Transcript

Speaker 1: You're tuned in to 90.7 FM, k a l x Berkeley. My name is Tesla Munson and this is the graduates, the interview talk show where I speak with UC Berkeley graduate students about their work here on campus and around the world. Today I'm joined by geologist Elizabeth and yes, below from the Department of Earth and planetary science. Thank you. I guess I should have asked that earlier, but you're, you're right there ready to go. Earth and planetary sciences. Okay. Or science singular. Can you just tell us a little bit more about that department and what it encompasses here on campus?

Speaker 2: [00:00:30] Yeah, so the Department of Earth and Planetary Science is an earth sciences department that covers a multitude of different topics that have to do with the earth systems. So we have different subjects like climate science, geophysics, which largely deals with things happening below the surface of the earth, geology and geochemistry, which largely have to do with rocks that make up the composition of the crust and deeper into the earth. And also, um, marine science. So [00:01:00] we talk about, um, oceanography and the chemistry of the ocean. And that subject matter. But generally we all fall under the category of Earth Science because we all study the world we live in together.

Speaker 1: Excellent. And so I called you a geologist, but you have other titles, right? A Geo chronologist and then there was another one, isotope geochemist isotope. Geochemist. Yes. So why are those are specific types of geology?

Speaker 2: Yeah, so, um, I usually call myself a geologist [00:01:30] because I study the rock record predominantly. And so I do have to go out into the field and collect those rocks. And for that reason I need to understand something about other aspects of geology, like structural geology that has to do with things like plate tectonics and fault zones and how things move around the earth in deep time. Um, but I also need to know quite a bit about the chemistry of the rocks that I'm studying because that's [00:02:00] how I'm able to use the tools I need to understand how old things are. And that's where geochronology comes in. That's essentially the study of the rock record and time and how you can use the rock record to understand the history of the earth. And how things have changed in the past.

Speaker 1: So I guess, you know, I, I'm clearly, this is not my field, but when I think back to high school, for example, they put chemistry in a totally different room than geology. So how is it that we should [00:02:30] think about rocks having chemistry? What does it mean?

Speaker 2: That's a great question. You know, when we take chemistry, usually initially we start with things that are made of fluids. Um, things like water and acids and alcohol and other things that have a chemical composition that exist in, you know, Earth's pressure and temperature space as liquids, but rocks as solids also have understandable chemical compositions. And so when we study geochemistry, we're [00:03:00] studying the chemistry of rocks. That is the chemical composition of the solid materials that do behave as fluids over long timescales. And that's why we have things like plate tectonics because we have this fluid like behavior of rocks over long time scales. So things that are made of gases and solids also have chemical compositions. And so to study the rock record and its composition, you would need to study geochemistry. So I guess when I think of chemistry, I think of things that are volatile [00:03:30] for example, or things that are moving.

Speaker 2: But when I think of rocks, I think of things that are stuck in time. So our rocks changing over time besides like plate tectonics, but individual rocks, they definitely can. There are other processes of rocks interacting with fluids and with gases like atmospheric gases that can lead to weathering products. So for example, a mineral inside of a rock that has an interaction with maybe an acidic fluid or [00:04:00] atmosphere gases can change and decompose over time or alter into another mineral that has a similar chemical composition. But there may have been some exchange of chemistry with that other interface, like the fluid or the gas. So rocks can change over time. They can be structurally deformed as well. So we, we see this in the rock record when we observe rocks that have folds in them or they have laminations that weren't originally there. Um, we also see that [00:04:30] in the process of lithification for example, if you were to walk down a muddy river bed after a heavy rain like we just experienced, um, you would see these soft muds that over geologic timescales would lift the Phi into heart rocks.

Speaker 2: And that process of lithification vacation is even in a certain sense, um, a change of state. And is that process of lithification at all related to the process of fossilization? It can be, yes. Um, so in some cases, [00:05:00] lithification is simply a hardening and compaction process, which doesn't change the chemical composition of the rock itself. Fossilization is actually a chemical alteration process. So for example, if there's a bone on the ground on day one, that bone will be composed of mainly mineral called hydroxyapatite or often referred to as bone mineral appetite. And then there's a large percentage of organic material that makes your bones flexible [00:05:30] and able to withstand tension. Over time that appetite and organic material will alter the organic material, will tend to decay away and the bone mineral appetite will be replaced chemically by a more common, a more suitable mineral in earth surfaces that's more stable in the surface environment, which is calcite. And so over time that bone mineral appetite will become something like calcite. I'm more commonly and that [00:06:00] will withstand the test of time, much longer. Bones can also fossilize to other minerals. Calcite is just a very common one.

Speaker 1: Okay, so we're talking about rocks, we're talking about time. So is this, but this isn't just basic stratigraphy like right, like the layers of the rocks and the ones that are down lower, probably older. You're going way beyond that,

Speaker 2: correct? Yes. So those principles of superposition and original horizontality, these are laws referred to as Stenos [00:06:30] laws that we can use in the field to understand stratigraphic relationships. But geology is a little bit more complex than that. And really the earth system is more complex than that. And so we also have to worry about things like tectonics when there's an earthquake or a fault in the area. And things move up and down or side to side. Our stratigraphic relationships can be compromised if we only rely on those rules. So we have to use field relations to also understand how old rocks are. And [00:07:00] we also, when we want to know precise time, we want to know, um, what the geochronology would tell us, which is the way we get at understanding the true age of a rock.

Speaker 1: Okay. So before we go more into that, I want to go a little bit back to the beginning, right? Uh, first of all, you must have an awesome rock collection, right? Yes, I do. Like this is like the eternal like biology joke is like, hey, you want to see my rock collection?

Speaker 2: Yes, indeed. Actually I have bookshelves that [00:07:30] just have boxes of rocks on them at my house, um, where the books are stacked up next to them sometimes, but the rocks seem to dominate in many cases. Excellent.

Speaker 1: And did you always have a rock collection? It was this, your passion from the beginning was going out into the field and grabbing rocks.

Speaker 2: Well, it actually wasn't, I kind of came into geology from another discipline. Originally when I came into college, I was an undergraduate at UC Berkeley actually. Um, and I studied astrophysics and classics. [00:08:00] So I was really interested in a lot of different subjects and I was sort of overwhelmed by all of the choices when I came to college. So I knew I wanted to study a physical science when I came to college. So I declared astrophysics as soon as I could and started on those prerequisites. And I always had a passion and interest in history. So I started taking some courses in classics and I found myself just completely captivated by ancient history. So I decided to double [00:08:30] major. And as time went on I found that I was struggling to decide which avenue I wanted to take for a career and that something more interdisciplinary would probably be better suited to my interests.

Speaker 2: And so when I graduated, I spent some time working for archeologists in the classics department, getting exposure to what archeology was like because this was potentially an opportunity me to do some scientific analysis while still studying history. [00:09:00] And so I went to the field with Kim Shelton, who is a classical archeologist in the department of classics here. And I excavated with her field school in Nemaiah Greece for six weeks. And from that point on I was totally hooked on to field work. So I got really interested and how I could continue pursuing field projects. And while I was in the field, I found myself wondering a lot more about the natural materials that we were excavating into to [00:09:30] bring out the artifacts that the majority of the archeologists there were interested in studying. But I got the sense that if we probed more into the natural materials that were the context of those artifacts and human remains or you know, whatever you find on your excavation, we might be able to understand those archeological deposits better.

Speaker 2: So what are the soils telling you? What are the different types of sediments [00:10:00] telling you about the environment that those things were deposited in? What was the environment like when those people were living there? And so as I started to ask these questions, I realized that I was probably going to be better suited to being in an earth science department where I was collaborating with archeologists. So I would be able to look at the natural materials on a site and get some information about those things, try to interpret the rock record or the soil record, and then collaborate [00:10:30] with somebody who was interested in studying the artifacts or the fossils themselves. And we could put together a more integrated picture of what was going on in the past. And so did you did do that, right? You went on to get a master's in geology, correct?

Speaker 2: Yes. So at that point I was ready to give geology a shot in terms of the academic work and figure out if this was really the route for me. So I went to cal state long beach for a masters program, which ended up being a really enriching experience [00:11:00] for me because most of the people in my program were more professional geologists. So I got a lot of exposure to what industrial geology jobs are like. So things like hydro-geology, environmental consulting, uh, petroleum resources, other energy resources, and realizing that geology was something that we all have to understand to some level to function and thrive in our civilizations. The things that we use every day [00:11:30] are made of natural materials from earth and literally every single thing you use and experience is derived from an earth material. So for example, the House that you live in probably has drywall in it, which is made from gypsum that was probably quarried somewhere crushed up and made into a fine powder and then turned into drywall to build your house. Another example is your cell phone. Most of the, the chips and components to the batteries [00:12:00] and the circuits in your cell phone are made of things that have rare earth elements in them. And rare earth elements are found in particular types of geological deposits that have to be mined. So we use geological materials every single day. We're just not necessarily aware of it.

Speaker 1: So if you're just tuning in, you're listening to the graduates here on Calex. Today, I'm joined by a Geo chronologist Elizabeth and yas below from the Department of Earth and planetary science here at the University of California. Berkeley. [00:12:30] We're talking about geology. Obviously you got fully into this path. You said that fieldwork is one of the things you fell in love with and I know you've actually been quite a few places to work in the field and having you. Yeah, I

Speaker 2: feel very lucky after that first experience in Greece and um, that first exposure I realized this was something I really wanted to integrate into my work on a regular basis. And so I pursued other projects that allowed me to go into the field in Italy. I got to work in

[00:13:00] Pompei and study some of the pottery there as well as get to see Mount Vesuvius, which was a volcano that erupted in 79 d covering the city with volcanic ash. That was my first sort of exposure to volcanics and the interaction of volcanics with human civilization. And that becomes sort of a theme in my research today. Um, because I as a Geo chronologist collect ashes for dating. Um, so [00:13:30] I got to go to Italy. Um, and then as a master's student, I was working with a Mesoamerican archeologist and an isotope geochemist who was my master's advisor.

Speaker 2: And so I ended up working in Chiapas Mexico on a Mayan archeological site that had been newly discovered by the archeologist I was collaborating with. And I was able to also obtain access to an assemblage of artifacts that came from [00:14:00] Guatemala, which were fragments of jade that had been found in an archeological workshop where jade was brought in from the, from the jade resources in Guatemala and moved into this workshop. And then, um, jade crafters would make sculptures out of them. So I was able to obtain some access to those materials and do a simultaneous geochemical and archeological study of trying to figure out [00:14:30] if there was a geochemical way of sourcing the providence of that jade. So was all the jade in this workshop coming from a single region, or were there multiple regions that were being sourced for Jay that would then be moved into this workshop?

Speaker 2: And what does that tell you about the economy of jade moving through? The Mayan Empire as they moved up north to the main capital cities where these sculptures would be prized by the elite d. Do you have any answers for us? Cause he [00:15:00] ain't leaving us hanging here. Do we know? So it as always in science, the answer is complicated. That's right. That's, there's nothing wrong with that. Let me just say that. Okay, continue. Sorry. Yes. Unfortunately I wasn't able to say with complete absolute certainty that we could geo chemically sourced this jade to, for example, the outcrop scale. And when I say outcrop and geology, that essentially means the hill you're looking at or the wall of rock that's been cut through by a road. [00:15:30] It's sort of bigger than human sized rock exposures, but not mountain size. So at the outcrop scale, we weren't able to source the jade, but at the regional scale we were able to distinguish something about the different jade sources.

Speaker 2: So there's a large fault that crosses the from coast to coast of Guatemala and there's jade north of this fall and south of this fall. And we were able to show that these two resources of jade were different geo chemically to the extent that you [00:16:00] could say whether one was coming from one side or the other. Awesome. I think that's awesome. And then I know more recently you did some work in Ethiopia, right? Yeah. So my phd work is largely focusing on constraining the ages of fossiliferous deposits, so fossil bearing deposits within east Africa, as well as developing a new dating method to constrain the timescales of archeological deposits that are found [00:16:30] in eastern and southern Africa in a time range. When we see a lot of interesting human behaviors evolving, such as the creation of our first art art forms, um, things like egg shell beads, the first evidence of the use of pigments in perhaps personal adornment or also the staining of other materials and the use of a certain types of stone tool technology, including [00:17:00] certain kinds of projectiles such as the bow and arrow.

Speaker 2: And in this time period, we're looking as far back as beyond 50,000 years ago. And unfortunately a lot of the conventional dating methods used in these areas doesn't reach back that far. Things like radiocarbon, for example, which are used very frequently in historical archaeology places where we have also a written record don't work past 50,000 so we have to figure out new ways to approach the problem [00:17:30] of understanding the age of those sequences. And you mentioned ashes from volcanoes before. Why are volcanoes a good way to date things? That's a great question. So there's a couple of reasons and some of them have to do with the geologic process of a volcanic eruption, and some of them have to do with the geochemistry of the samples that are coming from volcanic eruptions. So what is the process of a volcanic eruption tell you in geologic time, [00:18:00] most rocks are deposited Litho, fide or metamorphosed over long timescales, thousands to hundreds of thousands to millions of year timescales.

Speaker 2: So understanding when those lithification or metamorphic processes began or ended can give you a very long stretch of time of volcanic eruption occurs virtually in an instant in terms of geologic time. It's something that humans [00:18:30] can tangibly understand as a fast process, which if you extrapolate that to the billion year timescale that Earth occupies, that is a geologic instant. And so when we see an ash deposit that represents a geological instant in time, we can essentially say with quite good precision that if we're able to date that ash, we're really dating the event of the volcanic eruption. And we can, we can equivocate that to a moment [00:19:00] in time. And you mentioned all these different places, uh, that you've worked. You know, I spent some time in Ethiopia recently, not out in the field, but in the country and you know, I've been to Latin America and these are very different places.

Speaker 2: What are some of the things that are the same across field sites and some of the things that are different? That's a really good question. Um, some of the things that are the same for me at least is my, my experience getting to know the local people, which [00:19:30] is always a wonderful treat in the field. You know, you get to, as a tourist, if you're traveling somewhere, you might get a little bit of interaction with the local people when you're in a restaurant or if you're at a museum and you're talking to the person you're paying to for admission, you might interact with some locals on the street if you're a more social person. However, when you're in the field, you're really interacting all day, every day with local people and you're seeing more of [00:20:00] what it's like to be there in a longer period of time when you have a chance to have daily habits develop with these people that you've just met, but somehow you're able to break bread with them and you know, share jokes and have funny experiences and weird experiences and laugh about it later together.

Speaker 2: So that sort of sense of community is something that doesn't change when you go into the field and different places. One of the things that's probably the most [00:20:30] different about all of those places and I would say particularly Europe compared to South America or Africa, really has to do with the infrastructure that makes field work easier or more challenging just logistically so for example in Europe there's a lot of very accessible public transportation and so if you're trying to get from one place to the other, there's probably going to be a fairly simple way to do that and the roads you'll be traveling on will be [00:21:00] well paved and there will be traffic signals and there will be, you know, security of some sense that you have. Whereas if you're traveling or working in South America or Central America or Africa for that matter, at least in my experience, those differences in the logistical ease of planning, field work and coordinating field work can be a little bit more challenging because you have to think about things that in a first world [00:21:30] environment perhaps you wouldn't have to worry about so much.

Speaker 2: Things like, well, is this road actually accessible? It's on the map, but when I drive on that road, is it going to be there? Or if I run out of gas, where am I going to go? You know, in Europe you might have a gas station every few miles, whereas in a lot of these places, especially as you go deeper into the natural environment where you don't have as much civilization but probably really good geological exposures, [00:22:00] you're going to have to prepare a lot better. And so being out in the field, that's its own thing. It sounds like an adventure. I've seen some pictures. Uh, it's definitely an adventure, but that's only part of what you do, right? Cause once you excavate things you have to, you know, conduct scientific analysis. So what does that look like? Are there special types of machines you use for that?

Speaker 2: Yeah, so the majority of my years actually spent in the lab. Um, I get to spend hopefully somewhere between [00:22:30] one and two months of the year doing field work in various places and the rest of the year working in the lab, preparing and analyzing the samples I've collected while I was out in the field. And so I'm using a wide variety of different instruments anywhere from things that are very basic like mechanical saves. These things just have, you know, wire meshes in them and I'm separating rock samples by grain size after crushing them up. I use lots of different kinds of microscopes. [00:23:00] I use magnetic separators to eliminate magnetic minerals. Sometimes I use heavy liquids to use density gradients to separate minerals so that I can get at the mineral I want to date. And I use chemistry. Um, there are chemistry labs in my laboratory where we have to separate different chemicals within a single rock, so dissolve the rock and then separate the chemical composition [00:23:30] by components.

Speaker 2: And then probably the principle machine that I say I would say is the most important for geochronology to truly function is the mass spectrometer. And while mass spectrometers have been around for about a hundred years or so, the principle type of mass spectrometer that we use to measure elements in a rock is a magnetic sector mass spectrometer, which allows the user to separate elements by [00:24:00] their mass to charge ratio. And so this requires first understanding something about isotopes. That was a word that I use to qualify myself. When I say I'm a geochemist, I'm an isotope geochemist isotopes are just elements that have the same number of protons but different numbers of neutrons. And so their mass is different but their chemical properties are the same. And so you need to know first how do I separate those isotopes so that I can measure them differently and [00:24:30] and get good results from those measurements.

Speaker 2: And so we have to ionize those isotopes and that gives us a charge. So then when we can separate them by mass to charge ratio using this magnetic sector or mass spectrometer, we can, we know that there are masses have a certain amount and with the similar charge we can separate them sending them through a magnet. And so this mass spectrometer has made it possible to measure isotopes very precisely [00:25:00] and more importantly isotope ratios very precisely. And that allows us to see the components of uh, of a decay process from some parent element or isotope that has decay to some other daughter isotope measure both of those things and then back out how long it has been decaying or rather how old the rock is.

Speaker 1: So as we approached sort of the end of the program, do you have any, uh, I know you're still, you know, you got, you've got some time he'd left in the phd [00:25:30] program, but do you have any ideas or any results or just any, uh, anything you want to say about where your research is going to take you here at Berkeley?

Speaker 2: Yeah, so right now I'm focusing on dating these archeological and fossiliferous sites. And I think one of the really important things as we are able to hone in on the precision of these dates and discover more sites with more field work and more access to these areas is being able to correlate [00:26:00] the timing of different archeological deposits across large regions. So if you see similar archeology in different places, but you can't constrain those in time, you can't necessarily correlate the occurrence of that archaeology from one place to another. Whether it happened first somewhere, whether you see archeology, um, sort of developing simultaneously [00:26:30] in different places. We call that um, I soccer furnace in geochronology something that is equal in time. And so as geochronology gets better and as the quantitative aspects of continue to improve and, and also in paleontology, we might be able to better correlate occurrences of fossils and archaeology in time across broad regions and infer things about knowledge transfer or the [00:27:00] environment that you see these events occurring.

Speaker 2: Was that environment similar or different in different places? So I think as I continue forward, I'm seeing that there is a need for better dated records and understanding what the climate and what the occurrence of these records were with respect to each other. So you pretty much just answered this but I'll ask it one more time cause it's really pointed. Why do we care? I mean, is it just pure intellectual curiosity [00:27:30] to understand the timing of history or is there something you could say to just the general public about why this is an interesting subject, an important, interesting and important? That's a great question. And I think it's really important for scientists to be able to communicate why what they're doing is important. So for me, there's probably two things that I think about a lot that motivate me to get up and keep working every day.

Speaker 2: One is understanding where we come from and sort of a generic [00:28:00] sense in terms of human origins, in terms of our ability to innovate and learn. Um, human beings are different from most animals and that we have culture and what culture tells us about our species and our abilities to succeed and survive and flourish on the landscape. So I think that is a pretty strong motivator for me. And I think a lot of people are interested in knowing [00:28:30] where we come from, not just personally, but as a species. The other thing that I think is really important about this work is that interaction of the environment and the people that are living on it. And that partially has to do with understanding our ability to adapt to adverse environments and how that's going to affect us in the future as we continue to propagate climate change.

Speaker 2: So I think that there's some also future implication [00:29:00] to understanding the past and understanding how we as a species have responded to adverse climatic situations in the past. How can we learn from those experiences and what can we take from them in the future as we have to deal with new adverse climate situations. And you mentioned that you think communication of science is really important. I know that you're involved in a lot of outreach activities here on campus and in the bay and I was just wondering if you wanted to talk about that just briefly. Yeah, I'd [00:29:30] love to. So I'm a part of a group on campus called the Society of women and physical sciences or sweeps for short. And this is a collaboration of many science departments on campus, including physics, chemistry, astronomy, earth. And planetary science and some engineering fields as well as applied science and technology.

Speaker 2: And we get together on a pretty regular basis and we host dinners and tease with a guest speakers where we get to sort of share [00:30:00] a sense of community with other people in this field and other either advocates or allies of women in science or just simply women in science. I'm also involved in bay area scientists in schools or basis, which is an on campus program that invites scientists that are either working on campus or studying on campus to go to elementary schools in the bay area and teach science units to young kids. So we go to classrooms from any age of second [00:30:30] grade upwards through middle school and we give a science unit according to whatever subject that class is learning at the time. So as earth scientists, we tend to go into classrooms that are doing their earth science modules and we tend to do lessons on things like plate tectonics and earthquakes or rocks and minerals. And then finally, I think that outreach and this sort of work is very important for students to understand [00:31:00] that even if you come from one sort of background or another, you are just as capable and available to have a scientific career if that is what you want. And there are plenty of everyday people that go into science and they make it their job. So being a scientist isn't this unattainable goal, but rather something that you work towards every day and one day you might feel comfortable saying that you're a scientist.

Speaker 1: [00:31:30] Yeah. One day. No, we're both there. We're both there, I swear. Um, well, uh, so that's it for our time on the graduates. Do you have any last words before we give our closing statements? Um, you've said, you said a lot of great things, you no pressure, but yeah. Well

Speaker 2: thanks for having me. Of course. And I look forward to hearing about future graduate work as well in other fields.

Speaker 1: I think it's always interesting to hear what other people are doing and it was great to have you on. You're the first [00:32:00] person from Earth and planetary science, uh, out. Oh yeah. 53 people. You're the first one. So good job. Congrats on that. Thank you. It's very interesting work. Uh, you've been listening to the graduates here on KLX Berkeley. My name is Tesla Munson, and today I've been speaking with geologist and Geo chronologist and isotope geo chemist isotope geochemist Elizabeth in the s below from the Department of Earth and planetary science. And she's been telling us about her work, uh, in [00:32:30] isotopes and geology and field work all around the world and, and how you can understand the timing of past events and you can understand how they, to each other. And really just as you said, trying to understand where we come from and what that looked like in the past. I hope I did that well. Uh, thank you. And we'll be back in two weeks with another episode of the graduates. So stay tuned. You're listening to k a l x Berkeley.