600 seismographs listen in on the Alps

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600 sensors placed on and around the Alps constitute the largest academic seismographic network in the world. The AlpArray project will enable better understanding of the birth of the Alps as well as homogeneous seismic hazard maps of the Alpine regions. Comprising 36 institutions from 11 countries, the project is coordinated by scientists at ETH Zurich and the University of Lausanne and is supported by the Swiss National Science Foundation (SNSF).

"We use extremely sensitive stations", explains György Hetényi, SNSF Professor at the University of Lausanne and first author on the publication detailing the implementation of the network. "The stations can detect a mild earthquake in Japan, as well as thousands of seismic events that occur each year in Switzerland, 99% of which the population is unaware of."

The primary aim of the project is to better understand the structure and composition of the lithosphere (up to a hundred kilometres under the Alps) as well as the earth's upper mantle (up to 660 kilometres). It is at these depths that the traces of ancient ocean floors which are tens of millions of years old can be found. Tectonic movements continue at the surface and produce present-day earthquakes in Alpine regions, explains Hetényi. The collected data make it possible to compare and standardise the catalogues of events maintained by European countries, and thus to refine probability estimates for earthquakes.

Two thousand metres under the sea

Half of the network consists of existing stationary seismographs. The other half comprises mobile sensors, distributed during the two years of the project and placed both underground and in barns in high mountain pastures. "Convincing our partners to make so many stations available at the same time was not easy, but it's the only way to create this network and still keep costs under control. Only four countries had to buy new sensors." Launched by Switzerland, AlpArray is managed by Edi Kissling and Irene Molinari of ETH Zurich, John Clinton of the Swiss Seismological Service and György Hetényi of the University of Lausanne. The Swiss part of the project is supported by a Sinergia grant from the SNSF.

The sensors were placed in a hexagonal network, analogous to the cellular structure of a beehive. "It was the most efficient way to achieve a dense geometry considering the fixed stations", explains Hetényi. "No part of the studied region is more than 30 kilometres away from a sensor." AlpArray extends more than 200 kilometres around the Alps, from the Pyrenees to Hungary and from Frankfurt to Corsica. Thirty sensors were installed at the bottom of the Mediterranean Sea. "It was only after fishing them back out last February that we got confirmation that they had worked properly, because the water column above them prevents wireless transmission", says Hetényi. The deepest station is 2771 metres under the sea; the highest is at an altitude of 3005 metres.

An "ultrasound" of the Alps

Mapping the Alpine structure is akin to doing an ultrasound: the sensors record the echo of seismic waves reflecting off the deep layers of the Earth. Comparing the arrival times of the waves at different sensors enables the researchers to triangulate the position of the layer as well as its composition, since the latter affects the propagation speed of the waves.

The recorded shocks come from small seismic events in Europe and moderate earthquakes all over the Earth. The network can even use ambient noise, such as from the swell of the sea, to obtain information about geological structures near the surface, down to a depth of a few tens of kilometres.

The AlpArray network has been fully operational since July 2017. Initial results are expected in 2019.

More information: undefined undefined et al. The AlpArray Seismic Network: A Large-Scale European Experiment to Image the Alpine Orogen, *Surveys in Geophysics* (2018). DOI: 10.1007/s10712-018-9472-4

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