Joint inversion of magnetotelluric and seismological observations: Case study in NE Brazil.

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Abstract

We assess the performance of a joint inversion of collocated magnetotelluric and seismological data acquired along a NS-trending profile centered at the Araripe Basin, and sampling the neighboring western Borborema Province and northern São Francisco Craton. Previously, separate seismic (1D) and resistivity (3D) models had been developed from the same datasets by jointly inverting teleseismic receiver functions and group-velocity dispersion curves, and magnetotelluric apparent resistivity curves and phases, respectively. The seismic and resistivity models independently agreed that the lithosphere under the Araripe Basin is thin (< 120 km) when compared to lithosphere either north or south of the basin (> 150 km), and encouraged further investigation of the structural consistency of the collocated datasets. Our joint inversion utilizes the same site-specific receiver function and apparent resistivity curves and phases of the independent inversions, a newly developed phase-velocity dispersion curve representing a network average, and assumes a common seismic and resistivity layered structure (1D) under any given station. Moreover, the inversion is achieved through a multi-objective genetic algorithm (GA) scheme that effectively explores the entire parameter space. Our findings demonstrate that, in spite of significant geological complexity, it is possible to determine structurally consistent velocity and resistivity layered structures under the Borborema Province and São Francisco craton. Although the accuracy of our simple (1D) inverted models prevents us from developing empirical relationships between resistivity and seismic S-velocity at crustal or mantle depths, they seem to succeed in imaging an electric Moho under most of the sites. Indeed, most models display a resistivity increase at depths coincident with a seismic velocity increase corresponding to the seismic Moho. Moreover, the resistivity increase occurs immediately under a portion of conductive lower crust, roughly consistent with global compilations of Precambrian resistivity structure. The electric Moho was not observed in the 3D resistivity model, so we suspect that the removal of smoothness constraints in our layered resistivity profiles, along with structural help from the collocated seismic data, guided the identification of an electrical Moho. Structurally consistent estimates of lithospheric thickness would similarly be expected, but the lack of long period measurements in our average phase-velocity curve prevented us from imaging the continental lithosphere at the appropriate depths.