

**EPOS-NL is the Dutch solid earth science infrastructure for research on georesources and geohazards**

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**DOI**

[10.3997/2214-4609.202131023](https://doi.org/10.3997/2214-4609.202131023)

**Publication date**

2021

**Document Version**

Final published version

**Published in**

EAGE GeoTech 2021 First EAGE Workshop on Induced Seismicity

**Citation (APA)**

Pijnenburg, R., Laumann, S., Wessels, R., Maat, G. T., Armstrong, L., Vardon, P., Bruhn, D., Barnhoorn, A., Wapenaar, K., & More Authors (2021). EPOS-NL is the Dutch solid earth science infrastructure for research on georesources and geohazards. In *EAGE GeoTech 2021 First EAGE Workshop on Induced Seismicity: March 1-5, 2021* [We IS 02] EAGE. <https://doi.org/10.3997/2214-4609.202131023>

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## We IS 02

# EPOS-NL is the Dutch solid Earth science infrastructure for research on georesources and geohazards

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## Summary

The European Plate Observing System – Netherlands (EPOS-NL) is the Dutch research infrastructure for solid Earth sciences. EPOS-NL is a cluster of large-scale geophysical facilities for research on georesources and geohazards. It is a partnership between Delft University of Technology (TU Delft), the Royal Netherlands Meteorological Institute (KNMI) and Utrecht University (UU) and is funded by NWO, as part of the national roadmap for large-scale research infrastructure. EPOS-NL facilities include 1) The Earth Simulation Lab at UU, 2) The Groningen gas field seismological network and the ORFEUS Data Centre at KNMI, 3) The deep geothermal (DAP-)well to be installed on the TU Delft campus, and 4) A distributed facility for multi-scale imaging and tomography (MINT) at UU and TU Delft. EPOS-NL aims to further develop the infrastructure for solid Earth scientific research. It also makes cutting-edge research facilities and data available to (inter)national researchers, aiming to address key geo-societal challenges, notably:

- Exploration for (renewable) geo-energy resources
- Storage of fuels, CO<sub>2</sub> and wastewater in the sub-surface, and
- Hazards such as induced or natural earthquakes

Addressing these challenges requires a multi-physics, multi-scale approach, and open access to state-of-the-art research facilities and data. EPOS-NL contributes to addressing these needs.

## Introduction

Present-day research into georesources and geohazards, whether human-induced or natural, requires access to state-of-the-art research facilities and to existing research data and models. Dutch universities and knowledge institutions have a long history of operating advanced laboratory facilities and producing and maintaining unique laboratory data. However, these facilities and data are often less than optimally accessible for external users. EPOS-NL (European Plate Observing System- Netherlands) was formed to overcome this limited accessibility and to further develop the Dutch research infrastructure for solid Earth sciences.

EPOS-NL is a partnership between the Delft University of Technology (TU Delft), the Royal Netherlands Meteorological Institute (KNMI) and Utrecht University (UU) and is financed by the Netherlands Organization for Scientific Research (NWO). With the 12.2 M€ granted from the national roadmap for large-scale research infrastructure, EPOS-NL (PI Martyn Drury, Co-PI's Kees Wapenaar, Chris Spiers and Jeannot Trampert) integrates large-scale geophysical facilities in the Netherlands (see Figure 1) into a coherent infrastructure that will develop innovative new facilities and open access to facilities and data services.

EPOS-NL supports research that serves societal needs for supply of natural resources and protection and warning against induced or natural hazards, notably in the domains of:

- Geo-energy: exploration and exploitation of new, low carbon geo-energy resources in the Netherlands and Europe, in particular geothermal energy.
- Geo-storage: geological storage of CO<sub>2</sub>, fuels like natural gas and renewably generated hydrogen and waste related to energy production.
- Geo-hazards: such as induced earthquakes and subsidence caused by human activities in the subsurface.

## EPOS-NL facilities

EPOS-NL facilities contribute to a new, multi-scale experimental, observational and modelling approach that provides understanding, from the molecular to the reservoir, basin and even crustal scales, of the coupled processes of fluid flow and deformation that occur in complex porous and fractured media. The new cluster of experimental facilities will allow research on decimetre to millimetre scale rock samples, addressing the micro- to nanoscale processes active within them, but also features massively instrumented analogue scale-modelling approaches addressing the metre to kilometre and basin scales. At the reservoir and field scale, EPOS-NL intends to deliver first-time active monitoring of subsurface test-bed facilities and reservoir systems, providing validation of process models and upscaling procedures. This will substantially increase both our understanding and ability to evaluate and steer subsurface system behaviour.

EPOS-NL provides the financial, technical and scientific support for (inter)national researchers to use these high-end research facilities. Access is arranged through a regular call for applications and provided on the basis of excellence. The facilities included in EPOS-NL (refer Figure 1) are:

- The Earth Simulation Laboratory (ESL) at Utrecht University, for multi-scale rock physics and analogue scale model experiments;
- The Groningen gas field seismological network and the ORFEUS Data Centre (ODC) at KNMI;
- The deep geothermal well (DAPwell) and Petrophysics Lab (DPL) at TU Delft and;
- Distributed facilities for multi-scale imaging and tomography (MINT) of geo-materials at Utrecht University and TU Delft.

ESL – Earth Simulation Laboratory (UU)

The ESL will integrate new and existing world-class, multi-scale, multi-physics experimental facilities at UU (High Pressure and Temperature Lab and Tectonic Modelling Lab), with existing numerical modelling and imaging facilities and activities in geodynamic, geomechanics and seismological research. New facilities will include high-resolution imaging of 4D internal deformation analogue scale model experiments and an ultra-high resolution high pressure and temperature testing machine, able to deform rock samples and simulate fault slip under geothermal, flow-through conditions.

#### The Groningen gas field seismological network and the ORFEUS Data Centre (KNMI)

The Groningen gas field is a unique natural observatory for studying induced seismicity and effects of changes in production strategy. A vast data set from the dense seismic network of borehole stations in Groningen is being made public via EPOS-NL, courtesy of the field producer, de Nederlandse Aardolie Maatschappij (NAM). These data are currently integrated in the ORFEUS Data Centre and will be made openly available to the geoscientific community through EPOS-NL, and at the European level, via the EPOS Thematic Core Service Seismology.

#### DAPwell geothermal well and Petrophysics Lab (TU Delft)

A deep geothermal doublet, built with extensive embedded monitoring and testing instrumentation, will be installed on the TU Delft campus in the period 2020-2022. During installation, core will be taken from the doublet wells and from the nearby monitoring well. These are then analysed in the laboratory to determine the petrophysical properties of the reservoir rocks. Extensive geophysical monitoring at the surface and downhole will be carried out as well, to facilitate research on the interaction between geothermal fluids, reservoir rocks and the technical installations.

#### MINT – Multi-scale imaging and tomography (UU & TU Delft)

MINT is a cluster of instruments enabling visualization and correlation of 3D and 2D structures within rock samples, at all scales ranging from decimetres to several nanometres. It will include X-ray tomography systems with a range of resolutions and sample size capabilities and cutting-edge, automated electron microscopes and micro-chemical mapping. MINT will be able to image rocks at all scales and allow notoriously difficult sub-micron pore and fracture networks to be analysed and scaled to larger rock structures.

#### **Data sharing and access**

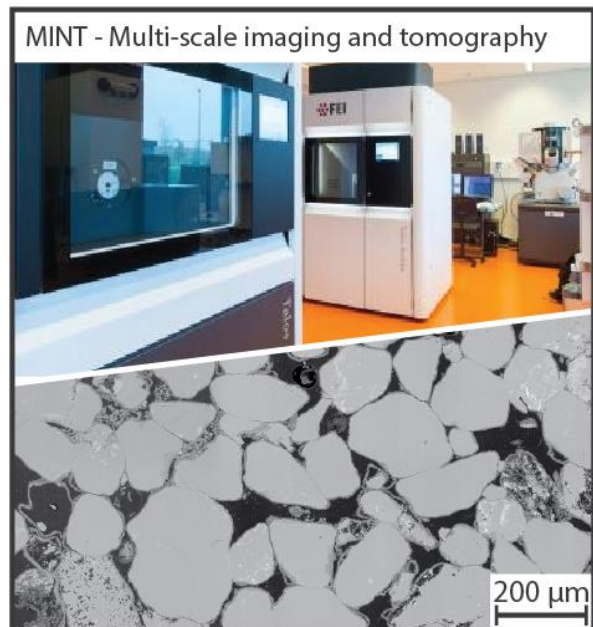
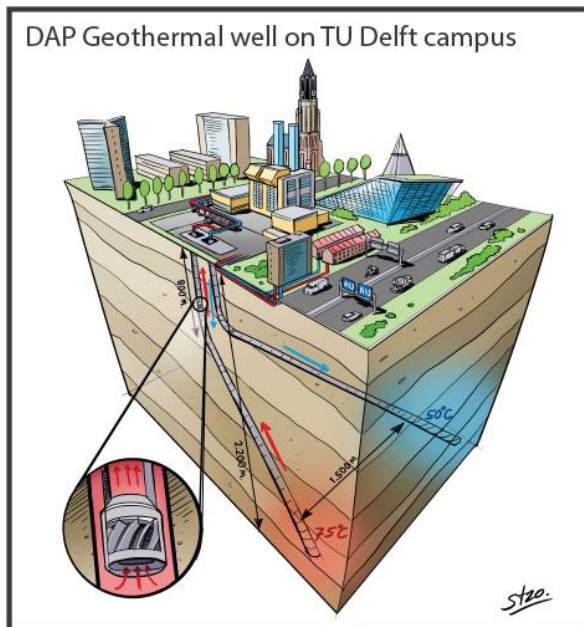
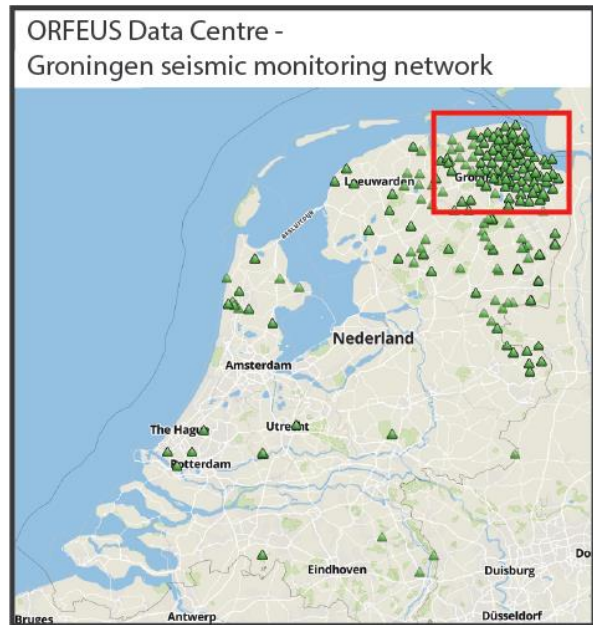
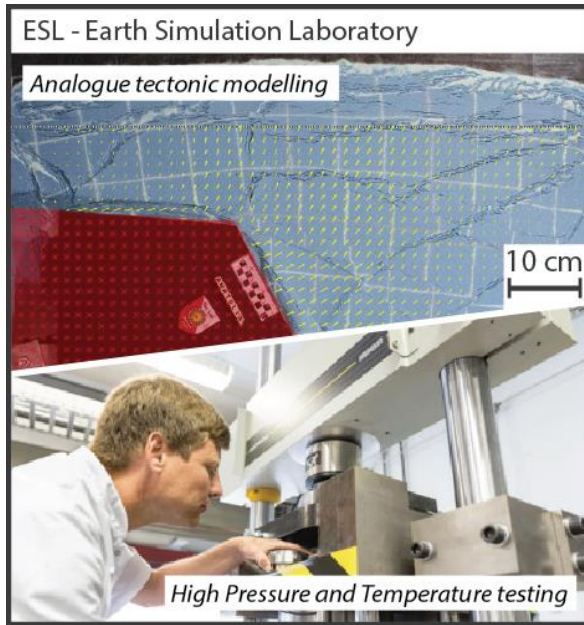
EPOS-NL facilitates global discovery of and open access to solid Earth science data from the Netherlands, with a focus on seismological and laboratory (experimental rock physics, crust/mantle analogue scale modelling, rock microstructures) data. To achieve this, EPOS-NL is working with researchers and data centers of its partner institutes to make data FAIR (Findable, Accessible, Interoperable, and Reusable). These data centers include Yoda Geoscience (UU), 4TU.ResearchData (TU Delft) and the ORFEUS Data Centre (KNMI). Data accessible via EPOS-NL include unique research data produced at the affiliated facilities (Figure 1). In addition, seismological data from the Groningen network are also included, as well as the Petrel geological model of the Groningen gas field, developed and provided by NAM.

#### **Connection with EPOS**

Incorporation of EPOS-NL within the pan-European EPOS research infrastructure facilitates trans-national access to Dutch and European facilities. It also contributes to optimal exploitation of research results via open access data services. These services are being developed to be fully compatible and interoperable with the EPOS e-infrastructure. The EPOS-NL partner institutes play a leading role in the development of the Multi-scale Laboratories and Seismology Thematic Core Services of EPOS.

For further information, see:

[www.EPOS-NL.nl](http://www.EPOS-NL.nl)



**Figure 1:** Large-scale geophysical facilities embedded in the research infrastructure for solid Earth sciences EPOS-NL. EPOS-NL aims to develop innovative new facilities and open access to facilities and data services (see: [www.EPOS-NL.nl](http://www.EPOS-NL.nl)).