United States Department of the Interior

U.S. GEOLOGICAL SURVEY
EARTHQUAKE SCIENCE CENTER

23 December, 2013

The Honorable Alan Brundrett
Mayor of Azle
City of Azle
623 SE Parkway
Azle, TX 76020

Dear Mr. Mayor:

In response to the recent earthquake activity in the vicinity of the City of Azle, the U. S. Geological Survey (USGS) has been working with colleagues at Southern Methodist University (SMU) to identify the region from which the earthquakes are originating. The first earthquake detected in the Azle area by the USGS National Earthquake Information Center (NEIC) in Golden, CO occurred on November 1, 2013, and activity has been continuing without signs of slowing down for the past 8 weeks. To date, seven earthquakes with magnitudes 3 to 3.6 have occurred, including earthquakes of magnitude 3.3 on December 22 and 23. The NEIC locations are scattered over a broad area, approximately centered on the community of Reno (Figure 1).

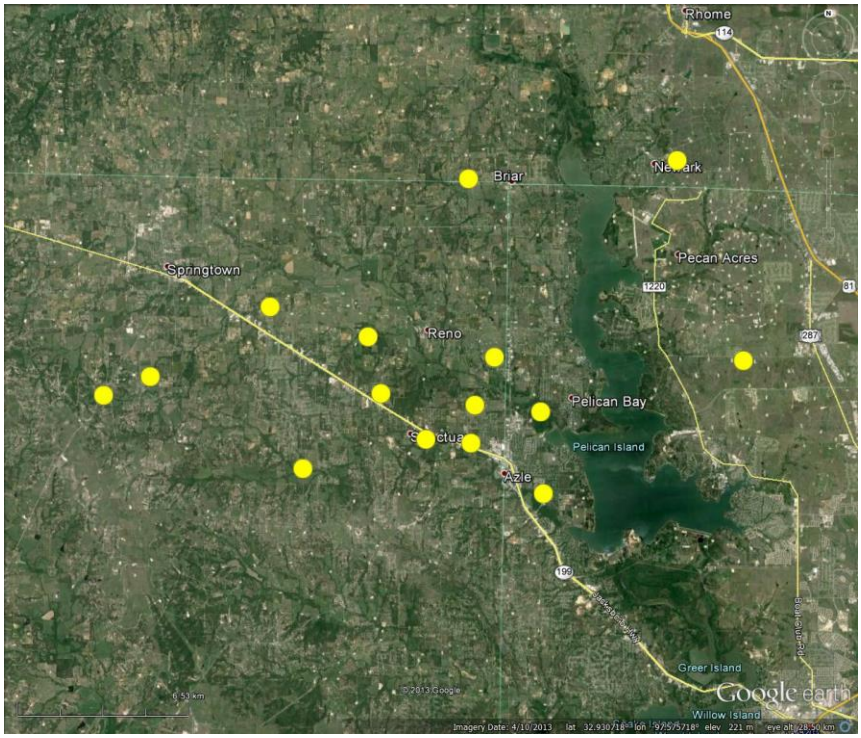

Figure 1. Earthquake epicenters determined by USGS-NEIC, November 1-26, 2013.

During my telephone conversation with you and City Manager Craig Lemin on December 5, 2013, I explained that the earthquake epicenters for earthquakes in Texas routinely determined by NEIC can be uncertain by 5 miles or more due to the very large distances between seismograph stations in this part of the country and the long distance from Azle to the nearest instruments. The closest station used by NEIC to locate the Azle earthquakes is over 60 miles to the south, the next closest is 125 miles to the west.

Fortunately, many of the residents of Azle and surrounding communities provided the USGS with information on the shaking they felt during many of the November, 2013 earthquakes through our "Did You Feel It?" website at http://earthquake.usgs.gov/earthquakes/dyfi/. My analysis of the shaking patterns for the November earthquakes showed that the center of the shaking for the individual earthquakes was concentrated in a more limited region than the NEIC epicenters, with many of the reports centered in the region between the communities of Reno and Briar (Figure2). This observation suggested that the earthquake activity might not be as broadly distributed as implied by the relatively imprecise NEIC locations.

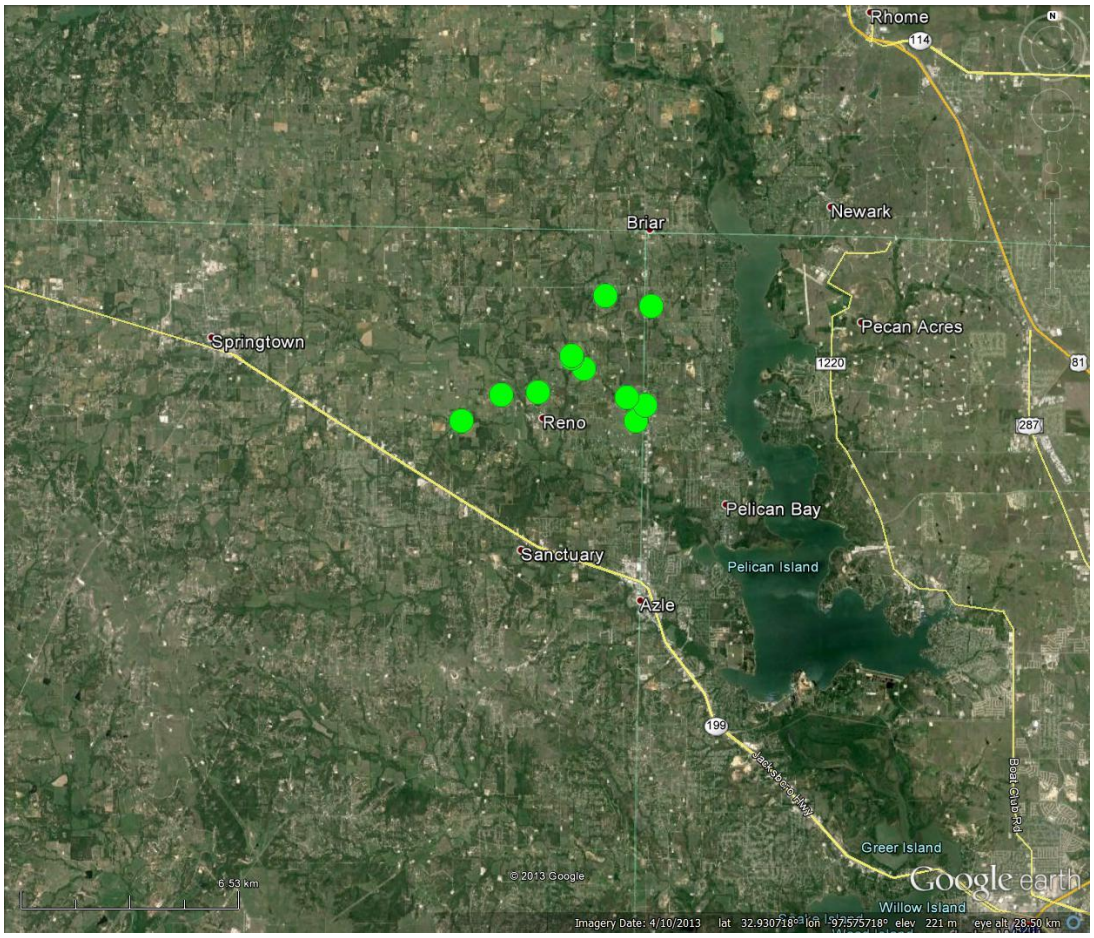

Figure 2. Center of shaking for earthquakes, November 6-26, 2013.

In order to accurately determine the epicenters of the earthquakes it was necessary to install additional seismographic instruments in the Azle area. Five "NetQuakes" seismographs were shipped by the USGS in Menlo Park, CA, to our colleagues at SMU who successfully installed them as soon as the conditions on the roads made travel safe following the ice storm in early December. We and they deeply appreciate the help we received from your staff and the local school district in finding sites for the instruments. The initial locations of the instruments are shown in Figure 3.

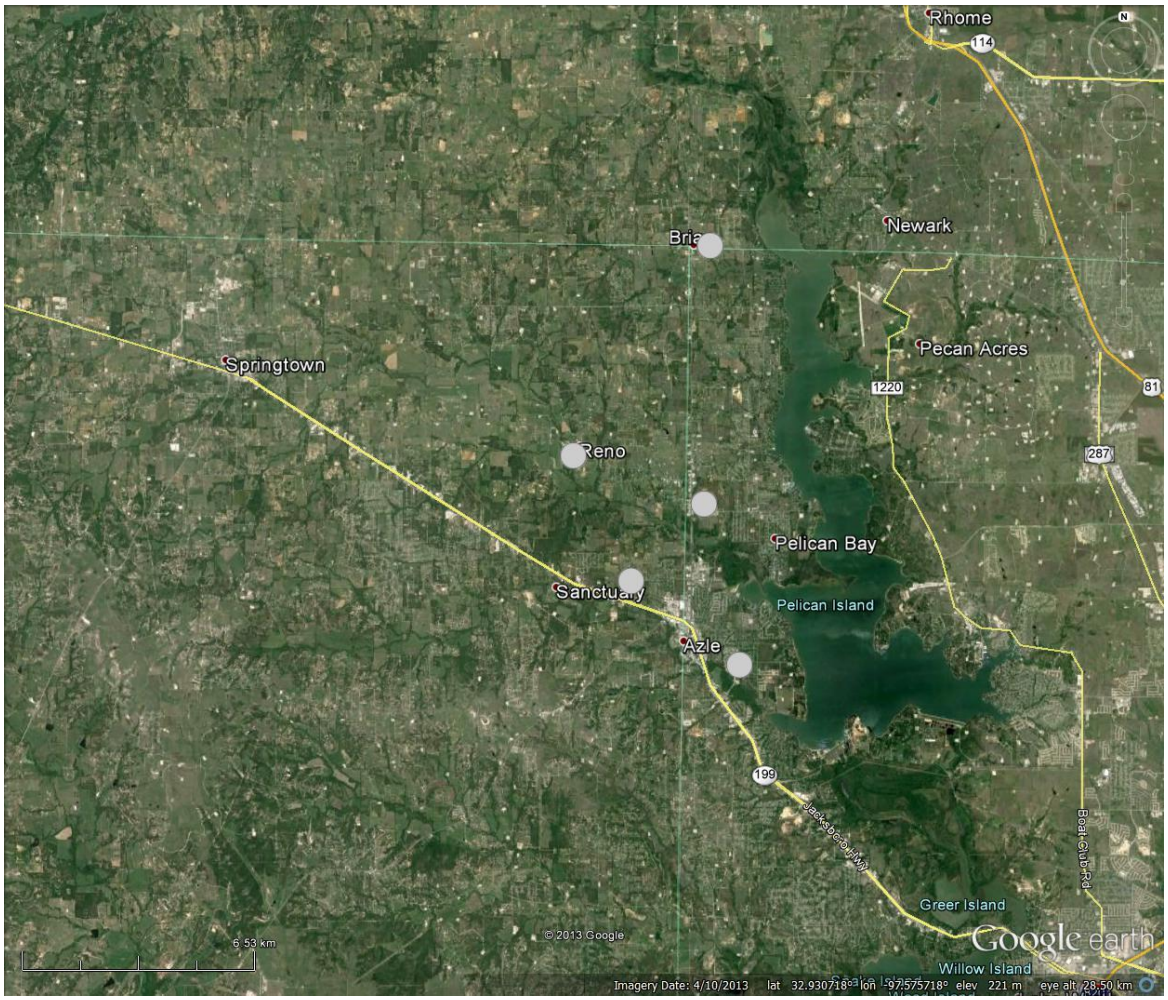

Figure 3. Locations of NetQuakes seismographic instruments as of December 23, 2013.

The network became fully operational for the purpose of locating earthquakes on December 15. Since then, I have located a number of earthquakes, including several that were also located by NEIC. The epicenters are confined to a limited area approximately midway between Reno and Briar (Figure 4). This source zone includes the epicenters of the two magnitude 3.3 earthquakes of December 22 and 23, 2013. The earthquakes are shallow, with depths between 2.5 and 4 miles below the ground surface. Although the depths are somewhat uncertain because of the lack of detailed information about the local geology, this deficiency can be remedied in the future. The current locations and depths were determined with the same geologic model that was used by Professor Stump in his study of the earthquakes near the Dallas-Fort Worth Airport. I also located the

earthquakes with other Texas crustal models to determine the permissible range of focal depths. The changes between models are small and I believe that it is safe to conclude that most of the earthquakes are located in the shallow crystalline basement below the sediments.

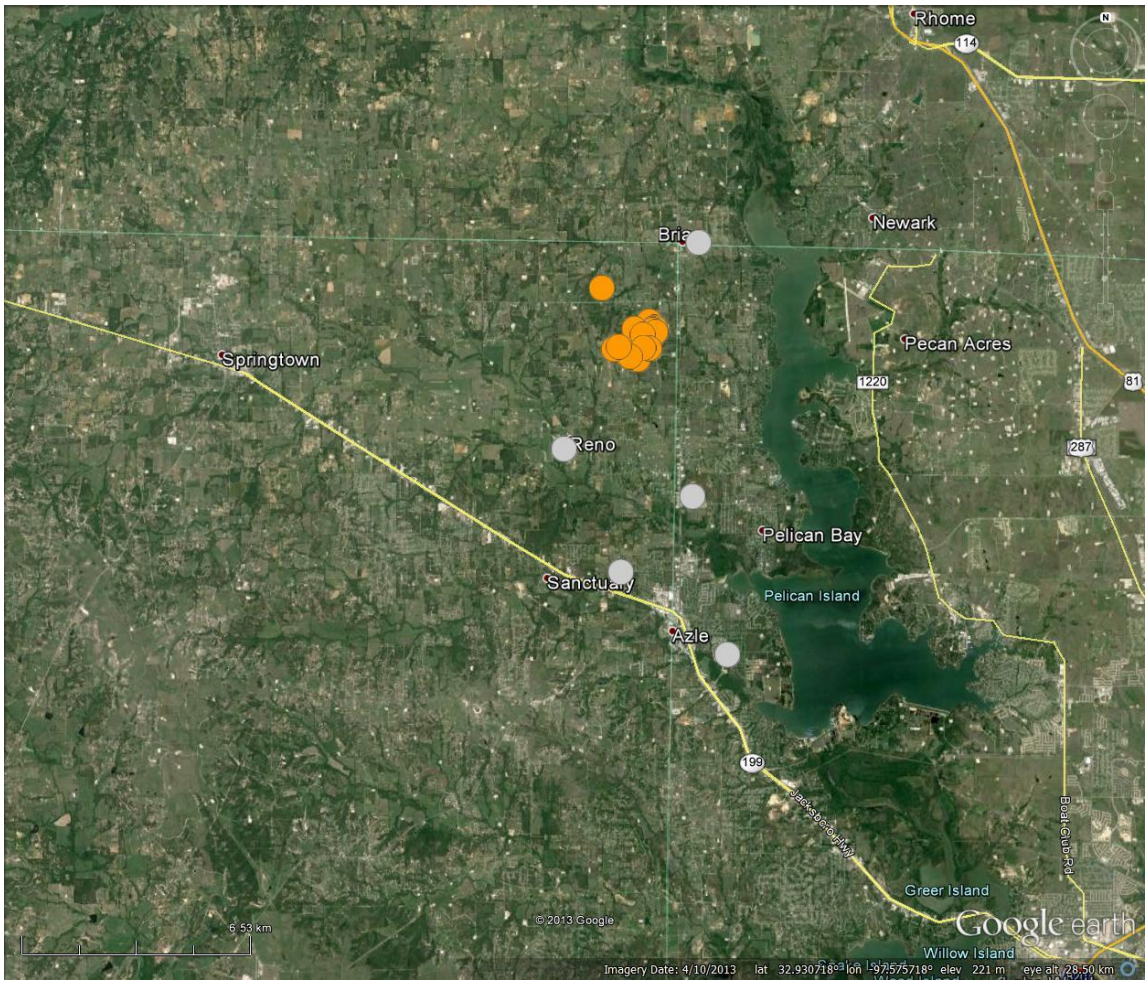

Figure 4. Epicenters of earthquakes located using the local NetQuakes seismographs.

I next reanalyze the locations of earthquakes reported by the NEIC. To date I have examined seven earthquakes, including four that occurred in November, two in December before the installation of the NetQuakes instruments and the magnitude 3.3 earthquake on December 22. Because the location of the December 22 earthquake is known from the local stations, I was able to calibrate the measurements for the other earthquakes and improve the accuracy of their locations. I also re-read the seismograms at the regional stations, taking advantage of the strong similarities in their waveforms to make very accurate measurements of the wave arrival times. This is a well-established methodology in seismology. I then used standard earthquake location methods to determine the location of the six events relative to the known event. The results of the analysis appear in Figure 5.

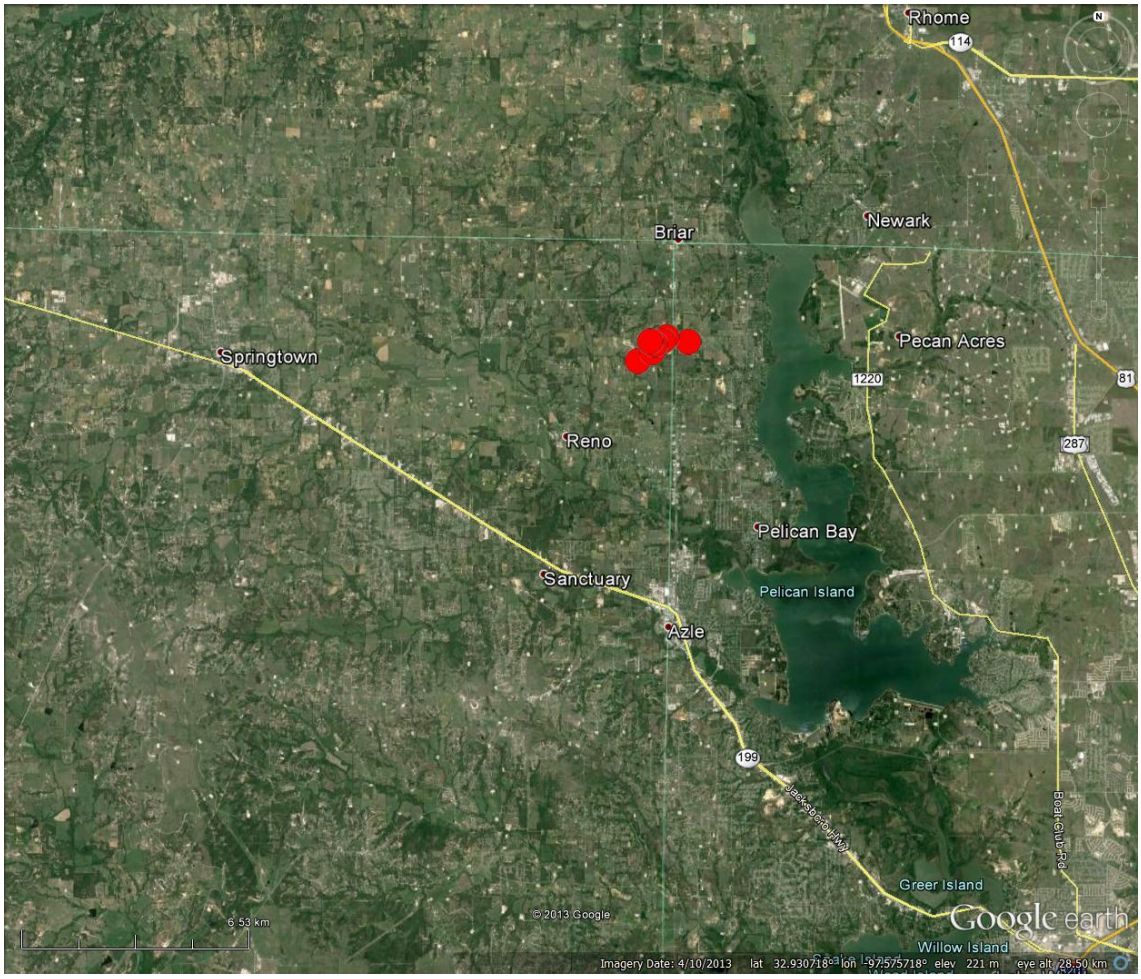

Figure 5. Re-determined epicenters for earthquakes in November and December 2013.

The epicenters of these earthquakes are no longer scattered over an area many miles in dimension (Figure 1), but now cluster in the same zone as the more recent earthquakes located using the local NetQuake stations. Visual examination of the seismograms for other November-December earthquakes strongly suggests that all of them will be found to have occurred in this same small area.

The next step in this study is already underway. My colleagues at SMU are relocating several of the NetQuakes instruments to better surround the source region of the earthquakes. It would be reasonable to expect that the epicenters determined to date could move a small amount, perhaps a mile, as a result of improving the seismic network geometry and application of a more accurate crustal velocity model. I believe, however, that it is very unlikely that the overall picture will change significantly, and that we can be confident that the earthquakes recently occurring in the vicinity of the City of Azle are originating from a small region roughly midway between Reno and Briar, and that they are located in the shallow crystalline basement.

My colleagues and I hope that you will share this information with the residents of your city, with other local and state officials, and with anyone else that you feel would benefit from seeing the results of this preliminary investigation.

Sincerely yours,

William L. Ellsworth

Dr. William L. Ellsworth
Earthquake Science Center
U. S. Geological Survey