

EARTHQUAKE IN THE EARTH'S CRUST RECORDED IN NORTH DAKOTA

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Recent Earthquake in North Dakota

A small earthquake with a magnitude of 1.5 was recorded in northwestern North Dakota at 7:53 a.m. on Saturday, January 3rd, 2009. The epicenter of this earthquake was located about 11 miles south of the town of Grenora (48.537° N., 103.946° W.) in Williams County (fig. 1). Mike Stickney, Geologist and Director of the Earthquake Studies Office at the Montana Bureau of Mines and Geology in Butte, Montana, came across the event while reviewing seismological data from the seismic monitoring station located at Dagmar, Montana. Mike quickly determined the depth and epicenter of the earthquake from the recorded seismic information and relayed that information to geologists at the NDGS. This event was a small earthquake, in the range of magnitudes generally recorded, but not felt by people. The

energy yield equivalent of this earthquake would be equal to 320 pounds of trinitrotoluene (TNT). An approximate real-world example would be somewhere near that of a large blast in a mine or quarry. Although this earthquake was small, it was large enough to be recorded on the Advanced National Seismic System station at Dagmar, MT and at an additional 10 stations belonging to the EarthScope Transportable Array deployed throughout eastern Montana. The epicenter of this earthquake was determined by

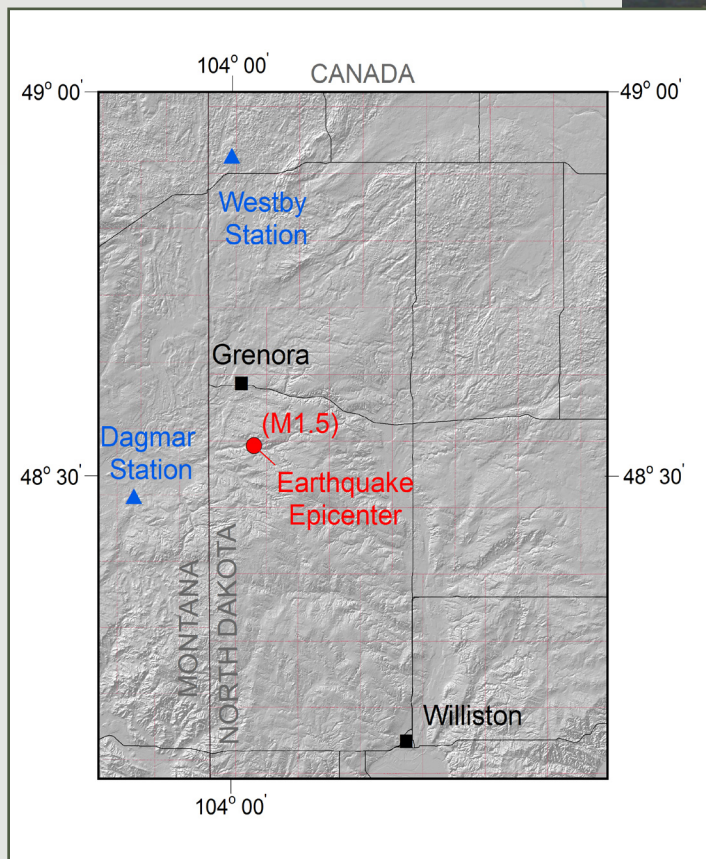


Figure 1. Location of the magnitude 1.5 earthquake instrumentally verified to have been located south of Grenora in northwestern North Dakota. Two broadband seismic monitoring stations, one at Dagmar, MT and one at Westby, ND, are currently operating in the area.



Figure 2. The seismic monitoring station at Westby, ND. Photo taken shortly after the instrumentation installation. Angled solar panel can be seen on the left side of the mast. This station recorded the seismic energy from the January 3, 2009 M1.5 earthquake shortly after it had been received by the Dagmar, MT station (Image courtesy of IRIS/EarthScope).

picking the P-wave first arrivals and, when possible, S-wave arrivals from seismograms generated at the Dagmar and Brockton, MT and Westby, ND seismic monitoring stations (figs. 2 and 3). The earthquake was determined to have originated at a depth of 8.3 miles, putting it about one-third of the way through the Earth's crust under North Dakota.

Other Earthquakes Recorded in North Dakota

This earthquake is the fifth to have been instrumentally verified to have originated in the state (fig. 4), according to data obtained from recently updated earthquake catalogs (USGS, 2009). The first instrumentally verifiable earthquake occurred on July 8, 1968 with an epicenter near Huff, ND approximately 12 miles south and east of Bismarck. This quake was felt over a relatively wide area (3,000 square miles) in central North Dakota. Some Bismarck residents reported feeling the event, but most evidently did not recognize it as an actual earthquake. (See the answer to X Marks the Spot #16 on page 23 for more information on this, and other recent earthquakes in North Dakota.)

Figure 3. Vertical Component Seismograms from three seismic stations that recorded the M1.5 mid-crustal earthquake in North Dakota at 7:53 a.m. on January 3, 2009 and were used to determine the location of the earthquake hypocenter. DGMT = Dagmar station, Dagmar, MT, A24A = Westby station, Westby, ND, B23A = Brockton station, Brockton, MT. The first arrival of seismic wave-form energy (the P-waves) at each of the stations is highlighted in red (modified from Stickney, 2009).

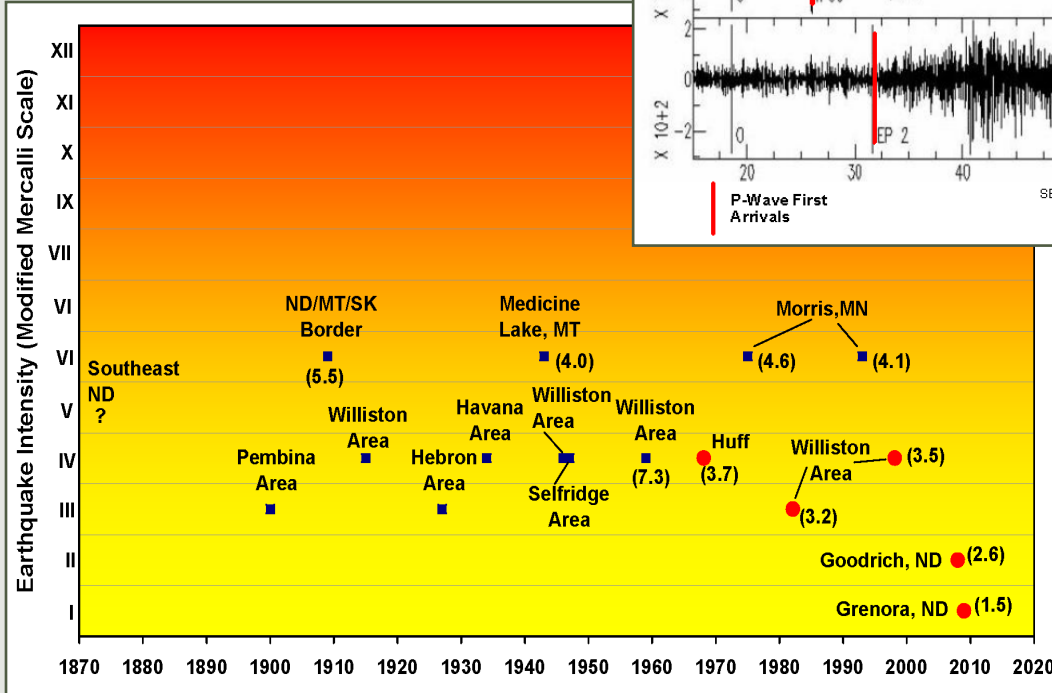
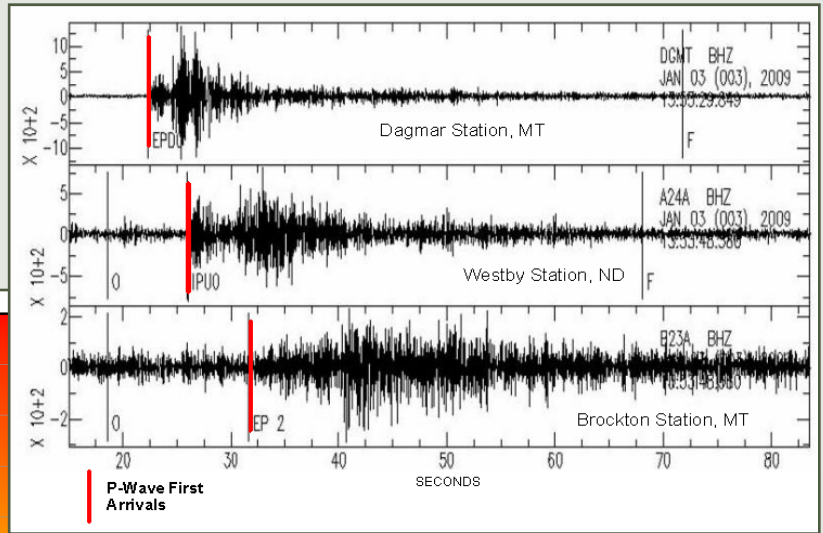


Figure 4. Historical timeline of earthquakes originating within North Dakota (red circles) or felt by residents in North Dakota (blue squares). The earliest recorded event of October 9, 1872 – location undetermined - is denoted with a question mark. Available calculated Richter magnitudes are shown below the time markers in parentheses.

Frequency of Earthquakes in the U.S.

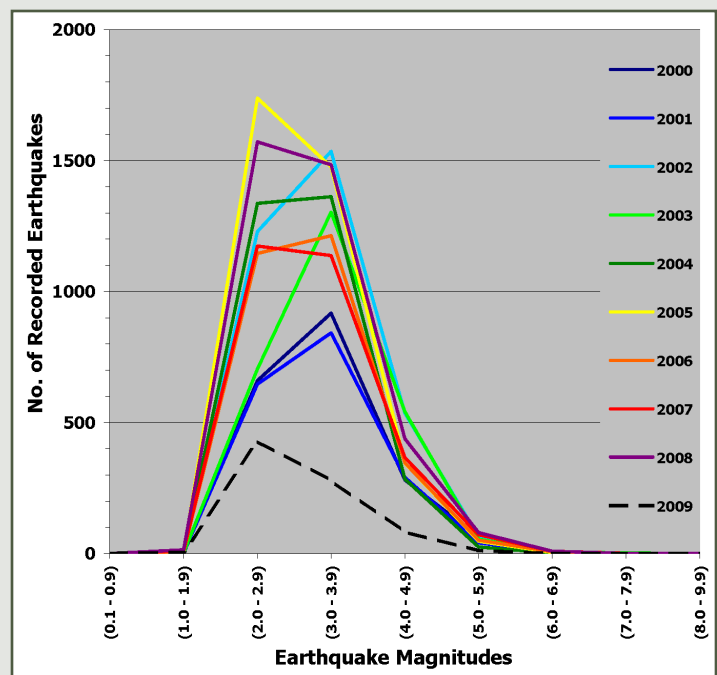
The frequency of low-magnitude earthquakes (from 0 to 2.0) in the U.S. is actually quite low, with an average of around five events being recorded a year. Comparatively, magnitude 2.0 to 4.0 earthquakes have the highest frequency of occurrence, and are recorded on average, over 1,150 times a year (fig. 5). With these numbers it is important to consider that since relatively few small-magnitude earthquakes are reported each year, it does not necessarily mean that they are not occurring. In fact, it is observed that each time we go down one number on the magnitude scale, there is generally a ten-fold increase in the number of earthquakes that do occur. For example, if an earthquake of magnitude 4.0 or greater occurs around once per decade in N.D., then it is likely that there are also 10 other smaller earthquakes of magnitude 3.0 or greater, and 100 earthquakes of magnitude 2.0 or greater that may occur (Stickney, 2009). We simply do not have the seismograph coverage needed to register and record these smaller events both locally and nationally.

More Earthquakes in North Dakota?

It is very likely that we will record more earthquakes in N.D. in the

Figure 5. Frequency of earthquakes recorded in the U.S. by magnitude from 2000 to 2009. For the last ten years, most earthquakes recorded in the U.S. have had magnitudes of 2.0 to 4.0, with both lower and higher magnitude events occurring less frequently (USGS, 2009).

coming years. In fact, just after the USArray reference seismic station was installed last fall near Maddock, it recorded a small, near mid-crustal earthquake, just east of Goodrich, N.D. (M 2.6). With the unprecedented size and sensitivity of EarthScope's dense seismic network (fig. 6), it will be exciting to discover how much



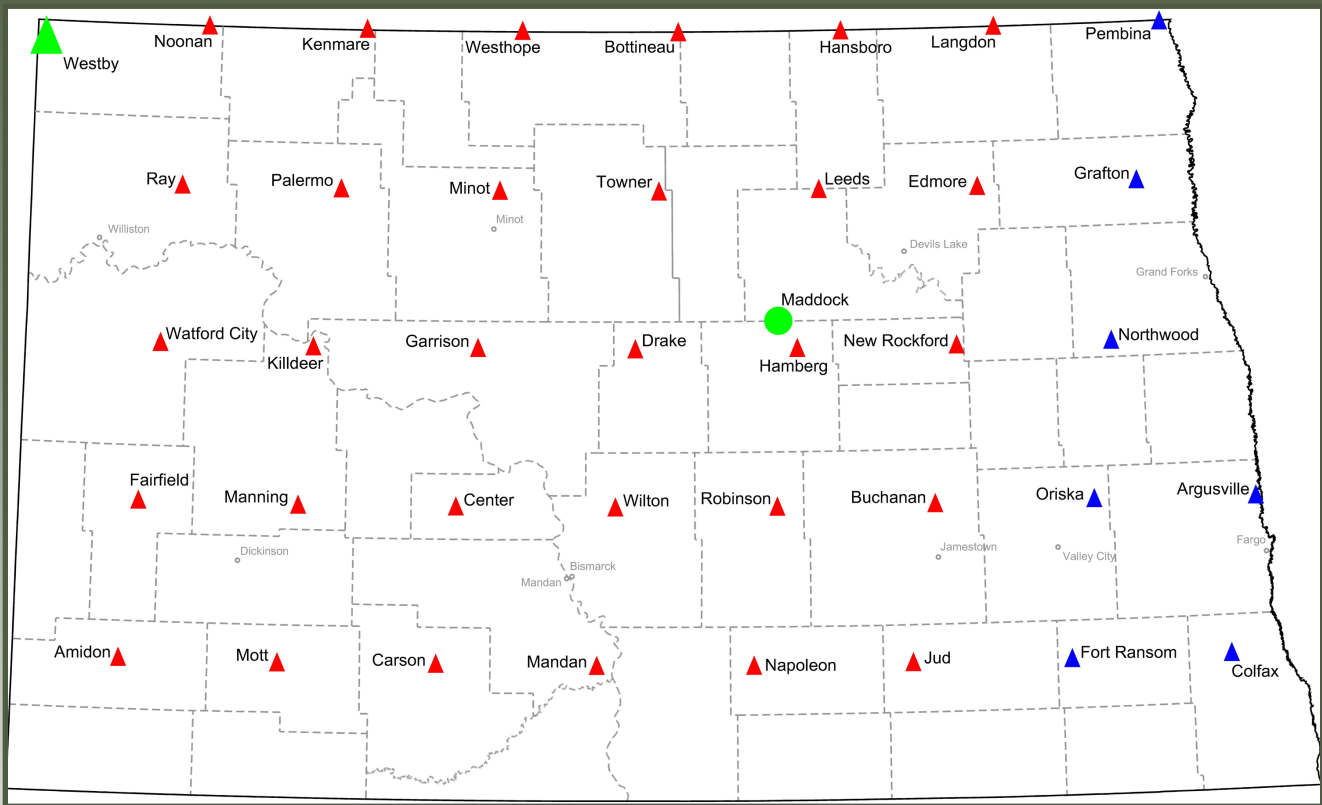


Figure 6. Location of proposed portable array stations in North Dakota. Stations installed in 2008 are shown in green. Stations currently being installed (2009) are shown in red. Stations planned for installation in 2010 shown in blue.

more we will hear, now that we are truly listening. It is likely that we will record several additional low-magnitude events that, without the presence of the EarthScope transportable array, would typically be beyond our ability to document.

References

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“Geologists have a saying - rocks remember.”
Neil Armstrong