

Things You Can't Live Without

Episode 8 – Dr Rosa Vásquez Espinoza's field microscope

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Dr Anna Ploszajski [00:00]

Welcome to Things You Can't Live Without, the science podcast where I, material scientist Dr Anna Ploszajski, ask my very special guest to reveal the single item they just can't live without. Throughout this series so far, we've heard of electric bicycles, dictionaries, prosthetic legs, climbing equipment, and insulated vacuum flasks, all being things we can't live without.

Dr Anna Ploszajski [00:24]

You might think that this list is a rather random collection of stuff. But what each of these items has in common is that their constituent materials are substances that have been mined, processed and made into this myriad of objects. On this podcast, we find out from a host of experts who lift the lid on all the science and engineering that these processes entail.

Dr Anna Ploszajski [00:43]

They also give us a technology forecast to help us understand what needs to happen for us to make this stuff greener. Today, I'm honoured to have with me a chemical biologist and explorer, who travels to the most extreme jungles and ecosystems of our planet, searching for the tiniest creatures, from heat loving microbes to Amazonian stingless bees in order to create big changes in the world. Dr Rosa Vasquez Espinoza, welcome to Things You Can't Live Without.

Dr Rosa Vásquez Espinoza [01:10]

Thanks so much, Anna. It's lovely to be here.

Dr Anna Ploszajski [01:12]

It's really great to have you. And Rosa, I imagine when you're spending your time researching in the Amazon, there are lots of essentials that you have to take with you. But if I could press you for just one, is there one item, above all others, that you just can't live without?

Dr Rosa Vásquez Espinoza [01:27]

Yeah, that's a fantastic question, because there's just way too many items, but I would say my number one, as a scientist and explorer, is my field microscope. I have plenty, but this is kind of my favourite, because it has this camera that allows me to be able to record and also show whoever is around me on my team or the communities kind of what I'm magnifying.

Dr Anna Ploszajski [01:50]

That's so exciting. As a scientist, I love microscopes and I'm very excited to talk to you about this more. And today we're joined by another exploration expert who operates in a completely different world to you. It's Rio Tinto's Managing Director of Studies, Alison Morley. Welcome, Alison.

Alison Morley [02:06]

Thanks, Anna. Thanks, Rosa. I'm really excited to be here.

Dr Anna Ploszajski [02:08]

Pleasure. Very, very excited to talk to you. But firstly, Rosa, can you tell us the story of how you first fell in love with the Amazon?

Dr Rosa Vásquez Espinoza [02:18]

So, I grew up in Peru and I have family that comes both from the high Andes mountains as well as the lush forest of the Amazon.

Dr Rosa Vásquez Espinoza [02:29]

And so growing up, I attended school in the capital city, just like any big city London like, but every summer I would be basically going to visit my relatives, cousins, uncles and aunts, whether that meant learning how to literally cultivate potatoes in the Andes, or spending time crossing the Amazon River in tiny wooden traditional boats, playing with monkeys, literally on our heads, getting fruits right from the rainforest.

Dr Rosa Vásquez Espinoza [03:01]

And my grandmother is a traditional healer. She never had the chance to attend school, but she lived with us in the city, and so she built her own kind of natural pharmacy, where I spent every single time I was not in school, I spent it with her, with this Andean and Amazonian combination of plants, and so it's been, the Amazon has just been rooted in me since, since I'm a child.

Dr Anna Ploszajski [03:24]

Wow, that sounds like an idyllic childhood, and a very adventurous one as well.

Dr Rosa Vásquez Espinoza [03:29]

Yeah, I never really appreciated, I think, enough the fact that it's so unique to do that. And not until I moved to the US and other places to pursue science, that's so incredible to have that closeness to such unknown biodiversity in many cases.

Dr Rosa Vásquez Espinoza [03:45]

And that's kind of really what drove me to do the work I do now.

Dr Anna Ploszajski [03:47]

So can you tell us a bit more about that? What sort of research projects do you work on?

Dr Rosa Vásquez Espinoza [03:52]

So I'm a chemical biologist, and basically it means I look at the tiniest life forms that most often go ignored, specifically in the Amazon. And so that means from looking at microbes that maybe living in boiling rivers that we have in the jungle, or tiny insects that nobody that does not live in the jungle would know about.

Dr Rosa Vásquez Espinoza [04:15]

And I look at the chemistry, the molecules they may be producing, as well as their genetics, how their DNA makeup may have an influence on how they live within a whole ecosystem, but as well as how they contribute to it, perhaps even giving us tools to help medicine, bioremediation, and even help with conservation in the jungle itself.

Dr Anna Ploszajski [04:37]

Wow. Okay. So, from the very small to the very large then, but kind of focusing on how changes in, in, the very small insects or the chemistry that's going on down at the tiny scales gives rise to big ecosystem changes.

Dr Rosa Vásquez Espinoza [04:50]

Yeah. Yeah. In a way, in all my work because of that, scientific training, but Indigenous upbringing, is really rooted hand in hand with Indigenous knowledge.

Dr Rosa Vásquez Espinoza [05:01]

And so, I'm Indigenous descent myself, and so all the work that we do is not just purely going to academic journals, but on top of that, we also really bring in close collaborations with Indigenous leaders, so then we can translate these studies, or even design them in a way that they have direct conservation impact in a positive way in the lands where we are doing our work.

Dr Anna Ploszajski [05:25]

That's so interesting. Do you have any favourite examples of projects that kind of, I guess, exemplify this relationship between people, place and your research?

Dr Rosa Vásquez Espinoza [05:35]

Yeah, it's with the Peruvian Boiling River, which is that insane boiling river that reaches temperatures over 90 Celsius. And yet you have a variety of microorganisms that are just thriving there.

Dr Rosa Vásquez Espinoza [05:52]

And, basically, studying this microdiversity could help understand how life came to be in the rainforest, how we could perhaps use them as a model to understand how climate change is impacting the rainforest, and perhaps even finding tools to help combat that.

Dr Anna Ploszajski [06:09]

That's incredible. So, Rosa, can you tell us a bit about how these sorts of exploratory expeditions work?

Dr Rosa Vásquez Espinoza [06:15]

Once you get there, I would say that the next greatest challenge, it's the actual navigation of the river. You have this constant intense vapour that can make you dizzy. There was this one specific moment where we got to one part of the river where the water was maybe 80 Celsius. So not your hottest, but still pretty damn intense.

Dr Rosa Vásquez Espinoza [06:38] They had told me that on the other side of one specific section of the river was an area that was quite pristine because nobody virtually went to that space because you needed to climb over a certain wall to be able to get to the other side. Of course, as a scientist, that sounds exciting because that means they have the least amount of contamination.

Dr Rosa Vásquez Espinoza [06:59]

They could really give me the cleanest view as to how this life looks like. They call it the spider man wall, because once you start climbing it, there is a section where you physically need to get your arm all the way to the other side in one single movement at the same time as your leg because that's the next space where you can actually hold yourself safe from to be able to cross it.

Dr Rosa Vásquez Espinoza [07:20]

Not only are you having this intense river below you with all this vapour coming out of it, but the rock itself, there were critters like spiders and other things. So, not only had I to be extremely careful with my grip and my movement, but I had to ignore everything else that was kind of going in and around, you know?

Dr Anna Ploszajski [07:40]

Rosa, you're the most badass person I've ever met. This is amazing. [music interlude]

Dr Anna Ploszajski [07:48]

Going back to your microscope then, how does the use of this piece of kit help you to understand these different ecosystems better?

Dr Rosa Vásquez Espinoza [07:56]

There are certain kind of microbes that many of them grow together in a community. They may look just like kind of this dark green algae to the naked eye, but when you put them under a microscope and magnify them, even if it's just, you know, 200 times what you would normally see things at, the microscope really was fascinating at being able to tell us within a second if the sample we were looking at was something we were actually interested in collecting and simplifying a lot of the steps after that.

Dr Anna Ploszajski [08:24]

Can either of you guess how old the technology of microscopes is?

Alison Morley [08:29]

All I can think of is Galileo, but I think he was telescopes, wasn't he? Not microscopes.

Dr Anna Ploszajski [08:35]

That's true. I guess it's a similar sort of technology, though, but yeah. Any guesses, Rosa?

Dr Rosa Vásquez Espinoza [08:40]

Yeah, no, I was, I should know this answer, and I feel really bad, I don't know it off the top of my head.

Dr Anna Ploszajski [08:46]

No, no, this isn't an attempt to shame you. I didn't know, but I did some research. There was a big development of technology in microscopes and telescopes around the sort of 1600s when, when, you're talking about, but way, way, way before that, there are ancient Chinese texts from 4,000 years ago. describe water-based microscopes.

Dr Anna Ploszajski [09:05]

So, how light is bent by different shapes of water. If you ever got water on your phone screen, actually, you'll know what this looks like. It kind of magnifies all the little pixels on your phone screen. The ancient Chinese were making tiny, tiny microscopes like that.

Dr Rosa Vásquez Espinoza [09:18]

That's fascinating.

Dr Anna Ploszajski [09:20]

Yeah, I know. Amazing. And the ancient Greeks and Romans were also really into glass and they did make glass lenses. So, it's possible that the ancient Greeks and Romans also had forms of microscopes thousands of years ago. Then there's a bit of a leap in the history of microscopes to around the year 1600, which is when I guess the study of alchemy and science, as we know it today, was starting to kind of form a bit more formally.

Dr Anna Ploszajski [09:47]

So, these early microscopes around the year 1600, they could magnify about, 20 to 30 times. But in the 1660s, a Dutchman called Antoine van Leeuwenhoek made microscopes that could magnify up to 200 times. So, this was a massive step forward. And with his microscope, he observed animal and plant tissue, human sperm cells, blood cells, minerals, fossils, and loads of other things that had never been seen before on this microscopic scale.

Dr Anna Ploszajski [10:13]

And by the 20th century, we were able to enjoy not only zooming in using light, but zooming in

using electrons and electron microscopes have much, much higher resolution, thousands of times more than we can see with a light microscope. Today's digital microscopes like yours, Rosa, combine ordinary microscope lenses with digital light sensors, which enable us to magnify and record the images on a digital screen.

Dr Anna Ploszajski [10:38]

The discoveries made by all these different types of microscopes, you know, are endless. Understanding what the building blocks of plant and animal matter are and non-living matter as well, in the atoms, they all owe their discoveries to microscopes. And by understanding the very, very small, we then come to understand a bit about the very, very large.

Alison Morley [10:59]

That's very cool.

Dr Rosa Vásquez Espinoza [11:00]

Yeah, that's a fantastic timeline. [music interlude]

Dr Anna Ploszajski [11:06]

So from an Amazonian explorer to now a geological one, I'd love to turn to you, Alison, and hear a bit more about your work in exploration and discovery. Because for you, explorations look like something a bit different from Rosa's. So, what does, what does exploration look like for you?

Alison Morley [11:23]

Look, there's, there's some differences, but there's an awful lot of similarities.

Alison Morley [11:26]

I found myself nodding along a lot with Rosa as she was speaking, so, you know, ultimately, I've spent 25 years in the mining sector, many of that doing exploration, and you're looking for concentrations of minerals that are economic. That's what you're ultimately looking for. The key thing that you're really looking for is differences in the rock.

Alison Morley [11:50]

There's usually some reason why a certain mineral or a certain element will concentrate in a certain place. And that might be because there's a fault there, or a structure, and that encourages a lot of fluid flow. To go through a particular part of ground, it might mean that there's a particular bit of ground that's really chemically different from another bit of ground.

Alison Morley [12:12]

So, as a geologist, what you're really looking for is, one, those, those concentration of minerals that makes them rich enough to be mined, but then the way that you find them is by noticing differences in the Earth's crusts that other people haven't noticed before.

Dr Anna Ploszajski [12:28]

And how do you use your knowledge of geological structures, I guess, combine it with new data to make these discoveries?

Alison Morley [12:38]

Oh yeah, and, you know, I think geology has changed a lot over the last couple of hundred years when it sort of started as a, as a, science. But maybe 30, 40 years ago, people were really using visual clues. So, they might have been looking for a particular mineral on the surface. There's plenty of examples of big mines that were discovered because people noticed a blue or green staining on the surface and then realised that, that, was a copper carbonate or a copper oxide, and they could follow that down to where the ore body is. And that was kind of like the old style of, of, discovering ore bodies. What we've found in the last, say, 20, 30 years, is we've got a whole bunch more technologies that we can now add to that. So, your geologists that are out in the field are still really looking for those visual clues.

Alison Morley [13:27]

But at the same time, they've got a lot of technology now that helps them look at these differences within the Earth's crust. So, you're looking for different physical properties like electromag or magnetism or density or gravity. And we use a whole bunch of different tools for that. And the thing that had me nodding along with Rosa's conversation is that the nearest sort of analogy to Rosa's infield microscope for a geologist is probably the hand lens, which has only, you know, is very, very small.

Alison Morley [14:00]

And whilst it might only get you to 10 or 30 times, depending on the hand lens. What it does is really give you a sense of what minerals that you're looking at. At the same time, we do have geologists who sit in a lab and they will look down lab microscopes at rocks. And I've got to say, the view down a lab microscope of a, of a, rock is something really amazing.

Alison Morley [14:23]

So, what you have to do with a rock, you can't just whack it in under the microscope. So, what we do is that we make a thin section of the rock. So, it's 30 microns thick. So, you can, you can, hold it up to the light and see through it. And when you put that under a particular type of microscope, you can see straight through the rock.

Alison Morley [14:40]

It means that you can identify what the rock types, what the minerals are within that rock by colour, shape, cleavage, it's always a great word to use with undergraduates, which is how the rock, um, breaks apart. And I've got to say, when you look down a microscope at a thin section, it's a magical experience. They are the most beautiful things. The colours are amazing.

Dr Anna Ploszajski [15:04]

And what's the reason that you shave them so thin. Is it so that you have that benefit of being able to look through and kind of discern the different rocks more easily?

Alison Morley [15:12]

That's exactly right. So, it allows the light to pass through it in a way that is, you know, standard across all, any different sections that you might have.

Dr Anna Ploszajski [15:21]

You're a bit like a forensic scientist, but of the earth. I love that.

Alison Morley [15:24]

Yeah, that's exactly right.

Dr Anna Ploszajski [15:25]

I really love the idea both of you actually kind of trudging around with various tools hanging off your belt, but actually quite similar approaches.

Alison Morley [15:34]

Well, I think you hit the nail on the head when you were talking about the difference in scales before, Anna.

Alison Morley [15:38]

There's, there's, you know, really fractal patterns in geology. So, what you see down a microscope can often be what you see in your hand and then what you see in the wall of a mine and then what you see from an aerial photo looking above. You can still see these same patterns and it's just magical.

Dr Anna Ploszajski [15:56]

Can you explain a bit more what you mean about the fractal patterns?

Dr Anna Ploszajski [15:58]

So, you know, a shape of a rock might be such under a microscope and then you actually see kind of bigger versions of that as well?

Alison Morley [16:06]

Yeah, yeah, you can do that. So, when you look at a rock sample in your hand, you can go, oh, okay, there's a sort of what we call an lineation or a fabric within the rock that shows you which way it's been squished and you end up with these really beautiful patterns.

Alison Morley [16:21]:

But a geologist can look at them and go, well, this is the way that the rocks were squished. You can then apply that at the macro scale when you're sort of in a, a mine, you might be able to say, well, I know that that fault from looking down my microscope moved in this direction. However, I don't know where this ore body's gone, but if I can tell that little bit of data about what I saw in the fault, maybe I can realise that the rest of the ore body is a 100 or 200 or 50 kilometres down that way.

Alison Morley [16:50]

And you can really use all the clues that you, you find at all scales to give you a sense of where you need to look next.

Dr Rosa Vásquez Espinoza [16:57]

I love the analogy that you did, Alison, of like looking at something at, with your tools at this micro level and then kind of seeing the pattern emerge at a larger, larger level.

Dr Rosa Vásquez Espinoza [17:07]

The question I would have, it's an exploration experience you've had that's just kind of like left you awestruck of like how beautiful earth crust or mineral, whatever it is that you were like looking at or the location itself that just kind of like hit you as to like, whoa.

Alison Morley [17:23]

Wow. I think the more profound experience for me, so going to one of our exploration sites, driving through a very, very small community there, realising that there was no employment opportunities within that small community, that the young people were leaving town. You could see the town was really kind of dying in front of your eyes. And then 15 kilometres out of town, we'd found a project that looked very, very prospective for Manganese at the time. And just kind of realising that if I had the ability to make that project work, the opportunities I could bring to the young people of that town.

Alison Morley [18:03]

So, for me, there's that element of, how do you make a good society? And I know that there's a lot of arguments against mining in that question, but there's a lot of arguments for mining within that question as well. So, for me, it was, how do I make sure that people in these far flung places have the same opportunity for work, employment, and to better themselves, as anybody else does?

Dr Rosa Vásquez Espinoza [18:27]

Thanks for sharing. Yeah, no, that's, that's something the, the human aspect of exploration is something that we also kind of really have not really just focused on. I think traditionally science tends to occur outside of culture, but when you go to places in my case, like the Amazon or the Andes, nature is intertwined with culture and it's unavoidable.

Dr Rosa Vásquez Espinoza [18:53]

And, so, I think that's how we approach our own explorations, which is science is intertwined with the people and the culture around. There's not two ways about it and just finding a way to celebrate all of that. [music interlude]

Dr Anna Ploszajski [19:09]

Now, Dr Rosa, I'm going to transport you to a terrible alternate universe. In which, when you were climbing on your spider man wall, you dropped your field microscope in the boiling river.

Dr Rosa Vásquez Espinoza [19:22]

Oh no.

Dr Anna Ploszajski [19:23]

You're now without it in the Amazon. What would you do? What would life be like without your microscope?

Dr Rosa Vásquez Espinoza [19:30]

So, just as a disclaimer, I haven't dropped any item in the Boiling River, but some of our colleagues accidentally did.

Dr Rosa Vásquez Espinoza [19:37]

And entire, very expensive, fancy cameras have completely melted with a lot of intriguing and unique material. So, it happens. So, you know, knock on wood. I think. You know, we, it's also about going back to the basics. I think it is amazing to have all this technology nowadays. Of course, it allows us to do things faster, more accurate, look at things we were not able to see before.

Dr Rosa Vásquez Espinoza [20:06]

But I think in a way, nature exploration is also very inherent to human nature. There has been cases where we were not able to bring equipment for X, Y, and Z or something happened and we just didn't have it with us. And, I think, it kind of reminds that there, there is this, you know, perhaps detail of observation, perhaps there's another factor I could be like looking at, perhaps is it the reflection?

Dr Rosa Vásquez Espinoza [20:32]

Is there a different like type of intricate colour that I could be taking attention to or connecting it more to where in the rocks I'm finding these? I'm all for equipment, but also all for adapting, which is 100% unavoidable when you are in the field.

Dr Anna Ploszajski [20:48]

I love that. So, you would adapt as you always do.

Dr Rosa Vásquez Espinoza [20:51]

We have to, we've already had to, so, you know.

Dr Anna Ploszajski [20:54]

No, for sure. But making anything has an inevitable impact on our planet. So, I now want to think a little bit about where the stuff comes from, you know. Alison, you're involved in sourcing the raw materials for Rosa's microscope, but I'm interested in where your work sits in the bigger picture, in the full story of mining.

Alison Morley [21:17]

So, the, the exploration team are pretty much at the beginning of the story. So, what you might end up with is a bunch of people in an office who have an idea. So, they will generally then put that idea to an exploration manager who holds the, the budget. And then there's also the element of, can you pick up that ground?

Alison Morley [21:40]

So, there's a system in most countries where the ground is held by the government and you have to apply in order to be able to pick up that ground and go and explore it. And then once you've realised that there's a target there, then you usually you get a whole bunch of people to go out to the ground.

Alison Morley [21:55]

You might put some drill holes in, you might take some surface or some soil samples. And you know, the idea is of course that you, you hit the big ore body right down the guts of it on the first hole. Very rarely happens that way. Usually takes a lot more holes and a lot more belief and a lot more convincing.

Alison Morley [22:13]

So that's kind of exploration in a nutshell.

Dr Anna Ploszajski [22:15]

And is there a sustainability element to this? Are you trying to do your exploration work in a more sustainable way or a lower impact way?

Alison Morley [22:23]

Exploration itself is fairly light touch. It's not until you move further down the chain where the sustainability really has big impacts.

Alison Morley [22:31]

But having said that, I would say that most of the geos I know are absolutely drawn to geology because they love the environment and they are intrinsically sustainability obsessed people. So, where it can be done, it is being done. That's good to hear.

Dr Anna Ploszajski [22:49]

Rosa, I know that you work with policy makers on this sustainability issue as well. What's your experience in doing so? And what is your hope? What are you trying to achieve by interacting with policy makers?

Dr Rosa Vásquez Espinoza [23:04]

Yeah, we partner with environmental lawyers as well as stakeholders and multiple levels in the local areas. And, so, these really came about in the last few years, after seeing the impact that our science and storytelling was having and listen closely to what the communities were needing as to what the next step was, okay, we navigated conversations to the different part of ministries to understand.

Dr Rosa Vásquez Espinoza [23:33]

Where is it that we start to change that the communities see within their timeline within, you know, in short-term periods. So, it involves a lot of conversation and bringing in the right messages and then finding the people that are keen to support and that also, like Alison said, live and breathe in sustainability and understand that they're, through their work, they can have quite direct impact.

Alison Morley [23:58]

I think there's an element there that, you know, anything, any decision like that that's made with that real scientific, factual backing, that's the thing that gets me really excited, is being able to convince people with real data. So, using your, your, skill set to change the world is awesome.

Dr Anna Ploszajski [24:15]

Yeah, absolutely.

Dr Anna Ploszajski [24:16]

Yeah, I mean, it comes back to communication again, right?

Alison Morley [24:19]

Yeah, and I'd just make a comment as a geologist. I heard somebody the other day say something, something was as dumb as a rock. And I was sort of like, it just means you don't know how to read a rock. You know, we spend our whole careers learning how to read the rocks.

Alison Morley [24:32]

So, rocks, the rocks speak, you just got to know how to listen, listen to the rocks.

Dr Anna Ploszajski [24:37]

Listen to the rocks.

Alison Morley [24:38]

Yep. [music interlude]

Dr Anna Ploszajski [24:42]

Looking to the future. Alison, what's next for you? What are you most excited about at the moment?

Alison Morley [24:47]

Yeah, I mean, we do, do, a lot of partnerships with startups and what we're seeing now is this data explosion where you can actually get, you know, readings from satellites that are constant, you know, and so the amount of data that's coming at us is really a tsunami of data.

Alison Morley [25:09]

So, rather than just looking at the data, we need to understand how we pull the data apart. So, I think there's a real piece there around data, AI, within geoscience. And it's just, it's just, fascinating. Geology is essentially pattern recognition, advanced pattern recognition. Now, at the moment, people do that better than anything, but I think that will probably remain the same.

Alison Morley [25:34]

But if you can cut out some of the grunt work of that pattern recognition with AI, just imagine how powerful that could be.

Dr Anna Ploszajski [25:40]

What isn't AI helping us with?

Alison Morley [25:43]

So true.

Dr Anna Ploszajski [25:44]

And how about for you, Rosa, what explorations await you next?

Dr Rosa Vásquez Espinoza [25:49]

In terms of the Amazon, we are creating the first map of stingless bees in partnership with the Ashaninka people. And so we are providing them with equipment and the training so that they can conduct science and basically really be able to generate the first visualisation as to where these bees are, not just with the hope that it can inspire natural corridors and be able to protect it, be able to guide reforestation, but also futuristically with the hope that by studying their honey, we've noticed not only are we able to look at the medicinal properties of that honey, which traditionally is being known already by the communities, but also potentially looking at pollution.

Dr Rosa Vásquez Espinoza [26:30]

So, we've been able to see that there is traces of pesticides or pharmaceutical pollutants. that can be still detected in the honey. And, so, we're, we're looking to submit that this year. I'm really excited for that.

Dr Anna Ploszajski [26:45]

Well, we've been on an exploration of our own this episode from ancient Chinese water microscopes and boiling rivers to working with communities to ensure sustainable mining and ecosystems long into the future.

Dr Anna Ploszajski [26:57]

Rosa Vásquez Espinoza and Alison Morley, thank you both so much for sharing your expertise and passion for exploration.

Dr Rosa Vásquez Espinoza [27:03]

Thanks so much Anna, it's been fantastic and so lovely to meet you Alison as well.

Alison Morley [27:07]

I've had a great time, thanks for having me.

Dr Rosa Vásquez Espinoza [27:09]

Bye, bye.

Dr Anna Ploszajski [27:12]

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