Crustal Structure of the Ruby Mountains Core Complex from Seismic Observations

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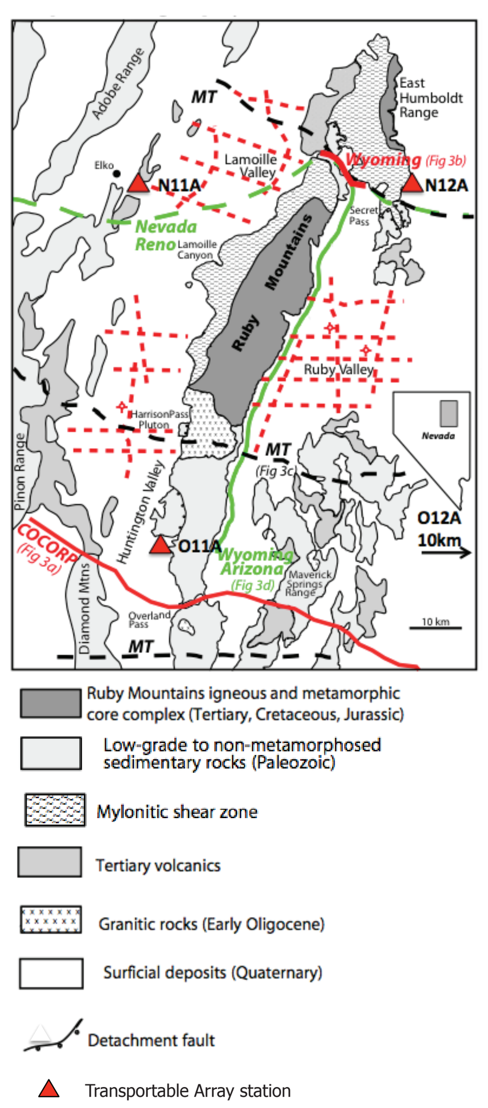
Motivation

- A metamorphic core complex is a structure that unroofs high-grade, ductilely deformed crust beneath a low angle normal fault. Core complexes have been extensively studied, but the process of their formation is controversial.
- The Ruby Mountains Core Complex (RMCC), located in the Basin-and-Range region in northeastern Nevada, has been extensively mapped at the surface, but more investigation of its deep structure is necessary.
- To address this, we are making a crustal velocity model of the region using data from a passive-source broadband seismic array.

Previous Geophysical Studies



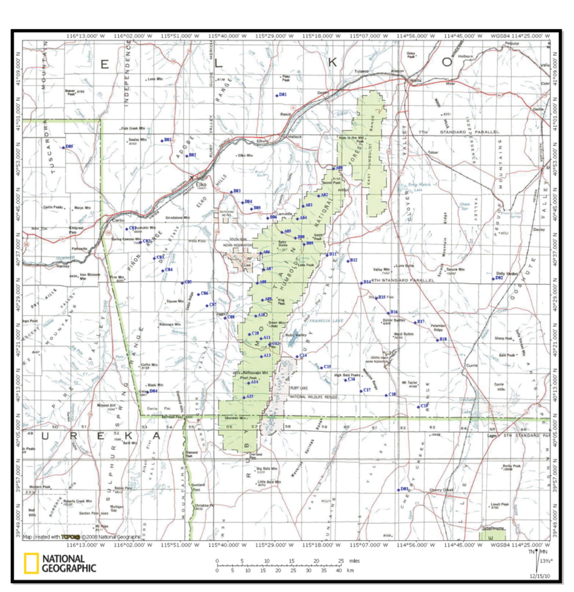
1983 COCORP reflection profile: crossed the southernmost Rubies at Overland Pass [1], but this is south of the main part of the RMCC, and shows a sub-horizontal Moho reflector at 32 to 35 km.

Wyoming-Arizona refraction profile: runs the length of the Rubies, but is east of the axis of the RMCC, in Ruby Valley [2].

Transportable Array: four stations surround the RMCC, but station spacing is too large to image crustal features.

New seismic data is necessary to image the RMCC.

Ruby Mountains Seismic Experiment



New 50-station broadband passive seismic array with dense station spacing of 5-10 km that is arranged in three crossing lines over the Ruby Range (see map).

The array was deployed in June 2010, and data acquisition will last up to two years.

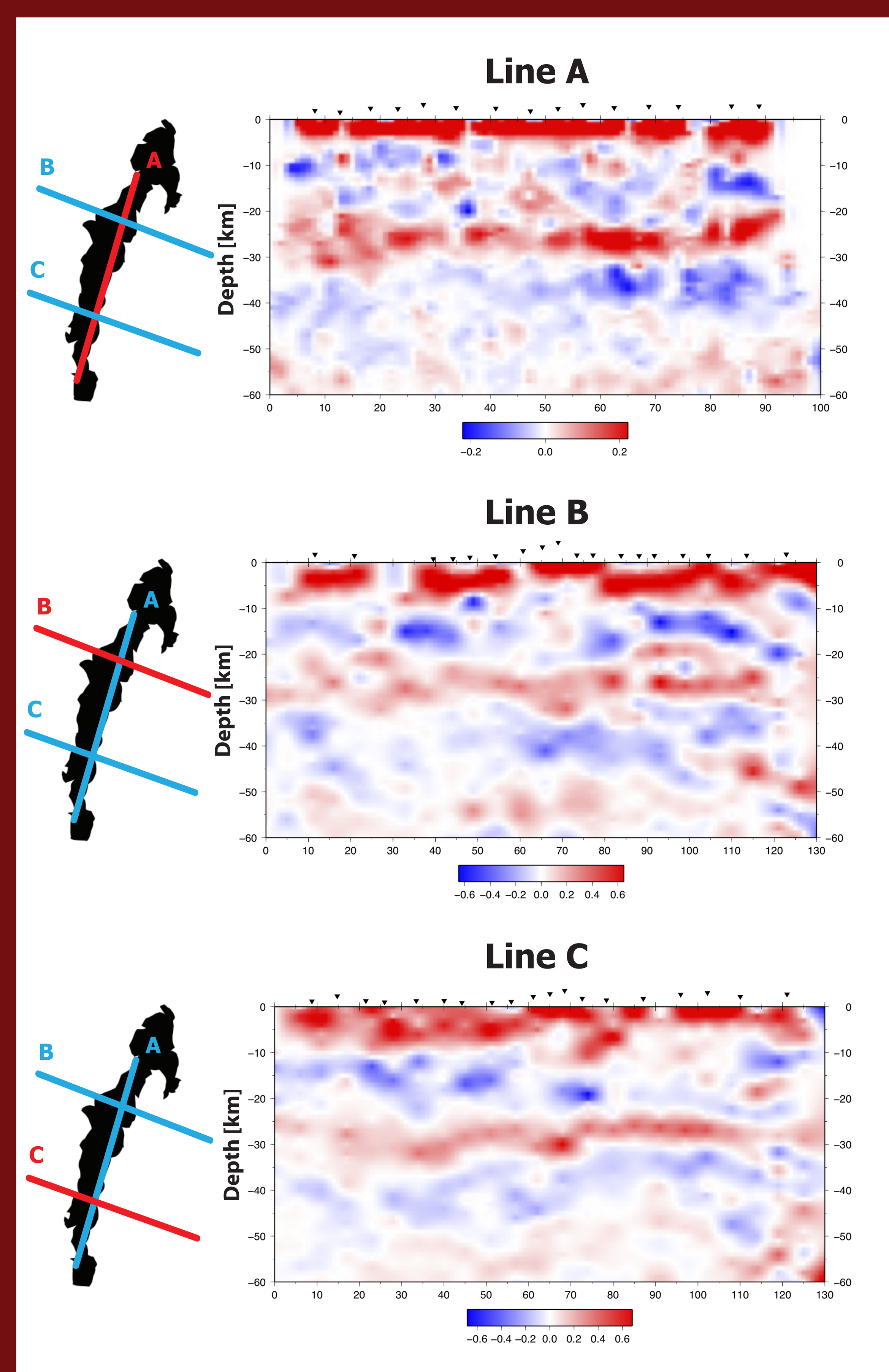
Objective is to produce a high-resolution geophysical model of the area around the RMCC.

Preliminary Results

Receiver Function Analysis

Receiver functions model the Earth response, allowing us to image velocity discontinuities within the earth. Here we used iterative deconvolution of the vertical and radial components to image the Moho beneath the RMCC.

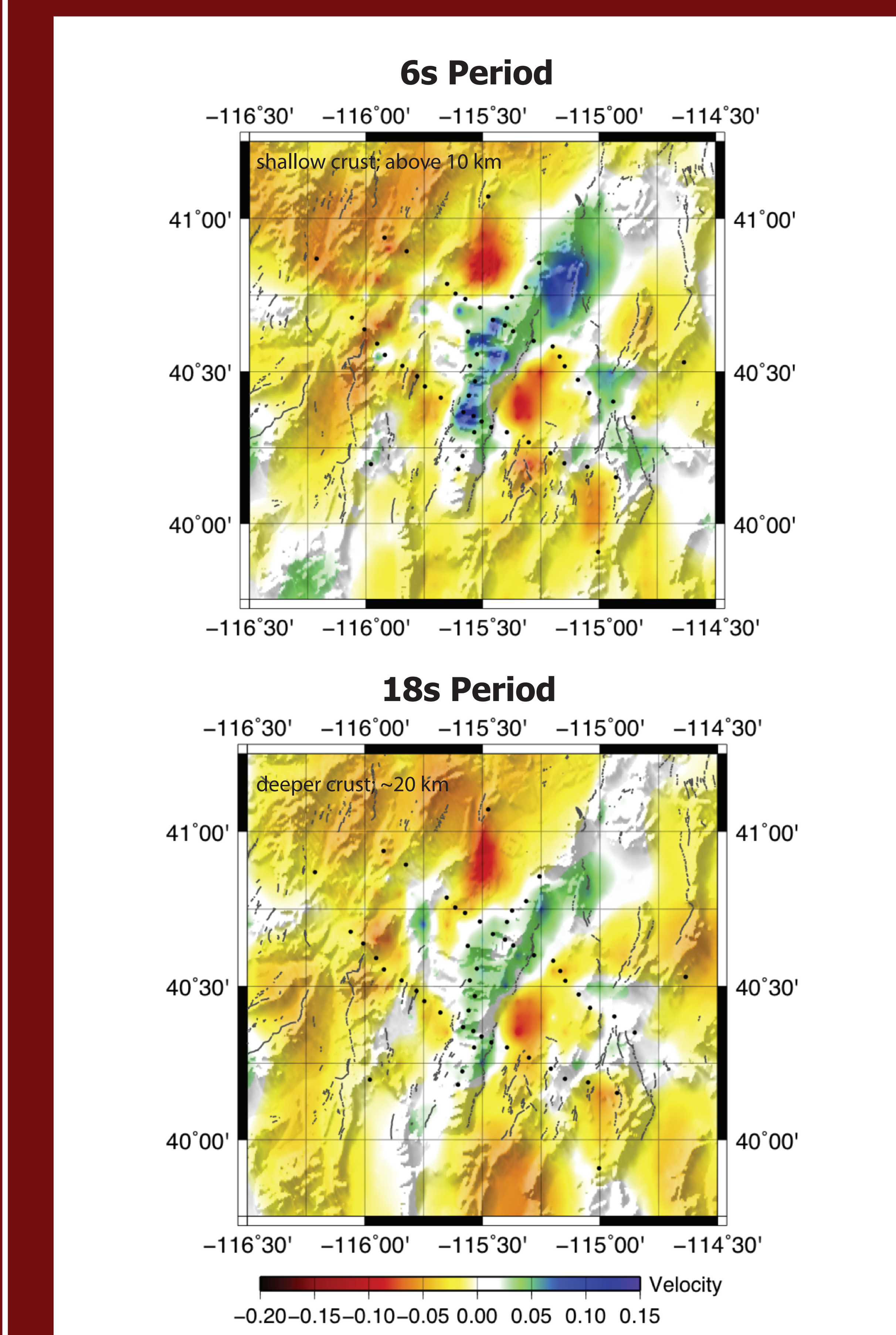
We created the following 2D profiles by stacking over a common conversion point for each of the three lines in the array. We applied a 5s low-pass Gaussian filter to the data and used the IASP91 velocity model for the time to depth conversion. In the future, we will make a 3D map and use the data from our ambient noise tomography to constrain the velocity model.



Ambient Noise Tomography

Ambient noise tomography takes advantage of the noise present in all seismic recordings to measure velocity in the earth. By cross-correlating hundreds of samples, random noise is canceled out and the result is a noise correlation function that approximates the Green's Function between two stations. This allows us to model the traveltime of a hypothetical surface wave traveling between the two stations, and produce a velocity map from it

Below are two depth slices from our velocity model. Each layer shows the velocity model for a particular period; larger periods sample deeper crust but each period covers a range of depth. Color-bar represents differences from the average velocity across the map area at each period.



Discussion

- We image a Moho between 25 and 30 km depth beneath the Ruby mountains. This is somewhat shallower than previous studies, but more work is needed to improve our velocity model before we can make a final depth estimation.
- The velocity model from the ambient noise tomography provides some initial constraints on the structure of the region. We observe three separate Tertiary depocenters surrounding the Ruby Mountains: Lamoille Valley (NW), Huntington Valley (SW) and Ruby Valley (SE) [2]. We also note relatively higher velocities beneath the Ruby Range and the Cherry Creek Mtns.

Future Work

- Refine preliminary results from receiver function analysis and ambient noise tomography and use in a joint inversion to produce the final 3D velocity model.
- Use shear-wave splitting from all stations in the array along with previous results [3] to study the anisotropy variation across the region.
- Combine receiver functions, ambient noise tomography, and shear-wave splitting observations into a self-consistent model of the RMCC, and provide insight into the processes that control core complex formation.

Acknowledgements

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