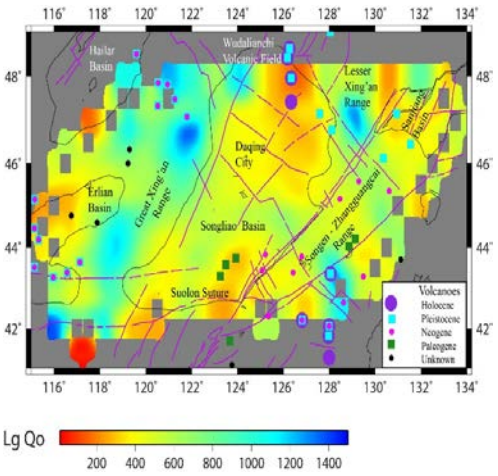
ERI Research Report

Dr. Thomas Hearn, Visiting Associate Professor, October 1 2013 to March 1 2014

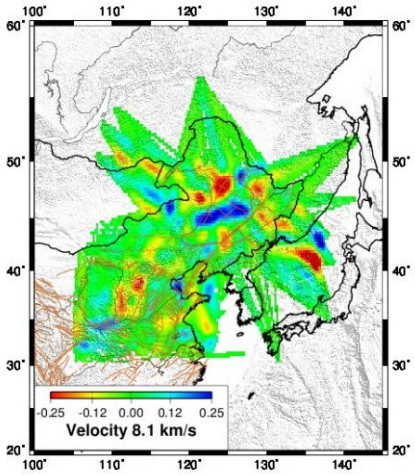
I would like to thank my host, Dr. Hitoshi Kawakatsu, and the faculty at ERI for my stay. Working at ERI and living in Tokyo has been a great experience.

While at ERI I have been working on seismic amplitudes and travel-times obtained from the NECESSArray experiment, regional Chinese networks, and the Japan national network. The NECESSArray (North East China Extended SeiSmic Array) experiment was conducted in Northeast China from September 12, 2009 to August 19, 2011 with OHRC at ERI as a key participant along with institutions in China and the US. About 127 broadband seismometers were deployed in the Songliao Basin and surrounding regions. The data from NECESSArray form the backbone of the research.

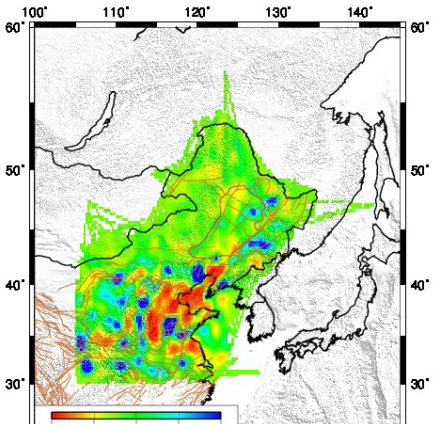


Lg attenuation beneath Northeast China

Our primary project has been studying the Lg phase amplitudes using two-station tomography methods for the NECESSArray. This method uses the spectral ratios of Lg amplitudes recorded from an event on two stations at the same azimuth. These amplitude spectral ratios are then used to invert for regional variations in seismic attenuation. We extended this method to include an estimate of regional spreading, which we find occurs as distance$^{-0.7}$. This spreading is slightly faster than cylindrical, but not as fast as spherical. Our regional Q varies from 50 to 1400, and averages around 390. A paper was submitted to Geophysical Journal on this and is being prepared for resubmission. This work has been supplemented using amplitude information from the China Bulletin of Earthquakes.



Pn velocity beneath Northeast China



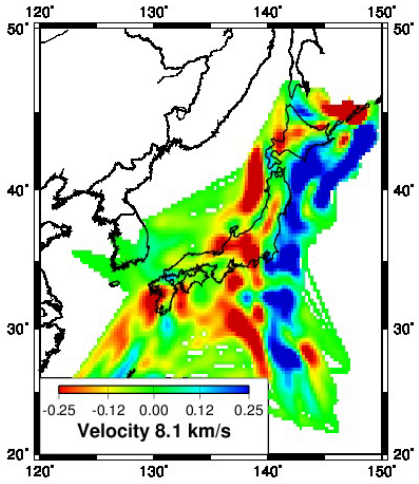
Attenuation beneath Northeast China from ML amplitudes

That bulletin reports amplitude information on the Sg/Lg phase and these were used for a regional tomography study. It finds a geometric spreading factor of 1.1 and distinguishes features at a finer scale than that from the NECESSArray. Most notable is the high attenuation of the Songliao Basin.

We also looked at Pn velocity anomalies using the NECESSArray. We found high velocities beneath the center of the Songliao basin with low velocities in its northeast corner. However, the NECESSArray did not collect as much regional

data as we would have liked and the aperture of the network was limited. This is true for both Lg amplitude data and travel-time data. So we have again supplemented these data with data from the China Bulletin. This greatly improved both the resolution and coverage of the data sets.

Data from the Japanese JMA bulletin includes both travel times and amplitudes from regional events. We were able to use the travel-times in traditional Pn and Pg tomography algorithms to map velocity variations in and around Japan. The most notable result is the contrast of the high mantle velocities of the Pacific plate with Japan. While interesting, these inversions do not account for the tremendous variability of Moho depths and were done mostly to get familiar with the data set. Of more interest is the amplitude information contained in the bulletin. These amplitudes, and their associated periods, are collected to estimate earthquake magnitudes. The bulletin is one of the most complete set of such amplitudes in the world and can be used to extract attenuation information that can be applied to hazard analysis and event size problems. The data show that data labeled as being from velocity instruments have a geometric spreading decay rate of 2.0, twice that of spherical, and that data labeled as displacement have a decay rate of 1.3, much closer to that expected from the Richter magnitude formula. Initially I was unable to estimate any attenuation from the data. Unlike almost any other earthquake bulletin the data also listed the time of the maximum amplitude. Plots of these showed that many of the amplitudes measurements were coming from different phases. For the velocity data traditional maximum amplitude measurements are made from the Sg/Lg wavetrain; however the velocity data show that there are also measurements from the Sn, Pg, and Pn parts of the data. This has skewed the analysis of the amplitudes and the data needs to be separated for further study. For the displacement data the maximum amplitude times show that the measurements are made from the surface waves. This has occurred because the integration from velocity to displacement records caused the longer period surface waves to become amplified relative to other phases. Work is continuing to use these amplitude data to produce maps of regional attenuation beneath Japan.



Pn velocity tomography beneath Japan