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Audio

File URL	MySafe_LA Fire & Life Safety Podcast - Episode #20.mp3
Length	25 min
Audio Quality	★★★★★(Very Good)

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Announcer: MySafe:LA is the public education partner of the Los Angeles Fire Department. You're listening to a MYSafe:LA Fire and Life Safety Podcast.

Cameron: Hello everyone, this is Cameron Barrett, the Education Director for MySafe:LA, and we are so fortunate in our Fire and Life safety podcast today to be joined by a friend of ours, Margaret Vinci. Margaret is the manager for the Office of Earthquake Programs at Caltech. Thanks so much for joining us, Margaret.

Margaret: Thank you, for having me.

Cameron: I have learned more about earthquakes and what seismologists and researchers are doing to study earthquakes from Margaret Vinci than from any other person. Every time I've sat with Margaret, I've learned a ton more things, and I'm hoping that I'm going to do so today in our conversation, and that all of you out there listening to this podcast will do the same thing. Margaret, We are going to talk about earthquakes tools. I love this. This is this kind of fun, geeky conversation that anybody who loves technology and science is going to really like about earthquakes. Caltech and other scientists in our region have developed some really fascinating tools to make it possible for laymen like me to understand earthquakes a little better.

And I wanted, first of all, to talk about, let's put this in context. Let's talk about La Habra. Last Friday, a 5.1. Tell us what you know about this earthquake.

Margaret: Well, the 5.1 earthquake happened at 9:09 PM on Friday night, when everybody was just getting relaxed from the weekend. And it hit. It was a magnitude 5.1 earthquake that happened down around the La Habra area. It was not on a distinct fault. It was in a fault zone. And a fault zone area is where several faults come together. So down in that area we have the Pointy Hills fault, we have the Elysian Park Fault, we have the Whittier Fault, Chino Fault, the Newport-Inglewood isn't too far away. So where the faults all come together.

So it was in that fault system that we had this earthquake, and we've had several over 150 aftershocks afterwards. That is very normal. This is actually normal for us in southern California. We've been in an earthquake drought for about the last 20 years, due to the 1994 Northridge 6.7 earthquake, and the earthquake up in Hector Mine. In 1999 we had a magnitude 7.1 earthquake. People don't remember that one. Because there were no tall buildings there, nobody lived there, it was out in the middle of the desert. It didn't affect anybody but the jackrabbits. And there was no damage. So people forget that we had a 7.1 earthquake in 1999. Because of that, we have been in an earthquake drought. We are now getting back to what is normal for southern California in having more of these fours and fives and threes that we normally have not felt for a while.

Cameron: See, I've already started learning stuff. I didn't know that there was such things as earthquake droughts, but it makes perfect sense. This is about the plates underneath our feet readjusting, and so when we have a larger adjustment, I would imagine things calm down for a little while. Is that what a drought is?

Margaret: Yes, that's exactly right. So when we have larger events, magnitude sixes, that can then put us into that ... It releases some of the stress, and so it puts us into that earthquake drought for a while. Now that may or may not happen. It may not always follow that way, but it has for the last 20 years.

Cameron: And the other thing we need to remember is an earthquake drought is just, those are just major earthquakes that really make you sit up and notice, but we have earthquakes every single day. La Habra was a 5.1 at 9:09 PM on Friday, but it was only one of, what, 30 earthquakes that happened that day?

Margaret: Well, we have on average. Actually, that day we had a lot more because we had all the aftershocks. We actually have ... On average, we have about 30 earthquakes a day in southern California. Most of those are ones and twos, and some may be under a magnitude one, many of them, that we don't even feel. And so we live in a seismic, a very complex seismic zone. We have over 300 known earthquake faults in southern California, it's not just the San Andreas fault, but we have over 30 known earthquake faults. About 24 of those are large enough, meaning the fault is big enough, that it ruptures from one wall to the other, can create a damaging earthquake under a populated area. So our San Andreas fault is actually not probably the worst scenario. If we were to have even a 6.7, 7.1 on the Newport-Inglewood fault, that's under a much more populated area. So again, this is not mean to scare people, but to make people aware of what they need, to always be prepared. No matter where you live, you are always going to have a risk of some kind. You need to know what that risk is and know how to then respond to that.

Cameron: And I think one of the first steps to being prepared, and we've talked about preparedness with all kinds of other folks in our earthquake podcast series that we're in the middle of right now, in response to the La Habra, and the Chilean earthquake -- 8.2 just a few days ago. We've talked a lot about preparedness. But I think, especially with your expertise, Margaret, the first step to preparedness is knowledge. And you, that's your job. You impart this kind of knowledge to folks all over our region. All over the world, really, about what we know about earthquakes, and what we should be aware of right here in our region.

Now as far as not feeling them. I'm not from southern California. I've been here 15 years. So I've been here only during really the drought. So I've had it pretty lucky. But even when the earth does shake beneath my feet, I don't think I have a very good antenna for earthquakes. I really ... It has to really shake for me to even be aware that it's happening. Is that ... Am I normal? Or do I just not have ...

Margaret: I think that's normal, because coming from another area, you think of other things. And so you don't always think that that might be an earthquake. Some earthquakes you can actually hear coming; it will sound like a train. So if the energy is big enough, then sometimes you will hear that. It sounds ... It's actually the ground moving. It will sound like a train. The Whittier earthquake. I remember the Whittier earthquake, and I could hear it coming. You could hear that rumbling. So you kind of stopped and paid attention and waited for the shaking to see if it was going to be an earthquake. So I think that is true. People that live in different areas aren't sure. You can see that with the response in Virginia. People didn't think earthquake in Virginia. They thought, another bomb blast, or something else was going on with that event, and so that is true it's getting used to that.

But also, understanding what an earthquake is. Earthquake is the movement of rocks. The stress builds up, and so pretty soon something has to give, and so it's the movement of those rocks. The more people understand what an earthquake is, the less frightened they're going to be of them. Because then they know what's happening. They know what's going to follow, and then they become, not used to them, but then they know how to respond to them. This is all part of alleviating the panic from people that don't know about earthquakes or understand what earthquakes are.

Cameron: Now scientists that you work with over at Caltech have developed early warning systems. This has actually been in development for many, many years. All over the world people have been working on early warning systems. To take a page from a story that you were telling me before we started recording here, an early warning system is not your dog.

Margaret: No. It's not the dog. People tend to think that animals ... Animals do feel things because they're closer to the ground. And what they're feeling is ... When an earthquake happens, it ruptures. The energy then starts and it stops. It's over with. It isn't something that's prolonged for a long period of time, that dogs are going to predict hours ahead of time. It starts and it stops. What our animals can feel is sometimes those small earthquakes that we're not feeling. Because they're more sensitive and they're close to the ground. But it is not an early warning. They may feel that P-wave before you feel it, because they're more sensitive, but it's going to be seconds. It's not days. And it's not hours.

Cameron: P-wave. You just mentioned a great term that we should spend some time defining. Is that the freight train sound, or is that something else?

Margaret: When we have a rupture, it's like dropping a pebble in a pond. The earth ruptures. It sends out waves. And those waves are seismic waves. So if you drop a pebble in a pond, it creates waves. So it's very similar to seismic waves. You have a P-wave, which is your preliminary wave, and then you have the S-wave that follows, which is your secondary wave or your surface wave. So these waves travel across. The energy ... You have the rupture in the ground. It then propagates the waves out in a circle, but also they go up and they go down. So they come up and they break through the surface. They travel, then along the surface. The P-wave is your preliminary wave, and then with the earthquake that is sometimes further away, you will feel it get stronger, stronger, stronger, because now the secondary wave is coming through, and that carries the heavy shaking. So that is where you have your vertical, your horizontal waves, your P-waves, your love-waves, so they will then travel, and the shaking will get stronger in some events. With the 4.4 that we had, it was a jolt here in Pasadena. In Encino they felt it much differently. They felt these waves, and they felt it differently.

So depending on where you are, the soils you're in. Because if you're in bedrock, the energy travels much quicker, you have less shaking. If you're in sediment, those waves get trapped into the sediment, and they continue to shake. And so you will have more shaking if you are in soft sediment. If you're in a two-story building, you might feel it more on the second story, rather than the person down on the ground or on the first story. So it depends on your building, the geology of the ground that you're on. It depends o

n the distance from the epicenter of that earthquake, and it depends on the depth of the earthquake. The further down where it ruptures further down in the ground. This is why we usually tell people how deep it was, because the further down it is, the less energy you're going to feel at the surface. The closer it is to the surface, the more energy you're going to have on the surface. So a 3.0 earthquake may not be felt very much if it's down deep in the ground, but if it's on the surface, then a lot of people might feel that.

Cameron: It's just a staggering amount of variables when it comes to an earthquake, aren't there?

Margaret: There are. Yes. That's why we've developed tools.

Cameron: Exactly. Did You Feel It? is the thing that comes to mind for me. I love this. Before there was Twitter, you folks invented a crowd-sourcing tool.

Margaret: We have many tools. We at Caltech, in collaboration with the US Geo, run the southern California Seismic Network. Berkeley and US GS run the northern California Seismic Network, and together, we are the California Integrated

Seismic Network. What is that? That is a series of stations that we have buried in the ground. We have over 400 here in southern California. Those are stations. It is equipment that we have buried in the ground so that when we have an earthquake. So when the ground ruptures, and it creates energy, our instruments pick up that energy. It then sends it back to our computers at Caltech US Geo. It then it is within seconds, because that travels the speed of light. And so within seconds we can determine the magnitude and location of that earthquake. We then send that information out to all of our emergency responders. So within seconds, they know where that earthquake occurred, how deep it was, and what the time and the location was.

We then have a tool that comes out that's called Shake Map. So within two minutes, of that rupture with a magnitude of 3.0 or above, a shake map is created. And what that shake map is, is it takes the ground motion off of our sensors, it combines it with the geology of the area, meaning bedrock, sediment. It then produces a graphic map showing where the probability of intensity of shaking is, so you can then within two minutes, emergency responders or the public, can go to these shake maps and see exactly where the epicenter of that earthquake was and then how it was felt throughout southern California. And it's done by color. That color is based on the modified mercality scale of damage, not magnitude, but what you are feeling. So ...

Cameron: In fact, I'm looking at your shake map. Exactly what you just described. At scsn.org, southern California Seismic Network .org, and it's fantastic. It's just amazing that you can do this within minutes.

Margaret: But I will tell you that website is particular for the La Habra, and it's giving a summary of the La Habra earthquake, so anybody can go to scsn.org and find out about our network or recent earthquakes. But if they want to go to Shake Map, you want to go to cisn.org, which is California Integrated Seismic Network, and that's where all the tools are.

Cameron: Being able to get this kind of information, and it's reliant, and make sure that I ... Tell me if I'm wrong here. It's reliant on the small, ground movement sensors that you've planted all over. Is that correct?

Margaret: Yes. And these sensors are actually kind of big sensors. It is a series of equipment for different, either long-range or short-range waves. They capture the ground motion, and that's then how we produce these tools for emergency responders, and for the public. It's also how you do, Did You Feel It? That's also based on ... So. The backbone to be able to be doing our tools is our seismic network. We also monitor the health of that system every single day, so we know which stations are not working, which ones need to have maintenance, so that at any given time, our sensors are always working.

This is also the backbone to being able to do our early warning system. This is the data that we utilize for early warning. The faster we can get the information from that epicenter, and we can calculate that information. So the more stations we have in the ground, the faster and the more reliable that information is. So now within milliseconds, we get that information. It travels at the speed of light. The P-waves and the S-waves travel at two miles per second, which is slower. That distance of time is how we can do early warning.

Cameron: So early warning systems are the Valhalla for earthquake scientists. We know that we can't predict them, but we can warn. We can have an early warning system. And so this was always ... I should probably say, better put, the holy grail for earthquake scientists, as far as informing the public and saving lives. Tell us about the early warning system that we have in place here in southern California. Are we a little behind the times? I understand that Japan has been using some early warning systems much longer. Is that correct?

Margaret: They've had an early warning system for about now three years. Mexico's had one longer than that. But the Mexico system is a much rougher system. It's run by a private company, and they really monitor one fault and alert Mexico City. It's also many miles away, so they get many seconds of warning because it's quite a long ways away. The Japan system is a very good system. It has been up and running about three or four years; it works very good. It stops trains. They have many large earthquakes in Japan. They sit on a subduction zone, so they can produce much larger earthquakes than we do here. And they have large earthquakes more frequently. So the government said, we want early warning, and they put it in. It slows down the trains. It saves lives. And it did very well in the Tohoku earthquake.

Cameron: And they're automated systems, which I think is wonderful. You're taking the human limits that can ... gum up the works sometimes. They lifted that out, so when that early warning goes off, it's an automatic train slowing down. An automatic tsunami horns warning, that kind of thing. Do we have that in place here?

Margaret: We will. We are working on early warning now. We've actually had it for a while. We've been beta-testing it. Caltech in collaboration with the University of Berkeley, University of Washington, and the University in Zurich, Switzerland have been developing early warning. The early warning we have right now is for California. We utilize our seismic sensors is the backbone to being able to do our early warning system and to be reliable and robust. We are running early warning as a beta test at this time. The scientists will create the signal. And USGS will run the public alert system.

Cameron: Now I think a lot of folks might not understand the true value of early warning. No, it is not enough time for you to pack the cat and your favorite works of art and casually get into your car and leave to go someplace else. It's not that kind of warning. This is an immediate warning that could do things that you might not first expect. Like warn a surgeon who's in the middle of a heart procedure to pull his hands out from that patient's chest. Or turn the laser that he's using off. It's a lot of instances like that. Just enough time to really help in critical situations. Am I describing it well?

Margaret: No. You are absolutely right. Early warning is the ability to provide a few seconds of warning before the damaging waves reach your location. So with early warning, it picks up as the rupture starts. Our instruments pick up the ground motion. Sends it back to our computers at the speed of light. We have an algorithm built into that that then will estimate the magnitude of that earthquake, the intensity of shaking at your location, and how many seconds before those damaging waves are going to arrive at your location. We're dealing with seconds here. We're not dealing with hours, like we do with tornadoes or hurricanes or tsunamis. We're dealing with seconds. So seconds, what can they do ...

Cameron: It's still enough time for your kid to get under his desk at school.

Margaret: Kids to get under the desk. Let's say, with the La Habra earthquake, I had four seconds of warning. What can I do in four seconds? I can't get out of town. What I could do is it gave me enough time to actually stop and think, "how am I going to respond? I'm going to get underneath that dining room table."

It gives people enough time to drop cover and hold on. Automated systems will open elevator doors so people aren't stuck into elevators. It will slow trains so they aren't derailed. It will allow doors to our emergency response vehicles, such as our fire trucks and our police cars or our public works vehicles, if they're in garages that the doors would automatically open. Because in an earthquake, that building twists and turns. After the shaking, sometimes they can't get their doors open. So now they've lost the use of those vehicles.

So it will allow doors to open. Surgeons don't operate. People that are working in hazardous conditions can step away from that, so if they're working with chemicals. If they're working with electricity. If they're working with anything that can be dangerous they can step away or get away from that. Caustic materials could be shut down so they don't go into, cause secondary effects. Gas lines can be turned off so that they ... Now we're not going to turn off the gas because that causes other problems. It will back up in the the lines. But let's say you're cooking at the stove, and you're using gas or electricity. You can turn that off. Now you don't have the secondary effect of a fire.

Cameron: It's completely brilliant. And it's these centers that we've placed all over southern California, that give that the opportunity to work. But there are other centers, and there's lots lots more of them here in southern California. And there are people.

I absolutely loved Did You Feel It? It's one of my favorite ... The concept of it always makes me smile. It's taking human beings and saying, literally, "Did you feel it?" In that case, put some information online. Can you talk about, "Did you Feel it"? Its just one of my favorite sites on the planet.

Margaret: Well it is, and it's interesting that you say that because it is citizen science. That is exactly what it is. Scientists will use these other tools. We use the waveforms. We want all this data. But Did You Feel it? Was built especially for the public. It is citizen science. People panic because they don't know and understand earthquakes, they're not in control of earthquakes. This allows them to have an interaction with that earthquake. They go on and they complete a survey, and there again, Did You Feel It? Is at cisn.org, and it is called Did You Feel It. You click on that. You fill out a survey form telling us what you felt. And so you answer the questions. Did things fall off the shelves? On a scale of one to ten, how much shaking did you feel? So people fill out a survey. That information is then calculated by zip code. Anybody can go into Did You Feel It, click into any of these and get these responses.

So it serves many purposes. First of all, it's for the citizens to really interact with that earthquake. To provide scientists with important information they need to know to make sure that our tools are working correctly. We go in and see how people are reporting that earthquake. So we know that our shake maps are reporting. Yes, there was this kind of shaking in this area, so that is accurate. So we use that information. People use it to interact, and it makes them more comfortable that they're sharing what they learned and what they felt with other people. And then emergency responders can go in and take this information and see exactly what areas and what zip codes were affected. So it has multiple reasons for having Did You Feel It, and it's a great interactive tool.

Cameron: It sure is. Well, Margaret Vinci, who is the Manager of the Office of Earthquake Programs at Caltech, thank you yet again, for spending some time and teaching this poor layman what she needs to know about earthquakes and living in earthquake country. It's been a joy to speak with you again. Thanks so much.

Margaret: And you too. Thank you for the opportunity.

Cameron: And for everybody listening to MYSafe:LA Fire and Life Safety Podcast, thanks so much for tuning in. We've got lots more information about, not just the La Habra earthquake, but earthquakes in general, here in earthquake country. So make sure to tune into our next episode. Thanks so much for joining us.

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