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Joint body and surface wave tomography applied to the Toba caldera complex (Indonesia)

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We developed a new algorithm for a joint body and surface wave tomography. The algorithm is a modification of the existing LOTOS code (Koulakov, 2009) developed for local earthquake tomography. The input data for the new method are travel times of P and S waves and dispersion curves of Rayleigh and Love waves. The main idea is that the two data types have complementary sensitivities. The body-wave data have good resolution at depth, where we have enough crossing rays between sources and receivers, whereas the surface waves have very good near-surface resolution. The surface wave dispersion curves can be retrieved from the correlations of the ambient seismic noise and in this case the sampled path distribution does not depend on the earthquake sources. The contributions of the two data types to the inversion are controlled by the weighting of the respective equations.
One of the clearest cases where such approach may be useful are volcanic systems in subduction zones with their complex magmatic feeding systems that have deep roots in the mantle and intermediate magma chambers in the crust. In these areas, the joint inversion of different types of data helps us to build a comprehensive understanding of the entire system. We apply our algorithm to data collected in the region surrounding the Toba caldera complex (north Sumatra, Indonesia) during two temporary seismic experiments (IRIS, PASSCAL, 1995, GFZ, LAKE TOBA, 2008). We invert 6644 P and 5240 S wave arrivals and ∼500 group velocity dispersion curves of Rayleigh and Love waves. We present a series of synthetic tests and real data inversions which show that joint inversion approach gives more reliable results than the separate inversion of two data types.

Koulakov, I., LOTOS code for local earthquake tomographic inversion. Benchmarks for testing tomographic algorithms, Bull. seism. Soc. Am., 99(1), 194–214, 2009, doi:10.1785/0120080013