ET EMR: E-TEST general objectives, geological conditions and hydrogeophysical imaging

Einstein Telescope EMR Site & Technology

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Outline

- **Overall project objectives**
- Site perimeter
- Key geological conditions
- Need for geophysical imaging
- Hydrogeophysical tests and groundwater model
- Future timeline
New data, database, models and design

Cross-border database
• Existing boreholes
• New structural data
• New boreholes
• New geophysics
• New geomechanical tests
• New hydraulic tests

New data
• 5 drillings including an observatory (2) for :
  • Geological exploration
  • Seismic vibrations monitoring
  • Hydrogeophysical tests

Underground models of the geology with different scopes:
• Engineering geology
• Groundwater
• Seismic noise

ET design in the EMR region

Jan 20    July 23
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Perimeter of study
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Geology dependent conditions

Soft rock to damp ambient noise

Hard rock to host ET subsurface cavern

Surface access building

Fault zones / Karst

ET subsurface cavern

Ambient noise in the subsurface
Structural geology

- Deeper and older rocks from Paleozoic are expected to be highly folded and faulted (ca. NE-SW-oriented Paleozoic folds and faults; ca. NW-SE-oriented Cenozoic faults).

- Those rocks are covered by 50-150m of younger soft sediment

Open-source geomodeling in Python gempy (www.gempy.org), developed at CGRE, RWTH Aachen University (de la Varga et al., 2019)
Lithology

- Cretaceous to Quaternary sediment, claystones and weakly lithified sandstones (clastic Aachen and Vaals Formations); Cretaceous chalk with flint layers (calcareous Gulpen Formation, Cretaceous), and various Quaternary alluvium and loess > dampering rocks
- Upper Carboniferous (Westphalian) shales, siltstones, sandstones and conglomerates;
- Upper Carboniferous (Namurian) sandstones, shales and quartzites;
- Lower Carboniferous (Visean) limestones;
- Lower Carboniferous (Tournaisian) limestones, dolomites and shales
- Upper Devonian (Famennian) shales, quartzitic sandstones, quartzites;
- Upper Devonian (Frasnian) limestones and shales.

Due to paleogeography and/or erosion, some stratigraphic units may be missing in parts of the subsurface of the study area.
Critical points

• Younger rocks important for later-stage access to corner points, groundwater issues, and drilling stability

• Limestones pose a karstification issue that need to be identified

• Find suitable rocks to hold the caverns

(see F. Amann talk later on)
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Multiscale surveys

- Fault mapping, fold mapping,
- Stratigraphic interpretation
- Correlation of potentially (and most likely) highly inclined, bended and disrupted seismic reflections of variable lithology.
- Direct link with 3D geological model incl. uncertainty (e.g. Wellmann & Caumon, 2018)
Multimethod survey

- Detailed imaging of "shallow" layers
- Identify potential karstic areas at depth
- Map faults at shallow depths
Seismic parameters quantification

- Seismological measurements with single and multiple stations
- Estimates Vs-logs typically beyond 80 m. (and for very large arrays down to 400-500 m).
- Seismic noise at surface and depth

See also S. Koley talk and F. Amann
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Why studying hydrogeological conditions?

- Groundwater is a key factor for any successful underground project.
- It is mainly controlled by strata discontinuities
- Controlling water inflow is critical for both the construction phase and the exploitation phase
- It is a critical input for the design of the Einstein Telescope
A cross-border EMR groundwater model enables sustainable management of ecosystem services:

- Water abstraction
- Shallow geothermy potential
- Environmental impact assessment
Hydrogeophysical observatory and monitoring public database

- Identify a site to host the underground R&D lab (Hombourg)
- Installing electrical, hydraulic and seismic sensors for monitoring the subsurface of the EMR
  - Gather seismic noise data
  - Perform hydrogeophysical tests
- Calibrate the EMR groundwater and seismic noise models
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To follow our activities: https://www.etest-emr.eu/

• Seismic vibrations campaign (windfarms and fault): works start in december 2020
• Drillings, testing, observatory installation: works start in february 2021
• Seismic lines: works start in 2021
• Deep ERT/IP: works start in spring 2021
• Deep SRT/Arrays: works start in 2021
• GIS
• 3D geological model (BIM)
• 3D hydrogeological conceptual model
• ...
Thank you!

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By investing EU funds in Interreg projects, the European Union invests directly in economic development, innovation, territorial development, social inclusion and education in the Euregio Meuse-Rhine.