Locating Earthquake's in the Dallas-Fort Worth Metroplex

Over the summer Louis Quinones has been examining data collected from seismic stations deployed in the Dallas-Fort Worth area near Irving, Texas. The state of Texas does not have any public maps of the system of faults in the Fort Worth Basin. However, by using seismological techniques and data gathered by the seismic stations Mr. Quinones can create a map showing the probable location of the fault that has been causing the earthquakes in the Dallas-Irving area. The stations detect the movement of the ground in both the vertical and horizontal directions and then record the data in a waveform format. Seismic waves are characterized by the large up and down motion like those seen in a seismograph or lie detector test. Each earthquake creates its own seismic wave that will appear in each of the station's data. By examining the exact time that the seismic wave hits each sensor, and using advanced calculations of how fast the waves move through the ground in the DFW area, he can get an estimate of where the actual earthquake has occurred. The seismic waves caused by larger earthquakes travel much farther than those caused by smaller earthquakes, therefore the larger earthquakes are typically seen on more station's data than their smaller counterparts. What this means is that he can find the locations of where the larger earthquakes occurred more easily, because the seismic waves caused by those events are seen on a lot more stations.

The research that Mr. Quinones is doing is to take that method of finding earthquake locations to the next level to get more accurate location estimates. When earthquakes occur near the same time or happen near one another, the seismic waves that these earthquakes cause are actually very similar in shape. What we can do is then look at all the seismic waves that a station has seen and compare all of the waves to see if we can find groups that are similar to one another. Mr. Quinones can do this using mathematics software to look at all the seismic waveform data from each of the stations, and then compare every single wave to every other wave to see if they are similar in any way. When he sees large groups of events that are very similar to one another he then finds the time difference between when he expected these seismic waves to hit the station, and at what time the waves actually hit the station. Mr. Quinones can then compare time differences of similar earthquakes by doing a second time difference calculation using multiple earthquakes to gain even more accurate time differences. With more accurate time differences, Mr. Quinones can then calculate better earthquake location estimates and better characterize the fault where all these earthquakes are actually occurring.

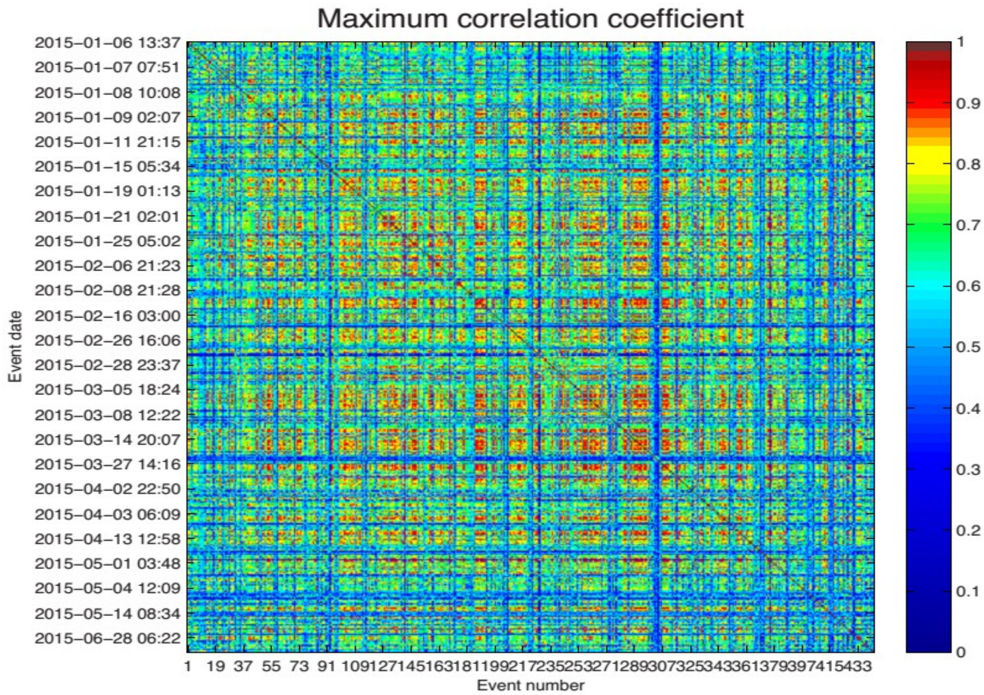

Figure 1: This is a plot comparing the waveforms of every event to the waveforms of every other event captured on a station called IPD1. The comparison is done by looking at the waves themselves and seeing if the shape of the waves and the overall length of the waves are similar to one another. The comparison is then given a number, 0 if the waves are nothing alike and 1 if the waves are completely identical as shown in the color scale on the right. Mr. Quinones can then examine this plot and search for pairs of earthquakes that have high degrees of similarity (>0.7) and use those to calculate more accurate time differences. The darker blue colors state that those events are not very similar, but these pairs are also important because they tell us that certain earthquakes may need to be rechecked, or that those isolated earthquakes may not be related to the rest of the earthquake sequence.