Planned Research Activities

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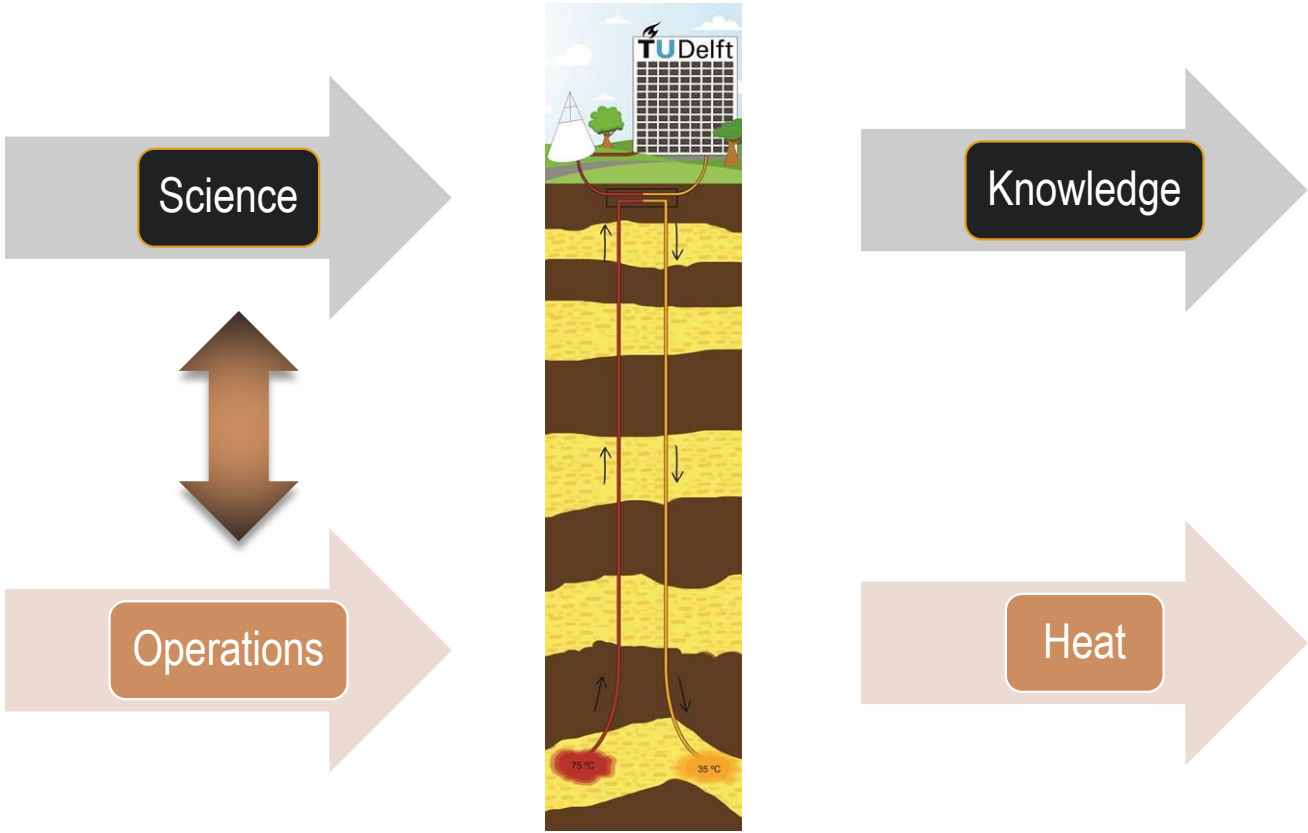
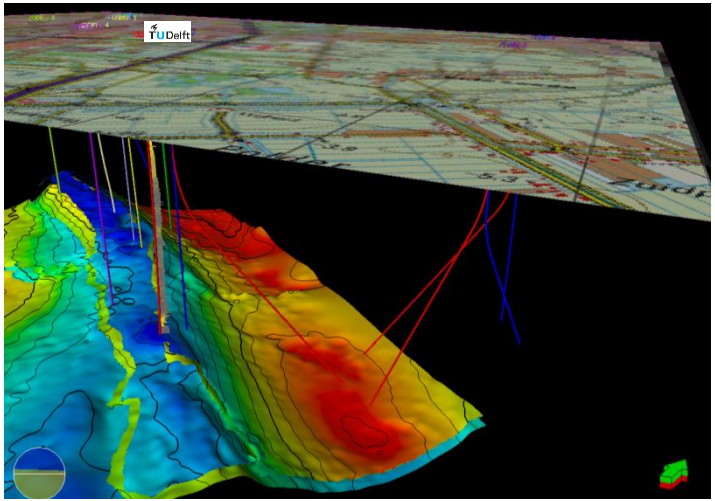
TU Delft

EPOS-NL
EUROPEAN PLATE OBSERVING SYSTEM EPOS-Netherlands

Urban energy laboratory



Research



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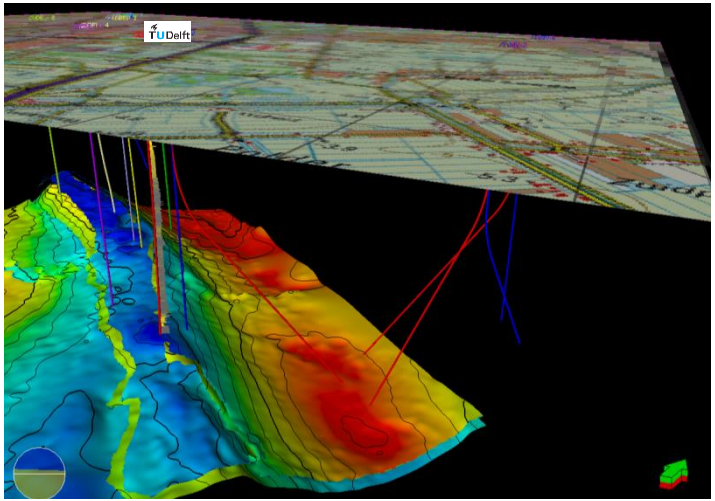
Research questions

How much energy can be delivered? What is the long term flow and heat flow behaviour?

How can we best monitor geothermal projects? For energy, for surface impacts.

How do (new) materials perform? Geothermal fluids, geochemical processes, reservoir material, casing materials.

Research



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Research topics

Prediction: models, control

Behaviour: thermo-mechanic-hydraulic-chemical

Geology: cores >300m

Monitoring: geophysics, fibre optics, flow, highly monitored well

Impact of activities at surface

Materials: testing casing material, monitoring of processes

Integrated: to campus, urban

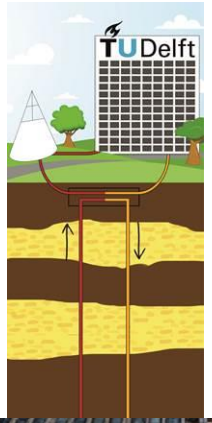
reducing uncertainties | making sustainable energy large scale

Science plans

Coring

More knowledge of reservoir

- Permeability / mechanical / thermal / chemical behaviour
- Heterogeneity and uncertainty
- Composition
- Matching with downhole logs



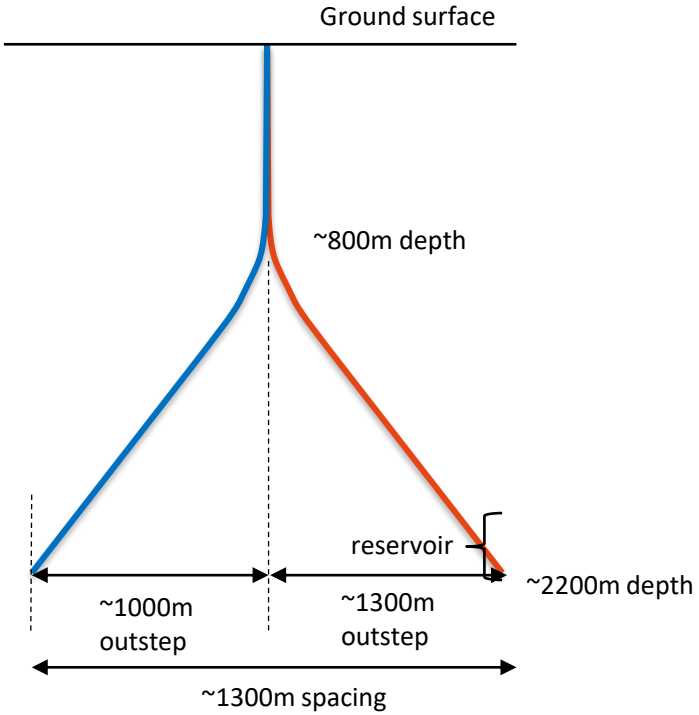
More knowledge of overburden

- Mechanical properties
- Transport properties
- Composition

Why is this important?

- Reducing uncertainties leads to better business models
- Reduces risks – possible to say more about induced seismicity
- Match what is observed downhole with laboratory tests
- Other industries / technologies also benefit

Well and monitoring locations



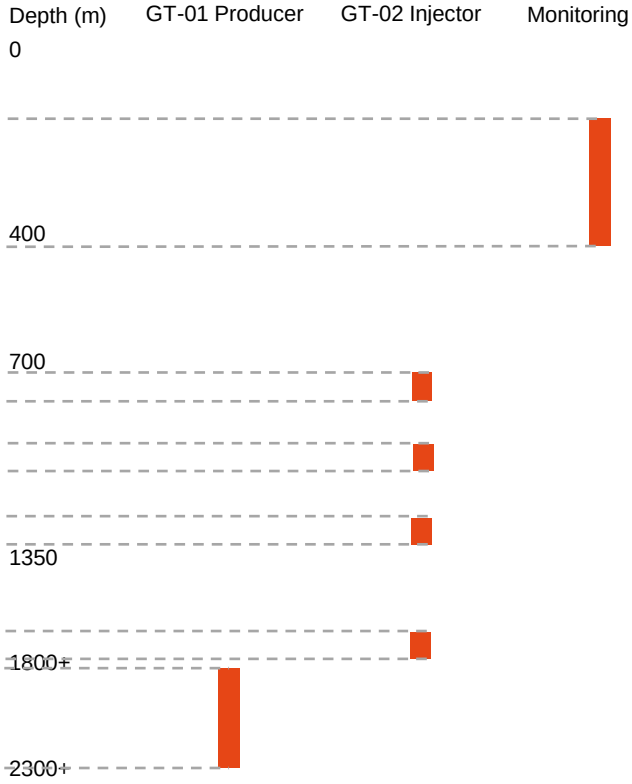
Coring (several 100's meters)

Lithostratigraphic Column Delft — Julian Stouwdam

Group	Period	Formation	Epoch / Age	Member	Lithology
Upper North Sea NU	Quaternary	Maassluis NUMS	Early Pleistocene		Deposits of coastal sands, very fine to medium coarse, calcareous, shell and wood bearing, mica rich. Within the Formation some sandy layers of clay or clay lenses are present. GR-response goes slightly up going into the Oosterhout Fm.
	Tertiary	Oosterhout NUOT	Pliocene		Succession of sands, sandy clays, and grey & greenish clays. The glauconite content is much lower than that of the Breda Fm.
		Breda* NUBA	Miocene		Sequence of marine, glauconitic sands, sandy to silty clays. In places a green to black glauconite-rich layer occurs at the base.
Middle North Sea NM		Rupel NMRF	Oligocene	Rupel Clay* NMRFC	Heavy grey to dark brown clays that become more silty towards basis and top. It is rich in pyrite, contains hardly any glauconite and calcium carbonate tends to be concentrated in the septaria layers. The clays grade into sands towards the basin edge.
Lower North Sea NL		Landen NLLF	Eocene	Landen Clay NLLFC	Generally dark-green, hard, flaky clay, somewhat silty, containing glauconite, pyrite and mica. The basal part of the member can be marly and therefore lighter in colour.
Chalk CK	Upper Cretaceous	Ommelanden CKGR	Turonian - Danian		Succession of white, yellowish-white or light-grey, fine grained limestones or limey chalks, in places argillaceous. Layers of chert nodules are common over thick intervals. In the base section, tongues of sand can occur and karst could have been developed!
		Texel CKTX	Cenomanian	Plenus Marl CKTXP	Interval of white to light-grey, locally pinkish limestones and marly chalks with some marly intercalations.
				Texel Maristone CKTXM	White to light-grey (locally pinkish) limestones, marls and marly chalks.
				Texel Greensand CKTXG	Greenish, glauconitic, calcareous sandstones with intercalated marls.
Rijnland RN	Lower Cretaceous	Holland KNGL	Late Albian	Upper Holland Marl KNGLU	Light-grey and red-brown marls, and is characterised by a carbonate content which gradually increases towards the top.
				Middle Holland Claystone KNGLM	Grey and/or red-brown calcareous shaly claystone with a distinctly lower lime content than the under- and overlying members.
			Early Albian	Holland Greensand KNGLG	Alternation of greenish grey, very glauconitic, very fine- to fine-grained, argillaceous sandstones, locally silt-stones with calcareous or sideritic cement, and olive-grey claystones.
			Early Aptian	Lower Holland Marl KNGLL	Grey and red-brown marl or calcareous, fissile claystone, frequently with intercalated bituminous claystone beds. On wire-line logs the unit is recognisable by its relatively low GR-response.
		Vlieland Sandstone KNVS	Late Barremian to Early Aptian	De Lier Sandstone KNVSL	Alternation of thin-bedded, very fine- to fine-grained argillaceous sandstones, generally glauconitic and lignitic, and sandy claystones, commonly glauconitic and with shell fragments and frequent bioturbation.
			Late Barremian	Vlieland Clay KNVCM	Dark brownish-grey to grey claystone. Mica and very fine lignitic matter are common. The formation is very silty to sandy with many intercalated siltstone and very fine sandstone beds.
			Late Hauterivian to Mid Barremian	Berkel Sandstone KNVSB	Sandstone, light-grey, very fine- to fine- and medium- to coarse-grained, locally gravelly, lignitic, locally glauconitic or with sideritic concretions. Especially in the upper part of the member calcareous cemented beds are common.
			Late Hauterivian to Early Barremian	Berkel Sand/Claystone KNVCC	Alternation of fine-grained, argillaceous sandstones and brown-grey silty to sandy claystones. Locally sideritic concretions are present.
			Hauterivian	Rijswijk Sandstone KNVSR	Light- to medium-grey sandstones with a very fine to medium and locally gravelly grain size; mica, lignitic matter and siderite concretions are common. Locally, lignitic claystone beds are present.
Schieland SL		Nieuwerkerk SLDN	Late Valanginian to Early Hauterivian	Rodenrijs Claystone SLDNR	Medium- to dark-grey, silty to sandy lignitic claystones and lignite/coal beds. Locally molluac shells are present. Siderite spherulites and concretions are common. The member shows a characteristic serrate pattern on wireline logs.
			Valanginian	Delft Sandstone SLDND	Light-grey massive sandstone sequence, fine to coarse-gravelly, fining upward, lignitic.
			Ryazanian to Valanginian	Alblasserdam SLDNA (incl. Pijnacker Sandstone)	A succession of dark to light grey, red and variegated clay- and siltstones, fine to medium grained sandstones with bed thicknesses up to a few metres, and massive, thick-bedded, coarse grained sandstones. Coal and lignite beds are associated with the grey claystones. Dispersed lignitic matter, siderite spherulites and concretions are common.

Figure 4: Lithostratigraphic columns of producer and injector

Target reservoir {

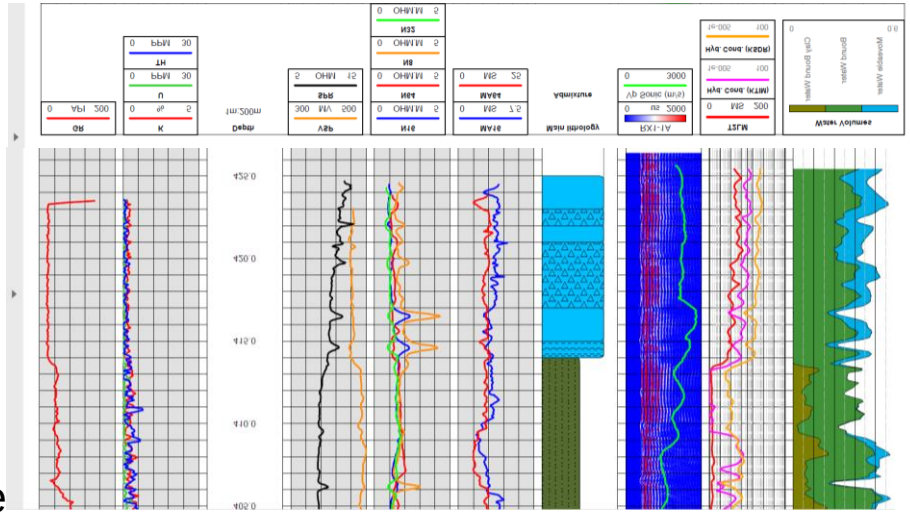


Wireline logging

- Logging in injector from 800 m, producer over the reservoir section
- All cored intervals will be fully logged

- Gamma ray
- Spontaneous Potential
- Caliper
- Porosity
- Density
- Resistivity

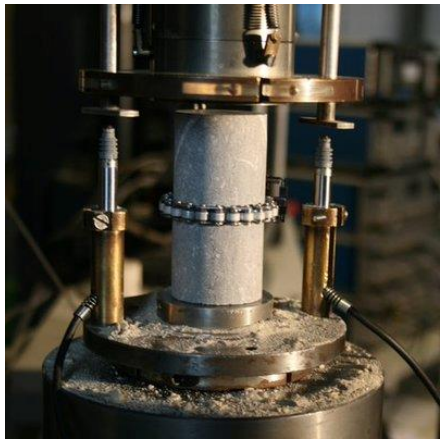
- Spectral Gamma Ray
- Full wave form sonic (vp, vs)
- FMI
- Acoustic Borehole Imager
- Nuclear Magnetic Resonance
- *Stress tests (mini-frac)*



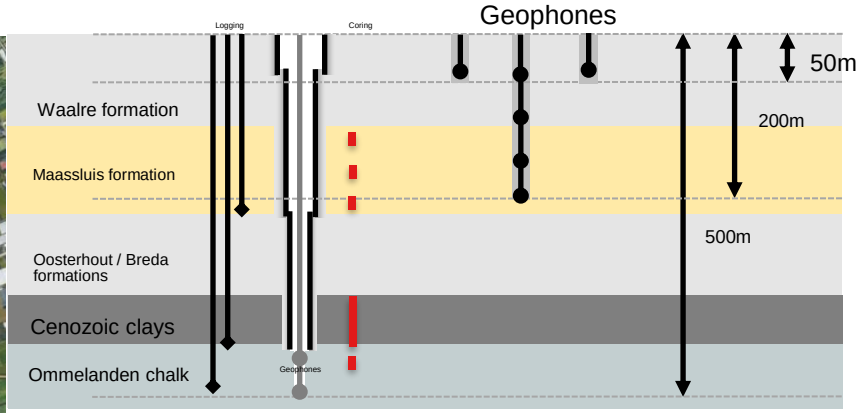
Research plans (cores & logs)

- Log-to-log correlation
- Log-to-core correlation
- Full core microCT scanning

- Full sedimentology analyses
- Subcores:
  - Por/perm
  - Mechanical Properties
  - Thermal Properties
  - Acoustics
  - Etc. etc.



Monitoring



- Seismic network around the doublet
- In wells: Fibre-optic cable (T, DAS), pressure sensors

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