Geophysical Research Abstracts
Vol. 20, EGU2018-17063-1, 2018
EGU General Assembly 2018

Surface-Wave Tomography by Ambient Noise Seismic Interferometry to Image Volcanic and Geothermal Systems in South Iceland

Joana Martins (1,2), Elmer Ruigrok (3,9), Deyan Draganov (2), Cornelis Weemstra (2), Philippe Jousset (5), Arie Verdel (10), Andrew Hooper (4), Ramon Hansen (2), Robert White (7), Heidi Soosalu (8), and Gylfi Hersir (6)

(1) TNO, Advisory Group for Minister of Business Affairs, Netherlands (joana.estevesmartins@tno.nl), (2) Delft University of Technology, Delft, The Netherlands, (3) KNMI, Utrecht, The Netherlands, (9) Utrecht University, Utrecht, The Netherlands, (5) GFZ, Potsdam, Germany, (10) TNO, The Netherlands, (4) University of Leeds, Leeds, UK, (7) Cambridge University, Cambridge, United Kingdom, (8) Tallinn University of Technology, Estonia, (6) ISOR, Reykjavik, Iceland.

Tomographic studies based on passive seismic measurements have proven to be a powerful tool to image the subsurface. This especially holds in areas like Iceland, where the microseism coverage arriving from the ocean is excellent.
In this study, we apply Ambient Noise Seismic Interferometry (ANSI) to generate a tomographic image of Rayleigh-waves velocity anomalies to further invert for S-wave anomalies at two Icelandic locations. We derive a tomographic image over Reykjanes Peninsula geothermal system using 30 Broad-Band (BB) stations deployed under the IMAGE (Integrated Methods for Advanced Geothermal Exploration) project framework and operated for approximately one year and a half. In the other case study, we derive a tomographic image of Torfajökull volcano using 23 BB seismometers that recorded ambient noise for $\sim$100 days. The later data were acquired in 2005 by Cambridge University.
We retrieve the surface-wave part of the Green's functions by cross-correlation between station pairs and consecutive stacking of the cross-correlations to obtain coherent ballistic surface waves (BSW). We pick the arrival times of the BSW, which are the input for the tomographic analysis. Both datasets show remarkably high signal-to-noise ratio of surface-wave arrivals between 0.1 and 0.5 Hz, even with only $\sim$100 days of recorded ambient noise. A beamforming analysis indicates a broad azimuthal coverage with persistent ambient noise arrivals within three azimuthal quadrants - between 90 and 360 degrees. The highly coherent surface-wave retrieval and the wide azimuthal coverage of the microseisms explain the success of ANSI techniques in Iceland.
For the tomographic inversion, we use a Tikhonov and a statistical regularisation to invert the ballistic surface-wave time-arrival to 3D frequency-dependent velocity variations. After further inversion to S-wave velocity variations, we detect low- and high-velocity anomalies with changes between -15% and 15% from an estimated average velocity, we interpret these anomalies as possible old dyke intrusions and heat sources.