But Why: A Podcast for Curious Kids

Why Do Earthquakes Happen?

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[Jane] This is *But Why: A Podcast for Curious Kids* from Vermont Public Radio, I'm Jane Lindholm. On this podcast, we take questions from curious kids just like you and we find answers. For this week's show, we headed to California to learn more about something you might have heard about in the news recently, or maybe even experienced yourself.

[News anchorman] First here, breaking overnight. Southern California braces for more aftershocks after another powerful earthquake rocks the area. A magnitude 7.0 earthquake struck.

[Woman] The lights were swaying, why's the chaise moving, where's the light?

[News anchorman] Pretty strong here.

[News anchorwoman] 8:21 here on the air, we're experiencing very strong shaking. I think we need to get under the desk.

[Jane] That was some of the news coverage of the Ridgecrest earthquake sequence that shook Southern California on July 5 with a 7.1 magnitude earthquake. We'll get into what magnitude means in a few minutes. But for those who felt it, it was really big. On some fault lines, the land moved between three and 13 feet and there were earthquakes both before and after that people could also feel. What are earthquakes? Why do they happen? You've been asking us earthquake questions. So, today we're going to get some answers. First, I flew to California, a place with a lot of earthquakes, to talk to this person.

[Jennifer Strauss] Jennifer Strauss, I'm at the Berkeley Seismology Lab.

[Jane] What's seismology?

[Jennifer Strauss] So seismology is the study of how the Earth moves and what happens within our Earth.

[Jane] Have you ever experienced an earthquake? I have. I was sitting in my house when the magnitude 6 Napa earthquake happened. There have been smaller earthquakes around the Berkeley area that happen every once in a while. But that's the biggest one that I've been in so far.

[Jane] This seismology lab at the University of California, Berkeley, is a place where scientists and researchers study earthquakes. And the week I met up with her in early July, she was talking to a lot of reporters and news people about earthquakes because of the ones that had happened just a few days earlier in another part of California.

[Jane] What is an earthquake?

[Jennifer Strauss] An earthquake is when a fault slips.

[Jane] So, what's a fault?

[Jennifer Strauss] It's two plates. You might have heard of the term “plate tectonics.” So there are plates that are around the globe. And when they move either past each other or over and under each other, you get energy, this release. Because if you can imagine to move a really, really big rock, you need a lot of energy. And when that rock finally moves, those energy waves start moving out. And that's what you feel is the earthquake, it’s the rock kind of resettling itself.

[Jane] When Jennifer mentions plates, are you thinking about something that looks kind of like what you eat your dinner on? That's not the kind of plate she's talking about. If you think about the surface of the Earth, even the parts that are covered by water, it might seem solid. There's ground underneath, right? But the top layer of rock, which is at least six miles deep, sometimes more, is not actually one solid ball of earth. There are about 15 or 20 big pieces of rock. Those are called the plates that come together to make the surface of the Earth. One way to think about it is if you picture an egg, there's an egg shell. If the egg shell was cracked, it would still more or less look like an egg. But those cracks are kind of like the plates, the tectonic plates of the Earth. They all come together to make one solid earth. But those plates are actually kind of cracked. They're not solid, all in one piece, and they're in constant motion. So when the plates push up against one another, you sometimes feel that movement as an earthquake. Earthquakes happen everywhere all over the world. Some places have more earthquakes than others, but they can happen anywhere, even in ice. That's what Celeste Labedz at the California Institute of Technology studies. She's a cryoseismologist. And we asked her to be part of today's show, too.

[Celeste Labedz] You can take apart the word cryoseismologist to see “cryo,” meaning cold and “seismology,” the study of earthquakes, which means that I look for shaking in ice. For my research, I take seismometers. The sensors used to detect earthquakes and deploy them on glaciers, which are large masses of ice, to find out what kind of motions are happening on the inside of the ice. While I spend most of my time in earthquake-prone Southern California, I also get to live on glaciers in Alaska for up to a month at a time from my research.

[Jane] Sadly, we did not get to go to Alaska with Celeste, but we did give her this question.

[Evan] Hi I’m Evan, I live in Cumberland, Rhode Island. I'm 6 years old, and my question is, why do earthquakes happen?

[Celeste Labedz] This is such a good question. Earthquakes happen mainly because our planet has something very special called tectonic plates. The outer layer of the Earth isn't one single worldwide shell like the peel on an apple is. It's in several different pieces. Those are the tectonic plates that can move around over the surface of the Earth. They move pretty slowly, about the same speed that your fingernails grow, but over time that can add up a lot. At the places where tectonic plates touch each other, like in California, where the North American plate is up against the Pacific plate, the relative motion between them is what's causing the earthquakes. Plates stay stuck together most of the time because of the friction between them. But over time the force builds up and then they'll suddenly slip against each other. That jolting slip is what an earthquake is, and it's what creates the seismic waves that move the ground. That's what you feel. It's kind of like if you tried to push a really heavy piece of furniture across thick carpet. When you start pushing, the friction is going to keep that furniture in place. But if you push really, really hard, you can get it to scoot forward in a jolt.

[Jane] That jolt is an earthquake. OK. So both Celeste Labedz and Jennifer Strauss have been talking about tectonic plates. So we know earthquakes happen because of the motion of those plates. But Jennifer Strauss at the Berkeley Seismology Lab says there's still a lot of research being done about why the pieces of the Earth's crust keep moving.

[Jennifer Strauss] So we have plate tectonics as a theory. And we know that as plates are pushing up against each other, they cause earthquakes because rocks can only be pushed against each other. Oh, my gosh. I'm getting squished. I'm getting squished. I'm getting—aah! I need some, some release and they move past each other. But the specific mechanism that is happening to cause all this moving and shifting is still an open question for science. Some people think that it's because of the convection. What does convection mean? It means the way that heat is moving throughout the mantle, underneath our crust, in our earth.

[Jane] The mantle is that molten rock that's somewhat liquid underneath the solid rock of our Earth's crust, as Jennifer said.

[Jennifer Strauss] And some people think that that is what's triggering the plates moving. But I don't think we have a super definitive process answer yet.

[Jane] But the Earth is always moving. Things are always changing.

[Jennifer Strauss] Right. So we have some earthquakes that are creeping earthquakes where the plates just move past each other and you never get an earthquake. They're just constantly moving. Other plates, you have, again, this sort of stress, that builds up, builds up, builds up, builds up and then it breaks in the form of an earthquake. And earthquakes are happening all over, all over the United States, all over the world. Most of us are just so tiny that you don't feel them.

[Jane] So August wants to know how the plates move.

[August] I live in Los Angeles, California, and I’m six years old. How do the plates move underground?

[Jane] Jennifer says those plates move because they're in motion.

[Jennifer Strauss] Once they're moving, they're going to keep moving because you have the one broken part at the top that's moved to its neighbor. And then that neighbor is like, oh, my gosh, I'm getting pushed from this side. And then that neighbor starts moving and pushes its neighbor. And so, you know, the system in motion tends to, tends to stay in motion. And the rocks are constantly trying to readjust to the new form that they find themselves in.

[Jane] So have they been moving since the Earth was created?

[Jennifer Strauss] Of course.

[Jennifer Strauss] So you might have heard of something called Pangea where we had a mass where all the continents were together. And so over geologic time, which is thousands and thousands and thousands and thousands and thousands and thousands of years, all of those continents moved, the plates moved and we have the continents where

they are today. And so it's always been moving. It's always been forming. We've even lost some plates, right? Because sometimes you have a plate that dives below the other plate and it gets pulled into the, the mantle of the Earth and it gets pulled and pulled and pulled. And then eventually it doesn't exist anymore. It's gotten eaten up by the, by the earth. And then you have mountains on the other side that are getting created. So, it's this constant, constant motion.

[Jane] Yeah. I was going to ask you about that. Can you talk about the connection between earthquakes and mountains?

[Jennifer Strauss] For some mountains, let's think about the, the Himalayas near Nepal and India, you have uplift, which means that one side of the plate is moving up and the other side is moving down. Well, rocks that move up start getting taller compared to the earth around them. And so that's how you can get mountains, you can get waterfalls that are forming in tectonic areas. And of course, it's not like it all happens at the same time, much like a volcano. You get layers and layers and layers of lava that make it happen. So earthquakes over, over, over time cause the, the mountains in those areas to come up.

[Jane] This stuff is so fascinating. Want to know more about those tectonic plates and how they move? Here's Celeste Labedz again.

[Celeste Labedz] Tectonic plates, the pieces of the outer layer of the earth, move underground because they are the ground. You are on a tectonic plate right now. The crust of the Earth varies from about 10 kilometers thick in the ocean to 70 kilometers thick under the highest mountain ranges on the continents. That's about six miles to forty-five miles, if you like miles. Compared to humans and houses and other things that we see on the surface, that's a long way down. Some tectonic plates go down even further than others, though. There are places called subduction zones where two tectonic plates collide and one gets pushed underneath the other and down into the Earth's mantle. That's the layer below the crust. Alaska, Japan and Chile are all like this. They have the Pacific plate sinking down hundreds of kilometers below their respective continents. We know how deep the plates go because they cause earthquakes as they sink. You can find out the depth of an earthquake by using the times when seismic waves arrive at different places. And that tells you how deep the subducting plate has gone. The strongest earthquakes in history have happened at subduction zones like those.

[Jane] Sometimes the change created by an earthquake is really slow. Remember, there are small earthquakes happening all the time because the Earth's tectonic plates are moving around all the time. But when there's a big moving or a big coming together of those tectonic plates, that's when we often feel an earthquake. And when it can be really strong. Coming up, we'll talk about how scientists measure the magnitude and intensity of an earthquake. And we'll learn a little bit about how to stay safe when you're in the middle of one.

[Jane] This is *But Why: A Podcast for Curious Kids* I'm Jane Lindholm. And today, we're talking about earthquakes. Some of you may have been hearing about earthquakes in the news. So we're talking with two people who are helping us understand what an earthquake is and why it happens. Jennifer Strauss, who works at the Berkeley Seismology Lab at UC Berkeley in California. And Celeste Labedz, a cryoseismologist, someone who studies earthquakes in ice, at the Caltech Seismological Laboratory, also in California. To recap what we've learned, scientists don't know for sure why earthquakes happen, but a lot of the clues they've found support the theory called plate tectonics. That theory describes the

Earth's surface as a number of plates that float on top of a surface of molten rock. The friction created when those plates bump up against each other as they try to move around and past one another is what causes earthquakes. Now, speaking of that constant motion of the Earth, here's another question pretty related to earthquakes that you've sent us.

[Sarah] Hi my name is Sarah, and I live in Aberdeen, Maryland. My question is, why are continents so far apart?

[Jane] If you look at a map of the Earth, you might notice that some of our continents look like they could fit together, kind of like puzzle pieces. Well, there's a reason for that. Scientists think that at one point in the Earth's history, long before people were alive, all of the Earth's continents were together in one big landmass. And, over time, a couple hundred million years, those continents have spread apart. And in some cases, kind of come back together. A lot of the spreading of continents takes place deep under the seafloor at underwater mountain ranges. The seafloor spreads and continents move farther apart. For example, North America and the Eurasian continent, where Europe and Asia are, move apart at about one inch or two and a half centimeters per year. But because the Earth is a globe, some of the land masses are actually getting closer together. If you could come back to Earth 200 million years from now, the landscape would look very different. All right. Back to earthquakes. This is all part of the theory of plate tectonics, the idea that the Earth's crust is constantly moving and that movement of big pieces of rock crust is what causes the earth to shake. So it's causing the continents to move further apart or closer together. And then sometimes when it's a big movement, we feel it as an earthquake. Now, if you live near one of the edges of the plates where those edges are rubbing up against each other, that's sometimes called a fault line, there's a lot of earthquake activity. But how do you know how strong an earthquake is? When I was at the Berkeley Seismology Lab, I made sure to ask Jennifer Strauss.

[Jane] OK. So the other thing I wanted to ask you about earthquakes is we've been you've been talking about the magnitude a 6.4 or a 7.1. What do those numbers mean?

[Jennifer Strauss] OK. So this is this is getting into math. So, kids, this is one of those instances where you're going to use your math in life sometime. So normally, if we think of counting one, two, three, four, there is exactly one step in between all of those numbers. However, magnitude is what's on a log scale, which means that it's exponential. And in this case, specifically, the difference between the energy released and a magnitude 4 is 32 times higher than the energy released in magnitude 3. So you would need 32 magnitude 3s happening at exactly the same time to equal the same energy in a magnitude 4. And this multiplies in each step. So you would need over 900 magnitude 3s to equal the energy release in a magnitude 5, and so on and so forth. And so that is a measure of the overall amount of energy released in an event. You might have heard of another term called intensity. And that has to do with the amount of shaking that you feel at your particular location, because the magnitude is going to be a fixed number for whatever the earthquake is. But obviously, people that live in different parts of the area are going to experience the earthquake differently. And that is the intensity.

[Jane] For adults listening, do you remember something called the Richter scale? Scientists don't use that anymore because seismologists have better instruments to test the magnitude and intensity of earthquakes. Here's a question from Zander.

[Zander] I live in California. And why does houses burn down when there’s an earthquake?

[Jane] Zander wants to know why houses burn down when there's an earthquake. It's true. Sometimes buildings do burn during earthquakes and sometimes they collapse or fall down. Sometimes bridges collapse or roads get really big cracks in them. There can be a lot of damage caused by an earthquake, because remember, the earth is moving and shifting around. It's changing. There can be a lot of damaged caused by an earthquake because remember, the earth is moving and shifting around. And so sometimes the buildings and the things that humans have made don't withstand that movement.

[Jennifer Strauss] The manmade structures sometimes suffer for the same reason that people fall down in earthquakes. Right. We're not really used to being shook side to side. And so, if you're shook hard enough side to side, you're gonna fall down because you have nothing to stand on if the earth is moving side to side. So same with buildings. They can they can be built strong and sturdy to withstand wind. But if the earth at the ground is shaking back and forth, sometimes that can overcome the, the building's ability to stand up. Fires, why do fires come with earthquakes? Well, there's, there's two main things that cause fires after an earthquake. The first thing is because there is what's called an ignition source, something that starts a fire. So either it's a gas line that broke and so there's flammable gas places and something lights it on fire and it starts a fire or somebody was doing something with fire at the time of the earthquake and it got out of their control. The second thing that causes fires after an earthquake is our response to fires.

[Jennifer Strauss] So unlike something like a tornado or a general fire, an earthquake is not one thing happening to us. An earthquake is a whole bunch of things happening to us at the same time.

[Jane] But just to be clear, an earthquake doesn't cause a fire. An earthquake doesn't cause a spark. The fire happens because if the earthquake might damage a building, something in that damage, I mean, that earthquake made the damage, but then something broke with a gas line or something. And that causes a fire. Earthquakes don't make fire.

[Jennifer Strauss] That is exactly right. So earthquakes,

[Jennifer Strauss] all earthquakes do is shake the ground. That's it. But earthquakes can cause what we term cascading failures. Things that start failing that cause other things to fail and then start further problem. So exactly. They don't, all the earthquake does is shake the ground.

[Jane] In many parts of the world that experience a lot of earthquakes, buildings are built to withstand that shaking. For example, in the United States, places like California have specific rules for new buildings to try to make sure that any new building that's built won't collapse in an earthquake. Not every country or place has the ability to make sure that buildings are that strong. So the damage an earthquake does can be very different depending on how strong the earthquake is, where it hits and what other things like big waves called tsunamis might happen as a result of the earthquake.

[Hawkin] My name is Hawkin and I live in Sunnyvale, California and I'm 6 years old. My question is when there's earthquakes, why is there salamis after?

[Jane] Hawkin mixed-up salami and tsunami.

[Jane] It's kind of a funny mix up, but an easy one to make because tsunami is not a familiar word to everyone. We asked Jennifer to explain what a tsunami is and why the earth shaking could cause changes in waves.

[Jennifer Strauss] The way a tsunami happens, which is a large amount of water coming in to land, isn't it?

[Jane] Does it actually mean big wave?

[Jennifer Strauss] It does mean big wave. But you have to keep in mind that usually a tsunami is not what you see in a cartoon of like 150-foot-tall wave that is crashing on somebody one time and that's it. You can think more of tsunami as a constant flood of water that just doesn't stop. It just keeps flooding and flooding and flooding and flooding in areas where normally there's no water. And so, the way is tsunami happens is when an earthquake causes the ocean floor to raise up and—

[Jane] because it's the ground again. But we're talking about the ground under the ocean.

[Jennifer Strauss] The ground under the ocean rises up through the movement of the plate that ruptured. And there's a whole bunch of water sitting there. You can think of it as a column of water almost. And if you lift up a column, of water, gravity is gonna have it move. And so now you have a bunch of water moving to an area where there was already water and then that bunch of water has to go somewhere to flatten out with gravity and so it moves. And what happens is as the water gets closer and closer and closer to the shore. Now your ocean floor is closer and closer and closer to the level of the land where the people are. And so, as the water keeps moving forward, it has nowhere to go but onto land where the people are. And that's why it just keeps it keeps flooding.

[Jane] Tsunami actually means “harbor wave” in Japanese, not big wave, like I said earlier. But when a big shift in the earth under the water happens, it can be a very big event on shore. Tsunami can also happen in lakes, not just oceans. And they are sometimes caused by things other than earthquakes, like a landslide. Now, earthquakes can be scary. Feeling the earth move underneath you is really unsettling. One time when I lived along a fault line in Chile, I was woken up by an earthquake in the middle of the night. And for a minute I thought maybe I was on a train, but I wasn't. Or like a subway was running underneath my home. Another time when I was living along a different fault line in Southern California, it kind of felt like there were waves moving or rolling my building when I was in an earthquake. Most of the time, earthquakes don't cause buildings to collapse, but they can be dangerous. So if you live in a part of the world where there are earthquakes, you should talk to your adults about what you should do when you feel one.

[Rianne] Hi my name is Rianne, I'm four years old. I live in Saratoga, California. My question is, how do we keep safe?

[Jane] What are the best ways to stay safe?

[Jennifer Strauss] The best ways to stay safe is to realize that an earthquake can happen to you. So what do you do? The first thing is you can participate in the Great ShakeOut that's run by Earthquake Country Alliance. They do a drill every year for drop, cover and hold on. So you feel shaking, you drop to the ground. You try to find a sturdy table to crawl to and stay under. And you hold on to that table so that it stays with you when the shaking happens. There's no table nearby? Then you just protect your head as best as you can.

The drop part is obviously important because we talked about those waves pulling the earth side to side and making you trip. The next thing you can do is make sure that things are secure in your house so nothing's going to fall on you. If it shakes and then have a preparedness plan and a preparedness bag, this is useful not just for earthquakes, but in case there's a fire or a flood or something. So that—

[Jane] Tornado.

[Jennifer Strauss] Exactly. So that you have all the things that you need to get through your day when those events take place.

[Jane] Adults might remember we used to be told to get into a doorframe when an earthquake starts, but that's not the recommendation anymore. So just remember, drop, cover and hold on. If you have questions about earthquakes or things that are making you worried or concerned, you need to talk to your adults. If you live in a place where there are frequent earthquakes, you might want to practice what to do if an earthquake happens, but for any of us, it's good to know about these things. It's good to know how the world works, what's happening in the world around us and what we might do if we experienced these things. If any of you who are listening have experienced an earthquake, we'd love for you to tell us about it. What did it feel like and how did you stay safe? You can have an adult help you send an audio file; you can send it to questions@ButWhyKids.org.

That's also the address where you can send your questions about anything else. We'll do our best to get an answer for you. *But Why* is produced by Melody Bodette and me, Jane Lindholm at Vermont Public Radio. Special thanks today to, Celeste Labedz and Jennifer Strauss. We'll be back in two weeks with an all new episode. Until then, stay curious.