Preliminary results from the CIELO seismic experiment

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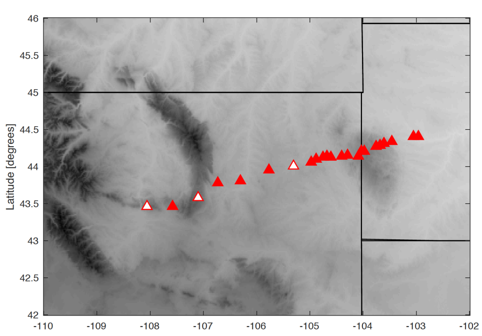
A commonly held view within the Earth Sciences is that cratons are regions of strong lithosphere, capable of withstanding deformation over extended periods of time. To first order, this assertion appears to be true, as most cratons have remained relatively stable and intact since the Precambrian. However, there are notable exceptions, such as the Wyoming craton, which underwent significant deformation during the Laramide orogeny, producing uplifts in places such as the Wind River Range in western Wyoming to the Black Hills of South Dakota in the east. Exceptions such as these have prompted questions as to why some cratons lose their immunity to deformation, and whether they may recover it once lost.

In September 2017 we set out to advance our understanding of the processes that modify cratonic lithosphere by installing 24 broadband seismometers across the eastern half of the Wyoming craton. The study area was chosen for two reasons. The first being the existence of anomalously thick mantle lithosphere, which has been inferred to be either a stable, rigid block, or a weakened remnant in the process of delamination. The second reason being the proximity of the block's edge to the uplifted Black Hills, which suggests that the block may have played a role in uplift in the region. The experiment, named *Crust and lithosphere Investigation of the Easternmost expression of the Laramide Orogeny* (or CIELO), is slated to operate for 2 years, during which data will be recorded continuously. A service run was completed in March of 2018, and data from 21 of the 24 stations were retrieved. Average teleseismic P delay times were calculated for 21 stations. While the delays are dominated by the effect of the Powder River Basin, after corrections for topography and basin thickness, early arrivals related to high-velocity mantle structure are apparent. These early results are consistent with a +2.5% anomaly over the upper 200 km of the mantle that sharply terminates at the western edge of the Black Hills. Single station stacked Ps receiver functions were calculated in order to better characterize basement topography and obtain constraints on crustal thickness. Preliminary results for stations within the Powder River Basin show good agreement from well logs and active source data (Blackwell, 1993). Modeling is currently being performed to help distinguish between basin reverberations and Moho structure. Beneath the Black Hills, where stations sit near bedrock, complex crustal structure appears to be widespread within the mid-crust.



(above) Distribution of stations deployed in 2017. Solid red triangles indicate stations for which delay times (right) were calculated. Uncorrected delay times (top right), delay times corrected for topography (middle right) and for topography and basin thickness (bottom right).