

## WESTERN SCIENCE SPEAKS PODCAST SEASON 5, EPISODE 2

### EPISODE TITLE

Mining Our Own Stories

### PODCAST SUMMARY

Dr. Bob Linnen, an economic geologist from the Department of Earth Sciences, joins the show to discuss the state of mining in Canada, the tech-building materials that are prompting a modern gold rush, and why are countries re-evaluating their own natural resources.

### INTERVIEW

#### **Henry Standage 0:29**

Hey, welcome to the Western science speaks podcast. I'm your host Henry Standage and today our guest is Dr. Bob Linnen from the Department of Earth Sciences here at Western. Bob is an economic geologist by trade, he helps find new locations for mining using a mix of intuition and precise analytical methods. He joins us today to talk about the state of mining in Canada, what materials countries and companies are competing for now and the lessons COVID has taught us about how we treat our own natural resources. Here we go.

All right let's start here. Bob, why don't you tell us in your own words why prospecting is so integral to the modern economy?

#### **Bob Linnen 1:12**

Sure. If you look at any commodity, it doesn't matter what the commodity is, could be rice, it could be apples, it could be gold, it could be copper. And if you look at that commodity over time, virtually every one of those graphs is exponential. And the reason is twofold. One is because there's been an exponential increase in the population of the planet. But on top of that, as the population curve slows, we're getting more and more middle-class people and middle-class people have stuff. So, if you're middle class, you've got a big screen TV and you've got a car and you've got all of these things. So, there's an ever-increasing demand for commodities. For instance, if you look at something like copper, in the next 20 years, people will consume more copper than is produced since the history of humans. So, it's not just a case of recycling, of course, we believe in recycling. And of course, we recycle, but we will never recycle 100%. And even if you did recycle 100%, you don't have enough of that commodity to meet the demands of humans on the planet. So, we need to find more and more resources. And the problem is that up until I'd say maybe 10-20 years ago, exploration success was very successful, and it was, quote, relatively easy to find an ore deposit or even though it's arguable that no, it's not that easy. But now all of the easy stuff has been found. You can't walk around and find things. So now instead of looking for things that are on the ground, we're looking for things that are 100 meters below the earth. And that's much, much more difficult. Modern exploration is much less successful than previous explorations have been. And we're relying increasingly more on scientific advancements, to come up with new techniques, to find the commodities.

#### **Henry Standage 3:28**

I'm curious to know when this transition from the surface, to slowly getting lower and lower into the ground began to happen.

#### **Bob Linnen 3:36**

It's been ongoing for 20 years. It's been going on progressively for a long, long time. And there are certain areas of the earth that haven't had extensive exploration. But even those areas, they've had exploration to a certain extent,

an example would be northern Canada, the population density in northern Canada is extremely, extremely sparse. So, there are areas in northern Canada which haven't seen extensive people walking over it, but even there, pretty much every kilometer of area in northern Canada somebody has walked over.

**Henry Standage 4:18**

Can you take us through the process of how a mineral deposit forms and just talk a little bit about your work specifically with magmatic hydrothermal systems?

**Bob Linnen 4:28**

Magmatic hydrothermal kind of ties it together, so magma like volcanoes, some metals crystallize, precipitate directly out of magma. For example, copper. Diamonds have a magmatic origin as well. And then hydrothermal, if you break down what the word means, hydro is water, thermal is hot, so it's forming out of hot water. That hot water may have become heated because of magma or it may be in the absence of magma and the temperatures of those fluids range from below 100 degrees all the way up to 800 degrees. So, I'm more interested in the high temperature stuff, people kind of have their own specialization of what they're interested in. So magmatic hydrothermal means that there's a magma, and that's at minimum a source of heat, and a source of heat will drive convection. So that will drive fluids to connect. And then metals can also be partitioned from the magma into those fluids, and then eventually form an ore deposit. So, what I'm interested in is primarily the chemical reasons why metals are transported in fluids and how they are deposited out of those fluids to form an order.

**Henry Standage 5:44**

In the case of Canada, I think the average person wouldn't necessarily associate our country with having lava-type substances. To what degree does Canada apply to a magmatic hydrothermal system?

**Bob Linnen 5:59**

You're thinking about the present, which geologists don't, Canada is roughly 4 billion years old. So, there are areas like here in Ontario that the shield is about, on average around three to two and a half billion years old. And what was the environment two and a half billion years ago - underneath us right now, there's lots of magma. And that goes all the way up to the present and there are active volcanoes in Canada.

**Henry Standage 6:28**

When I think of Canada, I think about how we've got the second largest country in terms of land, and we only have 35 million people, which makes me think we would be kind of a hotspot for mining.

**Bob Linnen 6:40**

We are, we're one of the leading nations. I mean, you take any sector of the economy, you can say, okay, let's look at biotech. Right? So, are we better than the Japanese? Are we better than the Germans? Are we better than the Americans? You know, that's tough to be better than those guys. When it comes to geology and mining, it's like, yeah, we're one of the best countries in the world.

**Henry Standage 7:05**

Resource wise, are we one of the most affluent?

**Bob Linnen 7:08**

We're in the top 10 of a lot of different metals, including gold. We're certainly a major gold producer.

**Henry Standage 7:16**

Why don't you describe for us what a mineral deposit looks like before you and your team start digging and after, when it's been optimized.

**Bob Linnen 7:24**

So, the way we look at mineral deposits, is it's a cycle. It starts off with exploration and that's the portion of the industry that I'm involved in, is mineral exploration. Even before you start exploration, there can be negotiations

with First Nations or whichever communities live there. Then you start exploring if you find something very early on, there are not only finding the resources, but there are environmental studies and permitting regulation studies that are going on. Even again, before you put the mine into production, you must have a closure plan. The government takes escrow to make sure that if the company goes bankrupt, there's still money there to do the environmental cleanup, now it didn't used to be that way 20 years ago, and there are all kinds of environmental messes left from 20 years ago, but the same is true with virtually any industry. So, the whole thing works in a cycle. I'm involved in the exploration stage where we're finding new metals, locations of new metals, and defining what's controlling them, how are they distributed? How can I find more of those? But then other people come in after that and develop the mine and then other people come in after that and close the mine and do reclamation and monitoring. So, the whole thing is a big circle.

**Henry Standage 8:53**

I'm surprised that going into a mine isn't more of a tourist attraction for us in Canada.

**Bob Linnen 9:00**

Even as a geologist that can be difficult to get into. So, there's a lot of security issues that you have to have. You have to have training to go underground. There are some tourist mines, for instance, in Sudbury, you can go to a tourist mine where you go in and you sort of get a feel for what it looks like. And there are a couple of other places as well across Canada where they have these tourism mines.

**Henry Standage 9:24**

My big idea I was going to pitch to you is the idea of a reverse skyscraper, a mine skyscraper, where you build like office spaces under the ground.

**Bob Linnen 9:35**

Not so much office spaces because they're really expensive to run, you got to pump water out of them, you've got ventilation, which is a big deal. Plus, just the all the safety aspects, but there are some labs. For instance, if you're, if you're a physicist, you'll probably have heard of the neutrino lab and again, it's in Sudbury. They were looking for a lab, you know, several kilometers underground where they could measure neutrinos and they picked a abandoned mine in Sudbury to set up that lab and there have been other mines that have been used in the past as doing environmental testing for radioactive waste disposal. And so, there are some cases where mines are used for research but not as an office, reverse skyscraper. It'd be just too expensive, and the cost would be prohibitive.

**Henry Standage 10:32**

I appreciate your polite reception of my mind-scraper idea. Okay, let's transition to gold. How would I know I was close to a gold mine in your line of work?

**Bob Linnen 10:45**

So, I do research on that. I just finished actually a major program called footprints where we're trying to discover literally what the footprint of an ore deposit is, so how do you know when you're in a mine, but then when you go 10 meters, 100 meters, a kilometer away, what is it that you see? So, we can see differences in what's called whole rock chemistry. So, we take a rock, we crush it up, we analyze it for half the periodic table. And we can also look at the mineral chemistry. We can also look at structural differences, faults and structural features in rock. And we do a combination of all of those. So, this is kind of the holy grail, the challenge right now, how do you know you're on the edge of something? Because we're standing on the ground, and how do we know that there's not something a kilometer beneath us, so we use geochemistry. So the chemistry of the rock, chemistry of minerals and we also use geophysics, which is looking at physical properties like magmatism, density, conductivity, these physical properties to see whether there is potential in an ore deposit at depth, and then the only way you can truly find an ore deposit is to drill it. So, we'll go to an area based on anomaly. So, for instance, if I took a rock sample, and it had 100 ppb gold in it, 100 ppb doesn't sound like very much (parts per billion). But I would be quite excited about that because in some places, ore grade: by definition what you can mine, we're mining one ppm gold, that's not very much gold or part per million. So, if you're half of that, you're potentially close to it. So that's how we would know when we're close to something.

**Henry Standage 12:43**

There is an impression out there that people just go drilling and go oh, we found gold, hooray! But what you're explaining is that it's a lot more precise.

**Bob Linnen 12:53**

Well, we call it economic geology, the study of mineral deposits, because there is economics to it. So, you say, hey, I'm going to drive a drill hole, it's like, okay, well, that might cost a minimum of \$10,000, anywhere up to \$100,000. So how many of these drill holes are you going to drill, and you have to realize that at the exploration stage of the game, you're not producing anything. So, you're raising money on the stock market. And then your ability to raise money on the stock market depends on how successful you are at finding stuff. So, if you just punch holes into the ground, if you miss, the people that invested money on you are only going to let you miss so many times. A typical company may only find a mine once every 10 years.

**Henry Standage 13:41**

Now, I was looking a little bit into the Gold Rush about halfway through the 19th century. And I was wondering, is there in our modern world material that you would find parallels to the gold rush, back in 1850, where you have a bunch of companies clamoring over a new material in the world of technology. Like is there something Silicon Valley is looking to find when they go mining that is incredibly valuable? I guess I'm asking what is the new gold?

**Bob Linnen 14:12**

First off, yes, there's rushes all the time, so that you have to state ground the same way that we did over 100 years ago, you have to have a mining claim. So, if somebody finds gold in a new place, then immediately what will happen is that companies will go around and they'll stake all the ground around it, to find more of it. So, what's the new gold? There are a lot of niche metals that overall aren't worth as much, we're still looking for the basics, things like copper, electric cars, if we start buying electric cars, each one of those electric cars, something like 10 or 20 kilos of copper goes into that car and cobalt goes into that car and graphite goes into that car. And still a lot of our demand is based on things that we've always needed. But we continue to need copper, lead, zinc, a variety of those commodities. Having said that, sort of the newer metals or things like rare earth metals, the rare earth metals are used all over the place like right now you're looking at me on a computer screen while the rare earth metals are used on that computer screen to make all the colors that you have. If you look at something like wind power, the turbines being turned by niobium rich alloys to make the super strong steel for the blades. But then to convert the turbine into electricity, they use neodymium magnet to do that conversion. Neodymium is a rare earth element. Rare earths if you start doing a little bit of research, you realize that virtually all the world's rare earths are produced in China. And the non-Chinese countries have started saying, maybe this isn't a good idea that everything we have is coming from China. Maybe we need to find our own rare earths. And the Canadian government and the US government have actually launched a fairly large program into securing Canadian sources for things like rare earth metals.

**Henry Standage 16:23**

Interesting. That's also a nice segue to my next question, what does the future of mining look like? I mean that in the sense of how does mining contribute to environmentally friendly materials such as the batteries in electric cars?

**Bob Linnen 16:39**

Mining always reacts to society, that when there's a demand for a specific metal, so, if a new metal is being used in a different way, and the demand for that goes up, then we as geologists working with companies, go and find it to meet the demand that the overall population is asking for. The future of mining: It's changed a lot in the last 20 years for the better. There's still a lot of work to do.

**Henry Standage 17:12**

If you don't mind me asking, when did you fall in love with mining,

**Bob Linnen 17:16**

Not mining per se, you know, it's more geology. One of the beautiful things about geology is I have been to places sorry, but you just will never get there. I've been on top of mountains in British Columbia at 14,000 feet. I've been dropped off there by a helicopter and you look around and it's like man, how many people have ever been here? I have the privilege of working in places that tourists just don't go to. I did my PhD in Thailand and you know, lots of people go to Thailand, well no, I worked on the Thai Burmese border - I've been in villages where forget about people speaking English. They didn't know speak Thai, they spoke local languages and that was just a riot. I love it. I absolutely love it. I've worked in the Kalahari Desert in the middle of nowhere. That's what I love is being outside and I look at my work, you know, I'm looking at my rocks. I'm doing my mapping, I love geology, but it's also being outside and being able to work in in some places that I'm there because I'm a geologist. Otherwise, there are no tourists there. It's too remote.

**Henry Standage 18:29**

What's your favorite part of there not being terrorists?

**Bob Linnen 18:32**

Oh, you interact with local people. My fondest memories are interacting with local people, because if there are no tourists there, then I mean, you're a visitor. You're not a tourist because you're there working, but they're not used to seeing that many people. Going back to my PhD, I learned how to speak Thai and I would come up to people and just start speaking Thai to them and they would just be blown away that they couldn't believe that I was actually speaking there language.

**Henry Standage 19:00**

Definitely something to be said for the reception you get when you actually immerse yourself in a culture in contrast to hanging out with people from your culture just in a different location. Speaking of being outside and traveling, I think I'm going to call this segment COVID corner. So, a vital lesson from this pandemic appears to be the notion that it is imperative for a nation to be prepared to rely on itself. As we've been over in this podcast. Canada doesn't lack natural resources, but are we as resourceful as we could be with regard to mining and developing supply chains out of gold, lithium, etc. With our own materials?

**Bob Linnen 19:43**

I think it really depends on each individual commodity. There's also the manufacturing side of it. And now we're getting into politics as opposed to Earth Sciences. So, if we use lithium as an example, we've got lithium, right now the mining is just ramping up. But right now, in Canada, if you want to open up a lithium mine, virtually all the lithium exploration is being backed by Chinese companies. So as Canadians we'll mine the lithium we'll produce the lithium product using lithium carbonate or lithium hydroxide, and then we ship it over to China and then China makes the lithium batteries and makes the cars and puts those lithium batteries in the cars and all the electric car manufacturing is going on in China. And this is a long going debate in Canada, not so much are we using our natural resources? But why are we always sending our natural resources overseas to get developed into something that we buy back? We know with COVID that we'll take trees chop them down and out of the pulp, that pulp goes to making 95 masks but up until now we've been shipping that pulp to other people countries like the United States to make the mask and buy the masks back. So, it's like, wow, maybe we should be making our own masks. So, it's the same thing.

**Henry Standage 21:08**

It's interesting how a pandemic like this does expose the flaws of a country because the way you put it just then, it's like yeah, that sounds totally ridiculous that we're getting the resources for something and shipping it somewhere else to be developed and buying it back.

**Bob Linnen 21:24**

Because it's cheaper. It's a question of you as a Canadian, if we made that same electric car that's being made in China, are you willing to pay 20 or 30% more?

**Henry Standage 21:36**

Personally yes, but I understand the dilemma there.

**Bob Linnen 21:41**

That's the dilemma and, that's up to the people of Canada. I know personally, when I go shopping, when you have your little stickers on your vegetables and fruit. You know, I will buy an Ontario Apple as opposed to an apple coming from another country and I'll pay more for the Ontario Apple than the Apple that's coming from another country when I buy now with COVID. I deliberately buy from local producers, my vegetables wherever, wherever possible because it's something I believe in and you're right, it's, you know, if we want to make our own electric cars, then as Canadians if we're willing to pay a little bit more for them, we should make them here. Right now, we're chatting via computer screens, and they're probably made in China, right? We don't make computer screens in Canada.

**Henry Standage 22:31**

So, we're a little bit behind in the tech sector, in some ways.

**Bob Linnen 22:35**

Well, that's one way of looking at it. I mean, if you're Chinese, you realize that what they make now is not what they're going to be making 10 years from now because they'll be forced with the same situation where there'll be a country where the people are less wealthy, and it'll be cheaper to make the computer screens in that country. So, to me, where we're we are in, in the Western world in general, is, we're at universities, and that's one place where it starts. We have to be smart; we have to come up with the next new thing. And then as long as we're coming up with ideas, then things like manufacturing get done in other places, whereas the new ideas and this is why there's a lot of concern about intellectual property. Because intellectual property is kind of the domain of the rich countries because that's what our bread and butter is, that's where we're making our money. As a geologist, I'm trying to come up with new ideas. I'm not personally trying to make money off of my intellectual property, but it is the Canadian companies that are using that technology to be better at exploring than companies from maybe from other countries.

**Henry Standage 23:53**

If China starts building mine scrapers, I'm going to be really ticked off. Okay, so I've got one more question that I'm really interested to get your take on. Hypothetically, if Canada calls China up one day and offers to just switch lands, and we can just teleport both populations into their new country, so Canada moves to where China is currently and all the Chinese people move to where Canada is. Does China make up the offer and go wow, we can do so much with this country, or do they decline and keep the land they already have.

**Bob Linnen 24:28**

They could do a ton with this land, but they already are, so Chinese companies already own many Canadian oil companies, they already own many Canadian gold mines, they own Canadian copper mines, etc. And what China is doing which isn't well recognized by the general public, is that China owns a lot of natural resources, China is the biggest investor in mining in Africa as a continent, everywhere in Africa. China is a big player in mining in South America, so the mining is going on in South America, but the Chinese are quite deliberately making sure that they're securing natural resources for the future of China. They're very smart about it. So, China's already doing that. And China's already buying Canadian resources as well. And that's something, the Canadian government monitors it. And there are regulations as to how much of our natural resources external countries can own, they already own a fair chunk of our natural resources. And there are other countries like for instance, valets are the major company in Siberia. That's a Brazilian company, and there are Swiss companies and German companies. And so, everything is multinational. And I think there's sort of two visions of the of the world, one is that because of COVID. We're thinking very much internally and shouldn't we have supplies of everything and that's being very isolationist. The other way of looking at it is, no, we're in a global market and everything is international. And it's almost as if countries don't exist anymore. We're selling goods on an international market.

**Henry Standage 26:15**

If a Chinese company owns some of our natural resources, it's like they have a key to our house. Does it work vice versa. Do we have Canadian companies in China?

**Bob Linnen 26:24**

It's very difficult to work in China, so no, it doesn't. It's much more difficult to operate in China. And it's not only China. There are many countries in the world where if you're a foreign company, and you want to operate in that company, there has to be 50% local ownership in that company in order for it to be allowed to operate. So, it's not just China there. There are a lot of countries that work that way. But there are a lot of countries like Canada where no you don't have to have a minimum Canadian ownership to operate. If we had those regulations where 50% of all foreign companies had to be Canadian owned. We wouldn't have the companies here. They would just stay at home and say, well, no, I don't need to go to Canada.

**Henry Standage 27:10**

All right. Well, thanks a lot for coming on. Bob. This was super interesting. We'll end the interview there. But once again, thank you for coming on. That wraps up another episode of Western science speaks. If you enjoyed the show, subscribe to us on Apple, Spotify, or wherever you listen to your podcast, to make sure you stay up to date with the latest episodes and research from our community.

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For now, I'm Henry Standage, signing out. Thanks for listening.