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Ortenauhalle Kongress 1
Tiefe Geothermie

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Ortenauhalle Congress 1
Deep geothermal energy

NANT and ANAT: Fast, Affordable, High-Resolution Prospection Methods for Geothermal Systems

NANT und ANAT: Schnelle, kostengünstige und hochauflösende Prospektionsmethoden für geothermische Systeme

Iván Cabrera-Pérez[1], Matteo Lupi[1], Adriano Mazzini[2,3,4], Julien Sfalcin[5], Monika Przeor[5], Michail Henry[5]

[1] Department of Earth Sciences, University of Geneva, Geneva, Switzerland

[2] Department of Geosciences, University of Oslo, Oslo, Norway

[3] Institute for Energy Technology, Kjeller, Norway

[4] National Institute of Geophysics and Volcanology, INGV, Rome, Italy

[5] Invert Sàrl, Switzerland

Seismic tomography is a geophysical imaging technique that reconstructs the velocity of seismic waves traveling through the Earth to infer the mechanical properties of the subsurface. Traditionally, this method relies on artificial sources—such as explosions or vibroseis trucks—whose location and characteristics are precisely known. While effective, these sources often involve high costs and complex logistical operations. Alternatively, natural earthquakes offer a low-cost solution for seismic tomography, yet their use is limited or even unfeasible in geologically quiet regions.

A groundbreaking alternative lies in the Earth's ever-present ambient seismic noise—a type of seismic signal available anywhere on the planet, free of cost. This noise can be harnessed to build velocity models through a technique known as Ambient Noise Tomography (ANT). ANT has proven effective for imaging Earth structures at continental, regional, and local scales, including volcanoes and geothermal systems. However, one major limitation for industrial applications has been its relatively low resolution.

This limitation is now being overcome with the advent of seismic nodes—compact, low-cost sensors that can be deployed in large numbers to dramatically increase spatial resolution. This evolution of the method is known as Nodal Ambient Noise Tomography (NANT). Using NANT, we can construct high-resolution 3D models of S-wave velocity. Moreover, the same seismic network

can be used to extract information about seismic attenuation through a technique called Ambient Noise Attenuation Tomography (ANAT), which enables the construction of 3D attenuation models. These models are particularly valuable in geothermal exploration, as they help identify fluid pathways and fracture zones.

In this study, we present results from a geothermal exploration project in Switzerland, showcasing the significant potential and advantages of applying NANT and attenuation tomography in the search for geothermal resources, highlighting their effectiveness in imaging the Permo-Carboniferous Troughs and crystalline basement.