A THUMP IN THE NIGHT

REPORTS OF POSSIBLE

Cryoseismic Occurrences in North Dakota

BY FRED J. ANDERSON

Most of us are aware that earthquakes are a dynamic Earth process and have the potential, in certain areas of the country, to cause significant damage and loss of life. Fortunately, North Dakota is in the most seismically quiet portion of North America, where only minor earthquakes occur relatively infrequently. Minor, low-magnitude earthquakes, that are commonly only detectable by seismic instrumentation, with local magnitudes of around M 3.0, have occurred somewhat infrequently in North Dakota about once a decade (Anderson, 2016).

Over the past twenty years that I have been with the North Dakota Geological Survey in Bismarck, I have served as the resident seismologist (when needed) in addition to my regular day to day geologic duties as an applied geologist investigating our state's geologic resources and creating geologic maps. One of the many additional duties of a Survey geologist, is to respond to public inquiries and geologic information requests from our residents. Occasionally, we receive some interesting and sometimes colorful calls from people reporting things such as unexplained bright lights in the night, possibly witnessing a meteor shower with an associated meteorite fall, and infrequent unexplained loud noises and sounds like loud cracks and booms from the field and farm. Occasionally, we receive a report of a perceived earthquake occurrence, some of which have been rather interesting and somewhat entertaining.

Commonly, with these types of reports, further investigation shows no indications of recorded seismicity on regional seismographs. At first these reports were just taken as anomalous possible earthquake reports but when these reports are considered collectively, they are found to have many of the reported characteristics of cryoseisms, which are small non-tectonic earthquakes caused by freezing action in ice, ice-soil, and ice-rock materials (Lacroix, 1980).

A cryoseism can occur when the outside air temperature drops suddenly, causing rapid freezing within the frost zone or areas with permeable soils that contain shallow groundwater and within ice itself such as in a freezing river, lake, or pond (fig. 1). Since the expansion of water due to freezing can be up to 9% by volume, it is this rapid expansion that causes acute fracturing within the frozen ground or ice mass creating cracking noises often described as loud "booms" or sounds like thunder (fig. 2).

One of the more interesting public reports that we have received somewhat recently (Table 1) occurred during the midnight hours of December 04, 2018 when a trailer-home resident from Tioga reported that "it felt like my trailer house was wobbling like it does when my clothes dryer is spinning".

Considering this as a possible earthquake report, a review of regional seismic station data showed no seismic activity occurring during the reported period. However, this type of report is somewhat consistent with that of a cryoseism.

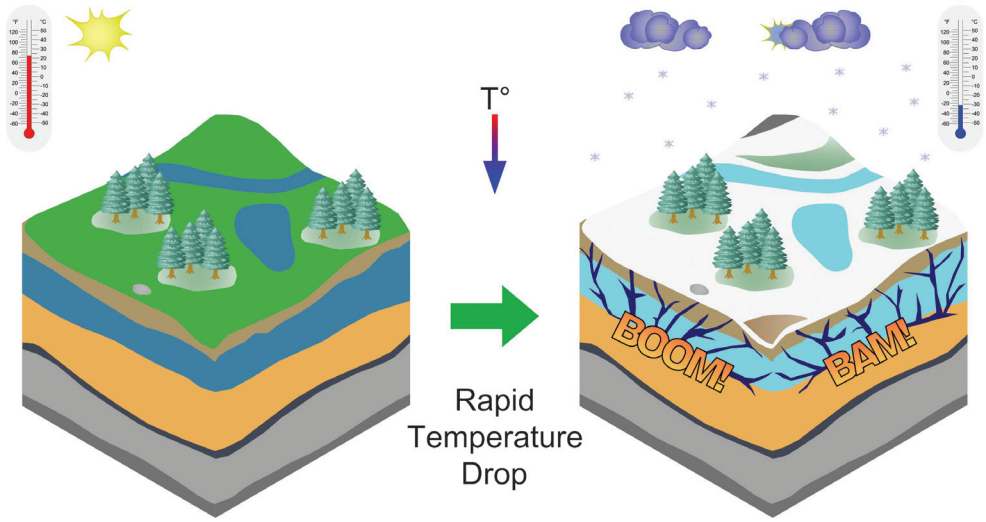

FIGURE 1.
Block diagram illustrating some of the common features associated with cryoseisms such as rapidly freezing saturated permeable soils, lakes, and streams.

FIGURE 2. Ice-jam on the Missouri River at the Double Ditch Indian Villiage State Historic Site during late March in 2009. Buckling and grinding slabs of ice can be noisy creating sounds like creaking, twangs, and booms.

The characteristics of Cryoseisms fall into three categories: meteorologic, geologic, and seismologic (LaCroix, 1980, MGS 2005) and include events that:

- Occur in the early morning hours commonly from midnight to just before sunrise.
- Show no association with recorded seismic activity during the time of the report and are often reported for only a singular location.
- Take place during the colder winter months from December to February.
- Occur after a considerable rapid temperate drop such as when a Polar Vortex occurs.
- Are found where permeable soils are susceptible to frost action such as sandy and gravely soils (meaning lots of pore space filled with groundwater that can freeze rapidly).

Cryoseisms have been reported in several mostly northern states including Alaska, Wisconsin, Michigan, Indiana, Ohio, New York, Vermont, Maine, Massachusetts, Connecticut and now, possibly, North Dakota. These types of events are likely under reported, possibly just shrugged off as local anthropogenic activities, or mistakenly cataloged as apparent low-magnitude earthquake events in other parts of the country.

Of the few reports that we have received so far, other explanations are also possible. Please feel free to contact us if you happen to experience any perceived ground shaking, and we will follow up on your report in a timely manner. You can contact me directly at 701-328-8037 or via email at: fjanderson@nd.gov

REFERENCES

Anderson, F.J., 2016, North Dakota Earthquake Catalog (1870 – 2015), North Dakota Geological Survey, Miscellaneous Series No. 93, 23 p.

Lacroix, A.V., 1980, A Short Note on Cryoseisms, Earthquake Notes, Vol3. 51, No. 1, January-March 1980, Seismological Research Letters, Seismological Society of America, pp 15-21.

MGS, 2005, Cyroseisms (or frost quakes) in Maine, Maine Geological Survey, Maine Department of Agriculture, Conservation and Forestry, https://www.maine.gov/dacf/mgs/hazards/earthquakes/quake-cryoseism.htm#:~:text=Cryoseisms, accessed February 25, 2022.

TABLE 1. Summary of potential cryoseismic events reported in North Dakota.

Date	Time	Location	Reported Effects	Outside Air Temperature[1]	NDGS Comments	Likely Cause
1/24/2018	01:30 AM	Southeastern Minot, North Dakota	Apartment resident felt interior walls of room shake abrubtly during the early morning hours. Reported as an abrubt jolt with no sustained duration of shaking.	9°F, -12.8°C	No seismic activity recorded on monitoring stations during last 24 hours. No local events reported by the USGS through the NEIC. Recent M 7.9 Alaska earthquake has been in the news the last few days. No additional reports received for the area.	Residential activity in the building occurring in the early morning hours.
12/4/2018	12:33 AM	Northeastern Tioga, North Dakota	Trailerhome resident reports trailer shaking during the middle of the night. Trailer wobbling like when clothes dryer is spinning.	10°F, -12.2°C	No seismic activity recorded on monitoring stations during last 24 hours. No local events reported by the USGS through the NEIC. Recent M 7.1 Alaska earthquake has been in the news the last few days. 4 SWD wells within 3 miles of Tioga. No additional reports received. for the area.	Possible cryoseism or high-wind gusts.
2/8/2012	Early Morning Hours	Ft Yates, North Dakota	Heard a large "boom" sound coming from the river.	2°F, -16.7°C	No seismic activity recorded on monitoring stations during last 24 hours. No local events reported by the USGS through the NEIC. No additional reports received for the area.	Possible Cryoseism - Ice activity on Lake Oahe.
3/27/2007	Early Morning Hours	Central Mandan, North Dakota	Felt house shaking during the early morning hours.	31°F, -0.6°C	No seismic activity recorded on monitoring stations during last 24 hours. No local events reported by the USGS through the NEIC. No additional reports received for the area.	Possibly Mandan rail yard activity.

[1] Meteorlogical Data from the North Dakota Agricultural Weather Network (NDAWN).