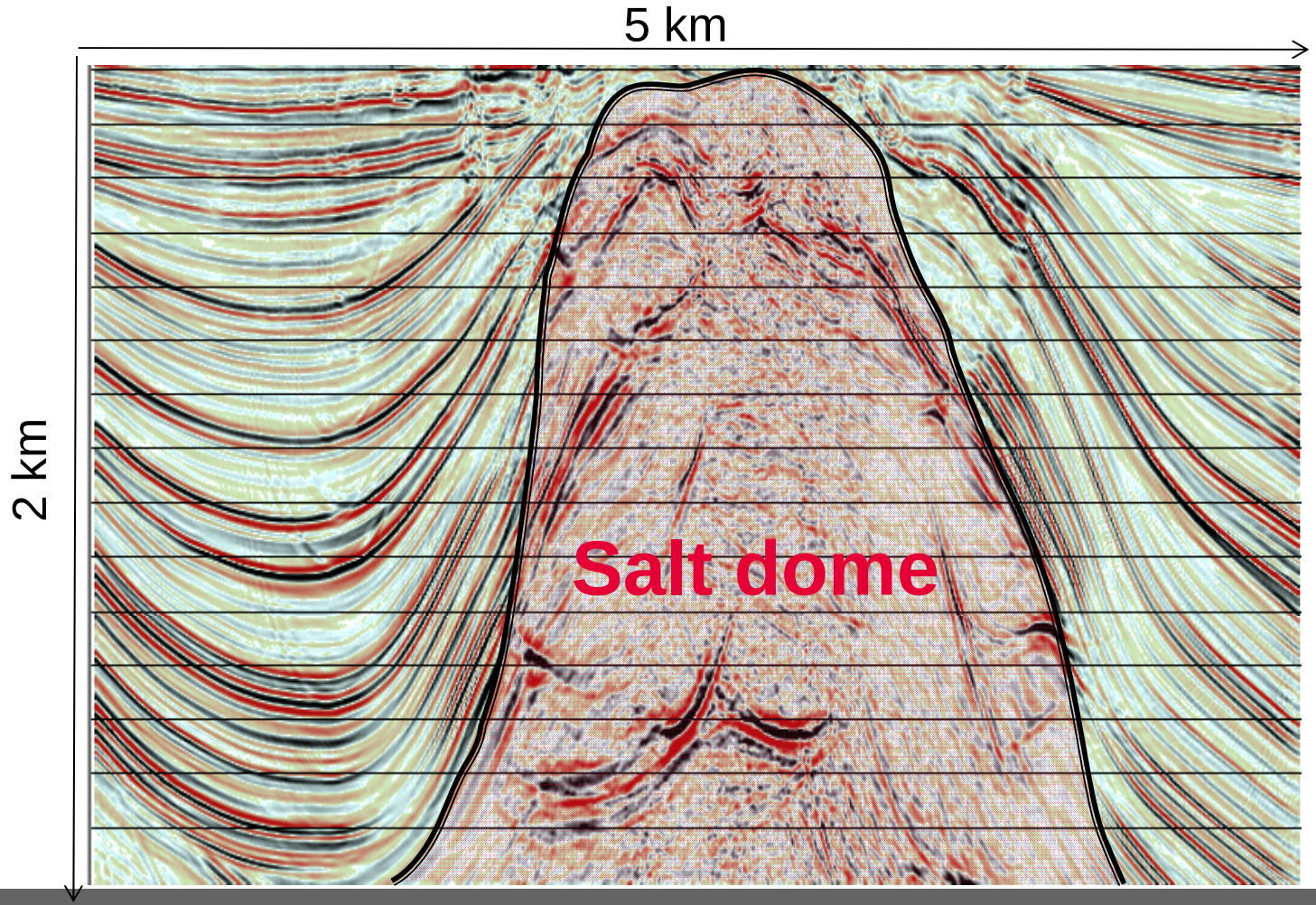
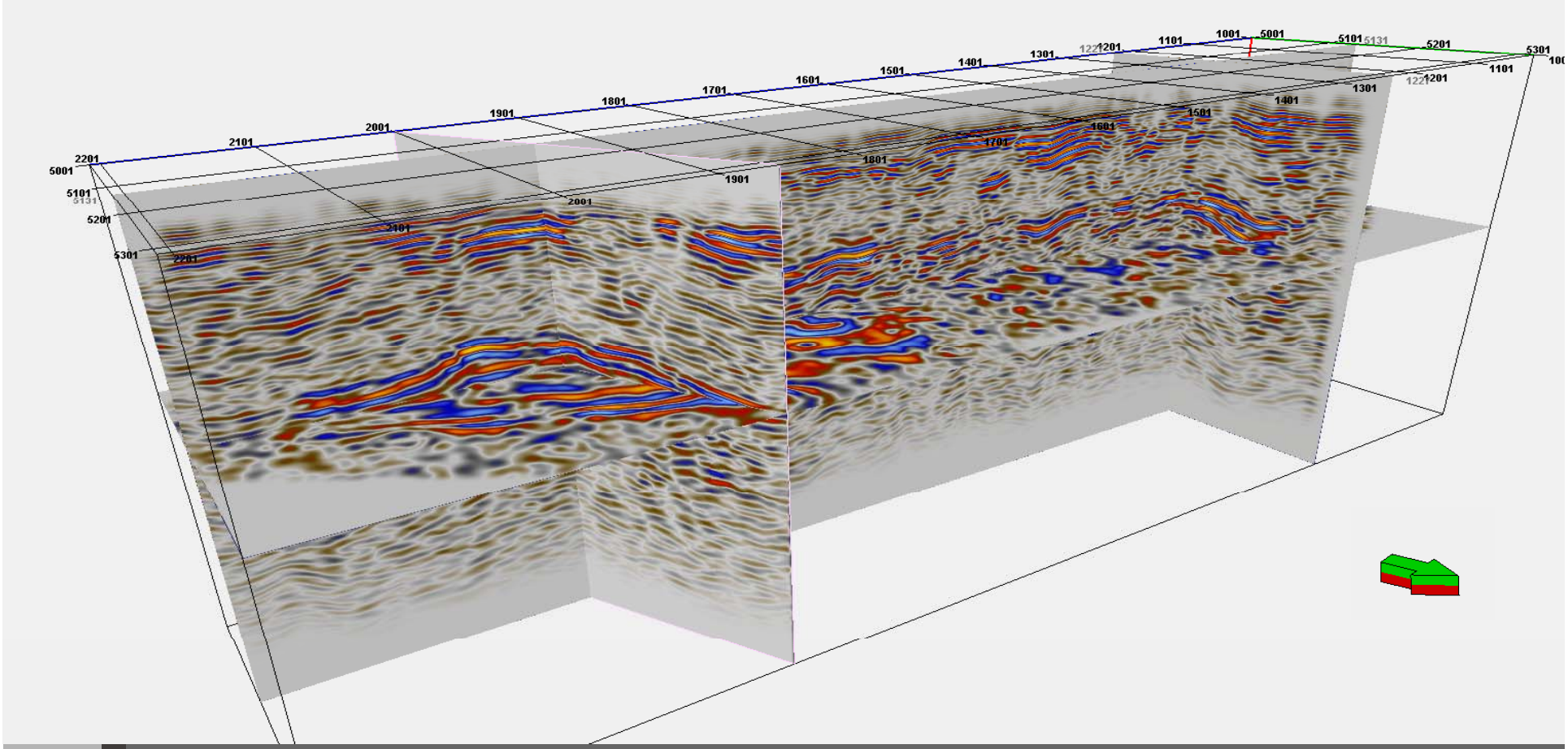


Result of 3D Seismic Data Processing

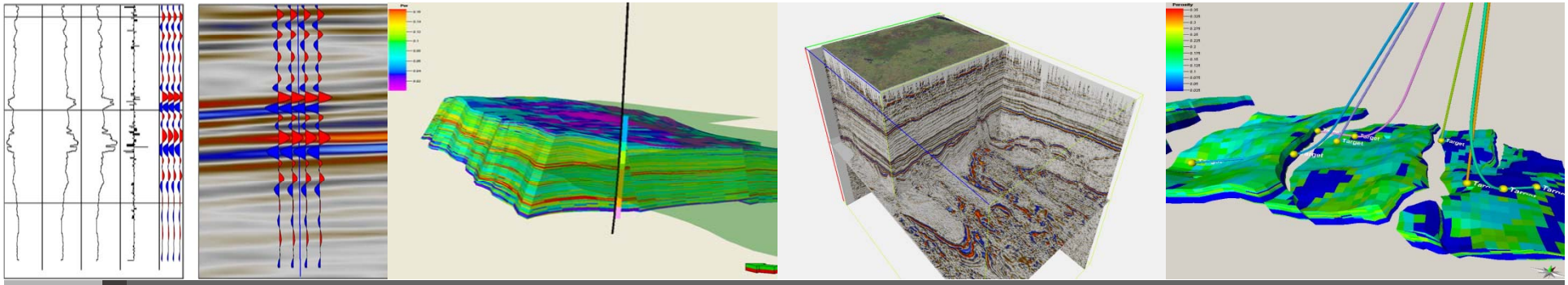
Seismic cube



Interpretation Phase

Geological Interpretation – 3D Modelling – 3D Imaging

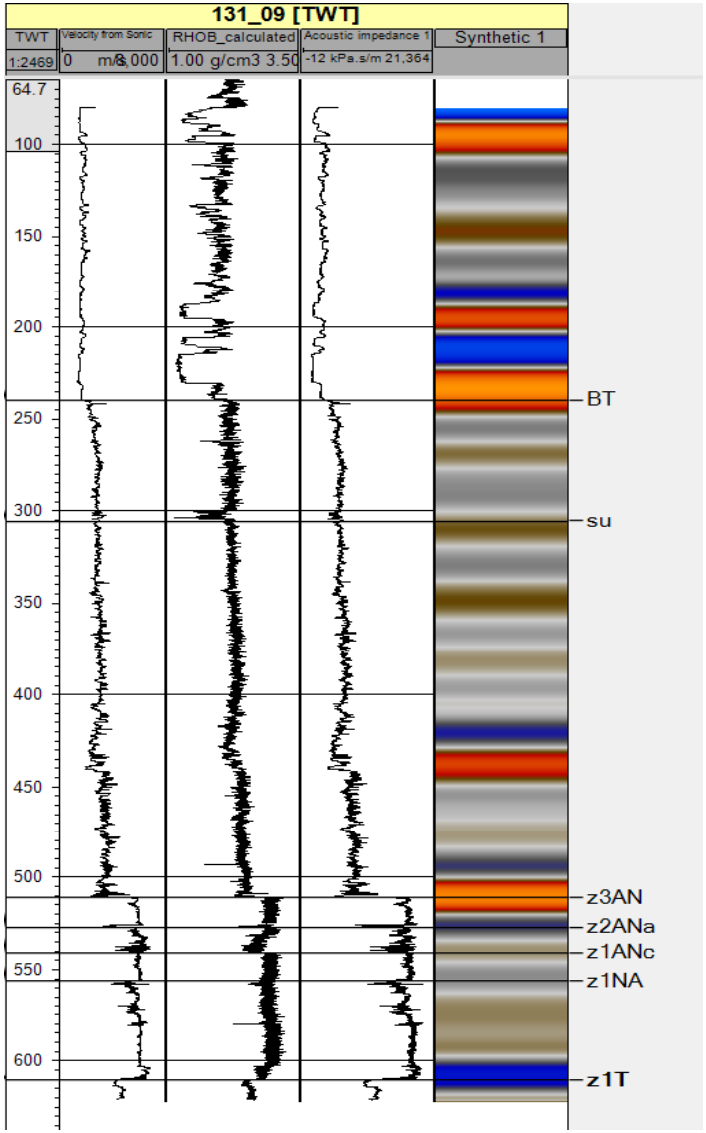
- Structural interpretation
- Integration of exploration information from boreholes
- Generation of 3D block models / imaging
- Volumetric calculations and reservoir characterization
- Team working of geologists & geophysicists



Generation of a Synthetic Seismogram

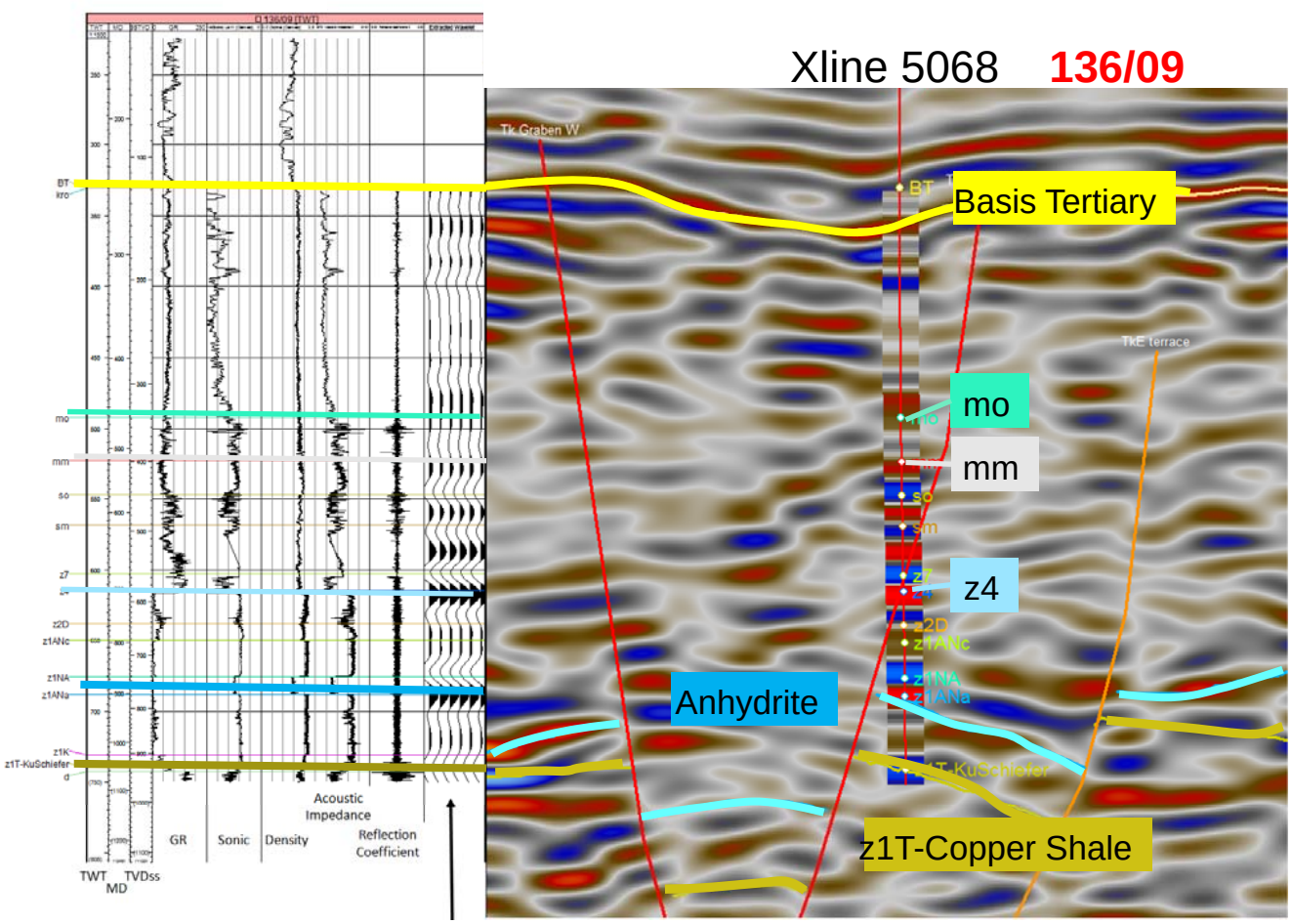
Needed information

- Velocity log
- Density log
- Vertical Seismic Profiling (VSP)
- Velocity * Density = Impedance
- Impedance determines seismic amplitudes
- Synthetic seismogram = Model of a recorded seismic signal at the location of the borehole



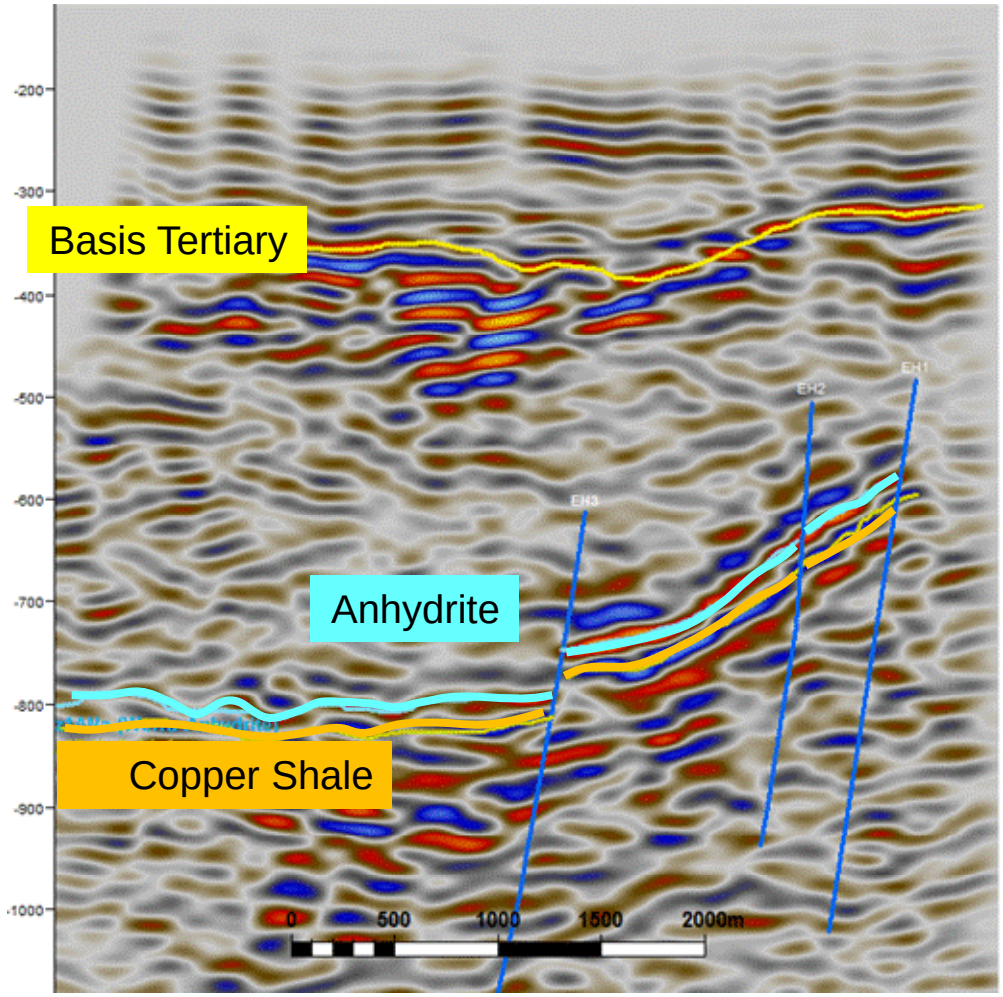
Calibration of Seismic Reflectors

Borehole Location “Spremberg 136/09”



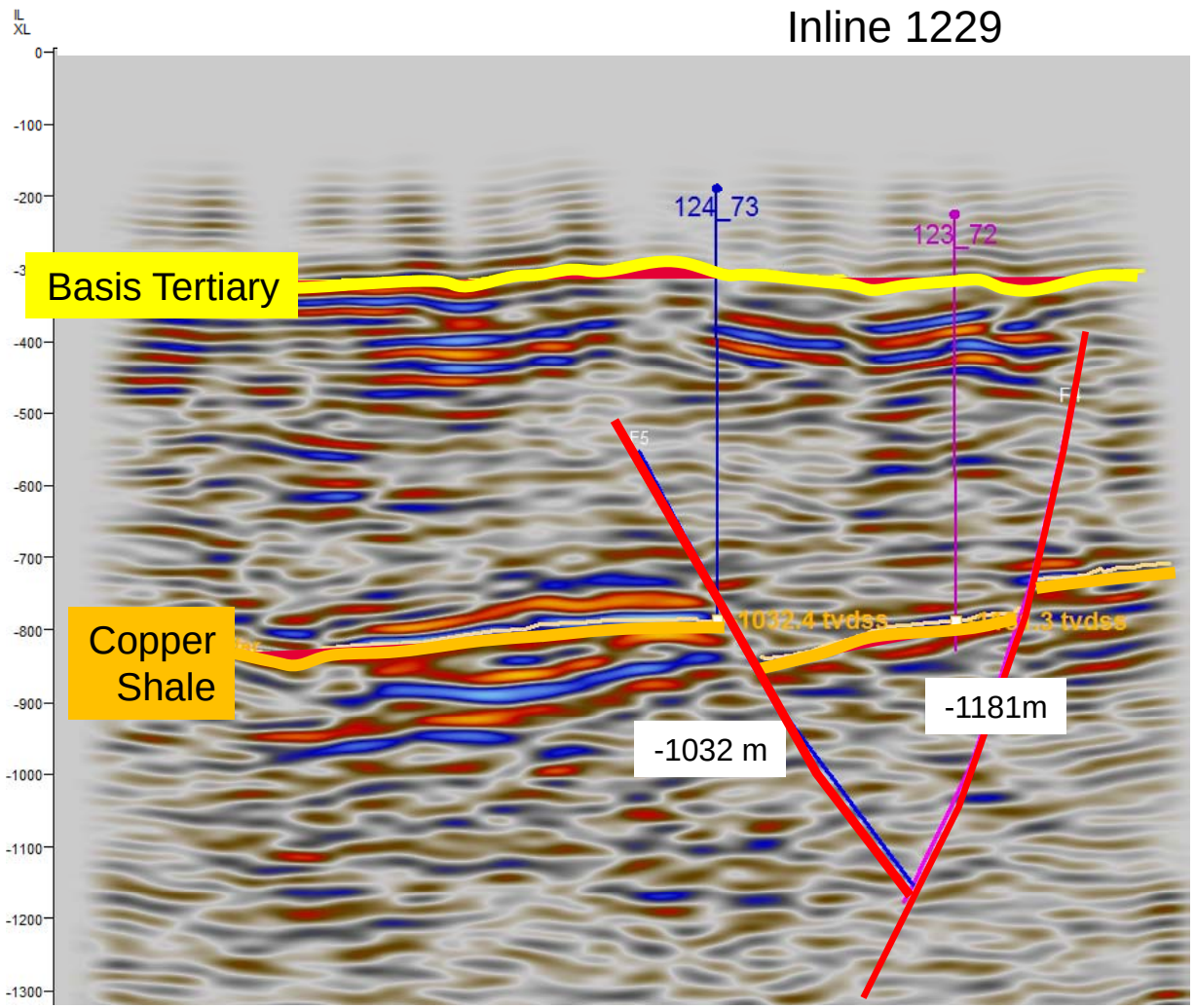
Character of Different Reflectors

- **Basis Tertiary:** strong positive amplitudes; represents the discordance between nearly horizontal tertiary elements and the underlying dumping Mesozoic elements
- **Anhydrite:** most strongest positive amplitudes; locally a little weak.
- **Copper Shale:** varying phases between two strong amplitudes of Anhydrite and Pre-Zechstein.

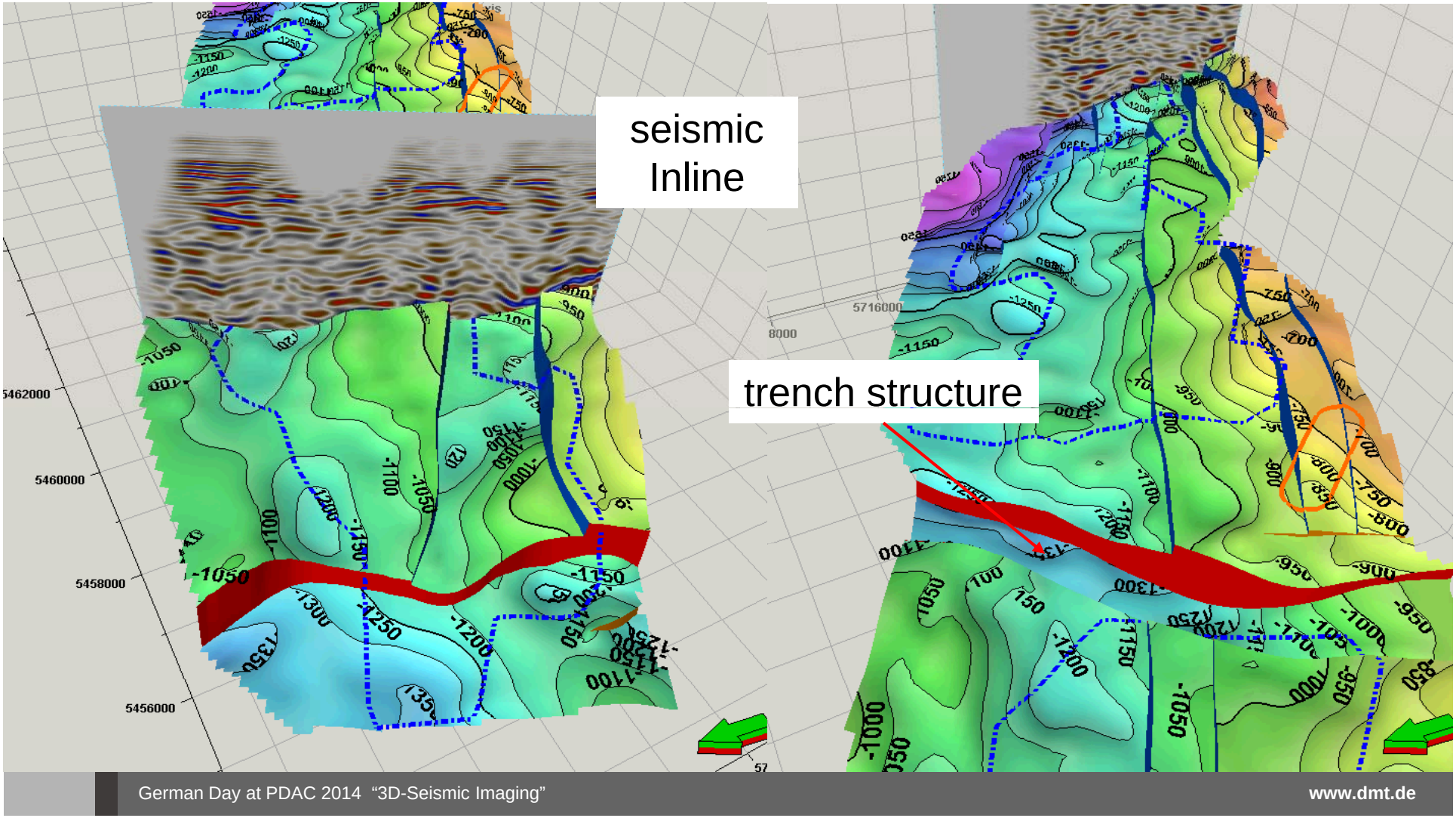


Challenging Interpretations

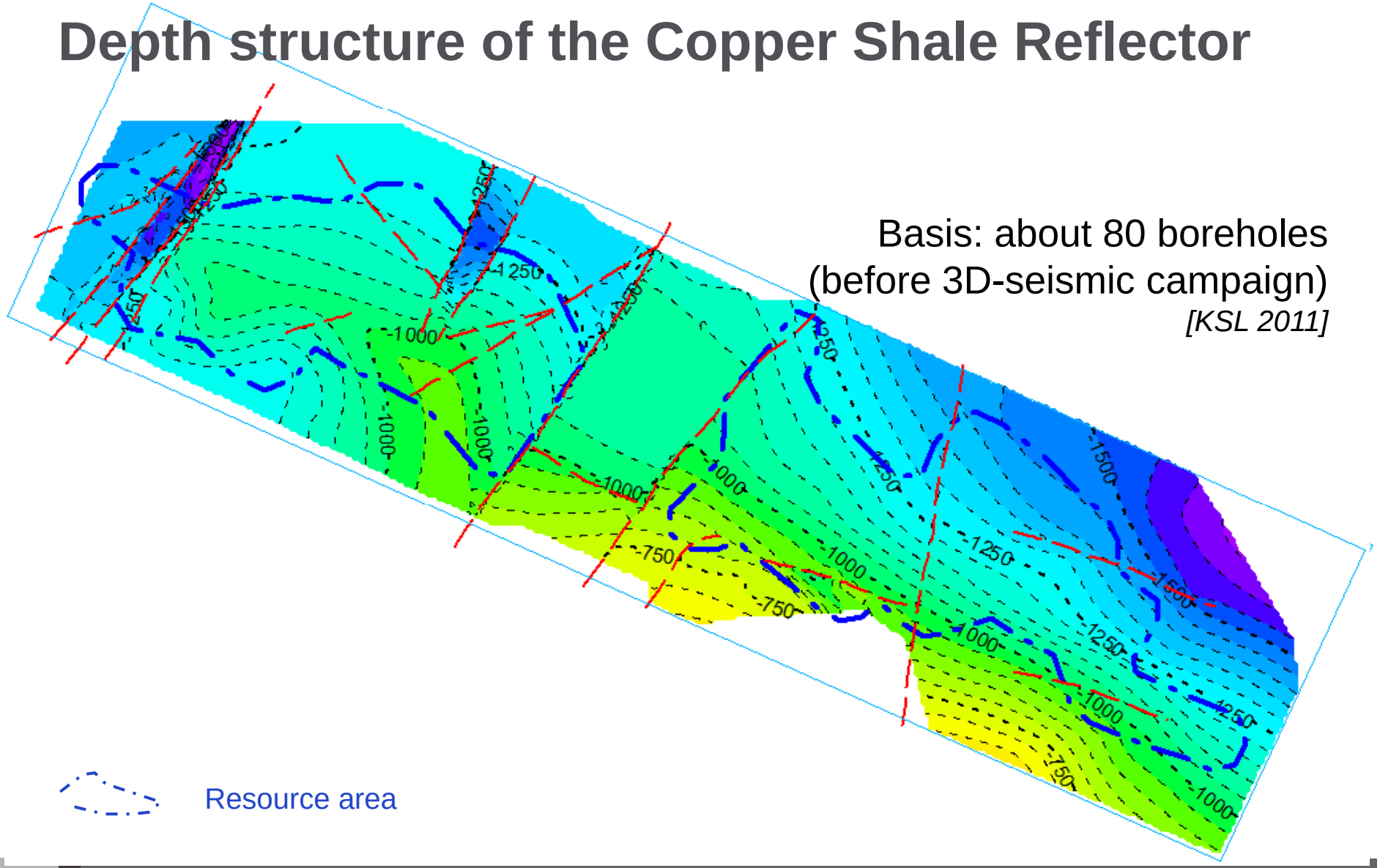
- Large intervals “chaotic structures” in the area of Triassic elements
- Strong changing pattern, especially at small tectonic structures
- Varying thicknesses and changing character of Anhydrite sequences



3D image of the Copper Shale Horizon



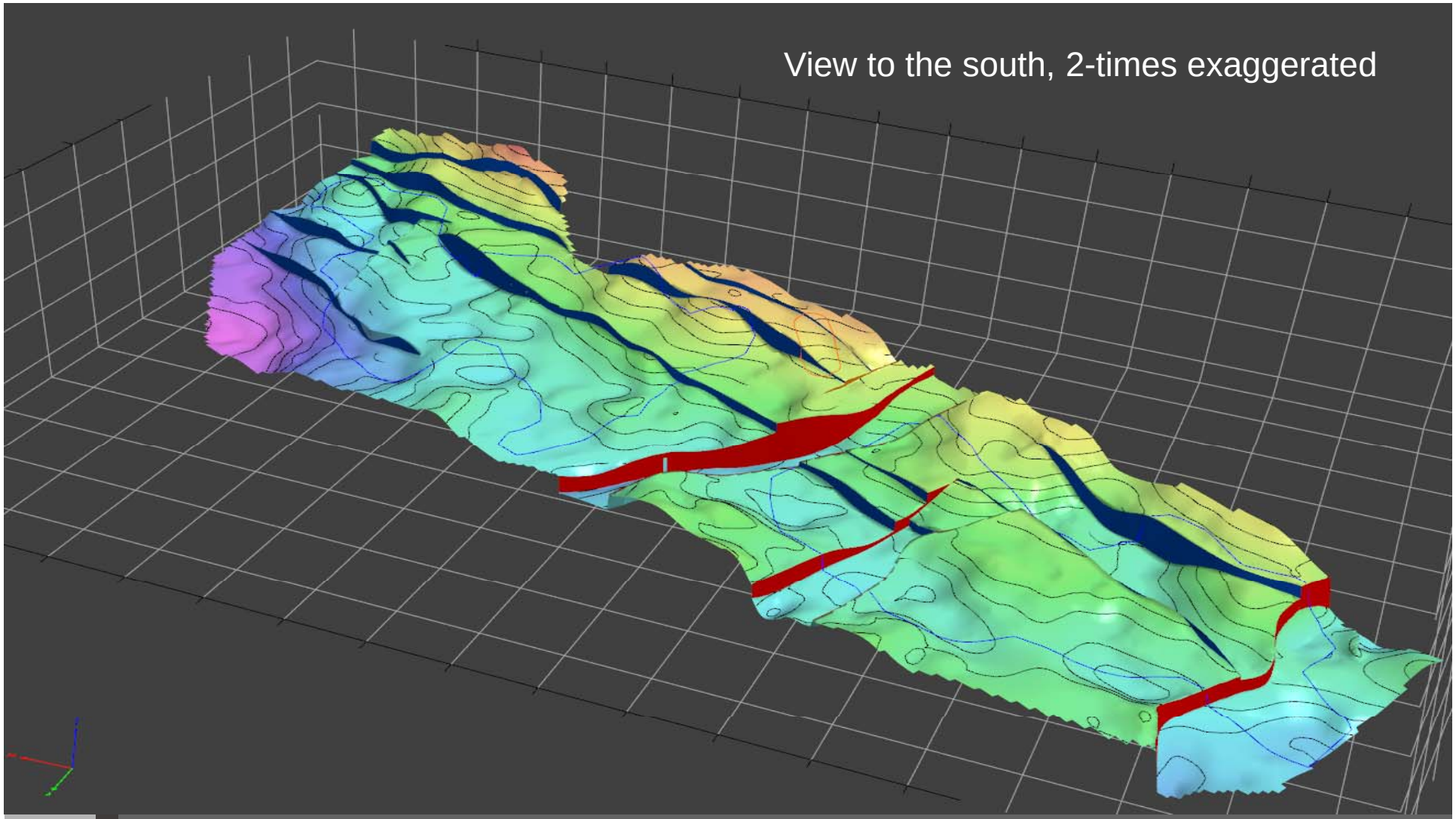
Depth structure of the Copper Shale Reflector



Basis: about 80 boreholes
(before 3D-seismic campaign)
[KSL 2011]

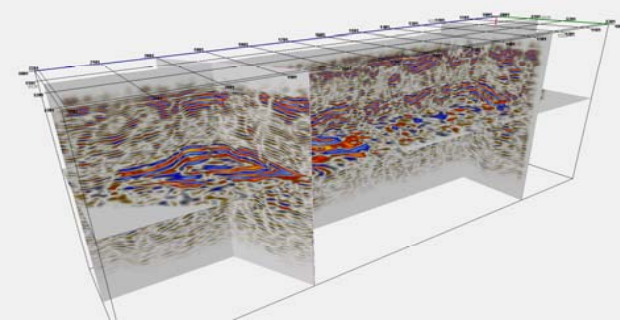
Resource area

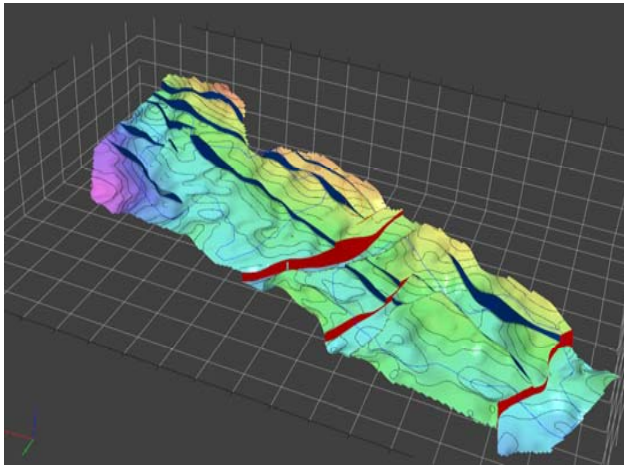
3D-Image of the Copper Shale Horizon



Summary and Conclusions

- 3D-seismic imaging is an important tool to describe the geological situation of deep-seated deposits
- The 3D geological image can be used for an optimized mine planning to reduce risks and costs for the construction of shafts and underground roadways
- 3D-seimic surveys need to be well adapted to the local circumstances in the survey area
- Seismic data processing and interpretation of the results have to be calibrated at borehole positions
- In Spremberg in eastern Germany the 3D-seismic survey led to a more detailed knowledge about the Copper Shale layer
- On the basis of the results in Spremberg now the planning of the mine can start





Thank you for your attention
&
Glückauf!

Acknowledgement
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