Intro (00:01):

Welcome to Earthly, a Clemson University podcast discussing issues of agriculture, horticulture, nature, and design impacting the world nation, state of South Carolina and even your home. Here's your host, Jonathan Veit

Jonathan Veit (00:17):

Radon is the second leading cause of lung cancer after smoking. And in South Carolina, lung cancer is the most diagnosed form of cancer and the most common cause of cancer deaths. In fact, the EPA estimates that radon alone causes more than 21,000 lung cancer deaths in the United States each year. The South Carolina Department of Health and Environmental Control has produced a map showing that radon levels in upstate South Carolina homes are higher than other parts of the state. Today on Earthly, I talk with doctors Nicole Martinez and Lindsey Shuller-Nichols. Martinez is an expert in radiological health sciences, and Shuller-Nichols is a material scientist both in Clemson's Department of Environmental Engineering and Earth Sciences. They're going to help us understand what causes radon, why it's higher in the upstate, its potential health effects and resources for testing and mitigation.

Jonathan Veit (01:03):

Nicole and Lindsay, thanks for joining me on Earthly Today. Happy

Martinez (01:06):

Happy to be here.

Shuller-Nichols (01:07):

Yeah, happy to be here.

Jonathan Veit (01:08):

So, uh, as you guys know, DHEC produced a map that shows radon rates are higher in the South Carolina upstate than in other parts of the state. In fact, DHEC reports that OK and Greenville County have the highest average in-home rates in the state. Uh, can you tell us what radon is, where it comes from, and why it might be higher in the upstate?

Shuller-Nichols (01:27):

Uh, radon is, uh, what we call a noble gas. So if you're looking at a periodic table, it's all the way on the far right side. It comes from the decay, radioactive decay of uranium and thorium that are naturally present in the earth. And we see the higher concentrations in the upstate because in the upstate, the bedrock or the, the primary rock beneath our soil is a little bit different than what it looks like in the, the Midlands and the Low Country. So in the upstate we have granite, and in that granite we have lots of different types of minerals. So there, there's a mineral called biotite, which is a mica. It's shiny, flaky, it's used in makeup, and we have a mineral called, um, well the feldspars, those are the most dominant mineral in Earth's crust. We have quartz and we have garments. There is a lot of flexibility because there are a lot of different types of sites where atoms can go.

Shuller-Nichols (02:43):

And the way that I like to think about it is, you know, that old game when you were a little kid and there was this cube with different size holes, like a star hole and a square hole and a circle hole, and you stuck the little peg in the different holes. That's what I think of minerals like. So you have minerals that have different sized and shaped spaces where atoms can go. And in, in the garnet you have spaces where the uranium can go. So there are very flexible structured minerals. So in the garnet you can have pretty high concentrations of uranium. There are also other kind of rarer minerals in the Upstate. So because of this rock that formed under high temperature and pressure, that's what granite is, um, we also have some pockets of regions that slowly cool from really high temperature and pressure.

Shuller-Nichols (03:41):

And in those regions you can get, because of the slow cooling, you can get high concentrations of rarer elements like uranium. Even in, um, central South Carolina, there's a, what's called a pegmatite. And in that pegmatite we have really high concentration of odd minerals like these tantalites. So inside those tantalites we have even higher concentrations of uranium. Because radon is a decay product of uranium. The uranium is, you can't stop that process. So it's decaying over time and producing eventually radon. And the radon is a gas, so it seeps up from the earth through pore space. The higher radon concentrations are really found in homes that have like a basement or a crawl space where the radon, like a gas can accumulate. It's kinda like a balloon. So the radon can go into that space and fill up that space, and that's where you have to mitigate the, the radon in the house.

Jonathan Veit (04:44):

Most people have heard of uranium, um, but I don't think a lot of people have heard of thorium. Can you talk a little bit about thorium and what it is?

Shuller-Nichols (04:51):

Thorium is kind of like a, I think of it like a sibling of uranium. Uh, so they often find them associated with one another. They are both called actinides. They're really heavy. They're on that last row of the periodic table, that subset way down at the bottom. Um, and it's a naturally occurring radioactive element. It has a really long half-life, so it's still on earth. And thorium can be used like uranium for nuclear energy. It is not fissile, which means that it can't fission itself, but it can take on another neutron and become a, a uranium isotope, which can then fission. So there are some countries in the world that use thorium for nuclear energy for the fuel where we use uranium for the fuel. So countries, um, like India, India has really high concentrations of thorium in their, in their beach, beach sands. And Brazil actually has a lot of, uh, a lot of thorium deposits. In the uUpstate. We have some thorium, some elevated concentrations of thorium along with the uranium. The way that the thorium moves in the earth is a little bit different. So the way that the deposits have formed is a little bit different because the uranium can, um, what we call oxidize, it can become, it can lose more electrons and that makes it more soluble in water so it can move more easily in the earth. It's more mobile.

Jonathan Veit (06:35):

So radon is measured in picocuries per liter. So if you could help our listeners understand what that measurement means and how it might compare to like an x-ray or an MRI or something else that they can relate to.

Martinez (06:48):

Picocurie is a unit that expresses radioactivity. And I think a fun fact is that the Curie was named after the Curies Maria and Pierre who discovered radium in the late 1800s. And originally it was defined as the radioactivity of one gram of radium. So as we kind of move forward, we kind of redefined that to be a specific amount of radioactivity or a specific decays per second because it's more precise. But that's really what radioactivity is. We have an unstable nucleus, it wants to be more stable, and to do so it releases energy. So that process is referred to as radioactive decay. So then 100 picocuries is about four decays per second, and then picocuries per liter would then be radioactivity concentration. So this energy that's emitted the radiation is referred to as ionizing radiation because it has high enough energy to knock out atomic electrons from the orbit and create ions.

Martinez (07:44):

So this has the potential to lead to damage in the cells of our bodies. So for high concentrations of radon and air, we come become concerned about radioactivity depositing in the lungs. And so actually, as Lindsay mentioned that radon is a noble gas, we breathe it in, we breathe it out. Radon itself is actually not a problem, but radon has decay products and those can deposit in the lungs, and that's what we would be concerned with. So if we're comparing that to like an x-ray machine or a CT, on the other hand, those actually don't have any radioactive material associated with it. Right there. They use electrons to strike a target to generate radiation. So that's called bremsstrahlung, which is a, a fancy waves, I think it's German of saying breaking. Radiation radiation given off by electrons when they're like deflected. So they use that then to create images, but nothing becomes radioactive and there's no radiation being admitted if the machine is turned off. And then an MRI uses magnets to generate radio waves. So although that's electromagnetic radiation, it's not ionizing that does not have the energy, um, to create ions like ionizing radiation does. So it's the activity in the body that then can then cause damage, but you can also have energy outside the body, right? In some cases energy can come towards the body and deposit its energy, but it's that energy deposition, that's what we're concerned with.

Jonathan Veit (09:08):

So DHEC suggests that homeowners should consider mitigation if the average of two tests is above 4.0 picocuries per liter. What can the effects on human health be from that level of, of radiation?

Martinez (09:22):

Great question. As I, I mentioned the health outcome of concern for radon is lung cancer. And again, a variety of factors can affect someone's risk. Most notably smoking. According to the EPA overall, radons, the second leading cause of lung cancer behind smoking and the leading cause of lung cancer in non-smokers. So we're, we're talking about the action level specifically though, if a thousand people, non-smokers were exposed to this level over their whole lifetime, about seven people would get lung cancer. So about seven out of 1000. And then if 1000 people who smoke were similarly exposed, that goes up to 62 people could get lung cancer. So 62 out of 1000. So smoking makes a huge difference in it, a big difference in risk.

Jonathan Veit (10:07):

How, how can homeowners test their homes and how can they mitigate if they, if they discover that they have a problem?

Martinez (10:13):

So there's a lot of options for testing ranging from you can pick up a test kit at Lowe's or an Amazon for about $15. Um, but you do wanna make sure you check the expiration date or you could hire a qualified radon professional. Also, right now, you can request a free kit from DHEC, and if your home tests higher than the action level, they'll send you a second kit for free as well, since the EPA recommends those two, two data points as you mentioned. And then the, the choice to mitigate in the mitigation strategy really is gonna depend on the situation. Um, it's gonna depend on what the radon level is, how your home, the ventilation is set, all kinds of things like that. Um, improved ventilation might help, but a technique called active soil depressurization is probably the most common. I mentioned those, those air pressure differences earlier. This technique is trying to shift that basically that differential under your home. But if you do decide to do a higher radon measurement or mitigation provider, you do wanna make sure that they're certified. And there's two national certification programs, the National Radon Proficiency Program, and the National Radon Safety Board, um, the EPA consumer Guide to Radon. And you can just find that on EPAs website also has a really lot of great information about this as does DHEC's website.

Jonathan Veit (11:30):

Is 0.4 picocurie a magic number, or can people mitigate to zero?

Martinez (11:36):

Everyone really kind of have to decide for themselves what's appropriate and what is the, like a, a appropriate, um, radon level or really any risk, right? You kind of have to decide for yourself what you think is acceptable. Um, because if you are in an area like Colorado is probably gonna have a, a good bit higher radon concentration. So for someone with a higher natural background, it's gonna be harder to mitigate their home to, you know, even in South Carolina, maybe to two picocuries per liter is going to be easier than it is in Colorado. That's not always the case, but there are some circumstances where you have to consider is, is it worth spending a few thousand dollars to reduce your radonconcentration from four to two, for example. Those are just, I just made that up. I don't, you know, I I don't have a case study in mind, but it, it is something that you kind of have to consider.

Martinez (12:26):

We kind of have to decide for ourselves. And I just wanted to tell a story. Um, and that is, I have a, a radon detector because I think it's interesting and fun. Uh, and so I measured my parents' house. So we measured their main floor and we measured their basement. Um, and the, the main floor was fine under the action level, but the basement was on the order of let's say 10 picocuries per liter. Um, and this was like a fairly quick measurement, and generally you wanna measure over a longer amount of time. And so my, my mom asked me if she was worried. She was like, well, what do we do? And I was like, well, you don't live in the basement, it's just your basement. That's pretty much where you store things. Your main floor is fine. Um, and so for me, I'm not worried about that.

Martinez (13:06):

They're also older, um, and we know that cancer is a, a long, um, term disease and they're also not smokers. So I was suggested, well, maybe you can work on the ventilation in the basement a little bit and we can measure again. But in general, I personally wasn't worried about that. Now, if that ten picocuries had been in the main floor, we would have had a different conversation if that ten picocuries was in a house with smokers or young children, that also would've probably been a different conversation. So it really honestly depends on your situation, what that kind of number you're looking for would be.

Shuller-Nichols (13:42):

I think the other thing that would be useful to discuss is whether you should mitigate to zero. So it's impossible, but, but I think that, you know, whenever we're trying to get rid of some contaminant or something that is, we, we recognize as harmful to our environment, it's really easy to say, well, I don't want any of it. Why would I even want a little bit? Um, and it's not that you want a little bit, it's just if you're looking at the cost benefit, there's not really a benefit to mitigating as low as possible.

Jonathan Veit (14:19):

What do we say to the people who live in the Upstate, particularly in Oconee County, who are concerned that the higher radon levels are due to the Duke Energy plant?

Shuller-Nichols (14:30):

The uranium that's used in fuel is purified before it's made into the fuel pellet. And so all of the decay products, which would include the radon, are removed from the uranium. And then the uranium has the isotopes that we use have really long half lives, which mean that it takes billion years, billions of years, millions of years for it to decay. And so the production of radon from the fuel that's being used in the nuclear reactors at Oconee, we don't have those levels of radon that are even being produced.

Jonathan Veit (15:08):

Lindsay, jump in here and tell us about your research. So what it is you're working on and, um, why it's important.

Shuller-Nichols (15:15):

So I really love studying minerals, and I like looking at them as puzzles and figuring out where contaminants or other atoms, atoms from the outside would go if they were to be incorporated into the mineral. And so that can be for the purpose of radioactive waste disposal, nuclear waste disposal, or it could be for the purpose of designing a new battery. So, or it could be to understand where elements are in natural materials. Uh, so that, that's like one big passion of mine. I also enjoy looking at how contaminants can be trapped on the mineral surface because of the structure of the surface and because of what elements are at the surface and how they might share electrons. So I kind of think of it as like how their arms might come up and grab something, a contaminant from a water system or a, a soil system and pull it to the surface and keep it fixed on that surface.

Shuller-Nichols (16:16):

Uh, I also like looking at like, that's a really small view, right? So this is a subatomic <laugh> view. I'm looking at electrons. I also like to take a huge step back and look at the whole system. And so we're getting into a lot of life-cycle assessment, which is looking at the material flow, um, from the cradle, so from the start of a process or product to the grave, so the end of life of that process or product. And so we're looking right now at, um, modeling the United States Nuclear Fuel cycle, uh, in a more robust manner to be able to start asking questions like, is it beneficial to decommission this facility now versus letting it run for longer? Or how does, how does a, the nuclear fuel cycle compare to wind energy or natural gas. On the side, I'm also always interested in how people learn. And so, and, and I like playing games and I like thinking of games. And so I do a little bit of research in game-based learning. And so how we use and how we can design science and engineering games or STEM games to help people learn. And in particular, what we found is that STEM games really help students who might think differently.

Jonathan Veit (17:52):

Uh, Nicole, tell me about what you're working on.

Martinez (17:55):

Uh, my research is related to radiation protection, as you might have guessed, uh, and also radio ecology. So I'm interested in how different radionuclides move through the environment and then potentially what affects radionuclides might have in the environment. Uh, I also am interested in what's called dosimetry. We mentioned energy deposition earlier. And so I do some work looking at how radionuclides deposit their energy, what the dose associated with that is, um, and then potentially working with epidemiologists to develop a, like dose response, what that means. Um, and so the, probably one of the interesting, uh, more, more interesting projects I'm working on currently is looking at, uh, doses to the radium dial painters. Uh, a group of women in the 1920s who ingested radium, uh, when painting watch dials. And so that's been a super interesting project. Um, I'm also interested in like the social sciences, humanities aspect of our field. And I, I teach a course called Nuclear Culture where we explore how radiation is represented in the media, and we kind of talk about what that means, um, and we try to tie that to ethics, like environmental justice and transparency, um, to make sure that our students are well, well-rounded,

Jonathan Veit (19:10):

You know, radiation, uh, it's both scary for people and it also is incredibly useful to us in so many ways. Comment on that a little bit.

Martinez (19:20):

That's a great point. And it's, there might be another example that escapes me, but radiation can cause and cure cancer, right? And so that's such an interesting, like two sides of a coin, right? So it's something that, uh, deserves healthy respect.

Shuller-Nichols (19:37):

Yeah, I always like to think about it too, from that perspective of a continuum. So there's, it's not a yes or a no. People always ask me, people, my family <laugh> always ask me, so you must be a hugely in support of nuclear reactors. You, you must think that we should have a million nuclear reactors everywhere. Or, you know, people always kind of drive you to say a simple answer, yes or no. And it's just not simple there, there's just more to the picture. And so it is really important to take a step back every once in a while and look at that whole picture.

Jonathan Veit (20:15):

Nicole and Lindsay, this has been awesome. Thanks so much for joining me on Earthly today.

Martinez (20:19):

Thank you so much. Our pleasure.

Shuller-Nichols (20:21):

Thank you.

Jonathan Veit (20:22):

For our listeners, we're gonna have additional resources on the Earthly website. It'll include links to bios about Nicole and Lindsay. It's also gonna include links to DHEC's testing protocols and some mitigation protocols. And the map that relates to this podcast.

Outtro (20:40):

Earthly is a production of Clemson University and can be found wherever you get your podcasts. Listeners can find archived episodes of earthly transcripts and learn more about our guests by visiting clemson.edu/earthly.