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A joint geophysical investigation of the Cascadia subduction zone in central Washington using data from dense arrays of passive seismic and magnetotelluric stations

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Joint analyses that combine multiple geophysical methods can yield improved characterization of subsurface structure over that achieved by single methods. Here, we investigate the Cascadia subduction zone using dense seismic and magnetotelluric data sets collected along an E-W profile running through western Washington State. We present images generated by 2-D Generalized Radon Transform (GRT) inversion of scattered teleseismic data recorded at 41 three-component broadband stations from the CAFÉ experiment, the Earthscope Transportable Array, and the Pacific Northwest Seismic Network over a period of roughly 26 months. The resulting profile clearly images the subducted oceanic crust as a dipping low-velocity layer that persists to ∼40-50 km depth, and a disrupted continental Moho that may be weakened by serpentinization of the underlying mantle wedge. We also present preliminary results from a 2-D non-linear conjugate gradient inversion of magnetotelluric data recently acquired by 60 broadband and 21 long-period stations along a collocated profile. The resulting model shows evidence for a subducted slab exhibiting higher electrical resistivity than the surrounding mantle, and resistivity anomalies in the mantle wedge that might be correlated to the distribution of fluids and melt. We consider how each geophysical method informs us about the structure and dynamics of the system, and explore how the two sets of results can be used to constrain one another. Finally, we evaluate how these insights might be used to develop new techniques for joint inversion of passive seismic and magnetotelluric data that would result in tighter overall constraints on the key processes taking place in the subduction factory.