3D Crust and Mantle Tomography for the Bighorn Mountains, Wyoming, from a Joint Inversion of Active and Passive Source Seismic Data

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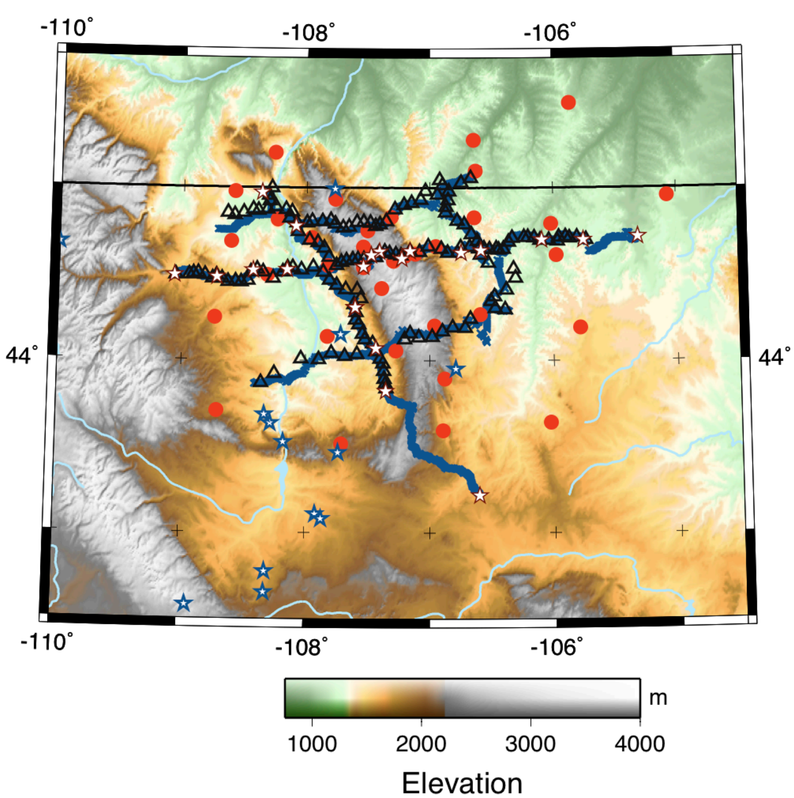
In 2009 and 2010 a seismic array was deployed across northern Wyoming as part of the Earthscope Bighorn Arch Seismic Experiment (BASE). The goal of the BASE project is to better understand the tectonic origin of the Bighorn Mountain Range and to evaluate existing models for the formation of Laramide thick-skinned arches. In total 35 broadband, 173 intermediate-period, and 834 single-channel seismometers (Texans) were deployed across the region in order to record both active and passive seismic events. The broadband stations were deployed in a grid designed to densify the existing USArray stations in the area. The intermediate-period and single-component instruments were deployed in five intersecting lines with station spacing of 5km and 100-1000m respectively. The broadbands were deployed for 13 months, the intermediate-period stations for ~5 months, while the Texans were deployed for 2 weeks as part of an experimental passive observation deployment.

The work presented here takes the seismic P-wave arrivals from active-source blasts, teleseismic events, and local earthquakes and performs a 3D joint-inversion of traveltime tomography. This is accomplished using the FMTOMO fast-marching-method tomography package published by Rawlinson and Sambridge (2004). The active-source component of BASE included 21 blasts that were recorded on all three types of seismometers. These blasts yielded Pg, Pn and PmP arrivals that are used in this study. During the passive-source phase the instruments observed over 30 teleseisms on the single-channel recorders, and over 100 teleseisms on the broadband and intermediate-period stations. These events range from magnitude 4.0 to 7.0 at epicentral distances of ~30-95 degrees. In addition, several small local earthquakes occurred inside the array during recording that provide direct arrivals and help constrain the inversion. By combining multiple types of sources in a joint inversion, the resulting tomography model is better resolved and can provide better insights into the subsurface geology.



Map of central Wyoming and southern Montana, centered on the Bighorn Mountains. Broadband stations shown as red circles, intermediate-period stations as black triangles, Texans as blue Xs. Active shots shown as red stars, local earthquakes as blue stars.