Ann Cook Identifies the Most P...ange (It's Not What You Think)

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SPEAKERS

Eva Dale, Ann Cook, David Staley

E Eva Dale 00:00

From the heart of the Ohio State University on the Oval, this is Voices of Excellence from the College of Arts and Sciences with your host, David Staley. Voices focuses on the innovative work being done by faculty and staff in the College of Arts and Sciences at The Ohio State University. From departments as wide ranging as art, astronomy, chemistry and biochemistry, physics, emergent materials, mathematics and languages, among many others, the college always has something great happening. Join us to find out what's new now.

D David Staley 00:32

Ann Cook is an assistant professor in the School of Earth Sciences at The Ohio State University. She's a researcher on understanding the dimensions, features and overall resource potential of natural gas. She earned her doctorate from Columbia University, and started working at Ohio State in 2012. She was awarded a National Academiesâ€™ Gulf Research Program Early-Career Research Fellowship in 2016, and the National Science Foundation Faculty Early Career Development Award in 2018. Welcome to Voices from Arts and Sciences, Dr. Cook.

A Ann Cook 01:05

Thank you.

D David Staley 01:06

Your website says, "much is unknown about natural gas hydrates." First of all, tell us what are natural gas hydrates?

A Ann Cook 01:15

So, natural gas hydrates look like ice or frozen snow, but if you put a match near them, they're going to light on fire. And the reason is that there's methane inside the structure of hydrates. And we find these in really interesting places, we find them in frozen places where you would think about finding cold things, like permafrost environments in the Arctic or in the Antarctic, but we also find them below the ocean. So if you get underneath the ocean, about 500 meters or that's the same as about 1500 feet, hydrates start to form because of specific temperature and pressure regime that is on that area. And they can form all over the ocean in lots of places.

D David Staley 01:56

How do you know that you've encountered a natural gas hydrate, you say it looks like ice, how will I know that I've stumbled upon a natural gas hydrate if I'm walking across the permafrost?

A Ann Cook 02:07

You wouldn't probably know, if you were in the permafrost. If you're underneath the ocean, you also probably wouldn't know because unless you are drilling a hole and are able to recover some of those hydrates, you wouldn't be able to see them. The way that I see them is when we drill a hole down into the ground, we also put tools into the hole so we can measure things, like we can measure the natural radiation of what's coming off of the sediment or rock. And we can also put current into the formation, so that tells us how...

D David Staley 02:36

So like electricity or something?

A Ann Cook 02:38

Yeah, how resistive or conductive the environment is. And we can also put sound into the formation so we can tell how fast or slow things are. And hydrates are very resistive, so they show very clearly when we measure things with current. And they're also very fast, sound travels very fast through them, so we can also see them with those tools. And so, my specialty is using those tools to see what's in the hole without having to recover anything, although it's very fun if we do recover some of it.

D David Staley 03:09

So what are the uses, the applications, I guess, of natural gas hydrates? I assume because it's natural gas, it's an energy source. Is it limited to energy or?

A Ann Cook 03:20

No, I would say it's not just limited to energy, right. Now, hydrates are not an economic energy resource.

D David Staley 03:26

Why is that?

A Ann Cook 03:27

Well, we still haven't figured out how to produce them. We know that they're in a lot of places, although we're still working on how much there really is and how to find it more efficiently. Some countries have done production tests, the U.S. has done production tests up in Alaska, in permafrost area. So when you're onshore, it's easier to try to produce something than offshore, that's just the way it is basically everywhere. Japan has actually done an offshore production test in an area where they have hydrate in the marine environment. And those production tests, though, however, have not lasted very long yet. China has also tried one. And so, they're not to the point where we can actually produce them over long periods of time to make them economic sources of natural gas.

D David Staley 04:11

So what are the uses, is this scientific curiosity or are there other sorts of applications?

A Ann Cook 04:17

So in science, when we look over long time periods, like over millions and millions of years of geologic history, we sometimes see really large and fast changes in the atmosphere. And we can see those because we look at things called carbon isotopes, and we can see those carbon isotopes changing. And when they change rapidly we wonder, like, what exactly caused that change? Like one of the things maybe could be like a huge outgassing of gas from like a large volcanic eruption.

D David Staley 04:47

Outgassing, meaning?

A Ann Cook 04:49

Yeah.

D David Staley 04:49

Spewing out gas?

A Ann Cook 04:50

That's a small one? Yeah, it's super tiny. It's like barely registering anything. But you can see, if you just look at the pictures, that there's all this gas coming off, right. So those are the, like, possible sources, but another source is these hydrates. So over long periods of time, the ocean moves in and out, and also the ocean can warm quite dramatically over, like, for example, in a large global change, and those things could warm up hydrates effectively and melt them. And so we could suddenly have a huge pulse of methane coming from these frozen hydrates. And we don't really understand how much hydrate there is on the planet right now, and we also don't understand how easily these hydrates are activated, and then could make it to the atmosphere. More recent studies have said that it's very hard for them to reach the atmosphere, like for example, if you dissociate some hydrogen in the Gulf of Mexico, it's never going to reach the atmosphere because it kind of melts a little bit and then it tries to travel up through the sediment and then little bugs in the sediment eat it and then it... Yeah, so like right now in Hawaii, there's like a really small volcanic eruption.

D David Staley 05:58

Bugs?

A Ann Cook 05:59

Yeah.

D David Staley 05:59

Like, like bugs?

A Ann Cook 06:00

Well, they're kind of like bacteria or microbes, I like to call them bugs because...

D David Staley 06:03

That's okay.

A Ann Cook 06:03

It seems easier to talk about. They, they can eat the methane or if things get into the water column, then the methane can decompose into, for example, carbon dioxide and maybe not make it all the way to the atmosphere. So we're not worried about things destabilizing in the Gulf of Mexico. But if we go to like, for example, the Arctic, we have to think a lot more about the paths that it will need to travel; hydrate forms much more shallowly on the shelf. So you could, maybe it would only have to travel, you know, a few meters through the ocean instead of like hundreds of meters.

D David Staley 06:36

Well, you anticipated my next question. Because of global warming, I know that the permafrost in the Arctic is melting. I assume that has implications for natural gas hydrates.

A Ann Cook 06:47

Yes. So, people are studying now trying to figure out if the methane that's coming out of different locations is from hydrate or from other sources. Also, when you just melt permafrost, you suddenly have all this organic matter that might get sort of activated, and the same bugs might start chewing on it and creating methane. So there's other sources in the Arctic besides hydrate, and so we're trying to parse out, did that used to be hydrate, or is it just like new methane that's being formed?

D David Staley 07:15

Any tentative conclusions, or are we still researching this?

A Ann Cook 07:17

I think that the Arctic is still kind of a large open question. It's definitely the most pressing for current global change. But, I would have to say, I'm less versed in that. I spend a lot more time thinking about deepwater hydrates, which, most of the hydrate in the world is not going to move as we change the temperature.

D David Staley 07:39

Well, let's talk a little bit more about that. Because, so you research gas reservoirs, both on land and under the sea. There must be different challenges in studying land based versus sea based.

A Ann Cook 07:52

So in different parts of my career, I have worked in like small oil and gas companies where we look for gas on land. And one of the biggest differences between looking for gas on land and looking for it underneath the ocean is it, it's so much cheaper for companies to look on land than to look in the ocean. It's so much more expensive to get a rig out in the middle of the ocean and looking for gas. And in fact, we don't really look for gas underneath the ocean right now, because it's so cheap. You'd have to....

D David Staley 08:20

Cheap on land.

A Ann Cook 08:21

Yeah, it's so cheap on land. And so, if you're out in the middle of the ocean, you're probably drilling for oil and not for natural gas. But even oil is now very cheap on land as well, because of fracking. So we can get both, very cheap natural gas and oil, right on land. And, and so in some ways, it may be that we never end up using this natural gas hydrate resource, especially in a place like the United States where we have very rich shale gas reservoirs.

D David Staley 08:48

Well, since you work in natural gas, you must have an opinion or have some thoughts, at least, on fracking. Obviously, this is a politically controversial topic, you must have thoughts on fracking.

A Ann Cook 09:01

So first, I just want to clarify that I mostly work on hydrates, and there's no fracking in hydrates right now.

D David Staley 09:07

Right, you're not an expert on fracking. But as someone in natural gas, you must, you must know and have some thoughts.

A Ann Cook 09:12

I've been on land rigs around, in Ohio, where they were actively fracking, and there is fracking in eastern Ohio and in the Point Pleasant or some people call it the Utica Shale. I am a supporter of fracking for several reasons. One is, it has dramatically lowered natural gas prices and made natural gas a very competitive alternative fuel to coal, and coal produces more CO_2 per the amount of energy you get than natural gas, nearly about twice as much of CO_2. Like if you had a pile of coal and a pile of natural gas that would make the same amount of energy, say like, one megajoule.

D David Staley 09:52

And a megajoule is?

A Ann Cook 09:54

It's just like an amount of energy, a standard unit of energy. If you had an amount of coal and an amount of natural gas for that, to make one megajoule of energy, the amount of CO_2 you would get from the coal is about twice the amount you will get from the megajoule of natural gas. So, you've really cut the amount of CO_2 that you're generating. And CO_2 is effectively the biggest greenhouse gas that's contributing to global warming. So in that sense, it has significantly lowered the CO_2 amount that the United States generates since 2005. And you can actually see the curve going down, and that curve correlating with our increased use of natural gas from shale.

D David Staley 10:37

And again, you're not an expert, but what about the other effects of fracking, the stories we're hearing about earthquakes being generated and, and other things happening, to drinking water and the water table?

A Ann Cook 10:50

Right, right. So, anytime you have any kind of natural gas or oil development, there is a risk that you're going to contaminate something like water. It doesn't matter if it's fracking or something else, you're drilling the hole in the ground, and there's potential for that. To try to stop that, they put in this thing called casing. Called casing, it's like a giant steel tube that they put in the ground, and they cement the casing in, especially through what we call the water table, the area where we're basically getting drinking water. So that gets cemented in, and then the area where we're actually fracking, or even if you're just like trying to get normal oil and gas, not actually fracking, is much, much, much deeper down in the ground. So I've been on a frack site, and when I'm there and they're fracking, they're actively fracking, you don't feel anything. It could be just like you're standing out in eastern Ohio. The thing that you might be feeling are the really large trucks driving down to the frack site, because there's just like a line of them sitting out waiting to come onto the site, and those rumble. But, it's not the fracking that causes the shaking. Now, when you frack you're creating like little tiny fractures down in the ground, and anytime you create a fracture and there's a little bit of movement, that's technically an earthquake. But, those earthquakes that are being generated are so tiny, you'd never even know that they're happening. In fact, there's earthquakes happening right below our feet right now as we speak, and I bet you don't feel a thing, right?

D David Staley 11:08

Say it again? Not right now, no.

A Ann Cook 12:18

And those are about the kind of earthquakes that get generated with fracking. There are a few locations, and in fact the Utica is a unique one, where there's a slightly higher magnitude that happens with some of the fracking, and that's actually something a student in my research group is working on. He's trying to understand why larger earthquakes happen, for example, in the Utica Shale. But when I say larger, I'm talking like magnitude two, maybe magnitude three, and these are really tiny earthquakes, like you wouldn't feel them either.

D David Staley 12:52

I'd feel a magnitude six, for instance, but not necessarily a two.

A Ann Cook 12:55

Yes. And like, those are the things that people are concerned about. Now in Oklahoma, they've had up to magnitude five, I believe, from wastewater injection wells. So, lots of oil and gas drilling generates wastewater, not just fracking, but fracking generates a lot of wastewater. And one of the things that people have done is to reinject that wastewater into another well that can basically serve as a giant reservoir to hold it. And in Oklahoma, they were injecting it, and they started to measure these earthquakes, and the same thing actually happened in northeastern Ohio, near Ashtabula. And they also started to feel a few earthquakes, like very low magnitude, I think maybe one of them was kind of a four, so you might actually start feeling that if you're indoors. You might, like, feel your chair go up and down or something, like a little bit of wiggling. In Ashtabula, Ohio, they just cut off the wastewater injection. They said, let's not risk it. In Oklahoma, they said, oh, that's not from wastewater injection, we're going to keep injecting and see what happens. And then they generated more and more earthquakes, they have actually, I believe, stopped now. But, it was kind of a good comparison. I think if we kept injecting in a place like Ashtabula, we could continue to have earthquakes. Or maybe not, it's hard to say, but nobody wants to take that kind of risk. You had said that most of the natural gas that we're, that we're extracting is land based, for all sorts of reasons. So what is it that we're studying then about natural gas hydrates in the sea? What is there to learn and how does one, how does one learn about that? Are you going underwater, are you like, are you like in a submarine or something going underneath the water? Some people do go in vehicles where they could see maybe hydrate on the surface of the ocean. I don't study that so much, just the surface hydrate, but some people do because they're very interested in like the communities that form around hydrates on the surface. So, there's some really nice pictures of that sort of system.

D David Staley 15:00

What does that look like in the sea? I'm trying to picture... I can picture ice, I suppose, but.

A Ann Cook 15:04

Right, so think about it, like, if you're just thinking about snow outside, and you know, like, okay, it's snowing, and then they like, come and scrape the street and there's like a mound. So you would see like, you know, a mound on the seafloor, and it will be all kind of white. And there might be like, little fishies and other like crabs around because they're like, ooh, methane is so yummy, and so they come and like eat some of the methane. Yeah. So yeah, they like it.

David Staley 15:26

They eat the methane? That's a really a great picture that you just painted for us with words. And speaking of painting a picture with words, you lead the Marine Geophysics Research Group here at Ohio State. I'd like you to tell us a little bit more about your lab.

Ann Cook 15:45

So I think of lab as broadly, so I have a physical lab where we have a CT scanner in my lab.

David Staley 15:51

A CT scanner?

Ann Cook 15:52

It's like an X-ray, so if you've broken your arm or your finger or your leg, everyone's had an X-ray, where they can see the bone on the inside. But a CT is a special type of measurement that like takes little, not literal slices, but image slices that go down your hand, and then you can reconstruct to what you're doing into 3D.

David Staley 16:15

Like a 3D X-ray, almost.

Ann Cook 16:16

Yeah. And so, in my lab, we don't X-ray people, but we X-ray rocks and cores. Because, if you've spent a lot of money going out into the middle of the ocean and collecting samples, you don't always want to just slice those up and send them all over the place, you want to see what's there first. So, you can take this image in 3D to kind of decide maybe where you want to sample or maybe you don't even need to sample because you can answer your question with image.

David Staley 16:42

So there's no need to dig, there's no need to drill if you have that, that sort of three dimensional image.

Ann Cook 16:46

Yeah. So one of my PhD students is kind of working in that lab, and she does a lot of imaging of sediment cores. But then I have another PhD student, and she spent all of her time looking at sediment cores. But then I have another PhD student, and she spent all of her time looking at well logs. Well logs are that sort of measurement I was talking about, that you make in the hole. And so, she's looked at like hundreds and hundreds of well logs in the Gulf of Mexico to try to understand where hydrate is there. And I have another student who's modeling how hydrates form, so she's thinking about the sources and things that happen in hydrate systems, and producing mathematical models. So, like, my students do a lot of different things and we're all kind of looking at hydrate systems, except for the one guy who has been looking at the Utica Shale in eastern Ohio.

D

David Staley 17:31

And what's he looking at?

A

Ann Cook 17:32

So as I mentioned before, he's really interested in how - it's called pore pressure. So some things have high pressure, and some things have low pressure, just like here on the surface. The Utica is really highly pressured, it's called overpressure, and that may be the reason that we see more earthquakes associated with fracking in the Utica. And again, those are not large earthquakes, and nobody should have panic attacks about it. But just, it's scientifically interesting why it's happening.

D

David Staley 18:00

And it may be as a result of, of particular geological characteristics of that area.

A

Ann Cook 18:06

Yeah. Especially the pore pressure, potentially, we're still working on it.

D

David Staley 18:11

What's a typical day look like in your lab?

A

Ann Cook 18:14

Um, well, gee, it really depends on if it's summer, or during the semester, I'm sure you feel the same way, as a professor. Usually, I'm coming in and I'm talking to one or two of my students about what they're working on. I'm trying to get a bit of work done, talking with other people in my department. I usually have some kind of conference call with another group that I'm working on. So it's - I wouldn't say I'm making a lot of measurements, but I'm working a lot, coordinating my students work and trying to do a bit of my own work and also talking about larger projects that are happening. For example, one of the larger projects I'm working on is in the Gulf of Mexico. So, we're trying to drill there for gas hydrate, we did drill last May; last May I was at sea in the Gulf of Mexico, and we collected a bunch of hydrate cores. Our next plan is to make some more measurements and collect some more cores, but we're still working out the details of how that's going to happen. So, we spend a lot of time talking about that.

D David Staley 19:13

And you say you work with other research groups, such as?

A Ann Cook 19:17

So the people leading this group, this drilling in the Gulf of Mexico is the University of Texas at Austin. So they're leading it, and like I'm a supporting group that's working on the project. And there's other ones, for example, at Columbia University, and then there's other people like at the University of Washington and University of New Hampshire, and we're all discussing what needs to happen, how to move sediment samples or core samples and what we need to do next.

D David Staley 19:45

And that sort of cooperation among institutions is probably not unique in the scientific world?

A Ann Cook 19:52

No, I mean... a lot of people, especially in earth sciences, we work on really big projects and we have to collaborate, people have different areas of expertise, and we need to capitalize on all of the resources that we have across the U.S., and even sometimes over the world, to look at different problems.

D David Staley 20:10

What's next? What's your next research project or research question?

A Ann Cook 20:17

Oh, what's my next question? I feel like, this is gonna sound bad, but I feel like I've been asking a lot of the same questions over the last five years, I sort of chip away at like a little bit of a question. But the biggest, broadest questions are still there. So one of the big questions is how much hydrate is there in the world? And I would like to answer that for now, because we think, for example, that maybe way back in time hydrate has caused, you know, large changes in the atmosphere. But we can't really say that, I think until we sort of understand what the modern system is like, and what would happen if we perturb the modern system. So that's one of my big questions. I want to know how much hydrate there is, and I mentioned before that one of my students has spent a lot of time looking at well logs in the Gulf of Mexico. So she's done a basin study there, and one of the next things I'm going to do is I'm going to be looking at well logs all over the world. I'm going to be looking in Western Australia and offshore England, offshore Norway, offshore Canada, where the data is public, and I'll be looking for hydrate everywhere. That's actually part of my Career Award that you mentioned at the beginning. So I'm going to be using this data to try to see if we can constrain, like, how much hydrate there is, but also the way that it forms. So, in rocks, we... and maybe when you look at it rock, it might seem kind of shocking, but there's actually space inside of rocks, which we call pores. And if you look at a rock that's made of sand, for example, like sand grains at the beach, that makes sense, right? Because like everyone's played at the beach - or hopefully you have, maybe played in a sandbox, if you're from Ohio - and you pour the water in, the water like goes into the sand, right. That's the water moving through the pores. In hydrates, though, we see hydrates form inside the pores, just like that water moves into the pores in sandy sediment. But in sediment that's finer grained and more like mud or even clay, if you live in Ohio, you know that we have kinds of clay soil. So that's kind of like the things that we see under the ocean is this clay or sand. And then clays, hydrate doesn't form mostly within the pores, it forms all kinds of crazy ways: it forms in fractures, in veins, in vugs. So, understanding how hydrate forms is really important, because if we're suddenly going to warm it up, it's actually much easier if something's in a fracture to move straight to the seafloor than if it's like all distributed within the pore space. So, I'm really hoping that my new study will be able to understand how hydrate forms all over the world as well as how much there might be.

D David Staley 22:51

So answering that question, and I understand why you would ask and seek and answer that question, but answering that question about how much, how much hydrates there are in the world - that sounds to me like a gargantuan task. How does one sort of begin to answer - you can't do it by yourself I assume?

A Ann Cook 23:07

Yeah. No, I have several students that will be working on the project, and the project will last for the next five years. So, it will be a long term question, and in fact, I recently like gave a talk at a conference in Galveston, Texas and I said I'm going to do this and I want people to work with me, like maybe you have data that you can have access to in your country that I can't get access to because I'm not, for example, Brazilian. So, I think if we all kind of work together we might be able to give an answer to this question, about how much modern day hydrate there might be.

D David Staley 23:41

And you will be leading this?

A Ann Cook 23:43

Right now, for this portion, yes.

D

David Staley 23:47

Ann Cook, thank you.

A

Ann Cook 23:49

Thank you.

E

Eva Dale 23:50

Voices is produced and recorded at the Ohio State University College of Arts and Sciences Technology Services Studio. Sound engineering by Paul Kotheimer, produced by Doug Dangler.