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Ambient seismic noise tomography for mineral exploration in the Irish Midlands

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Europe set out its goals for decarbonization in the EU Green Deal, which includes reducing net greenhouse gas emissions by relying more on renewable energy and green technologies. One goal of the EU project VECTOR (https://vectorproject.eu) is to test and develop passive, non-disruptive exploration methods to investigate Europe's raw material potential.

We test the application of passive seismic imaging in the Irish midlands, which contain potential areas for zinc mineralization, one of the multiple raw materials needed for green energy technologies. More specifically, we apply ambient noise tomography to image the Earth's subsurface and assess the utility of this technique for mineral exploration at depth:

Thus, 210 temporary, continuously running digital seismic stations were deployed in the Irish midlands (north of Collinstown) in an area of ~8 x ~6 km, and recorded ambient noise data for ~6 weeks. We then extracted Rayleigh wave group velocities in the frequency range 0.625 – 10 Hz by cross-correlating the data (~42517 time series in total) and using the FTAN method. In the first step we used 1% of the data (long offsets) in a stochastic, transdimensional, hierarchical Monte Carlo search with Markov Chains to derive a three-dimensional shear wave velocity model. In the second step, we added shorter offsets, which did not lead to any significant changes in the 3D model.

The velocity model shows distinct velocity anomalies down to approximately 1.6 km depth that correspond to features also seen in reflection seismic profiles provided by Teck Ireland Ltd, a subsidiary of Teck Resources Limited, that owns the project area and is an Associated Partner of VECTOR. This demonstrates the potential of low-cost passive seismic methods to investigate the Earth's subsurface compared to expensive active seismic methods. We used synthetic 3D Checkerboard tests to assess which areas of the model are well resolved and we will further compare our models with other data sets, for example, petrophysical borehole data available in this area.