Earthquake Hazards Program

Earthquake Booms, Seneca Guns, and Other Sounds

Introduction & Basics

Earthquake "booms" have been reported for a long time, and they tend to occur more in the Northeastern US and along the East Coast. Of course, most "booms" that people hear or experience are actually some type of cultural noise, such as some type of explosion, a large vehicle going by, or sometimes a sonic boom, but there have been many reports of "booms" that cannot be explained by man-made sources. No one knows for sure, but scientists speculate that these "booms" are probably small shallow earthquakes that are too small to be recorded, but large enough to be felt by people nearby.

As it turns out....there are many factors that contribute to the "sound' that an earthquake makes. To begin to understand these factors we have to understand the different types of waves, the speed they travel through the earth, and the speed that sound travels through the air.

Perhaps the best way to understand earthquake sounds are from an actual experiment that took place back in the 80's in California by David Hill. Dr. Hill's team recorded sounds that came out of the earth (from nearby small earthquakes between magnitude 2.0 and 3.0) and simultaneously measured the arrival of the P wave on a seismograph. Researchers also reported hearing a sound before the S waves were recorded; this turned out to be the arrival of the P wave. See this Alaska Science Forum article entitled "Earthquake Waves Outrace Sound" for a description of that experiment.

Observations of Earthquake Sounds

Spokane, Washington

The most recent documented earthquake sounds were from a swarm of small earthquakes that unnerved the city of Spokane, WA in 2001. Many of the Spokane quakes were definitely accompanied by "booming sounds". The quakes in Spokane were shallow, sometimes only a mile or two deep. This probably contributed to all the noise they made. Higher-frequency vibrations make the booming sound, and when quakes are deeper, those vibrations are gone by the time they reach the surface. Sometimes the quakes boom even when no vibration is felt.

New Madrid, Missouri

There are accounts of "artillery"-like sounds that were said to have occurred before or during the New Madrid earthquakes of 1811-1812.

Charleston, S. Carolina

As with most historical earthquakes, details about sounds and the actual level of ground motion related to the Charleston, SC Earthquake (1886) are somewhat sketchy and hard to authenticate. "Dutton, Clarence E., 1889: "The Charleston Earthquake of August 31, 1886," Ninth Annual Report, 1887-88, U.S. Geological Survey, Washington D.C., p. 203-528" is perhaps the most comprehensive scientific document that compiles seemingly credible accounts from numerous sources. Dutton objectively sums these interviews/observations with the following:

"According to the testimony of some, the first intimation of the disturbance was a strange sound or murmur. Others say that with the sound they felt the trembling, and that both increased, at first steadily, but by perceptible stages, and then suddenly or by swift degrees, to the full roar and energy of the climax. Dr. Manigault resides in a very quiet street near the Battery, and but a few hundred yards from the estuary of the Ashley River. He was engaged in a game of chess, and a member of his family was sitting by an open window. The latter, surprised or perhaps alarmed by the prolonged sound, arose, crossed the room, entered the hall, and passed out into the open air before the doctor became aware of anything unusual. The sound appeared to come across the water of Ashley River from the west-southwest. Another observer of intelligence was seated in the park at the Battery, near the statue of Jasper. He suddenly became conscious of a deep murmur, which swelled in volume, and which appeared to come from the open bay, lying southeastward. Very soon there was a sound of agitation in the leaves of the trees overhead, and at the same instant, he thinks, he became aware of a tremor in the ground. Springing to his fee, there suddenly broke upon his ear a rapid swell in the sound, which became a mighty roar, and with the roar came a shock."

It is apparent from these observations that, at least for the main shock, people heard the actual low frequency motions of the damaging earthquake waves as they rolled across the region and right down their street.....the "roar' came with the "shock".

As for scientific evidence for loud sounds that preceded the 1886 Charleston, SC Earthquake, there is none. To our knowledge, there were no seismographs or barographs that recorded the earthquake. The only data that was collected that could have scientific

significance (aside from tide gauge and other water surface measurements, was from large clocks that stopped due to ground motions. Unfortunately none of these clocks were precisely synchronized so those data are of poor quality.

For several weeks after the Charleston Earthquake (8/31/1886) there were many aftershocks that were reportedly accompanied by "loud detonations". But there was little mention of sounds occurring before an event. The earth was in a fairly continuous state of agitation and it would be difficult to relate a specific sound to a specific earthquake. The following account from the Dutton report is particularly informative:

"For several weeks following the principal disturbance minor shocks continued to be felt at frequent intervals. Many of them would have been considered very forcible and alarming and they not been greatly disparaged by the convulsion of August 31. Almost all of them were accompanied by loud detonations. Mr. McGee thus describes several which he experienced.

I reached Summerville about 5 o'clock p.m. Detonations were heard at intervals averaging perhaps half an hour. From that time until 9:30 p.m. occasional and very slight spasmodic tremors of an instant's duration accompanied the detonation. I endeavored to determine the direction from which the sounds came, but no two individuals agreed. They seemed to me to come from the northwest. They were much like, but somewhat more muffled than peals of thunder at distance of half a mile or more, or perhaps more like the discharge of a blast in a mine or quarry at a little distance."

Seneca Guns

The term “Seneca guns” is just a name, not an explanation. It does not tell us anything about what causes these noises and shakings. The name originated in a short story that James Fennimore Cooper wrote during the 1800’s. The name refers to booms that have been heard on the shores of Lake Seneca and Lake Cayuga in New York State. The name has been applied to similar noises along the coasts of North Carolina, South Carolina, and Virginia. Similar booms are called Barisol guns in coastal India. These phenomena have also occurred in three widely separated places around the world. That’s about all we know about the Seneca guns.

What might be the cause

The thing that comes closest to matching all of the observations is sonic booms from military aircraft. The article from http://www.farshores.org/ summarizes reports of Seneca guns from coastal South Carolina. The article in http://www.unknowncountry.com/ reports on one loud boom that was heard in Myrtle Beach, SC on Dec. 14 of an unspecified year. The sound was so loud that it shook a window and the sofa that the person was sitting on, and she felt the shock from the sound. Thus, a loud enough boom can be felt.

In the Myrtle Beach case, the Air Force claimed responsibility and said that they had been conducting training exercises at the time. The seismologist whom I called in Virginia reported that, during the 1970’s, Seneca guns were heard on the coast of Virginia. Reporters and seismologists investigated for several weeks but were unable to determine the cause. Finally the Navy admitted that one of their planes had caused a sonic boom. The problem with sonic booms is that they cannot explain Seneca guns that occurred before supersonic jets.

Naval ships firing their guns offshore might have produced some of the booms. Under certain atmospheric conditions, sounds can travel farther than usual so that they might be heard onshore as loud booms. Naval firing might explain some of the Seneca guns that occurred before jet planes were in wide use. In particular, naval gunfire might have caused some of the booms that were heard during the 1800’s and early 1900’s, when it might have been more common for ships to fire within a few miles of shore. However, naval gunfire cannot explain the Seneca guns inland, around Seneca Lake and Cayuga Lake. These lakes are much too small to have any military vessels on them, and no navigable rivers connect them to the ocean or to the Great Lakes.

Earthquakes are also a possible cause. In southeastern North Carolina, earthquake lists show seven events between 1871 and 1968. Each event was reported by people who felt it or heard it. The problem with the earthquake explanation is that something that is felt or heard that strongly should have been recorded on nearby seismographs (these are the instruments that record ground shaking for seismologists to analyze). A seismologist in Virginia who has tried, has never been able to match any of the reported Seneca guns with his seismograph records, and he has tried lots of times over the years. The article at http://www.farshores.org/ reports on a boom that occurred near Charleston, SC, sometime during the week before Aug. 2, 2003. Seismologists at Columbia, SC, and at Charleston examined their seismograph records and could find nothing at the time of the boom. It’s particularly interesting that the seismologist in Charleston, where the boom was reported, did not find any record of an earthquake. The article does not mention any shaking. Of course, seismographs have only been widespread since the 1960s, and they were few and far between before then. We can’t tell whether or not older Seneca guns would have been recorded by seismographs if the instruments existed then.

What is probably not the cause

Tidal wave: any wave large enough to produce shaking and booms on land would have been reported. I have not found any reports of tidal waves.

Landslides off the continental shelf: these have happened in the geologic past, but I don’t know of any reports that they happened during recorded history. The main effect of large landslides under the ocean would be tidal waves, which we’ve already considered.

Industrial disasters, like the Chernobyl explosion: anything that large would be reported. There would be no way to hide the news because too many people nearby would have seen, heard, and felt the blast, and there might be injuries too.

Global warming: the articles that suggest this don't offer any explanation of how a gradual warming of the atmosphere would produce something as sudden as a loud boom. Also, global warming would affect the whole globe, whereas Seneca guns have only been reported from a few areas.

A hole in the ozone layer: holes in the ozone layer form over the north and south poles, not over the U.S. or India. The reasons why they form are well understood, although I don't understand them myself because I'm a geologist, and the reasons apply only to polar areas.

Shifts of tectonic plates: there are no tectonic plate boundaries near the east coast. The nearest plate boundaries are in the middle of the Atlantic Ocean and in the Caribbean Sea.

Pockets of air being released: air can fill small pores between particles of soil, and cracks in rock, but it's not held in pockets that are tight enough to contain it under pressure. If the air is not under pressure, its release would not make booms or shake the ground.

Methane released from the ocean floor or lake bottoms and exploding when it rises to the surface and contacts the air: there is methane buried under the ocean floor and bottoms of lakes. It forms from the gradual decay of buried plants and microscopic animals. Sometimes the methane can seep upward to ground level. However, it does not come up suddenly enough or in large enough amounts to cause explosions. Also, burning methane makes flames, and a couple of the articles that Google listed point out that flames have not been reported at the times and locations of Seneca guns.

New faults forming: fracturing rock to produce a new fault, as well as moving an existing fault, should produce an earthquake. We've already examined earthquakes.

Cold air meeting warm Gulf Stream air: the articles that I've read which suggest this cause do not explain how it would operate. Two results might be thunder and lightning, but Seneca guns have been reported in clear weather as well as stormy.

Meteor exploding in the atmosphere: this suggestion would have to be evaluated by an expert in meteorites. It's a possible cause, but my guess is that any meteorite large enough to cause something as strong as a Seneca gun would be much rarer than Seneca guns. If my guess is correct, then exploding meteors might explain a few Seneca guns but not most of them.

Top secret military activity: the problem with this explanation is that it's too easy. Centuries ago people called on magic the same way. There's no way to disprove this idea as a cause of Seneca guns, because if it's top secret we won't know about it, but I've never seen any reason to take the explanation seriously. Sure, the military has lots of secrets, but something big enough to cause Seneca guns in so many regions, including India, would be really hard to keep secret. One of the great things about America is that it's hard to keep big secrets here. Most of us, including me, would be eager to share a really big secret with friends and family, and if we weren't lots of reporters would be glad to do it for us.

Indian ghosts firing guns to disturb descendants of settlers who took their land: you made the best assessment of this suggestion: "we want an explanation, not a ghost story".

Lightning: Some of the Seneca guns have been reported in clear weather.

Conclusion

There does not appear to be any agreement on what causes the Seneca guns. They have been occurring in several places around the eastern U.S. and in India for at least a century or two. As far as I can tell, they have worried people but they have never caused damage or injury. The Earth is a complex place and there is a lot about it that we don't understand. Perhaps someday we will understand what causes Seneca guns, but right now we don't understand what makes them. However, they do not seem to pose a threat to anyone.

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Acknowledgments

Thank you to Rus Wheeler, Gary Patterson, Paul Bodin, and Arch Johnston for summarizing the information for this webpage.

Earthquakes » Measuring Earthquakes

What is a P wave? An S wave?

When an earthquake occurs, it releases energy in the form of **seismic waves** that radiate from the earthquake **source** in all directions. The different types of energy waves shake the ground in different ways and also travel through the earth at different velocities. The fastest wave, and therefore the first to arrive at a given location, is called the **P wave**. The P wave, or compressional wave, alternately compresses and expands material in the same direction it is traveling. The **S wave** is slower than the P wave and arrives next, shaking the ground up and down and back and forth perpendicular to the direction it is traveling. **Surface waves** follow the P and S waves.

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Last update: 10-05-2012 13:20