The  project – Seismic interpretation, structural pattern and 3D modeling of the Upper Rhine Graben - first scientific results

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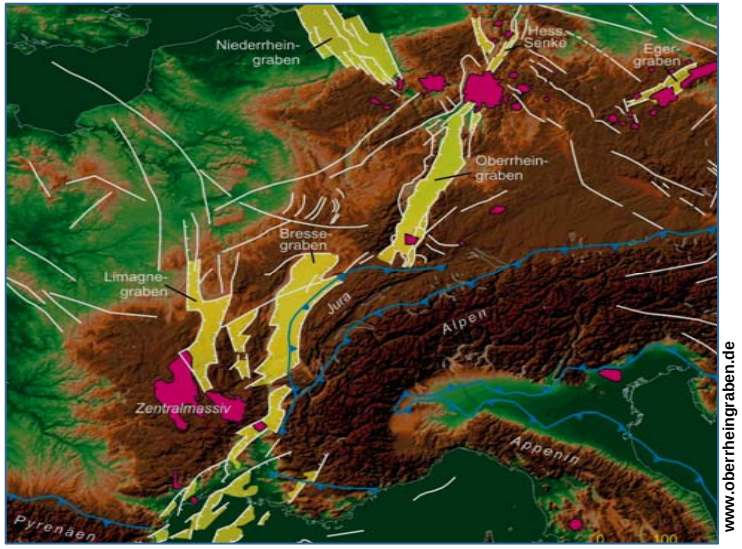
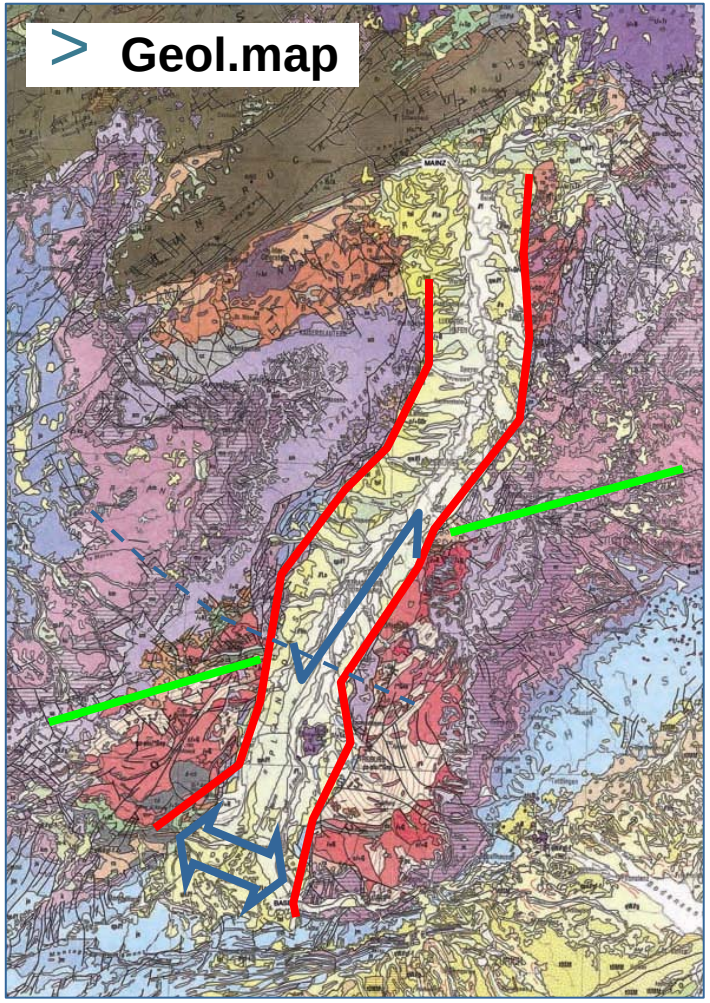
Geology of the URG 1

> Regional setting

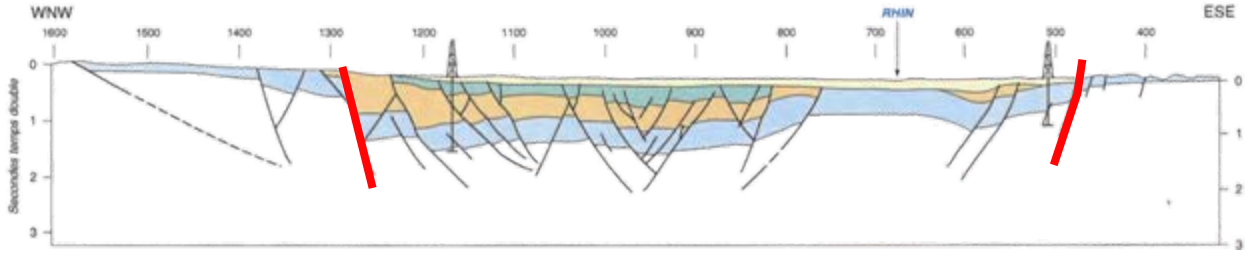


European Cenozoic Rift System

> Geol.map



> Cross-section



Geology of the URG 2

> Stratigraphic record

- 3.5 km of sediments
- unconformity at the base of the syn-rift sequence

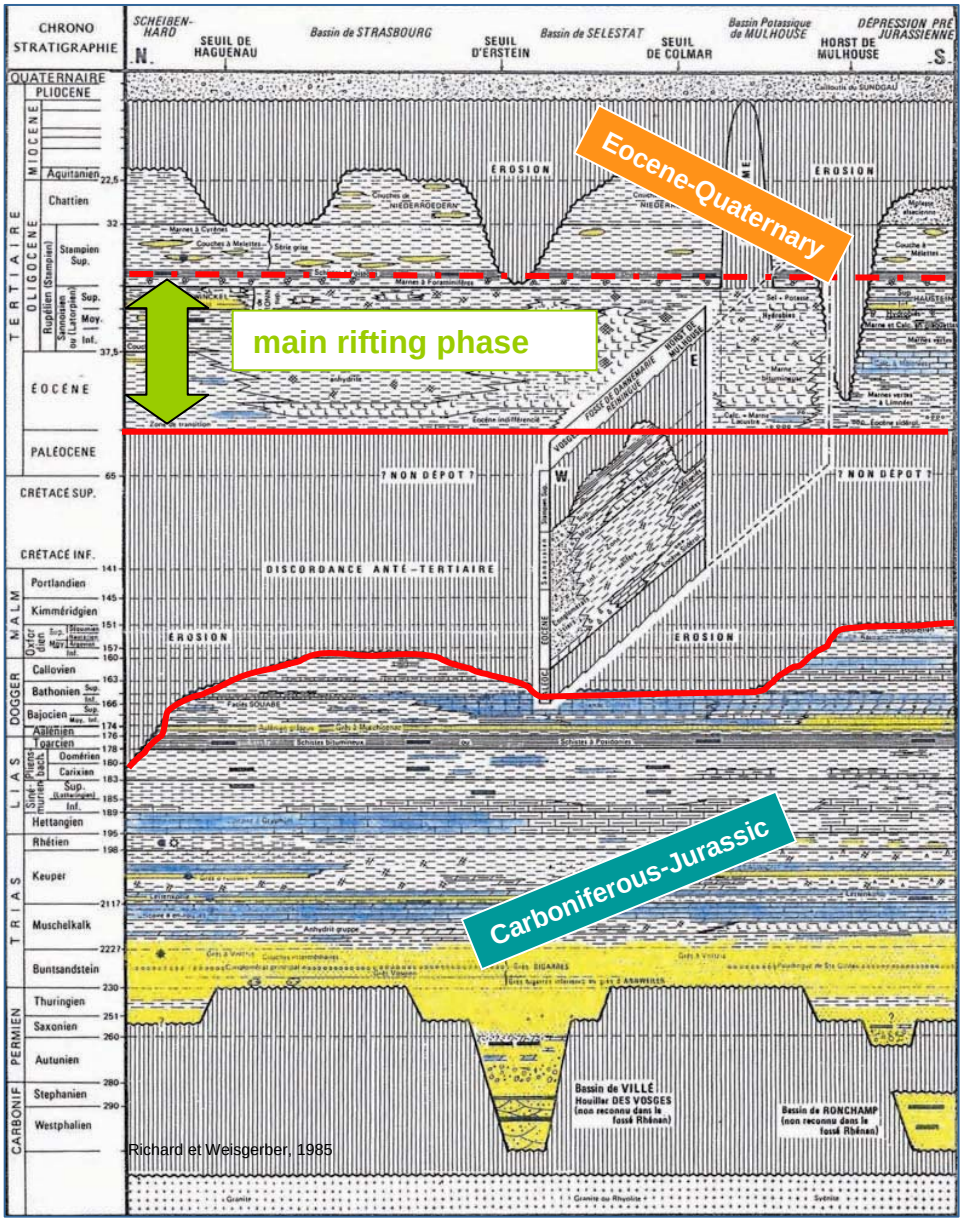
> Tectonic evolution

- main rifting phase between Late Eocene and Rupelian, E-W extensional regime
- Miocene: NW-SE compressional regime

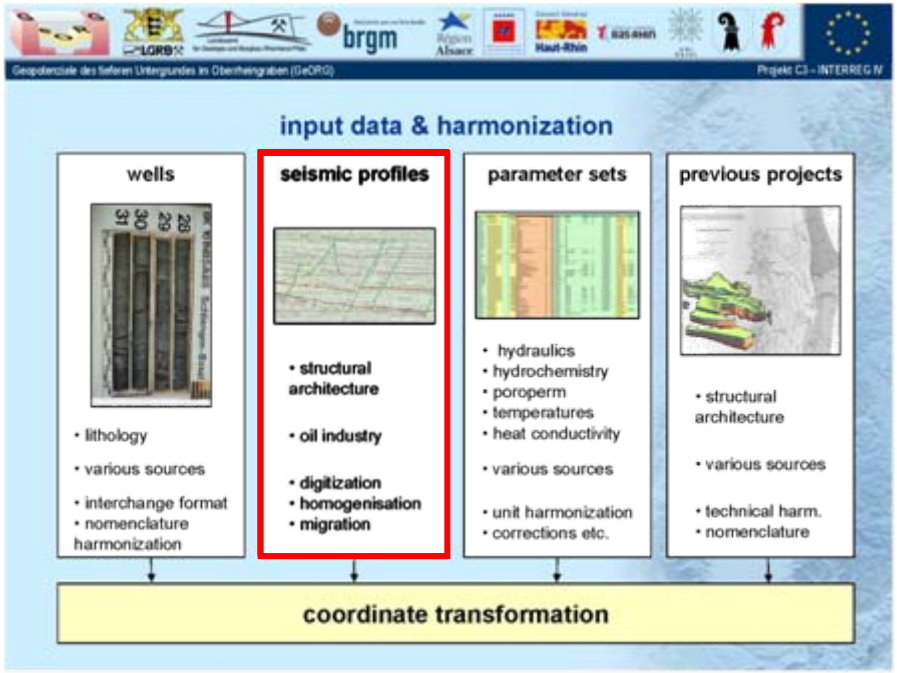
> Scientific issues

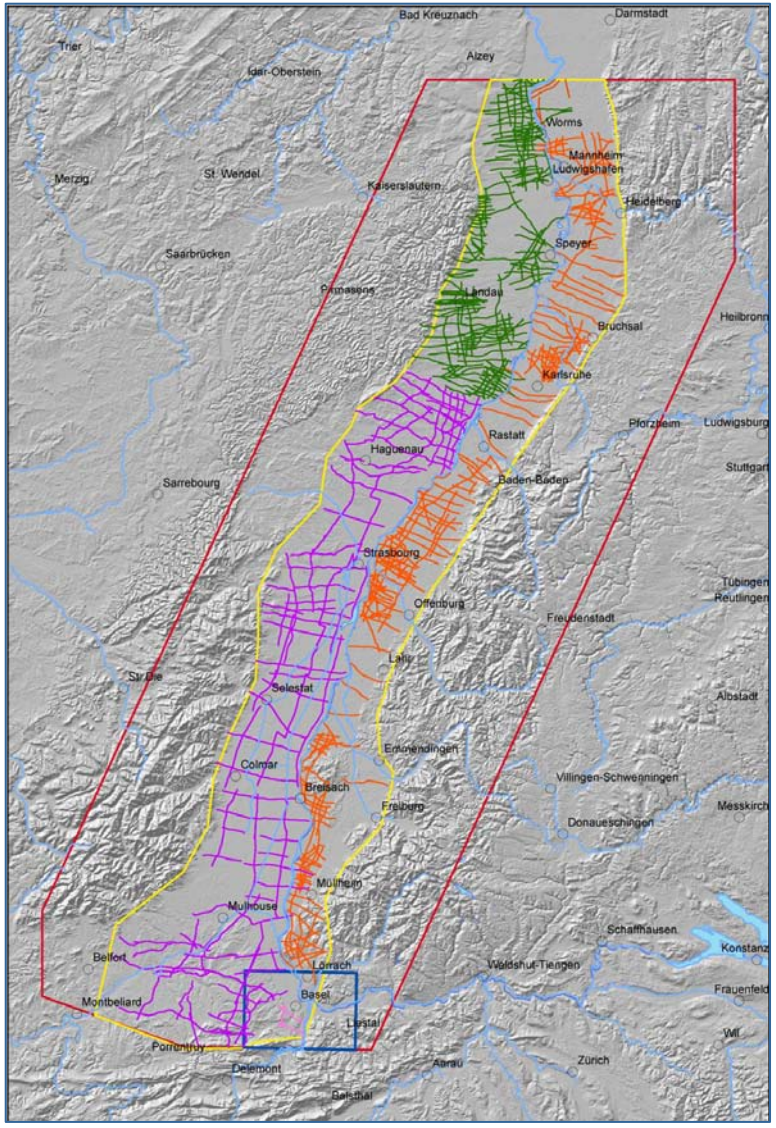
structural aspect

seismic study



Input data

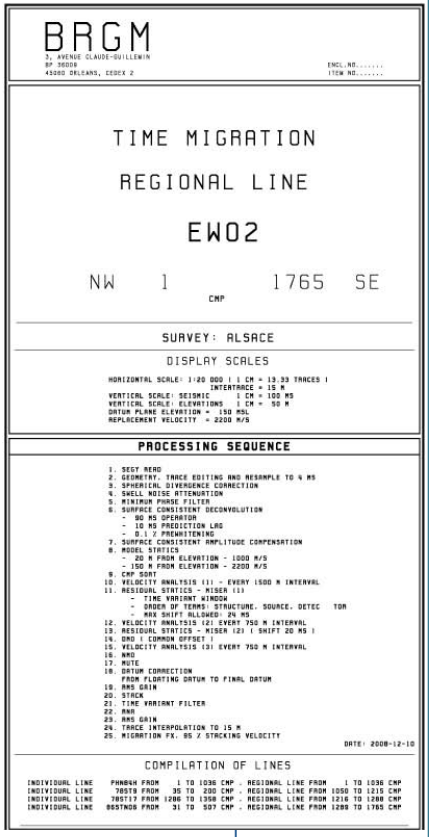




> **Seismic profiles**

- frame of the 3D model
- 521 reflection seismic surveys
- 5400 km…

Seismic lines – reprocessing 1


BRGM

TIME MIGRATION

REGIONAL LINE

EW02

NW 1 1765 SE

CMP

SURVEY: ALSACE

DISPLAY SCALES

HORIZONTAL SCALE: 1/20 000 (1 CM = 13.33 TRACES)
INTERTRACE = 15 M
VERTICAL SCALE: SEISMIC 1 CM = 100 MS
VERTICAL SCALE: ELEVATIONS 1 CM = 50 M
DATUM PLANE ELEVATION = 150 MSL
REPLACEMENT VELOCITY = 2200 M/S

PROCESSING SEQUENCE

1. SEGY READ
2. GEOMETRY. TRACE EDITING AND RESAMPLE TO 4 MS
3. SPHERICAL DIVERGENCE CORRECTION
4. SWELL NOISE ATTENUATION
5. MINIMUM PHASE FILTER
6. SURFACE CONSISTENT DECONVOLUTION
   - 90 MS OPERATOR
   - 10 MS PREDICTION LAG
   - 0.1 % PREWHITENING
7. SURFACE CONSISTENT AMPLITUDE COMPENSATION
8. MODEL STATICS
   - 20 M FROM ELEVATION - 1000 M/S
   - 150 M FROM ELEVATION - 2200 M/S
9. CMP SORT
10. VELOCITY ANALYSIS (1) - EVERY 1500 M INTERVAL
11. RESIDUAL STATICS - MISER (1)
    - TIME VARIANT WINDOW
    - ORDER OF TERMS: STRUCTURE, SOURCE, DETEC TOR
    - MAX SHIFT ALLOWED: 24 MS
12. VELOCITY ANALYSIS (2) EVERY 750 M INTERVAL
13. RESIDUAL STATICS - MISER (2) (SHIFT 20 MS)
14. DMO (COMMON OFFSET)
15. VELOCITY ANALYSIS (3) EVERY 750 M INTERVAL
16. NMO
17. MUTE
18. DATUM CORRECTION
    FROM FLOATING DATUM TO FINAL DATUM
19. RMS GAIN
20. STACK
21. TIME VARIANT FILTER
22. RMS
23. RMS GAIN
24. TRACE INTERPOLATION TO 15 M
25. MIGRATION FX. 95 % STACKING VELOCITY

DATE: 2008-12-18

COMPILATION OF LINES

INDIVIDUAL LINE PHN84W FROM 1 TO 1036 CMP . REGIONAL LINE FROM 1 TO 1036 CMP
INDIVIDUAL LINE 76ST9 FROM 35 TO 200 CMP . REGIONAL LINE FROM 1050 TO 1215 CMP
INDIVIDUAL LINE 78ST17 FROM 1206 TO 1358 CMP . REGIONAL LINE FROM 1216 TO 1288 CMP
INDIVIDUAL LINE 85STN05 FROM 31 TO 507 CMP . REGIONAL LINE FROM 1288 TO 1765 CMP

> Modern reprocessing - methods

- new algorithms (migration)
- improvement of the existing algorithms
- improvement of the static & dynamic corrections

> German side

- stack or migrated data
- digitization of scan files
- homogenization
  - (rms amplitude gain, datum)
- migration of stack data

> French side

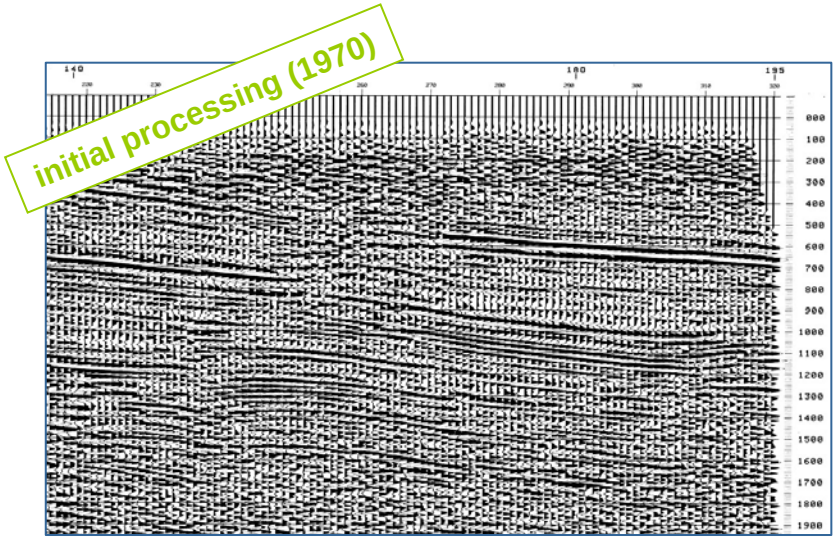
- full reprocessing of the raw Seg-Y data

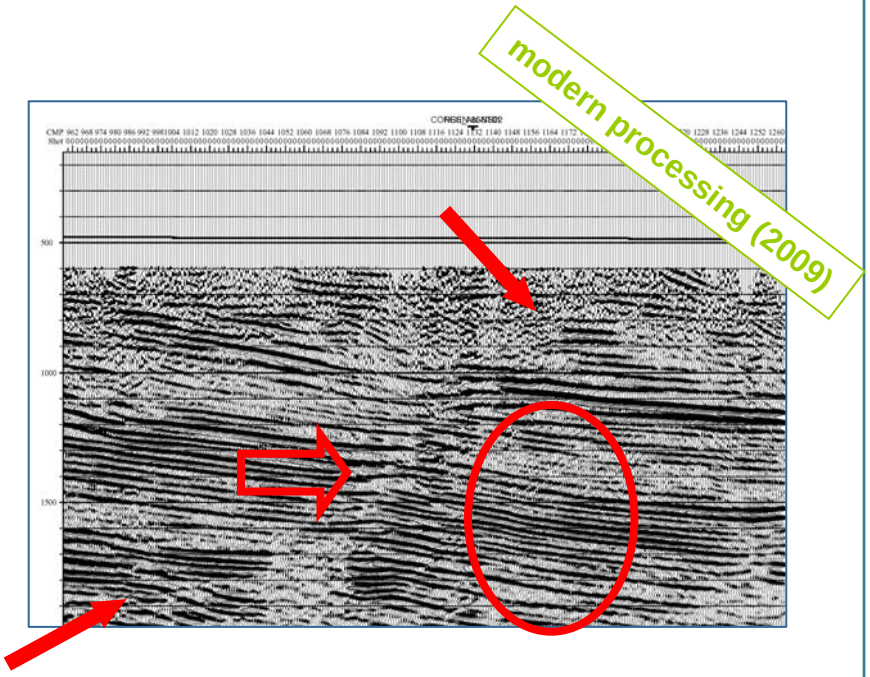
In both cases,
the seismic sections were finally exported in the standard Seg-Y format,
ready for interpretation.

Seismic lines – reprocessing 2

> Modern reprocessing - results

- improvement of the resolution & continuity of reflectors
- improvement of the resolution and display of faults and fault zones
- improvement of the display of near-surface and deep areas

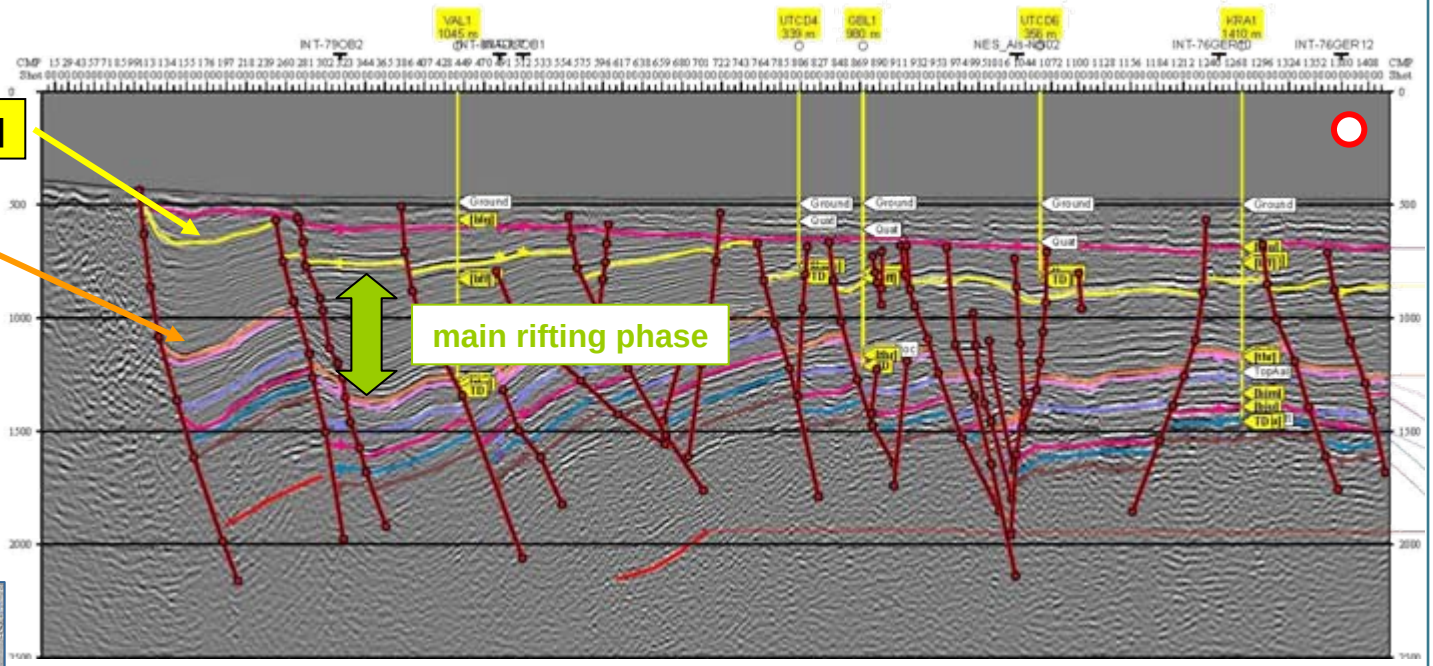


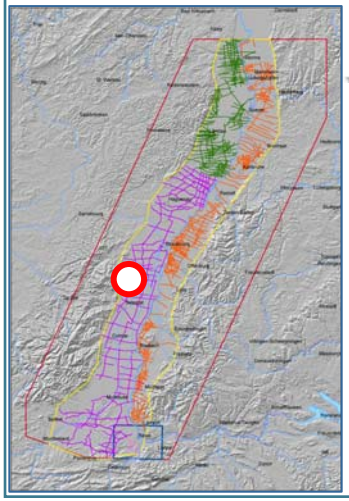


Seismic lines – interpretation 1

Seismic lines – interpretation 2

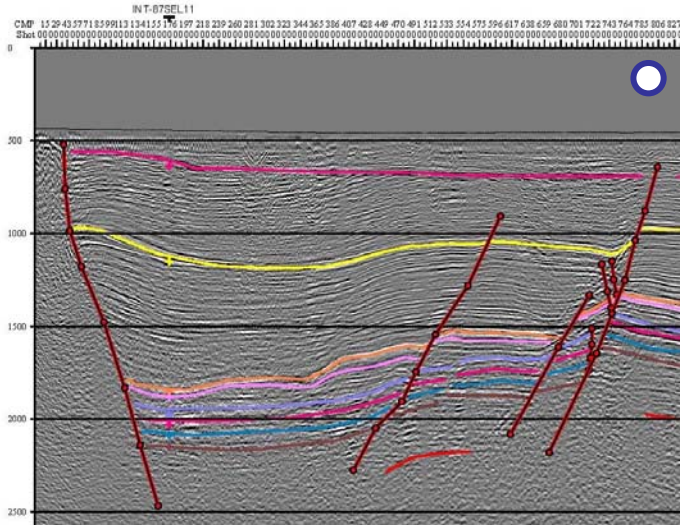
> Fault density



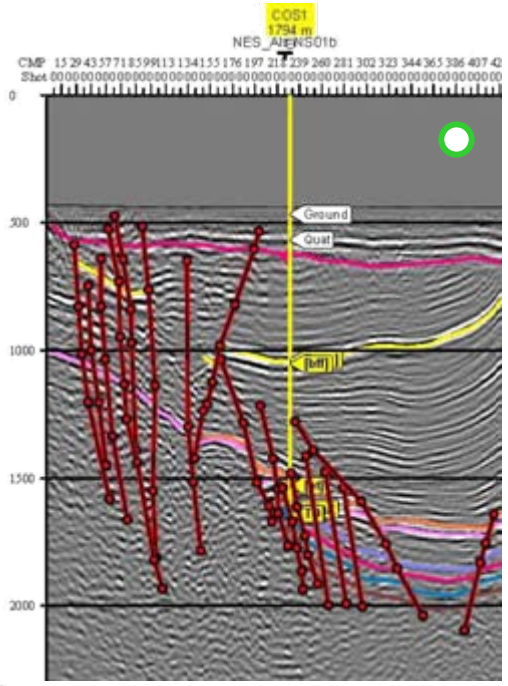


Seismic lines – interpretation 3

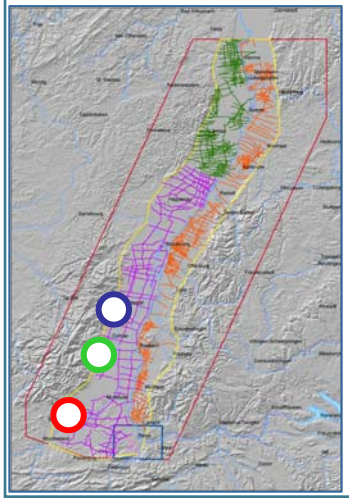
> 2D-typology of border faults

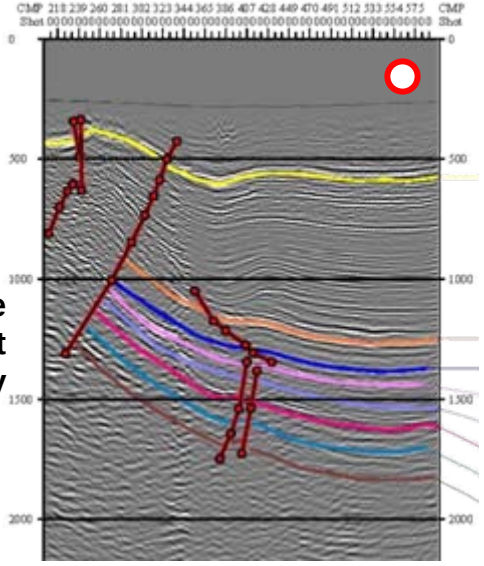


Normal fault geometry



Strike-slip fault geometry

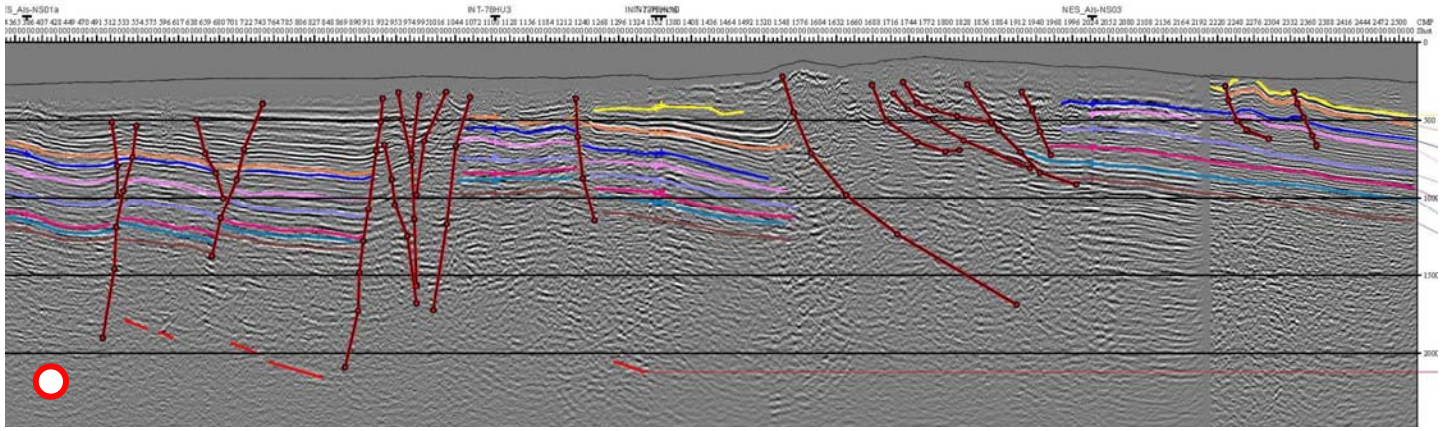




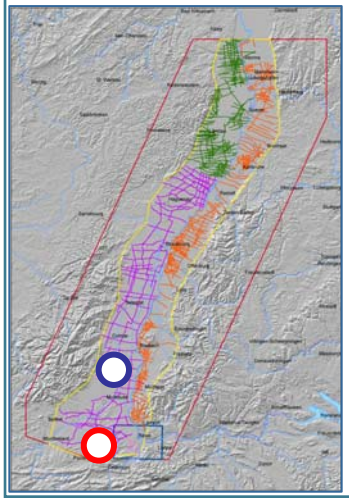
Reverse fault geometry

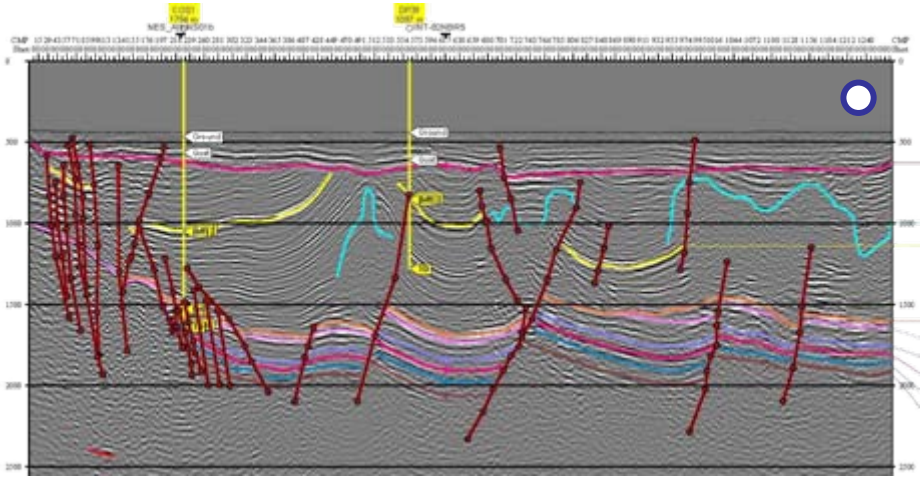
Seismic lines – interpretation 4

> Thrust faults



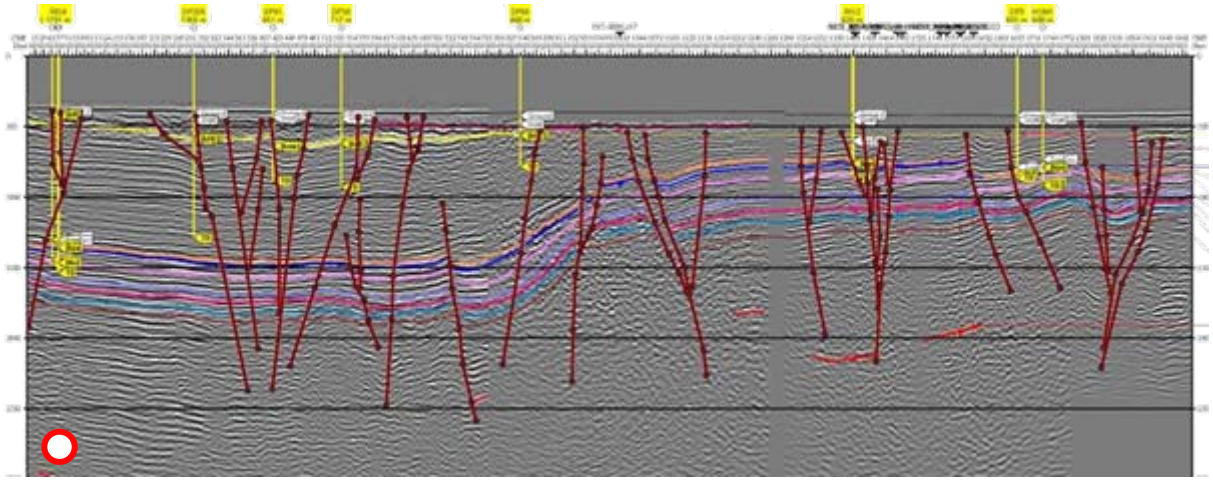
> Salt domes

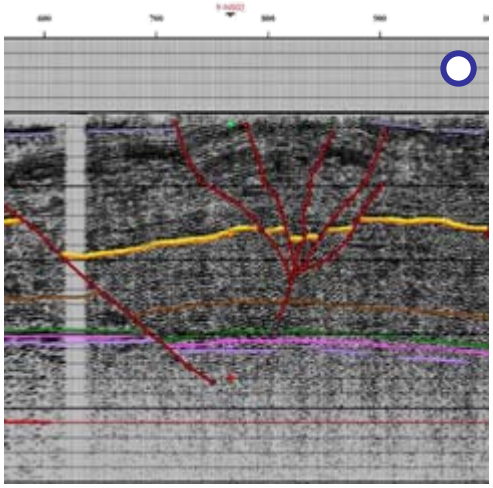


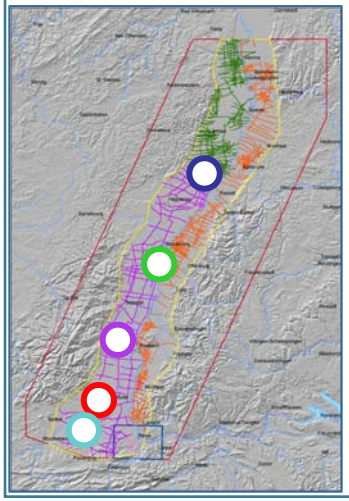


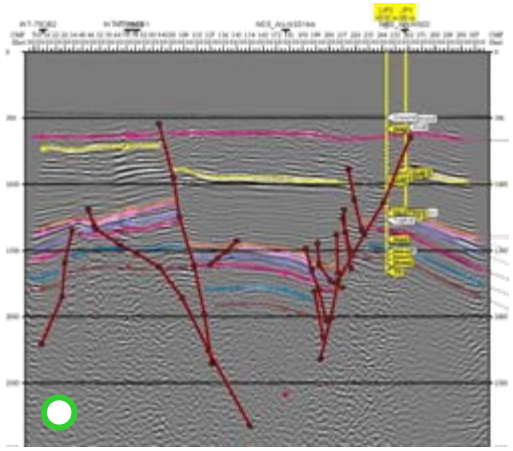
Seismic lines – interpretation 5

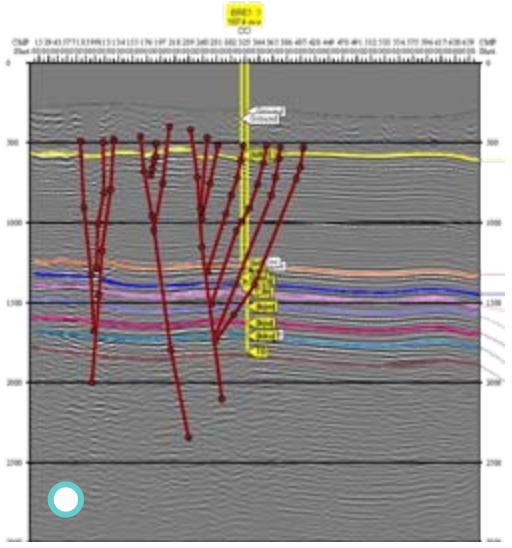
> **Strike-slip structures - negative flower structures**

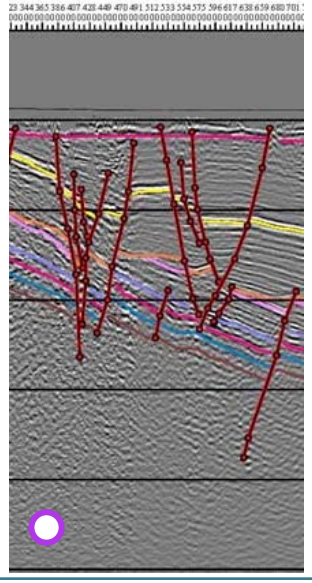












Seismic lines – conclusion

- **High normal fault density**
  - most of the faults cross-cut the entire Cenozoic sedimentary sequence
  - syn-rift thicknesses are more or less constant

- **Numerous occurrences of strike-slip features**
  - they occur at various scale

they obliterate the original normal faults

they are the most recent features

they may be related to the Early Miocene to present NW directed compressional regime

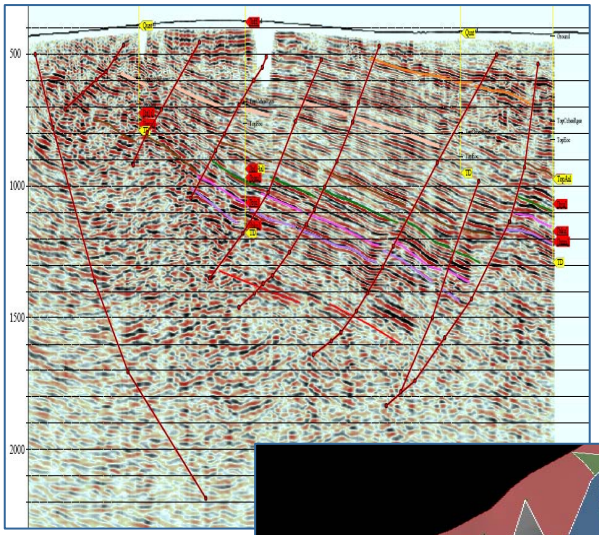
.The present-day URG geometry has nothing to see with the inital rift geometry

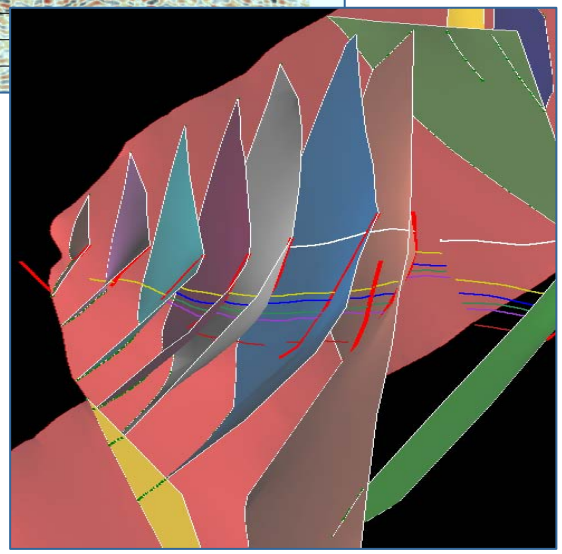
.The density of faults may have been lower during the initial rifting stage

First draft of the 3D-model 1

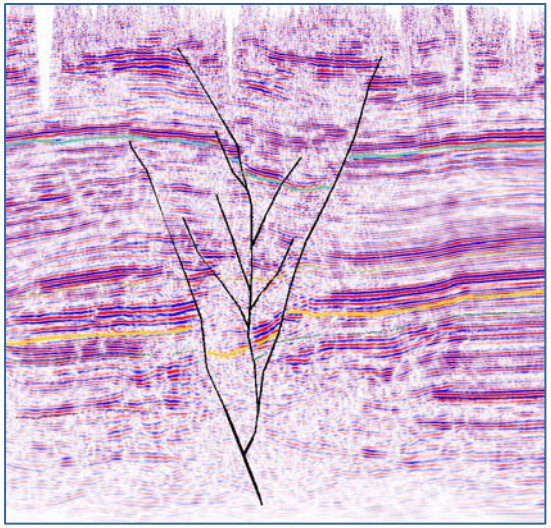
> Structural pattern

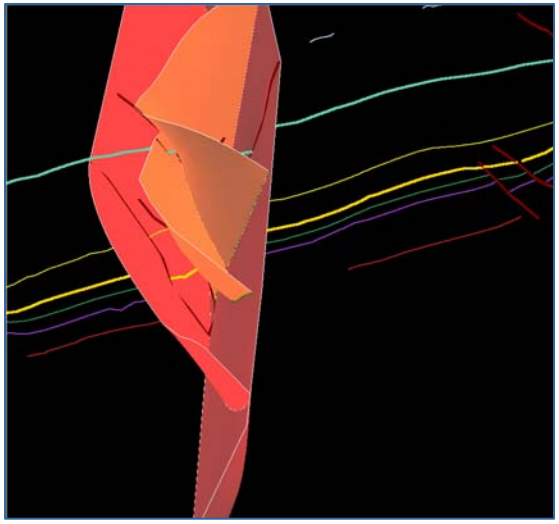
- example of normal faults





- example of a flower structure





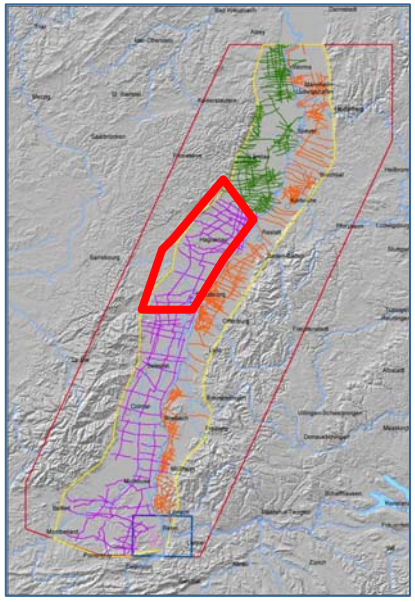
First draft of the 3D-model 2

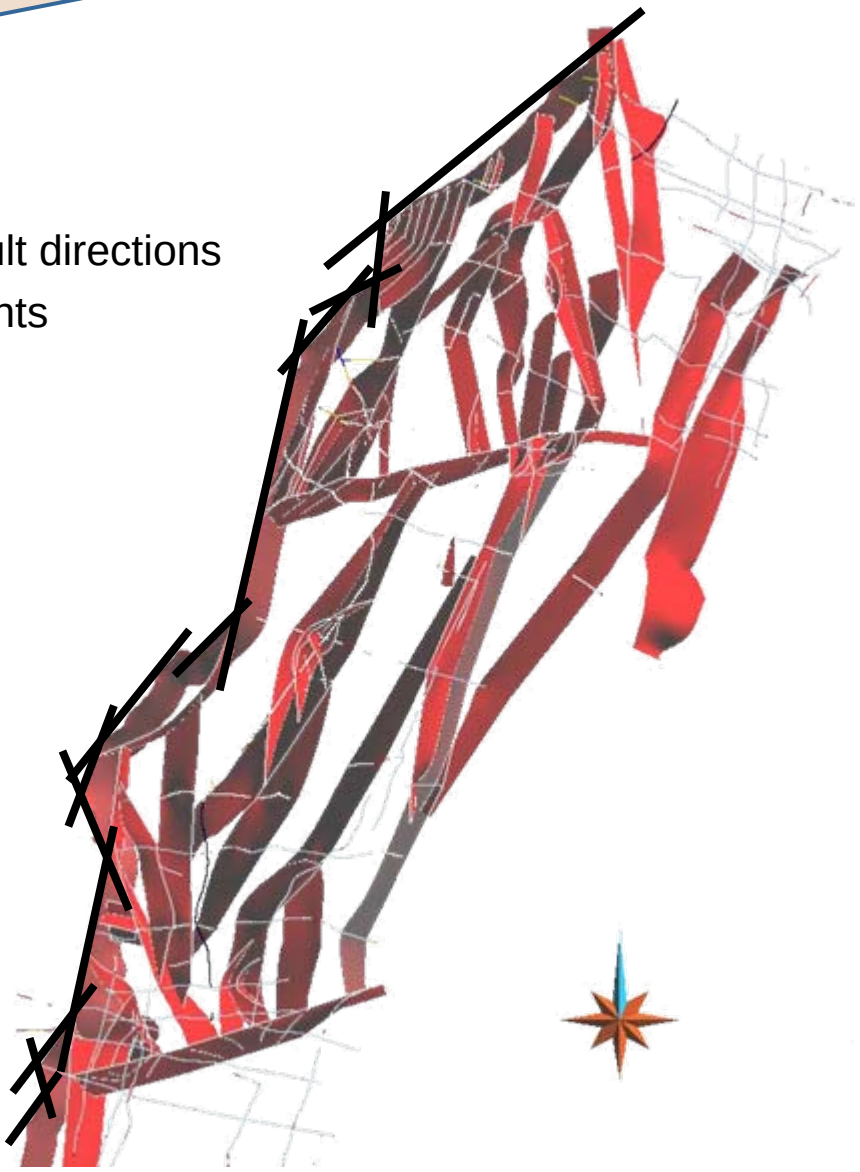
> Structural pattern

- extreme spatial variability of the fault directions

  ► numerous « short » fault segments

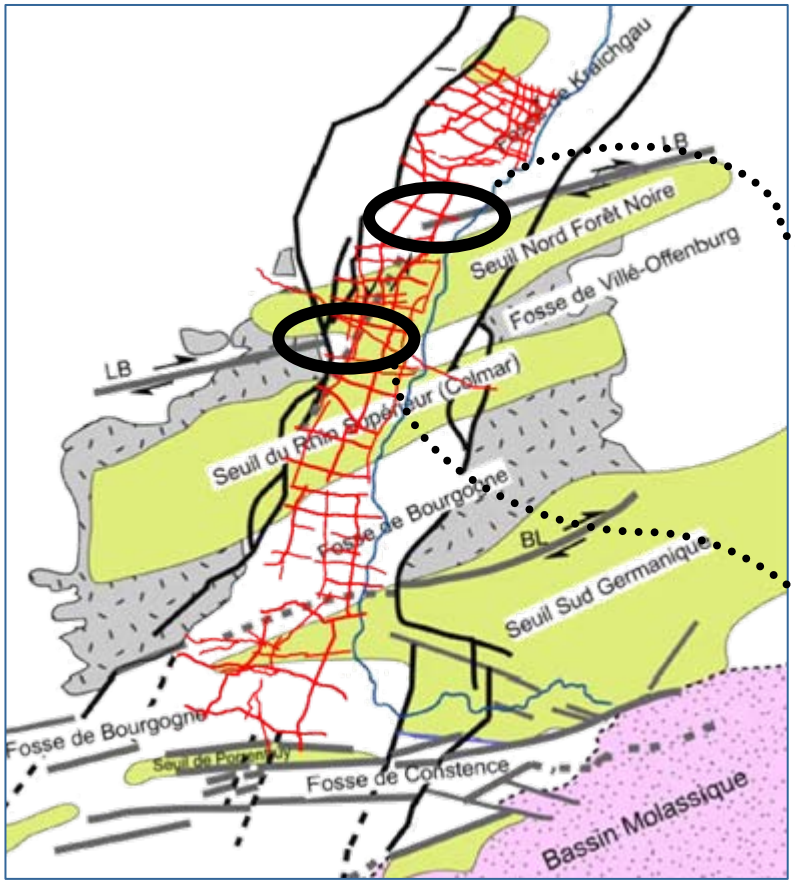
  eg. Western border fault



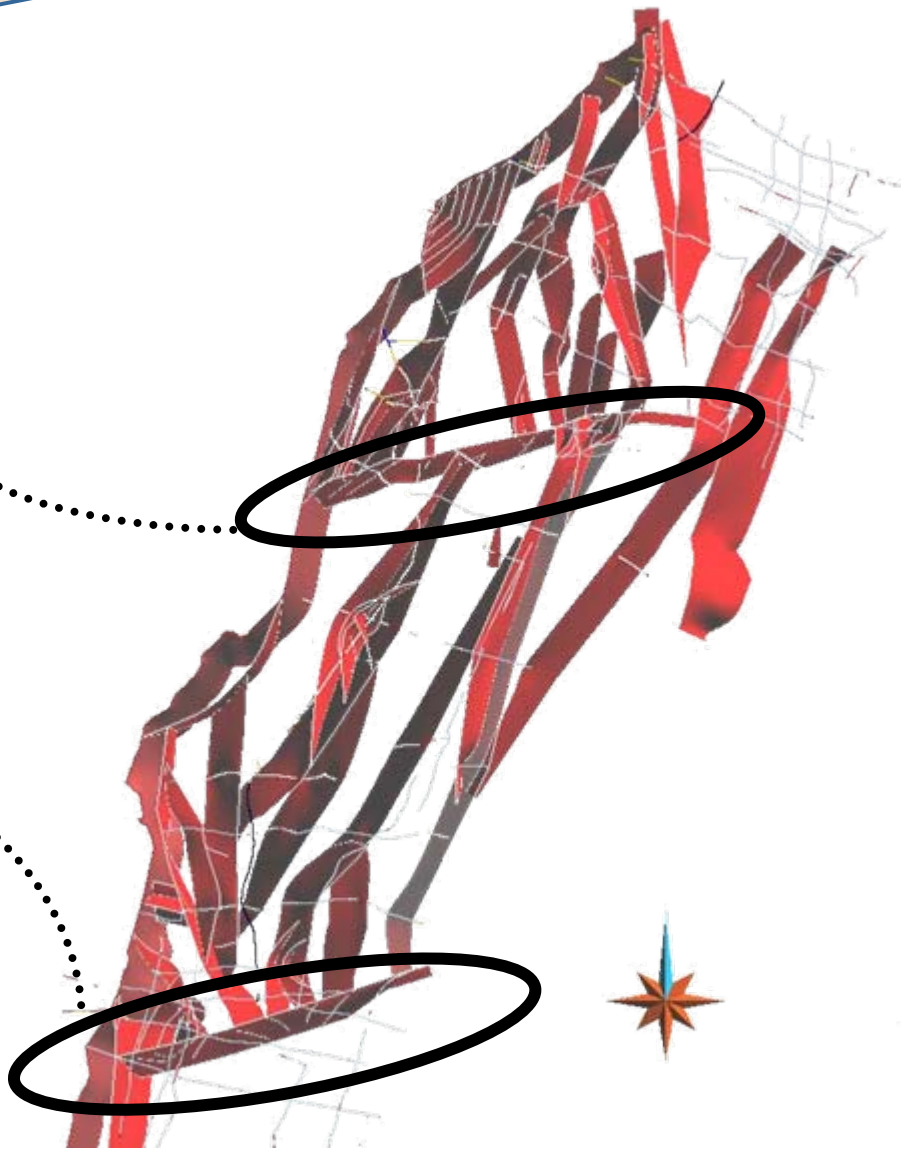


First draft of the 3D-model 3

> **(Late) Variscan inheritance**



Modified from Rousset, 2006



To conclude

> **will give a modern view of the 3D geometry of the URG**

- … big amount of available seismic profiles…

> **Several potential scientific interests:**

- Building the present-day geometry forces to think about the pre-existing structural patterns and geological history of the URG

► ***increase the knowledge on the tectono-history of the URG***

… Many thanks for your attention…