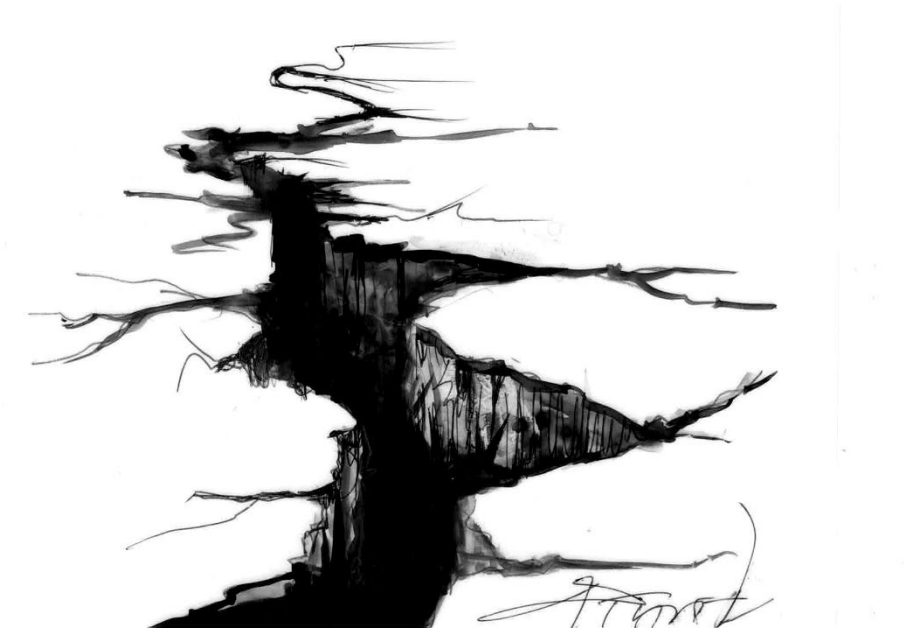
The Outside Story

Frost Quakes: Groans of Old Man Winter

By Colby Galliher



As the winter sun set on February 3, 2023, the Caribou, Maine branch of the National Weather Service (NWS) was flooded with reports of seismic activity. James Sinko, the office's hydrology program manager, recounted Mainers calling in from across the state's Hancock, Penobscot, Piscataquis, and Washington counties to describe homes and buildings trembling and deep rumbles emanating from beneath their feet. The previous two months had been warm and rainy, and a fast-moving cold front that day led to temperatures "15-30 degrees below zero, falling at rates of 2-3 degrees every 30 minutes in some locations," Sinko recalled.

These conditions set the stage for a series of frost quakes, a rare phenomenon some meteorologists and hydrologists also refer to as "cryoseisms." Unlike earthquakes, which are caused by shifting tectonic plates, frost quakes arise when specific meteorological and hydrological factors coincide.

These unusual seismic events occur when a rapid drop in air temperatures dramatically decreases the temperature of waterlogged soil, typically after rain or a thaw. "Water in the soil freezes and expands more rapidly than the soil particles can adjust. This causes a sudden rupture of the ice in the soil, generally in the coldest part of the night," said Henry Berry, senior geologist at the Maine Geological Society. "The release of pressure can cause effects similar to those of true earthquakes, especially explosive noises and high-frequency shaking."

Frost quakes tend to affect small areas and are more common in certain landscapes than others. They are "generally very localized events," explained Berry. "In one study where [detection] instruments were set up near each other, cryoseisms were felt and heard in several houses, but not in nearby houses only a few hundred feet away." Frost quakes are more likely in open areas, rather than wooded ones, as nighttime temperatures in fields and meadows, which lack the vegetative cover that can trap heat, tend to dip lower than in forests.

While powerful earthquakes can generate catastrophe, frost quakes generally leave behind little evidence of their occurrence. Louise Fode, warning coordination meteorologist at NWS Caribou, said that although her office receives reports of frost quakes once or twice a winter, the reports have never included accounts of frost quake-related damage. Berry noted that most frost quakes are so subtle that they fail to register on conventional detection instruments. However, he said that when frost quakes are more powerful, “long cracks in the ground or in pavement have been found, where the frozen ground snapped.” Sinko added that frost quakes “can sometimes alter underground drainage passages.”

Still, even when conditions seem ripe for frost quakes, they remain rare. “Cryoseisms require a particular set of conditions, which don't happen every year,” Berry said. But, he added, “when the conditions are right, they can come in a bunch” – as Sinko witnessed in northern Maine in February 2023.

Climate change is making New England winters milder, but rising temperatures may not mean fewer frost quakes. Snowpack insulates soil, keeping it warmer than the air. With “little to no snow on the ground,” as happens more often in a warmer world, soil temperatures crash, said Sinko. Without a snow barrier, water in the soil is more likely to freeze quickly when air temperatures drop. Inconsistent snowpack over the winter months could thus lead to more frost quakes. And even amid a pattern of higher temperatures, winter in the Northeast will still feature spells of frigid weather. “Frost quakes occur during sudden cold events, which can still happen in a warming climate,” Sinko said. Fode concurred: “Even with warming winters, it will be quite a while before we have winters with no rapid freezing events, so I would anticipate we’ll continue to get reports of frost quakes.”

If a spate of warm and wet days gives way to a harsh cold spell this season, pay close attention to the ground beneath your feet – you may bear witness to a rare seismic phenomenon.

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