EuroGeoSurveys
European Geoscience for Society
The Geological Surveys of Europe

Geophysics Expert Group

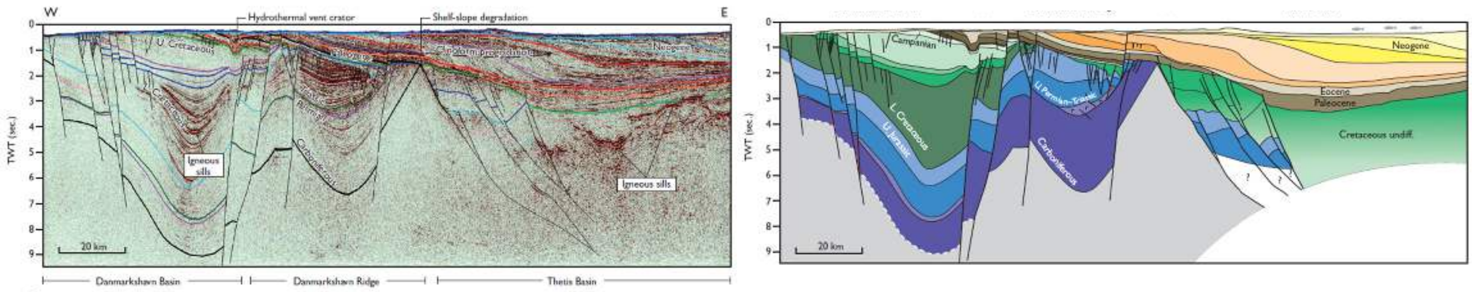
Factsheet: Geophysics

What is Geophysics?

Geophysics is a science that studies the physical properties and processes of the Earth, including its oceans and atmosphere. Geophysics is often subdivided by its different geophysical methodologies, each one investigating different Earth properties[1].

Geophysical methods allow us to measure deep into the ground and model or image different structures and features. Geophysics can also sense extremely small variations of physical properties such as changes to the magnetic field or tiny vibrations from distant earthquakes[2]. The information can be used to help us understand how the Earth works, study geological hazards, map groundwater, support construction work, conduct archaeological surveys, or target natural resources.

Because geophysical instruments can be carried or placed on vehicles, ship, aircraft or drones, surveys can be conducted in virtually all environments and locations without causing any damage or requiring deep drilling or excavations. Large amounts of data can therefore be collected very quickly over big areas, making it cost effective.

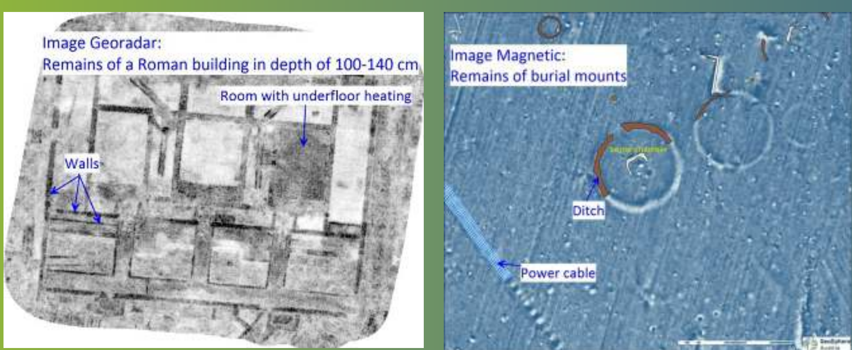


Seismic methods take a snapshot of the subsurface and are useful in structural imaging. Compare the seismic image from East Greenland (left) with its geological interpretation (right). This allows us to see deep within the Earth[3].

Why is Geophysics important?

Different methods can be used to study subsurface properties, Earth processes, and a wide range of applications such as:

- Determining the depth to bedrock and estimating rock strength for engineering site investigations.
- Monitoring volcanoes and earthquakes.
- Exploring mineral deposits or identifying the best place to drill for groundwater.
- Generating high-resolution mapping and modelling of geological structures that contain oil and gas or can store carbon dioxide.
- Studying planetary magnetic fields and space weather, including aurora forecasting.
- Visualising buried walls or ditches for archaeology investigations.
- Highlighting variations in soil characteristics to aid agricultural studies.
- Identifying soil or water contaminations as part of environmental site investigations.
- Detecting buried mines and munitions.
- Supporting investigations for geothermal energy and assisting in the energy transition.



Left: An example of a Ground Penetrating Radar (GPR) survey showing the Roman archaeological building at Carnuntum in a depth of 100-140 cm under the surface, today a meadow for horses in Austria. Right: An example of magnetic gradient measurements highlighting a power cable and refilled ditches around former burial mounts, within an agricultural used field, in Austria. Both features are no longer recognisable to the naked eye and can only be revealed with geophysical methods. Images:

Which methods do we use in Geophysics?

Geomagnetic

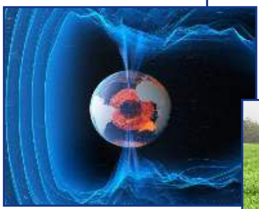
Magnetic surveys allow us to map different types of rock, improving geological maps, locate mineral resources, or to map archaeological ruins.

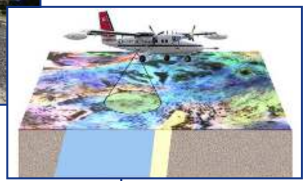
Gravity

Measures changes in the gravity field relating to the different density of rocks and can be used to identify subsurface bodies such as caves, to estimate depth-to-bedrock, to find mineral deposits, or to map geological faults.

Seismics

Measure the velocity of seismic waves (vibration of rocks and soils) that travel through the underground. They can help locate earthquakes, map geological structures particularly for hydrocarbons and mineral exploration, and are vital for hydrogeological or geothermal studies.





Electric

Electrical surveys measure how conductive or resistive rocks are to induce currents in the ground and are often used for site investigations to support engineering, hydrogeological or environmental projects.

Electromagnetic (EM)

Uses induced EM fields to measure the electromagnetic response of the material in the subsurface from which the waves pass through. It can be done via walking or instruments mounted on aircrafts or drones without direct contact with the ground.

Radiometry

Detects naturally produced gamma-rays emitted by rocks and soil. This tells us about changes in chemistry and can be used to identify different compositions of rock or soil.

Geophysics and Society

How is Geophysics relevant to policy?

Geophysics provides critical, science-based insights that help European policymakers to make informed decisions across energy, environment, hazard resilience, and urban planning. Geophysical data collected with different methods enable sustainable subsurface management and support the EU's environmental and energy transitions, for example by supporting the work of Geological Surveys in meeting the European Critical Raw Materials Act 2024/1252 and the European Green Deal.

The role of EuroGeoSurveys

European Geological Survey Organisations undertake geophysical surveys all the time. You might see a geophysical survey taking place with instruments mounted on aircraft, boats and drones or see geophysicists carrying strange equipment across the ground. Surveys are safe and are not dangerous to the public. Although geophysical surveys can tell us a lot about the subsurface, it is important that geophysical data is integrated with other geological information, such as from boreholes, to support their findings.

The EuroGeoSurveys Geophysics Expert Group (GpEG) supports this process by connecting specialists across Europe, fostering collaboration with experts in related fields, and promoting the development of best practices for integrating geophysics with other geological methods.

Towards long-term impact

A permanent **Geological Service for Europe** is key to safeguarding and building on the investments made in geophysical and geological data. By ensuring continuity and harmonisation across European countries, it will secure access to reliable subsurface knowledge that supports Europe's energy transition, raw material supply, climate adaptation, and resilience to natural hazards.

Reference:

1. Milsom, J. & Eriksen, A. Field Geophysics. (John Wiley & Sons, 2011).

2. Reynolds, J. M. An Introduction to Applied and Environmental Geophysics. (John Wiley & Sons, 2011).

3. Fyhn, M. B. W. & Hopper, J. R. NE Greenland Composite Tectono-Sedimentary Element, northern Greenland Sea and Fram Strait. Geol. Soc. Lond. Mem. 57, M57-2017-12 (2025).