Ultra Deep Geothermal (UDG) Heat for Industrial Steam in The Netherlands

Guus Willemsen

IF Technology

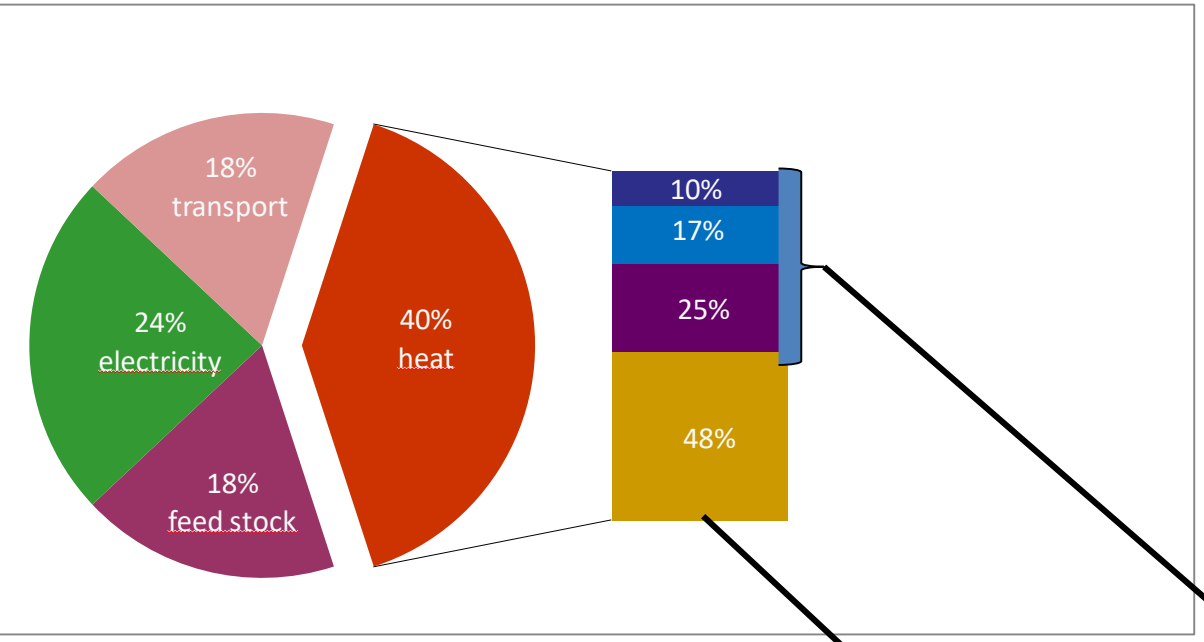
DAP Symposium

Election day March 15th, 2017

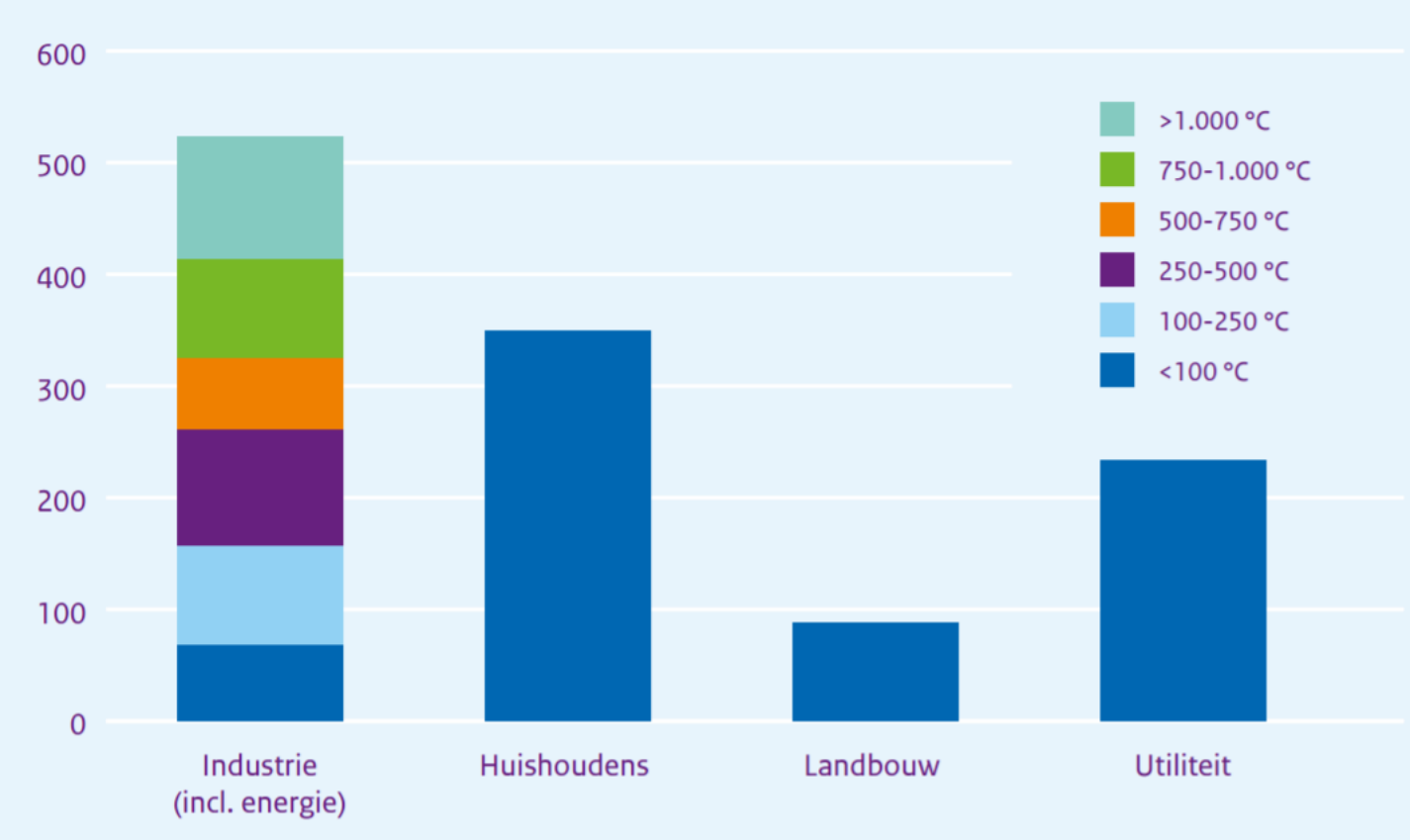
IF Technology: geothermal consultants and engineers

- Since 1989 in Arnhem
- 65 people
- Specialized in
  - Shallow and deep geothermal energy
  - Subsurface thermal energy storage
  - Thermal energy from surface water

Primary energy consumption in NL: 3.200 PJ/year

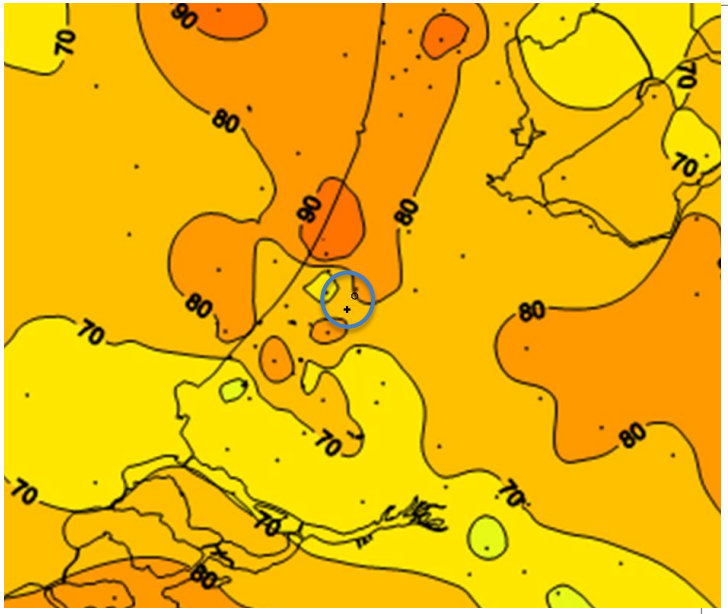


Heat demand in PJ/year in NL and temperature of demand

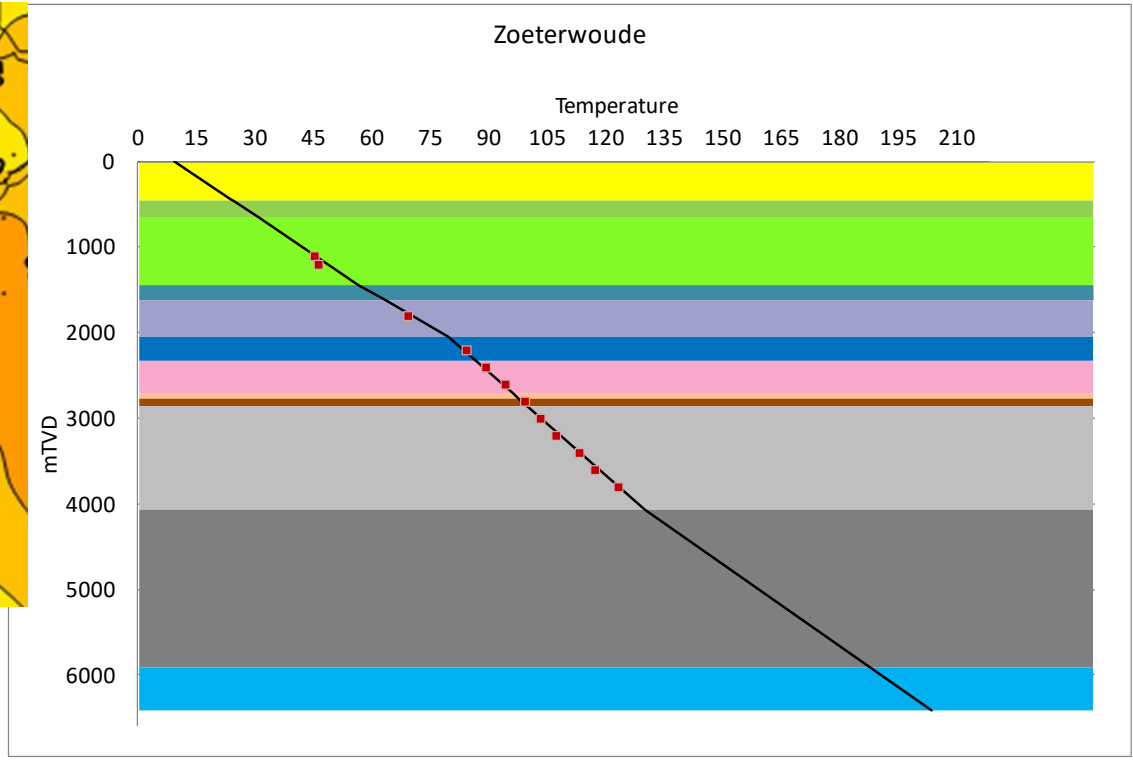


Looking for 120 to 200 C water

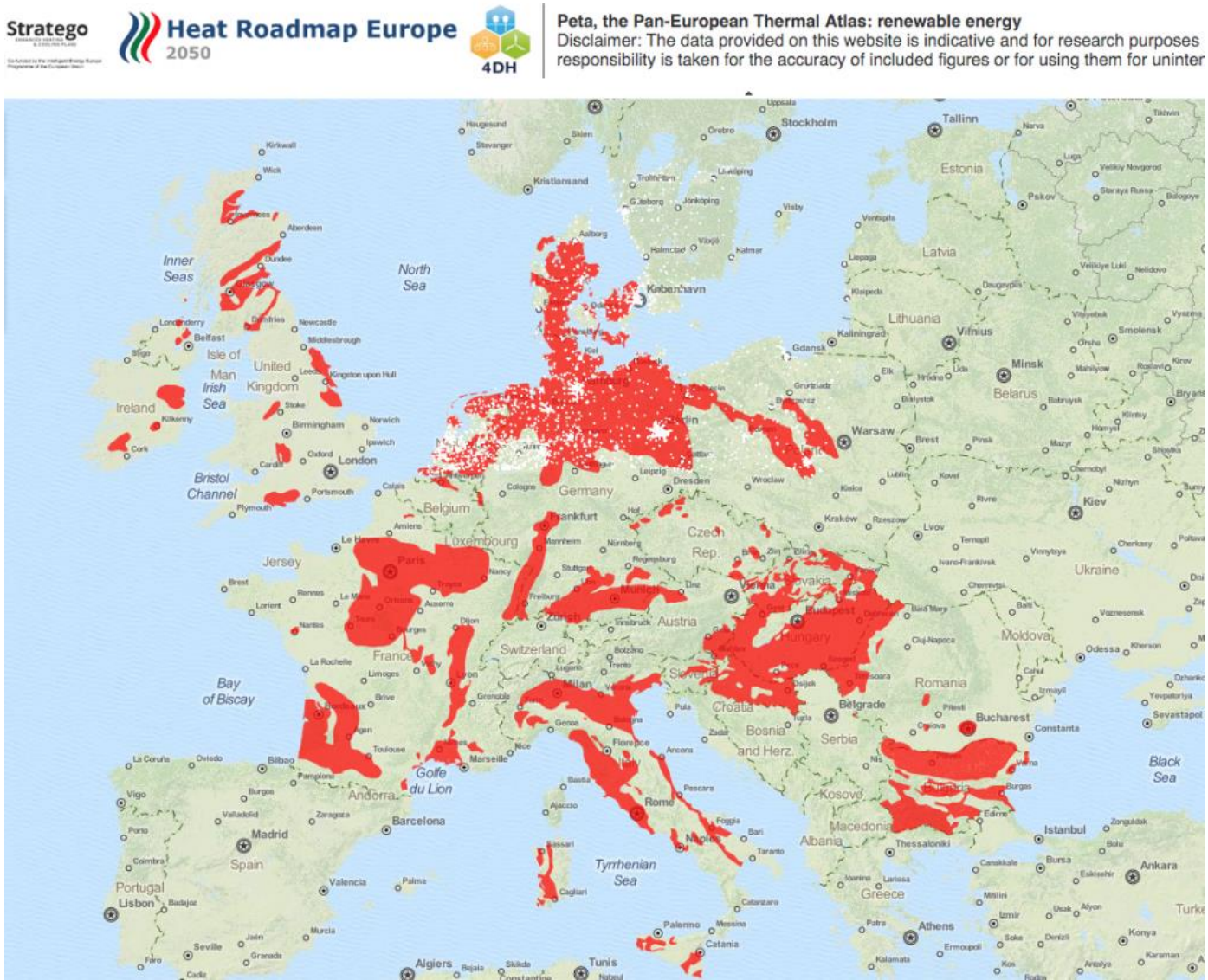
Heat flow in mW/m2



Temperatures measured and modeled



Geothermal potential in EU (and in NL) is in sandstones and in limestones

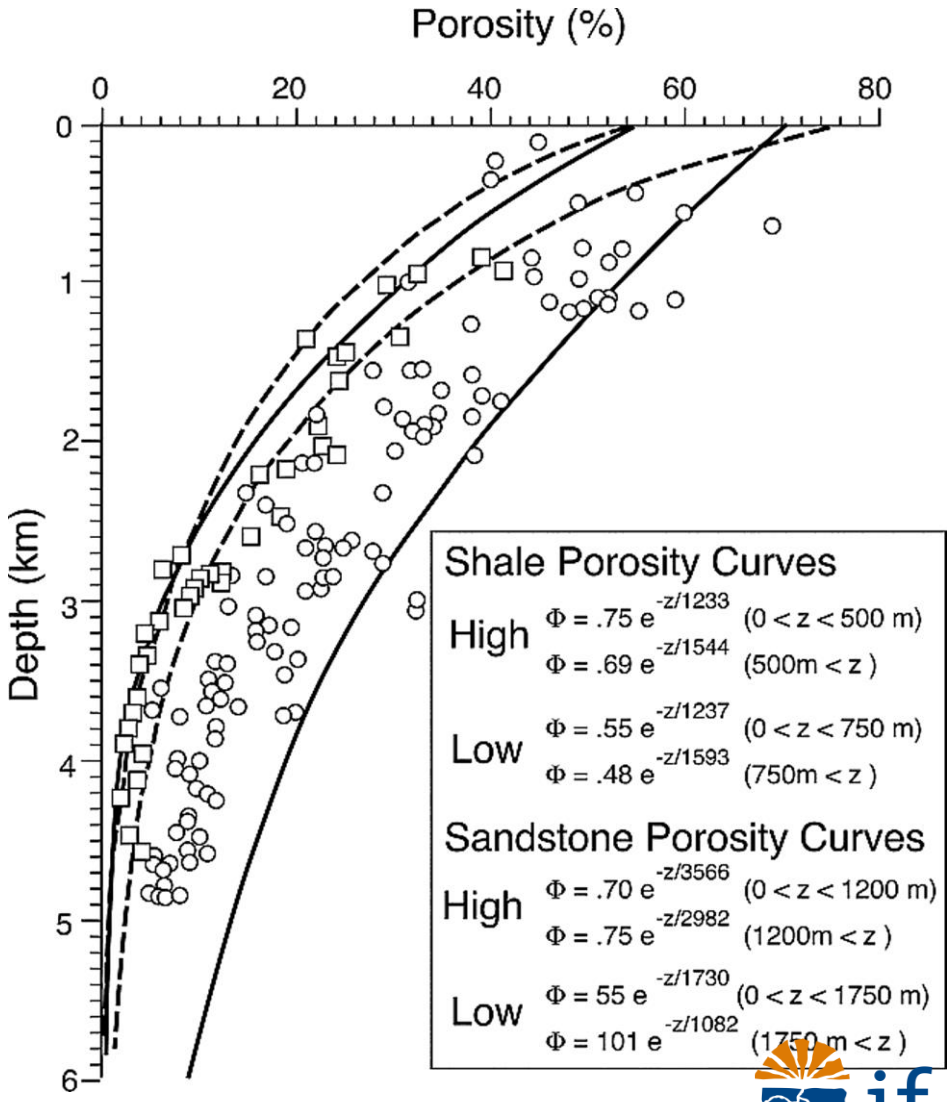


15 Projects in NL: 13 in sandstones, 2 in limestones

1 project in B (Mol) in limestones

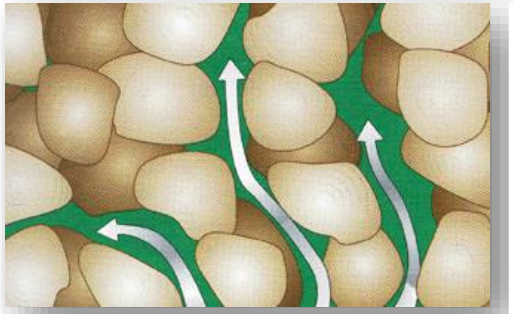
Permeability is the key factor

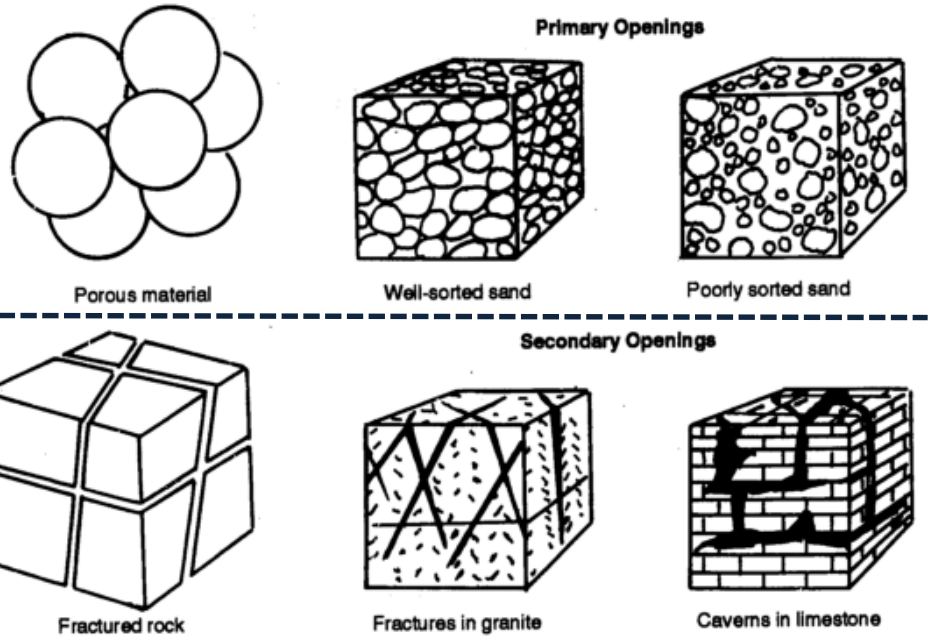
- Primary permeability decreases with depth



2 types of permeability; for UDG (> 4 km) we need secondary permeability

Natural primary permeability





Natural secondary permeability

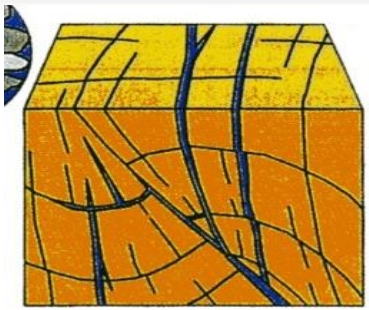
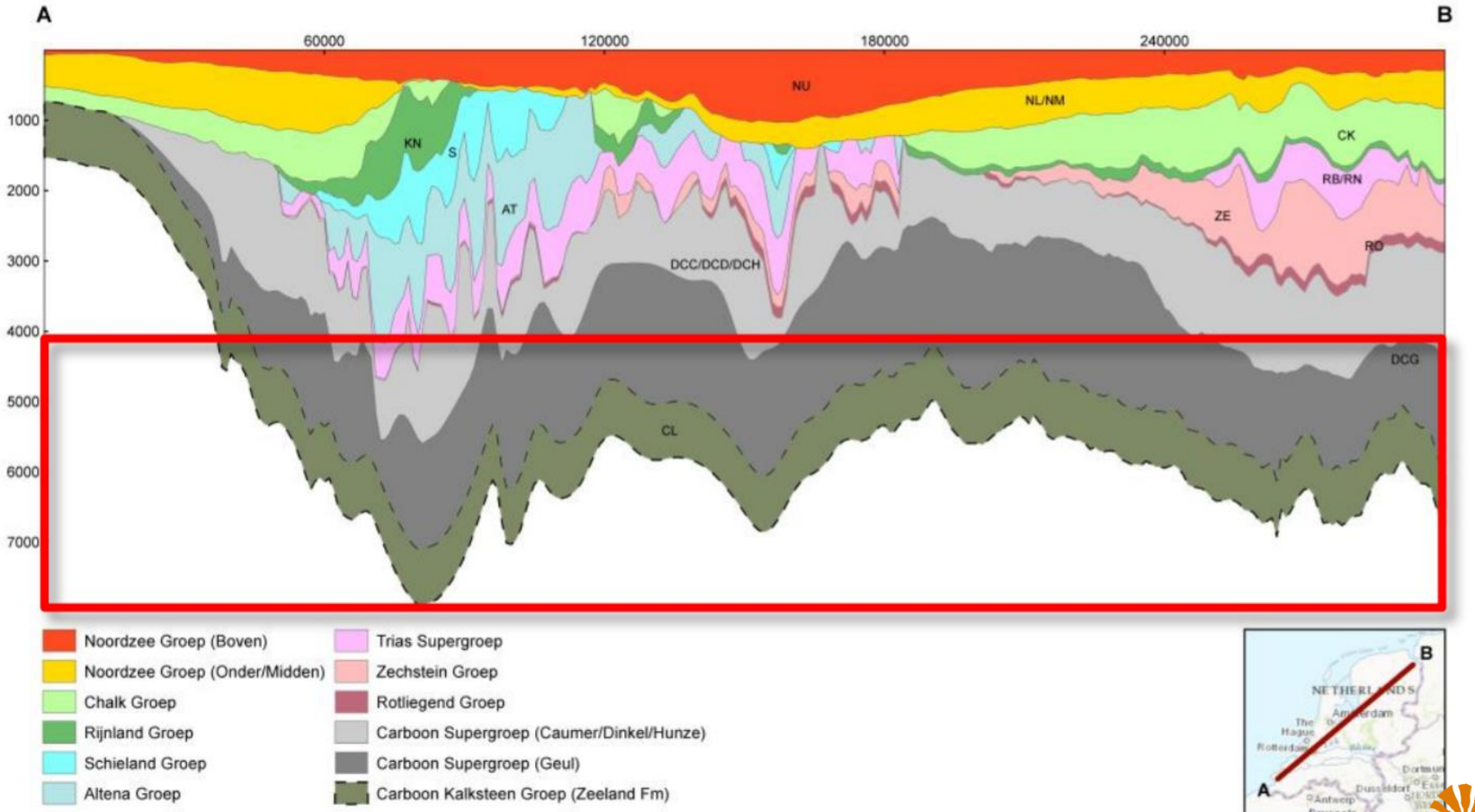
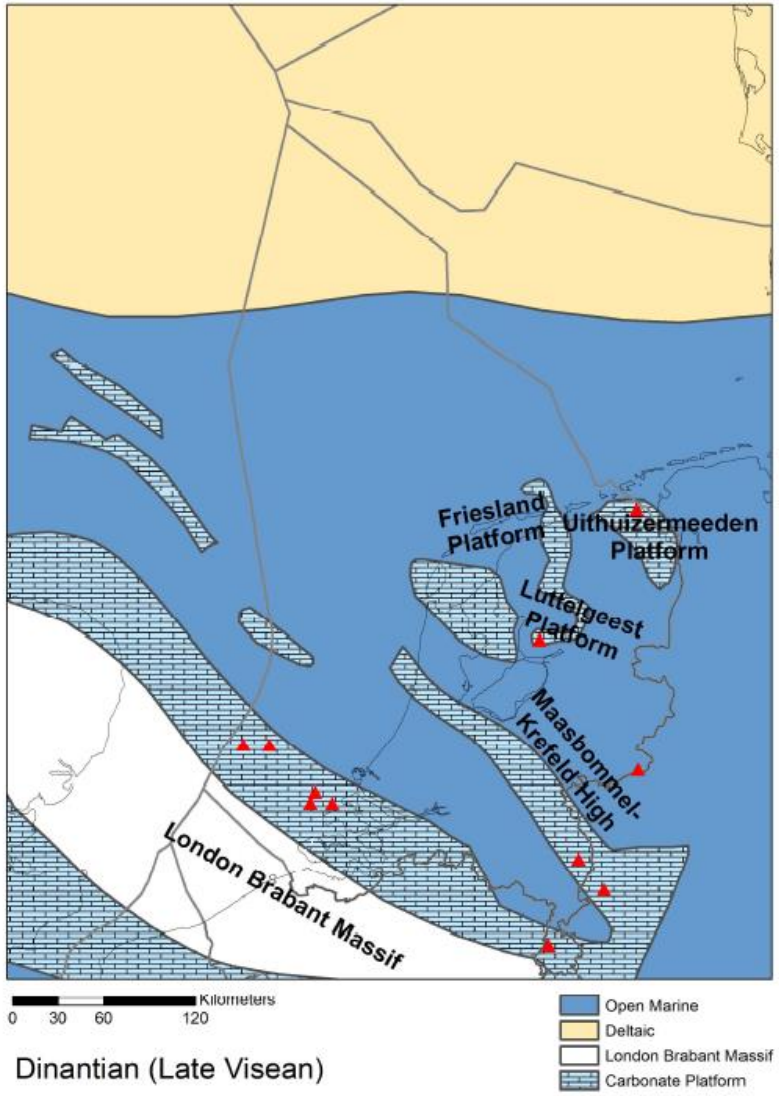


Figure 2-5. Primary and secondary openings

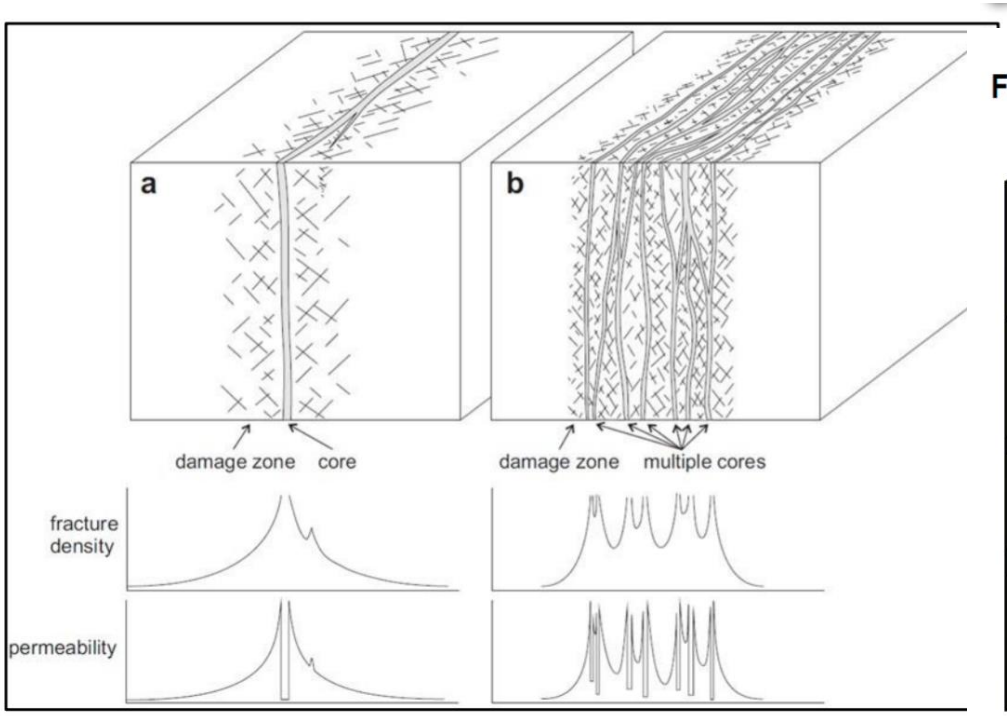
Dinantian limestones (Venlo and Mol reservoir) most interesting target for UDG

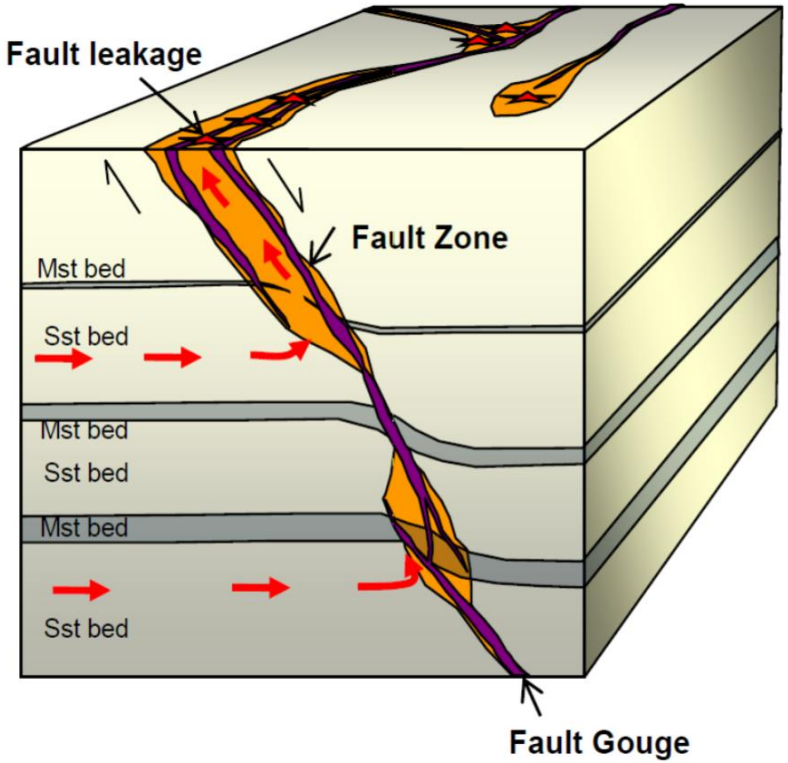


Is it limestone? And does it have permeable fractures?



Fault zone permeability



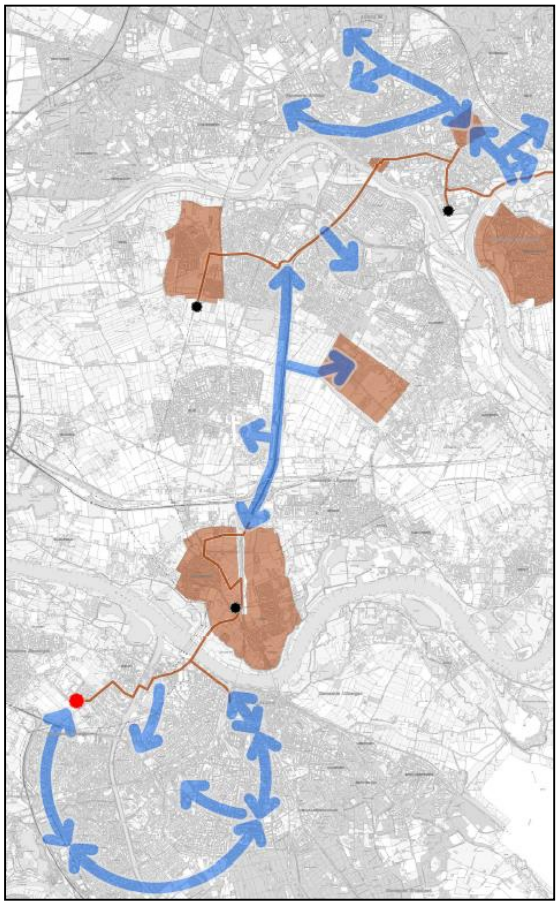


Fault zone permeability

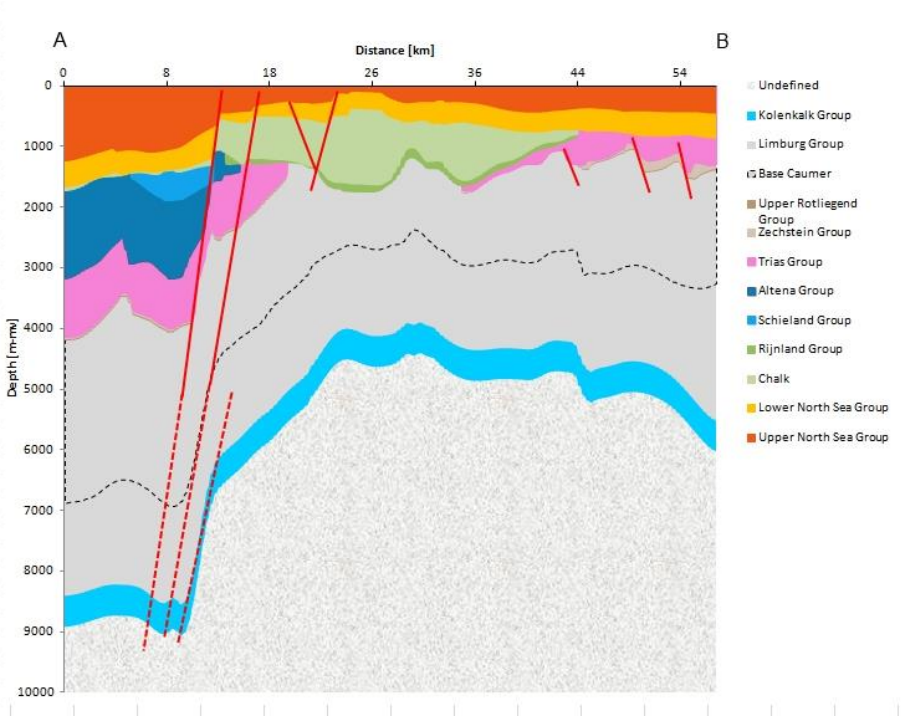
- Rock properties/rheology, temperatures and fluid compositions
- Old faults can be cemented, recent activity increases the likelyhood of permeability
- Orientation of fault <-> stress field: dilation tendency
- Permeable faults in limestones can induce karst

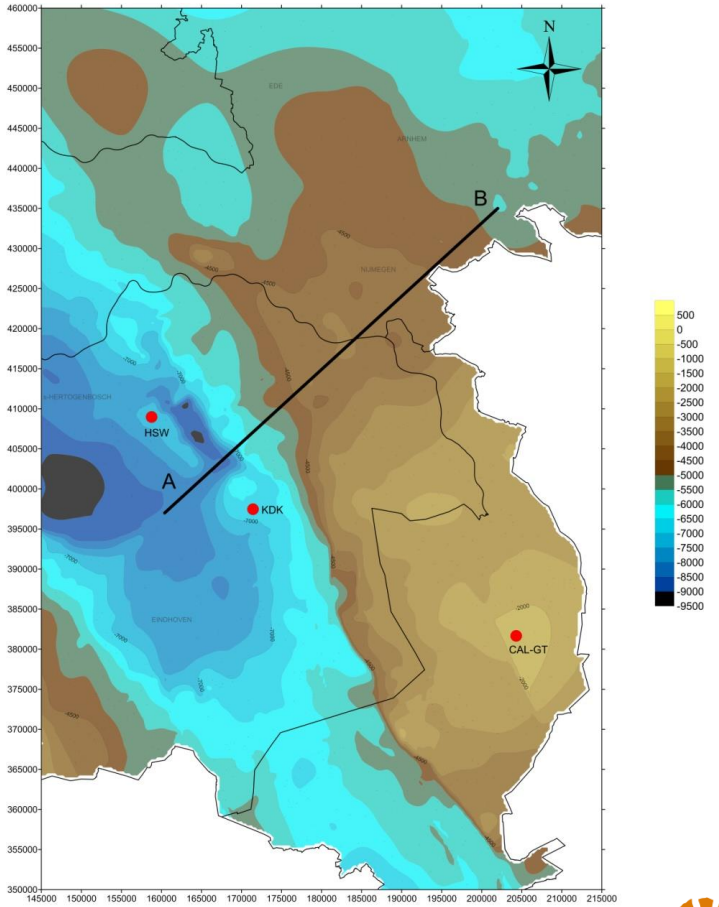
Example of first step in exploration for permeable fault zones in Dinantian limestones

- Geothermal heat for district heating in Nijmegen

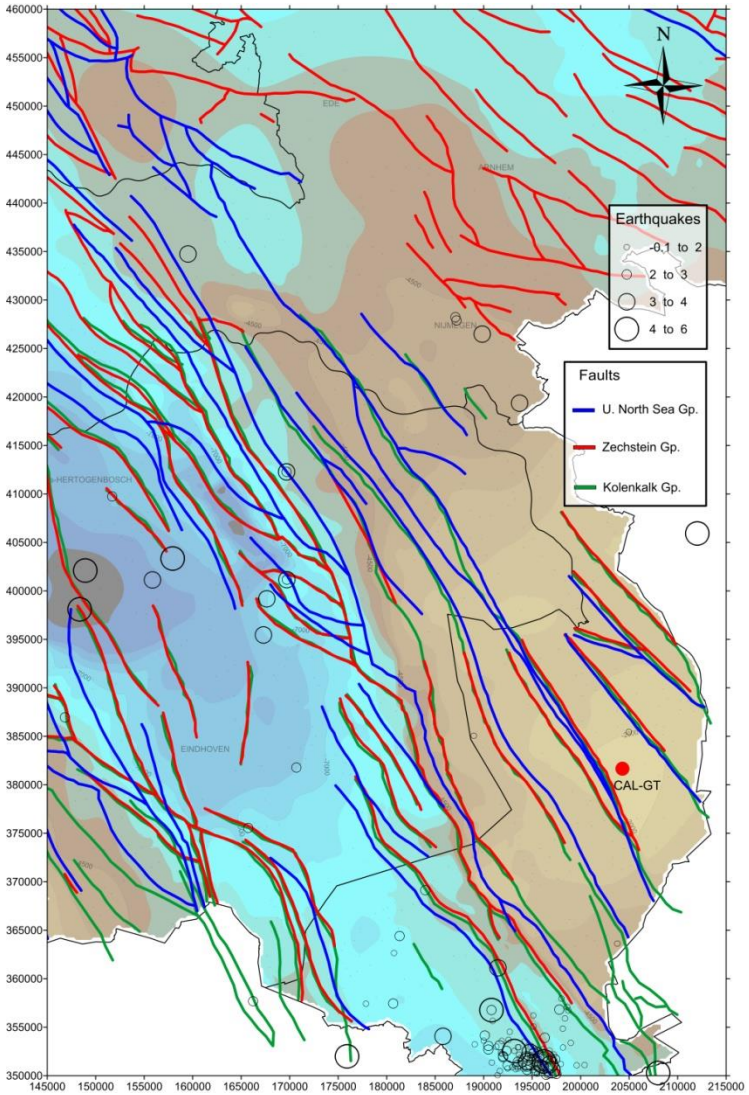


Succesful geothermal project in fractured/dissolved limestone @ CAL-GT

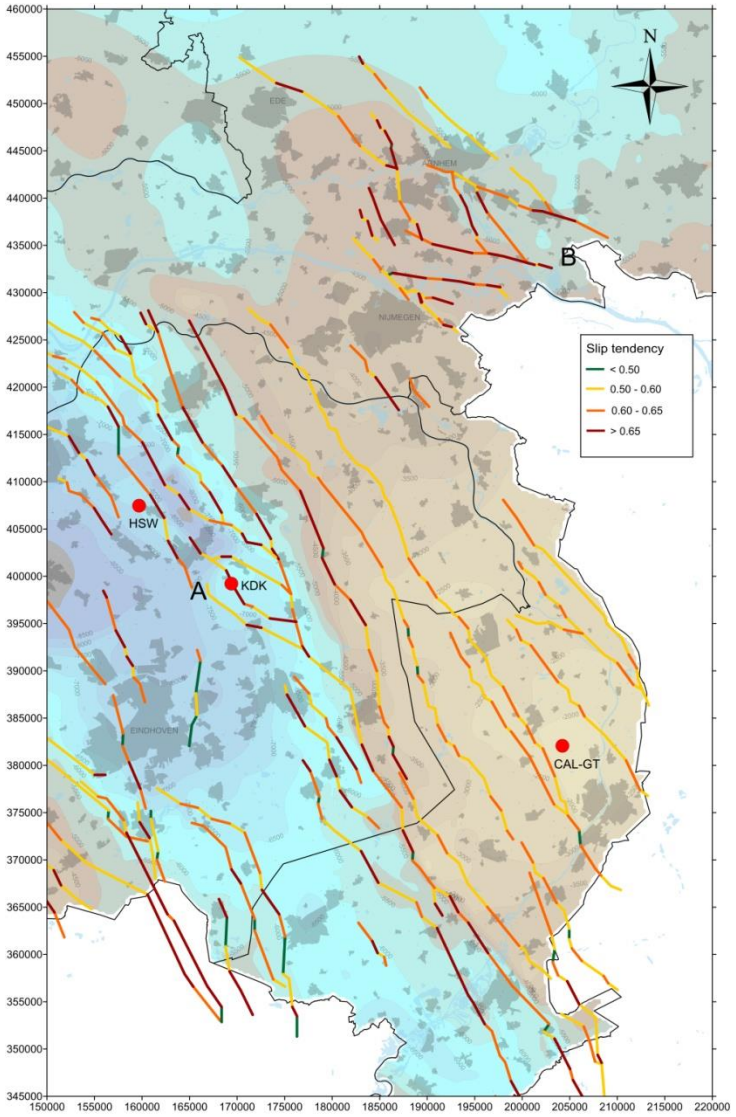


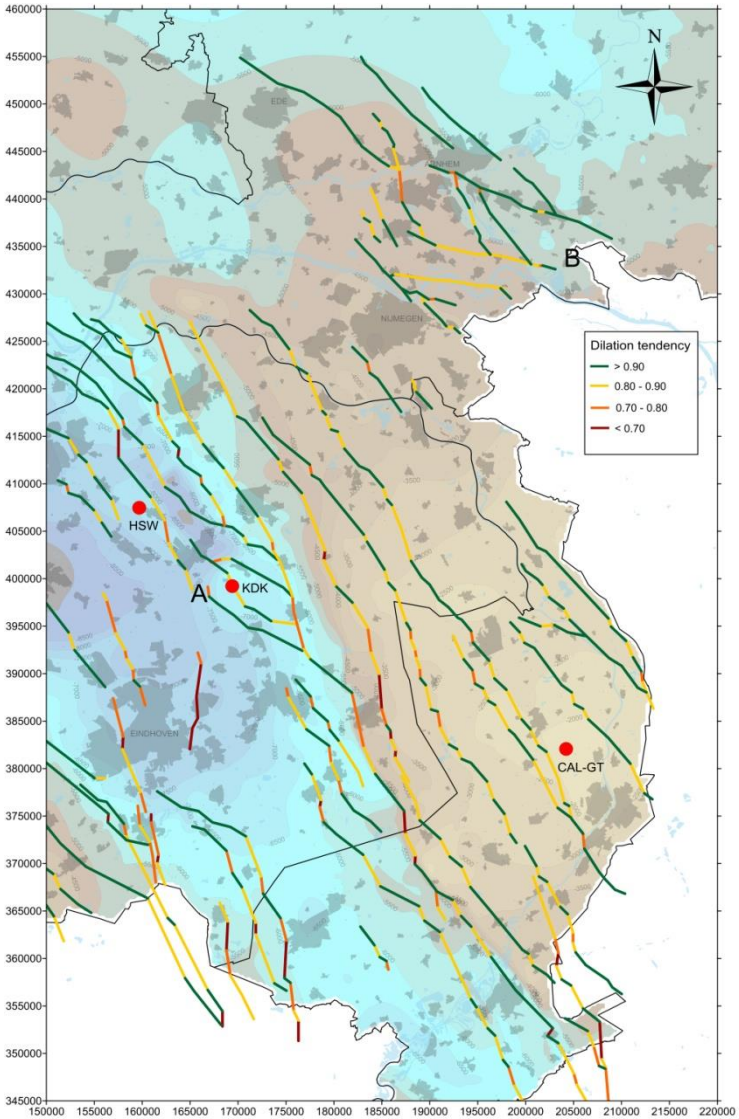


Mapped faults (by TNO) in Dinantian, Zechstein and U. North Sea



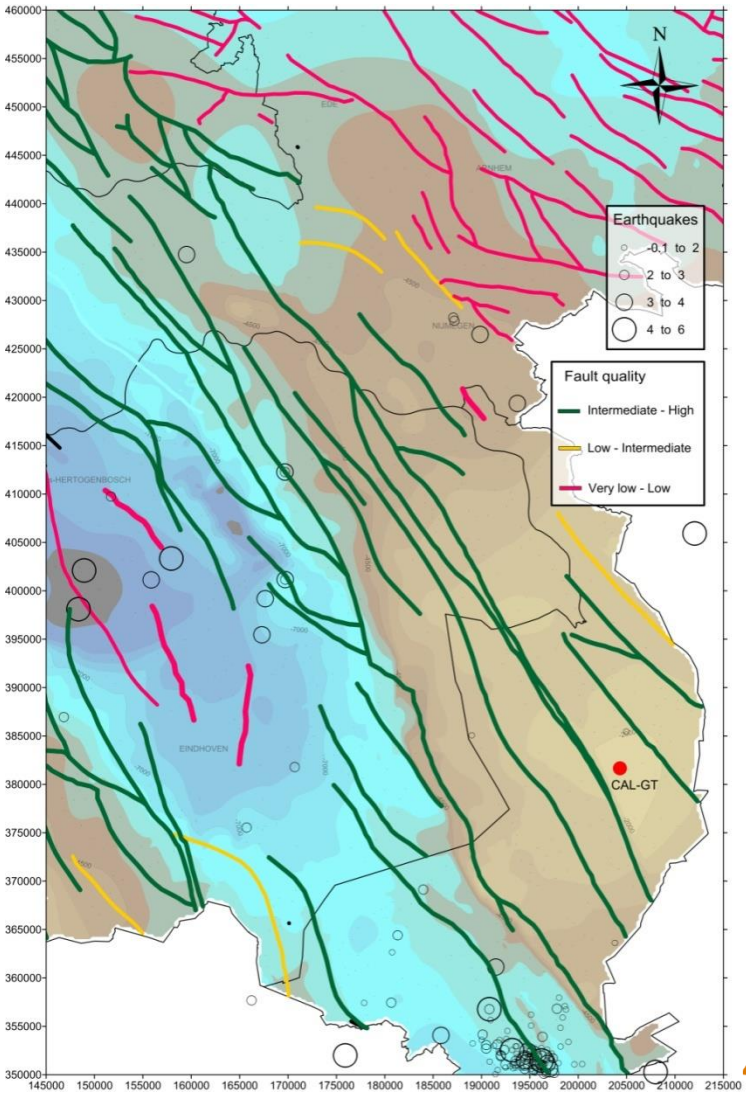
Slip- & Dilation tendency



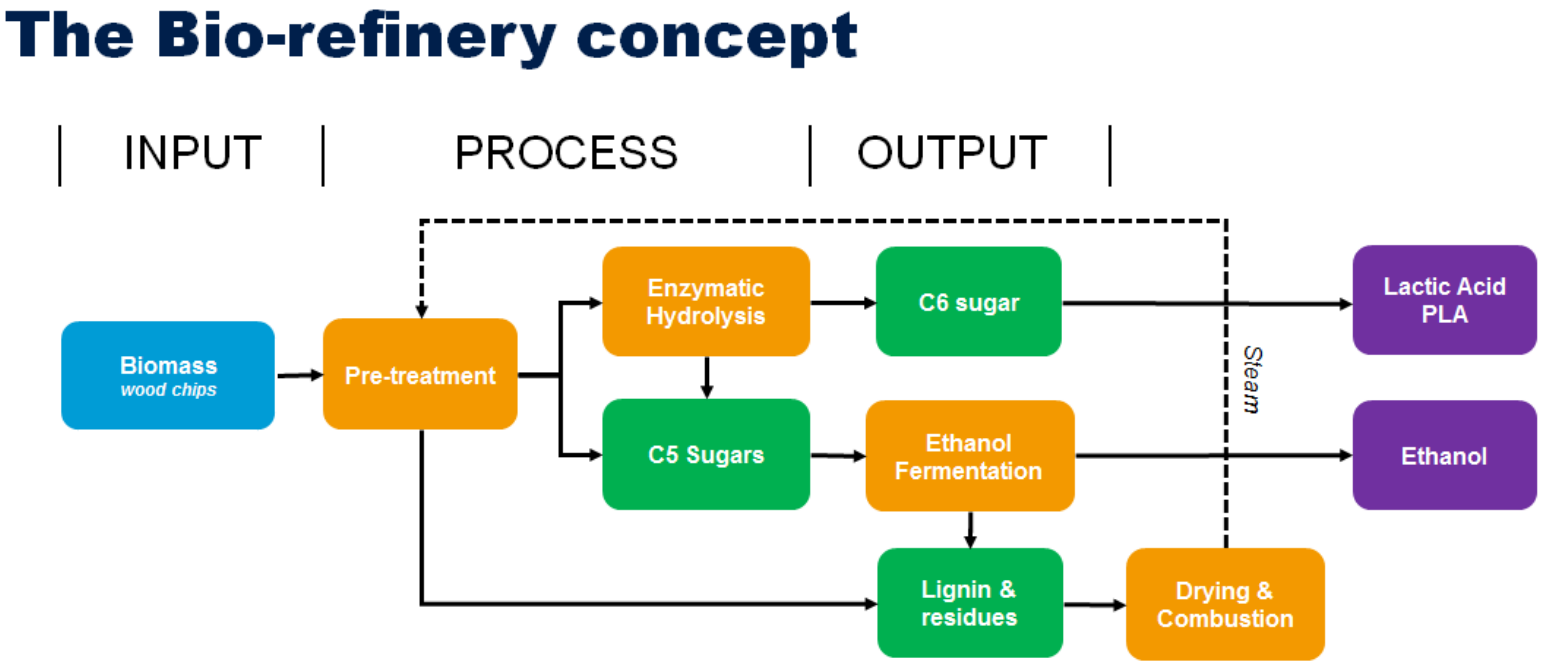


Geothermal potential Nijmegen

- CAL-GT: successful project, permeable fault zone in limestone platform
- Extension of geothermal potential to the north not unlikely
- Impacts of larger depth, higher temperature, etc?
- More study required: analysis of existing seismic data, gathering new seismic data, geological analysis



Biomass refinery Rotterdam
150 MW of 150 C steam required



Port of Rotterdam

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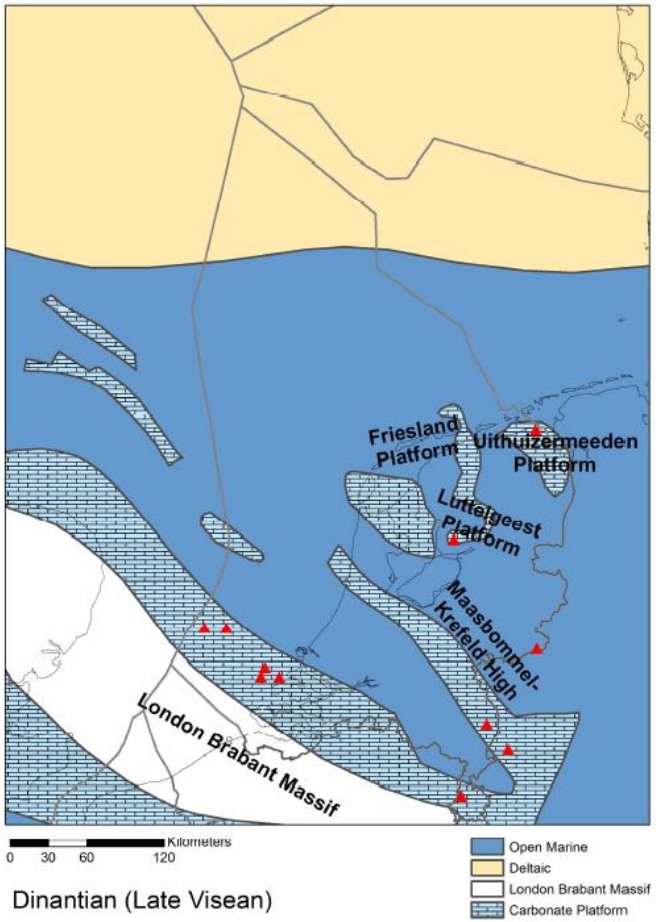
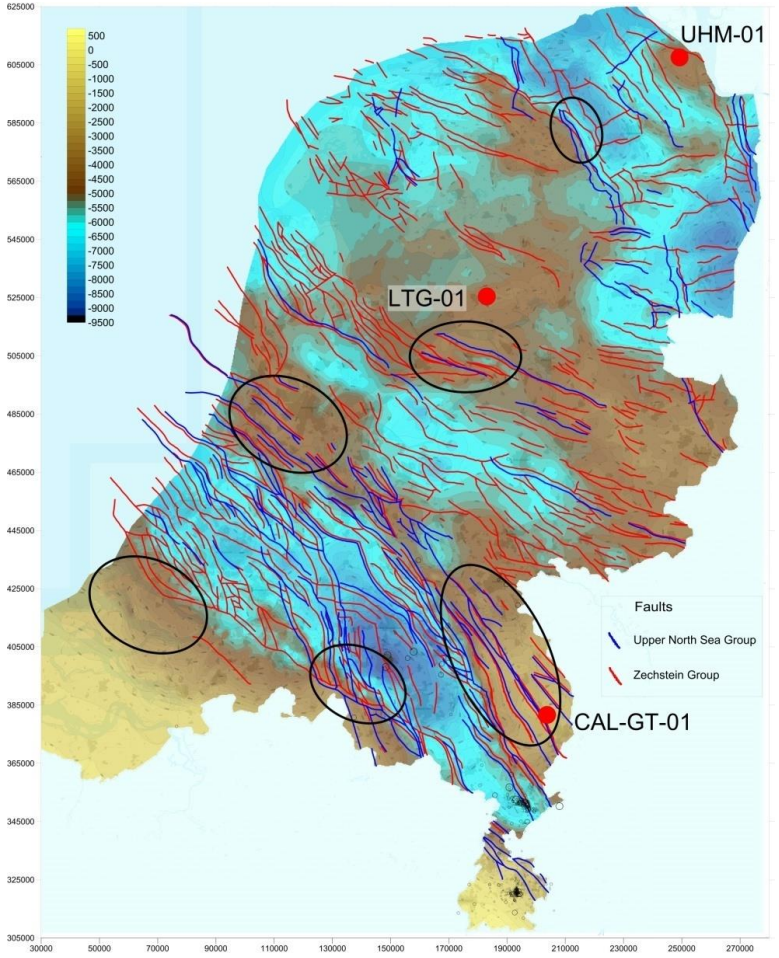
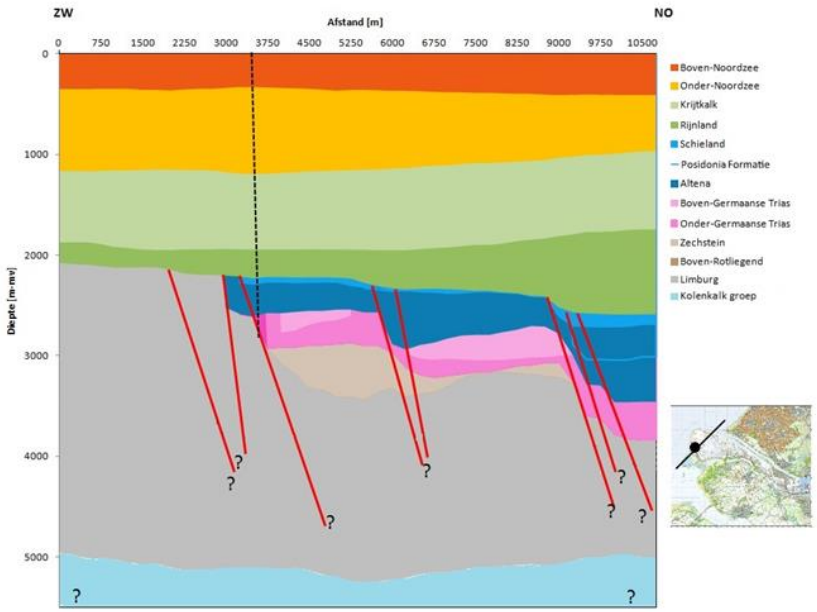
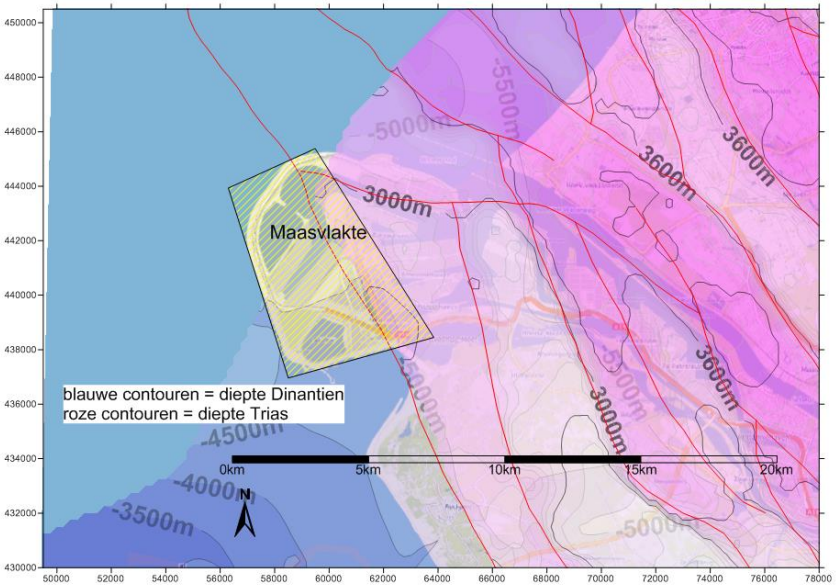
Potential of Dinantian limestones 2nd Maasvlakte



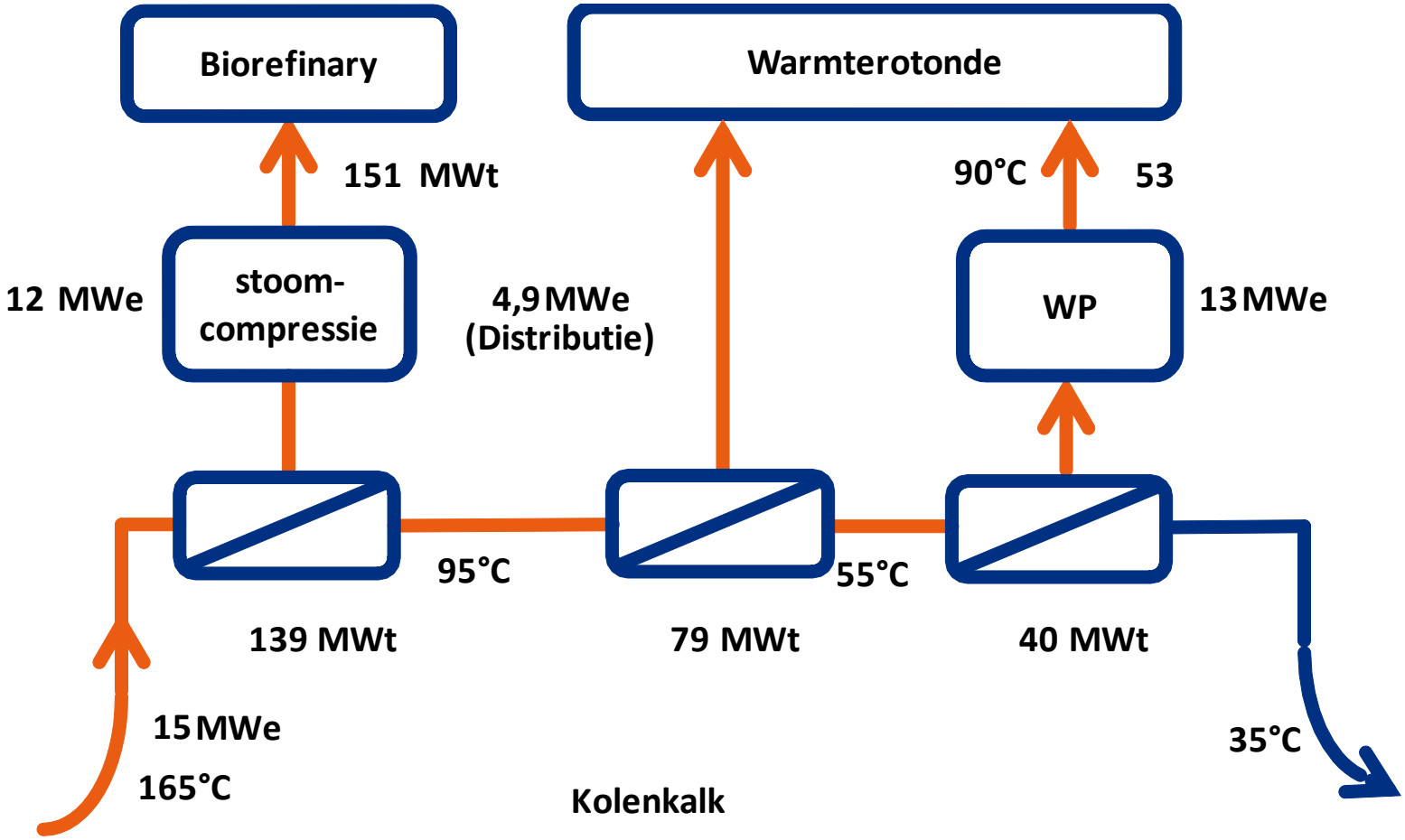


UDG for Port of Rotterdam





Geothermal system for biorefinery and district heating 280 MWth, using 40 MWe, COP = 7



Ultra Deep Geothermal

- High risk high reward prospect
- Excellent source of renewable heat for industrial steam & district heating
- Requires further exploration: seismic data, geological analysis and drilling
- Optimal integration of geothermal heat into offtake process is crucial