EGU24-3527, updated on 22 Mar 2025
https://doi.org/10.5194/egusphere-egu24-3527
EGU General Assembly 2024

Body wave retrieval from seismic ambient noise: results validation workflow within a known velocity model

Ali Riahi[1], Alexandre Kazantsev[2], Eleonore Stutzmann[3], Martin Schimmel[4], Jean-Paul Montagner[5], Mark Noble[6], and Jean-Philippe Metaxian[7]
[1]Institut de Physique du Globe de Paris (IPGP), Université Paris Cité, Paris, France (riahi@ipgp.fr)
[2]Storengy SAS – EISE/DGSM, Engie Group, Bois-Colombes, France (alexandre.kazantsev@storengy.com)
[3]Institut de Physique du Globe de Paris (IPGP), Université Paris Cité, Paris, France (stutz@ipgp.fr)
[4]Geosciences Barcelona, GEO3BCN-CSIC, Barcelona, Spain (mschimmel@geo3bcn.csic.es)
[5]Institut de Physique du Globe de Paris (IPGP), Université Paris Cité, Paris, France (jpm@ipgp.fr)
[6]MINES ParisTech, PSL Research University, Fontainebleau, France (mark.noble@minesparis.psl.eu)
[7]Institut de Physique du Globe de Paris (IPGP), Université Paris Cité, Paris, France (metaxian@ipgp.fr)

We estimated the Empirical Green's Functions (EGF) from ambient noise cross-correlations using a dense array of 3C broadband seismometers deployed above an anticline structure hosting an underground gas storage in France. In total, 580 recording locations are available. Several array configurations have been used, some of the seismometers being moved to new locations every day. The survey duration was of 16 days, with around 2 days of recording per location, and a typical interstation distance of 400 meters.

Our methodology uses polarization characteristics to separate body and surface waves. The approach uses the imaginary part of ZR+RZ cross-coherency (Z: vertical; R: radial) to enable the distinct reconstruction of diving P-waves. In order to enhance the signal-to-noise ratio of the retrieved P-wave, we employed common-offset bin-stacking over all virtual sources and receivers, with an offset bin of 50 meters. Subsequently, we assessed the stability of the extracted P-wave by computing a separate common-offset bin-stack for each recording day and each station couple azimuth interval. The consistent moveout of the extracted P-wave, regardless of various station couple azimuths and recording days, suggested that there was no significant source distribution bias in our EGFs.

In the next step, by using the P-wave window from the common-offset bin-stack as a template, we selected only the individual station pairs for which the correlation coefficient between the EGF and the template was above 0.8. This resulted in rejecting about 95% of the station couples. Around 7000 P- arrival times were picked from the selected EGFs in a semi-manual way. The accuracy of these arrival times was validated against the Eikonal solution for the first arrival within the "known" 3D velocity model of the site, based on active seismic and well logging data.

Finally, a 3D tomography based on the picked arrivals allowed us to invert for a P-velocity model up to a depth of around 700 meters. The consistency and the limits of the comparison between

this inverted model and the known model are discussed.