Transcript: Kimberly Blisniuk's interview with SJSU This Week

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Interviewer: "When I first think of geology, being in California, I think of earthquakes and fault lines. Is that an accurate assessment? I'm sure there's much more involved. Correct?"

Dr. Kim Blisniuk: "Yes, that actually is pretty right-on. The San Andreas Fault and what we refer to as the Pacific-North American plate boundary literally cut along California from basically Southern California near the Salton Trough that comes up through Mexico and it comes all the way up through Lancaster, up through an area called the Carrizo Plain near the central coast, and up through what we call the Mendocino Triple Junction which is just south of Humboldt County, and that's basically where the Pacific Plate, which is made of basaltic rock, and the North American Plate come together. And these two plates slide past each other. And what's really wonderful, or amazing, about the San Andreas Fault in California is that, along most of its length, it cuts through continental lithosphere. And that's pretty cool because most strike slip faults – where the fault slides past each other – are in the ocean. And so, in California along most of the length of California, we have all these different faults that form from basically little jogs of the San Andreas; so that's why we have little ridges and mountains pop up, and how we have earthquakes."

Interviewer: "You said how a lot of faults are in the ocean or bodies of water. I would assume that that's what contributes to tsunamis after earthquakes, correct? Is it more likely to have a tsunami from a fault that slips in the ocean as opposed to one that cuts through land, like the San Andreas?"

Dr. Kim Blisniuk: "Sure. It's a little bit more complicated. So I was referring to strike-slip faults when I said 'many strike-slip faults, or the majority of strike-slip faults on Earth are in the ocean'; when we think of tsunamis… tsunamis occur because you displace water vertically. When we talk about strike-slip faults, both sides of the fault slide past each other, so we consider that type of displacement lateral displacement. When we think of tsunamis, those are vertical – those occur on vertical faults. And what happens there is that, generally, in, say, a subduction zone, where you have one continental plate or oceanic plate subducting underneath another, you displace the crust vertically. And if you displace the crust vertically in the ocean, like often times in Japan or Sumatra where we hear about these tsunamis and earthquakes, you're displacing water vertically. And when you displace the water vertically, that's when water moves on land and that causes the tsunami. The type of displacement along the San Andreas fault where we are is lateral, or horizontal, so we're not displacing the crust vertically. So we don't think of tsunamis that way."

Interviewer: “You mentioned the San Andreas Fault, and I feel like that’s the first fault that comes to mind for everyone, not just in California, but probably across the country.”

Dr. Kim Blisniuk: “It’s a very-well studied fault, yes.”

Interviewer: “Are there any faults within the Bay Area in California that perhaps people don’t know about or aren’t as familiar with (and they should be)?”

Dr. Kim Blisniuk: “Well, there are many faults that cut across the crust in this region. Basically, we have a series of faults. So the main faults from west-to-east are what we call the San Gregorio fault, the San Andreas Proper, the Calaveras fault, the Hayward fault, and there’s this Grenville fault. And all of these faults cut across northern California. And they form the plate boundary – but you can just imagine, if you were to take a piece of paper towel and you try to shear it or tear it laterally, it’s not just going to tear on one section of the paper towel – it’s going to tear on multiple sections. And so that’s what’s happening here. So there are many faults that cut through this metropolitan area that we call the Bay Area.”

Interviewer: “Is that why, when there is an earthquake, you may have an initial quake, maybe small, maybe big, but then you’ll have subsequent quakes after the fact? Is it a trigger for other faults when one goes off?”

Dr. Kim Blisniuk: “What you’re talking about are foreshocks, main shock, and aftershocks. And, generally, when we think of foreshocks, main shocks, and aftershocks, they occur on the same fault when an earthquake ruptures. So usually an earthquake will rupture along a particular fault and we will have – sometimes you’ll have these foreshocks, the main big shock, and then a series of aftershocks. The second part of the question you were talking about is earthquake triggering, or whether you could have an earthquake on one fault and it may trigger another fault to rupture. Sometimes – earthquake geologists refer to these earthquake ruptures as multi-segment ruptures (where you can have the earthquake nucleating from one fault, directed in one particular direction, and then it steps over, and then it starts to rupture along another fault). So we definitely have those types of earthquakes, yes. But I don’t know when and where that will happen in the Bay Area; it just depends on the type of earthquake.”

Interviewer: “When can Bay Area Residents expect the next major earthquake? You just said that it’s hard to predict, correct?”

Dr. Kim Blisniuk: “Yeah, I would never predict an earthquake. Often times we’ve referred to figuring out when the next earthquake is as forecasting an earthquake, kind of like how you forecast the weather. But you never know what’s going to happen to the weather. I would suggest most residents in the Bay Area just be prepared. For example, in our home, we have a huge sixty gallon water container in our back yard just in case if there is an earthquake we will always have water. We have one month of dry food where we only need to add water to the dry food. We have a separate propane tank – Just these precautions so that you have enough food and water in your home in case you can't leave your home or it's difficult to leave your home. I would recommend (and hope) that residents of the San Francisco Bay Area not wonder when the next earthquake is going to be, but just be prepared for that next earthquake. Because we never know. We don't understand these fault systems as well as we do, and there's a lot heterogeneities with these faults and in the crust, so I would suggest to just be prepared."

Interviewer: "The radio station that this will air on is a college radio station, so generally the listeners of the station are probably between, I would guess, the ages of say 18 and 34, give or take. If that is the case, most of our listeners, when they hear about earthquakes and the big one hitting the Bay Area, I think it can be safely assumed they've heard that the big one is going to come basically their entire life. And it hasn't in the Bay Area yet. Are there scientific reasons why it hasn't occurred yet? Or, why is there this looming anticipation?"

Dr. Kim Blisniuk: "Well, the Bay Area consists of many different faults. And when one of these faults will produce an earthquake, we do not know. We can only figure out the probability of when an earthquake will occur on any individual fault based on looking at the geology, based on the seismicity, based on what we call the paleoseismic record – the currents of previous earthquakes – but we should just be prepared because it may happen tomorrow, it may happen in thirty years, or fifty years. But, you know, for someone 18 to 30 thinking of the next earthquake happening soon… if it happens in their lifetime, in geologic time, that is soon. So it's not a matter of our time scale, it's a matter of the time scale that we study these faults on. And the recurrence interval of many of these faults are in the lines of, say, every 200 years or every 250 years, but there are many of the faults and some of the faults are not identified and so we, as earthquake geologists, are very cautious when we want to say, 'oh, the earthquake's gonna happen in the next thirty years!' 'In the next thirty years' can be the next 60 years, or 100 years, but for our lifetime, it's a long time, but for Earth life time, it's pretty fast. And so these earthquakes happen so infrequently in our human lifetime that when they do, they can be quite devastating. And then they don't happen for so long; no-one remembers the Loma Prieta earthquake, really, or the Northridge earthquake down in Southern California; these were very disastrous earthquakes, but we don't remember because our time scale of which we remember these disasters are short-lived. And if we had that capacity to remember them, then I think we would be much better prepared for them."

Interviewer: "I hear the term liquification of the soil a lot when referring to earthquakes. Most recently I've heard about the liquification of soil in regards to the Millennium Tower in San Francisco and how that building was built. Is there a proven method for how to make buildings and structures just withstand a major earthquake? Is it basically, you have to go down to bedrock? Is that the formula?"

Dr. Kim Blisniuk: "That's the suggestion. Liquefaction is a direct hazard of earthquake shaking. Liquefaction is not an earthquake. What happens is that, in sediment, when you have saturated water, you basically make the ground unstable. And when the ground becomes unstable – and this water comes from maybe, you know, groundwater seeping up along faults or seeping up through the surface because you get shaking nearby – and that, basically, infiltrates through the pore space of sand and sediment. So if you look at the Bay Area, most of our ground surface is sand and sediment because it's the Bay. Right? So they Bay is just full of sand and mud and marsh, and so what we really want to do is go down to bedrock which can be hard, and you do want to dig down and have a good foundation… but there are definitely ways to mitigate these hazards, such as liquefaction, by building sturdy buildings. Japan is very good at building these buildings and California is slowly catching up to them. Our highways need to be retrofitted – they just retrofitted the Bay Bridge, spent billions of dollars on that – and basically infrastructure needs to be retrofitted."

Interviewer: "The Bay Bridge, you brought up… Of course, it collapsed (a section of it) in the '89 earthquake. However, the Golden Gate Bridge, from what I can recall from news reports, was relatively unfazed. Is that why the Golden Gate Bridge revered so much?"

Dr. Kim Blisniuk: "Oh, I don't know why the Golden Gate Bridge is revered so much. It has to do with the location of where most of the energy from the earthquake propagates through. So the Golden Gate Bridge is just north of where a lot of the shaking occurred. Because the earthquake that nucleated, that caused the shaking for the Loma Prieta earthquake, came from the Santa Cruz Mountains. So it's just further away from the Golden Gate Bridge. So it just has to be the location, not necessarily how the bridge was built. But I don't know, to be honest, the specific, you know, way the Golden Gate Bridge was built to comment on."

Interviewer: "The Bay Bridge, being a longer bridge over no land mass or ends… is that probably one of the reasons why it probably failed structurally? Because it had less of a natural land support?"

Dr. Kim Blisniuk: "Yeah… I mean, it was not built to withstand a certain magnitude earthquake. And I think now they've retrofitted the Bay Bridge to withstand larger magnitude earthquakes."

Interviewer: "I heard, also, about the Pacific Northwest, like in Washington, how that area of the country is at great risk for a major earthquake. Is there anything to that scientifically?"

Dr. Kim Blisniuk: "Oh, yeah! So, when we talk about earthquakes along the San Andreas fault, I mentioned earlier that the San Andreas fault ends at what we call the Mendocino Triple

Junction. And from the Mendocino Triple Junction up through to Canada, what we have is something called a subduction zone. So all of the mountains, like all the volcanoes that we have in California like at Mount Lassen and up through Oregon, like at, uh, what was it – up to Mount Saint Helens and all the way to Mount Baker… Those are volcanoes. And those volcanoes form due to this subducting slab underneath the continental crust – the subducting oceanic crust underneath the continental crust – and this subduction zone causes this vertical displacement of the crust. And as a result, if this vertical displacement produces enough displacement in the water, you can actually – there's evidence of a tsunami that hit the coast of Japan back in… I think the 1700s, I can't remember the exact date… and they called this… well, the Japanese are very good at recording earthquakes; they've been recording earthquakes for centuries, and they called this the Orphan Tsunami because they were unable to identify the fault on which the earthquake occurred. And it wasn't until a few hundred years later back in the 1980s and 1990s that US Geologists and Japanese Geologists and earthquake seismologists and scientists realized that that tsunami, that Orphan Tsunami in Japan, actually came from a (likely) large earthquake rupture along the Cascadia Subduction Zone, basically from northern California all the way up through Canada. And there was the New Yorker article about this tsunami that can strike this region and, um, it's definitely possible. But we don't think about there just because they happen so infrequently, again, that, on our human time scale, we always think that it's unlikely to happen until it does and then it becomes a disaster or a catastrophe."

Interviewer: "The 'Big One' that we allude to, that could happen tomorrow or could happen a hundred years from now or fifty years from now… how big would that be?"

Dr. Kim Blisniuk: "It all depends! So, when I think of… I'm from Southern California, and when I think of the 'Big One' and when earthquake geologists and scientists think of the 'Big One', they think of the southern San Andreas fault. And that's because the studies down in southern California on the San Andreas fault suggest that that section – there's a section of the fault from… I don't know if you know where the Coachella Valley is? But basically there's a section of the southern San Andreas fault in the Coachella Valley where we have paleoseismic records that indicate that it has not ruptured in over 300 years. And within these paleoseismic trenches, scientists have been able to document the occurrence of previous earthquakes since 1690 (which was the last earthquake to rupture this section of the fault) and it suggests that these earthquakes are occurring, like, every 225 years or so? But it's been over 300 years since we've had rupture on this section of the fault. And that's where we think of this big earthquake happening. And the size and magnitude we don't know because it depends on how close to the surface the earthquake nucleates, how long the earthquake nucleates… there's so many different parameters that… will it rupture in one earthquake? Two earthquakes to release the stress that's been applied?

Interviewer: “You spoke earlier of infrastructure needing to be improved in earthquake zones. Do you believe that there should be some kind of – and perhaps there is, I’m not sure – monthly, or yearly, or every six months, where you have roads or buildings inspected just to make sure that they’re up to code? I mean, is the infrastructure *that bad* in the state or the area that if a big one did hit the state would be in, at the very least, significant financial trouble?”

Dr. Kim Blisniuk: “Oh, um… no comment? I have no idea! I think it’s a great idea, I just don’t know how state funding works and what… I highly doubt there’s a group of people that go out and investigate all of the infrastructure and buildings. Often times I think what happens is that people want to build a new house or some type of expansion of a highway or freeway and that’s when you go in and make sure the infrastructure is built to withstand a certain magnitude earthquake. But I’m not aware of any organization or group of people or organizations that go out and investigate. I think we know, ideally, because we know when all the freeways were built – by just knowing the date of which freeways and homes are built, we know how likely they are to withstand various magnitude earthquakes.”

Interviewer: “Now, in terms of being able to predict an earthquake or forecast an earthquake, obviously an earthquake cannot be predicted spot-on. But is there something that happens down in the Earth’s, uh, insides, or crust, or what-have-you, where there’s something that could be developed that would sense imminently that something is about to happen? Does that technology exist?”

Dr. Kim Blisniuk: “Well we do have the earthquake early warning system now in the Bay Area that was spearheaded at the University of California Berkeley. This is – the earthquake early warning system is similar to what Japan has and it follows this concept where when an eaerthquake nucleates, it propagates something called P-waves. These are primary waves. And these P-waves move faster than what we call S-waves. And because the P-waves move faster, they hit these seismic stations first. And then the S-wave comes a few seconds later and then the surface waves come in. And so by knowing the arrival of the P-waves, we know when an earthquake will hit just a few seconds prior to the S-wave coming in. And we can automatically shut off, like, gas lines, stop public transit trains and whatnot – and I don’t know how much, this is basically based on the Japanese model, but the idea is that the P-waves come in, scientists know, they contact PG&E, they contact various government agencies to shut off the utility and gas lines because what usually happens after an earthquake, like the 1906 earthquake in San Francisco, is that it wasn’t the earthquake and shaking that caused the most damage; it was fires. And so if we can shut off the fires and the gas lines we can mitigate the probability of increased fires that would result from rupturing these power lines and gas lines. And so the idea is that these P-waves come in, we know, we can inform the government agencies, they shut off these power supplies, and it would just help mitigate the damage in an earthquake. So we do kinda have an early warning system in a sense, but we don't – we're not going to know, 'in a week or two', you know, we're not going to ever be mentally or psychologically ready for an earthquake and know two weeks in advance or something like that."

Interviewer: "This is a little bit detached from the topic of a warning system, but in Oaklahoma, there've recently been some earthquakes. There's been speculation and chatter that that has been caused possibly by fracking. Is there any scientific evidence to that?"

Dr. Kim Blisniuk: "Oh, yeah, yeah! Yeah, so, I have a nice little slide – I can't find it now, but – there's a lot of research in the increase in seismicity near these areas where they've been fracking and there's a direct increase with increased fracking and increased seismicity."

Interviewer: "And why is that? Is that because you're trying to extract stuff from the ground?"

Dr. Kim Blisniuk: "Yeah, you're basically changing the overlying stresses and the local stresses in the crust; you can just imagine if you had, um, say a cake. And say this cake is layered down, it's an eight-layer cake, and you have a layer of chocolate cake, you have a layer of fudge, the filling, and then you have a layer of whipped cream. And let's say the layer of whipped cream is underneath, like, five layers of various cake and fudge layers. But it's the whipped cream that you want. But you don't want anything else. So to do that, you take a straw and you poke it all the way down to where you know this whipped cream layer is and you have to figure out a way to just extract the whipped cream. But when you extract the whipped cream, all of the other layers on top of that whipped cream, you're basically changing the structure underneath the crust. And so you have to then put back the material or that so basically it's changing the local stresses beneath the crust by removing natural gas in fracking and doing all of that stuff."

Interviewer: "With that being said, it sounds like fracking disrupts the structural integrity of the surface?"

Dr. Kim Blisniuk: "You can think of it that way, yeah."

Interviewer: "So with that being said, do you think the practice should be stopped? Do you think it should be illegal?"

Dr. Kim Blisniuk: "I'm not an expert. I'm sure there are better people you can ask. I'm sure there are mechanisms in line to help mitigate for the changes that fracking is doing to the crust. There's an increase in seismicity, but it's called microseismicity; so they're small earthquakes. And I'm sure there's a whole field of expertise where they try to figure out how to least disturb the crust. It's just sometimes you still produce these micro earthquakes.

Interviewer: “Finally, I guess we’ll end on this, this is related to the campus community and is basically a campus community question: If a sizable earthquake were to happen in the Silicon Valley, what places would you suggest that people try to be at on campus? Say if an earthquake were to – if they’re walking through campus, where would be the best place you could be at?”

Dr. Kim Blisniuk: “Outside! If you’re indoors, you should go underneath your desk or table or within the door frame where you have more structural integrity, but the best place is to go outside so nothing can fall on you.”

Interviewer: “Alright! Dr. Kim Blisniuk, Assistant Professor of Neotectonics in the Geology Department here at San Jose State University. I want to thank you for joining us and giving us more of an education on earthquakes here in earthquake country.