WESTERN SCIENCE SPEAKS PODCAST
SEASON 4, EPISODE 6

EPISODE TITLE

Earth, Wind, and Fire: New Perspectives in Mining

PODCAST SUMMARY

Dr. Nigel Blamey joins the podcast to discuss the challenges facing the mining industry, what a mass extinction caused by gas would look like, and how oxygen has evolved.

INTERVIEW

You're listening to the Western science speaks podcast. Presented by Henry Standage.

Henry Standage 0:00
Hey, welcome to the Western science speaks podcast. Today we're talking with Nigel Blamey from the Department of Earth Sciences, Nigel is able to articulate a bunch of interesting issues. In this podcast we talked about the state of mining in 2019, how his understanding of liquid and gas leads him toward exploring new interesting energy supplying methods, and to finish we get to experience the world premiere of his band, so stick around. Here's the convo.

This last half century the narrative surrounding mining has centred around that while still lucrative, it's facing upcoming issues as an industry. Can you attest to what those challenges were and are and how the mining industry has responded to those challenges?

Nigel Blamey 1:17
Well, if you go back, Sydney 50 odd years ago, it was the best ore posits were already discovered because they were close to the surface. The highest grades were also available at that point and we look now, the best materials gone and ore deposits closest to the surface have also been discovered. And now we sit with the problem where we have to find deeper ore deposits, ore deposits of lower grade. And also back then we had the issue of trying to find things that were close to where we had infrastructure. In other words, railway lines, be able to get all ore out to the mill, roads into the place but now we find that we're looking for the lost deposit; those that have not been discovered at this point, so we need to get smarter about it. We've got lower grades to deal with, higher tonnages in many cases. The advantage is, technology is improving. So we have better ways about finding ore deposits using geophysics, geochemistry and improving our models on how we think these ore deposits formed. And as a result of that, being able to use that to our advantage and find new ore deposits. One of the other problems we've had in the industry, I won't say it's a problem, but it's more - one of the things that we've been facing from the mining industry perspective is the legislation is changing. 50 odd years ago, somebody could establish a mine, they didn't worry too much about tailings, more of a case of cost. Whereas now one wants to reclaim areas and be able to, one needs to be more cognizant of the environmental impacts and return the ground as much as possible to the original condition or close to original condition which was found. However, there's been a number of cases for example, in Nunavut, where mining practices have resulted in helping the ecology. So they've done a number of mines where

they have gone in. For example, there are places where they've had to block off the ocean, mine and now flood those extinct mines. This provides habitat now for fish during the winter when it's all iced over. So depending where you are there's new things that are happening, new ways of going about mining that ended up with positive environmental impacts. Of course, some of them not always positive, but we've been fortunate in some cases.

Henry Standage 4:15
Now, you brought up infrastructure. And so does that mean that there's just less stuff to build. So that mining's impacting negatively from that, when you bring up railways and roads, I mean, we don't need as much or as we needed during the Industrial Revolution.

Nigel Blamey 4:33
No, not necessarily it's a case of people used to go prospecting 50 odd years ago, it was easy to go out into the field and drive to an area and go prospecting.

Henry Standage 4:45
What is prospecting?

Nigel Blamey 4:46
In other words, looking for ore deposits, so you send a geologist into the field and see what he can find. But now it's a case of one has to get smarter. We use airborne geophysics to try and help locate new ore bodies. And as a result of that, we have to put a new road sometimes. The best stuff, as I say is now being found, so trying to find new ore deposits we have to be inventive,

Henry Standage 5:15
Work smarter, not harder.

Nigel Blamey 5:18
Exactly. And of course with the lower grades, bigger tonnage, you get the same amount of metal, sometimes more. But now you have to reduce your costs and be able to extract this and that's where new technologies help us a lot.

Henry Standage 5:32
All right, well, let's go into your work here. What types of metals are you looking for in your research? And how do you distinguish the value of different rocks?

Nigel Blamey 5:41
Most of my research is involved in other gold or base metals. When I say base metals I'm referring to copper, lead and zinc. A lot of my gold research goes anything from the Archaean that's pre 2.7 billion years, doing research around there. For example, up in Yellowknife. Other different ore deposits I'm looking at that our goal hosted would be fairly modern material things. So when I say modern, I'm referring to 10 million years, 20 million years, and they end up the way the ore forms is quite different to back as it was billions of years ago. The other thing that is happening is some of the more modern ones get eroded, and we no longer see the expression and the geological record. A lot of my research has been on column type gold deposits, where during the Cretaceous we had intrusive rocks, bringing in hydrothermal fluids depositing gold. And then, we've had additional gold being deposited from hydro thermal fluids that have used the exact same conduits to introduce gold to these deposits. So you end up now with a gold deposit that has been hit more than once and really enriches the gold that way?

Henry Standage 7:01
A quick look at your research page on Western, the word geothermal is everywhere. Can you just explain what that word means and how you use tools in the realm of geothermals to analyse fluid and gas?

Nigel Blamey 7:16
To me I see the word geothermal falling into three categories. The first one. When I say geothermal, I'm talking things you can now generate electricity from, those hot temperatures we're talking 200, 300 degrees Celsius. Good examples of that would be New Zealand, the guises California, where magnetic intrusive bodies have provided the heat. And now we can actually generate electricity from it. As a New Zealander, great examples are the places Indonesia, Japan. So those are the hottest fluids from which we can generate electricity. The next category, I would say falls into home heating and aquaculture. So for example, in Oregon, they actually use fluids that are below hundred degrees Celsius, piping it to actually warm the roads, you have these copper pipes through the surface of the roads, and it keeps it ice free during the winter. So also home heating is fearmount especially in the United States. And you can actually reduce your electric consumption by using this geothermal fluid that is available. And the third category is then what we would here call geothermal but it's more of a heat pump. So in other words, you would use fluid and pump it around a pack that is buried in the ground during the winter, and the grounds temperatures warmer than the ambient conditions so you actually provide heat assist to your house. Whereas in the summer when it's 32 Celsius as it is today. It's actually providing cooling. So it's a heat pump, transferring heat and between the house and the ground. So that's what over people here when they talk to your thermal, that's really what they meaning.

Henry Standage 9:17
From what you just said there, it sounds like geothermal comes from using what's available naturally where you live?

Nigel Blamey 9:25
Correct.

Henry Standage 9:26
Right. How does Canada differ that way from some places in the States?

Nigel Blamey 9:31
In the States, that is considerably more volcanism that has taken place and intrusive bodies. We do have very similar geology on the BC side. It compares to Oregon, Nevada. So the mega Creek, geothermal field, for example, that has not been accessed at the moment. But it's a potential geothermal source that could be used in the Future to generate electricity. The problem with that one is trying to get adequate fluids through the rock. It's basically very tight rock. So as a result of that, you can't get the fluid through it to be able to extract that same fluid, when it's now 300 degrees Celsius. So, but when you get out towards the east coast, we here in Canada as well as in the United States, have the East Coast. So basically, the geothermal term there is really heat pumps, rather than actually deriving electricity from it.

Henry Standage 10:42
What tools do you bring to the table in your research that gives you your own unique lens?

Nigel Blamey 10:50
I specialise in fluid inclusion gas analysis, and what I referred to there is rocks and minerals do trap fluids that once existed. And these fluids have dissolved salts and dissolved gases inside them. I have here at Western a mass spectrometer system for analysing the fluid inclusions quantitatively. And from the different gas ratios and concentrations, there's a lot that I can glean from that data that I generate. So I can tell whether something is a magnetic fluid, whether it's been in resonance in the crust for a long time as a basal fluid, or whether it's a meteoric fluid, such as from a river or lake or rainfall. Then I can identify processes such as boiling condensation or mixing of fluids. I can look at redox. One of the other key things that I do, which is different to everybody else, as I do it quantitatively, and analyse gold metal solubility in hydrothermal fluids. Because the H2S combines with gold and makes it soluble to transport it, which is actually a very key part of research into gold deposits.

Henry Standage 12:11
So your tools, you're able to profile the fluids, basically, you're able to look at its attributes. And then look at its potential upside, when you talking about solubility with gold.

Nigel Blamey 12:25
Yeah, for example, I can say, this particular fluid here is not good for gold solubility, or conversely, this is an ideal fluid for transporting base metals or there's too much H2S. So you're not going to transport base metals and it will be good for gold. It's actually very valuable information we get from it.

Henry Standage 12:51
How has the interpretation of atmospheric oxygen changed in geological time?

Nigel Blamey 12:56
A lot of their original research work and it's fantastic work by Dick Holland and Bob Burner, and they were looking at the modelling of how oxygen had changed. Up until that point, we said, we see fossils in the geological record to the beginning of the Cambrian. And after that, deeper in time, we don't see these hard body fossils anymore, but was the oxygen? That's a good question. It isn't until I think it's the ordifician that we see charcoal, so we say oxygen had to be sufficient to allow fires to exist. But going back in time, it's been quite a challenge and the work done by Bob Burner and Holland presented models simulated on the computer, to say, this is how much we think there was back then. The next step forward - I love the research work done on redux sensitive elements and isotopes. And here I refer to Tim Lyons, and others. And they have said okay, from Redux sensitive elements, we are determining This is how much should be there.

Henry Standage 14:15
Hold up there. So when you say Redux elements -

Nigel Blamey 14:18
Some elements depending on how much oxygen is available, will change the valence state. Manganese, for example, iron exists in FE two plus and FE three plus valence states .

Henry Standage 14:32
What's the significance of that change?

Nigel Blamey 14:35

If we go back in time, deep time, to about 2.7 billion years, we find that fool's gold was being transported in the rivers at the tribal mineral. And this is because Iron was was then present in the FE two plus state. Today we don't have Iron being transported in rivers, because there's so much oxygen around. Compared to back in the Archaean, there was no oxygen around. Well, very little. So through time, oxygen has evolved. And basically as a result of photosynthetic, cyanobacteria blue green algae that it's really, it's the Redux answers of elements that the researchers gone up one level to say, we have a better constraint, what we think was there at the time. More recently, the research work that I've been doing, through gas analysis, has been able to go and look at how much oxygen there was using haylight. Which is a mineral that actually grows at the interface between Bronze and atmosphere. Now why this is significant, is the previous work people have asked me where did that material come from because I myself didn't collect it. It's from sediments, rien sentiments from the ocean. The material I'm collecting is basically at that contact between the atmosphere and the Brian, as a result of that I'm able to sample some of the atmosphere and analyse it directly in the mass spectrometer. By actually analysing oxygen molecules, nitrogen molecules argon and other gases that are present and trace quantities. So I'm getting a glimpse at a certain period of time, but unfortunately, only when haylight or rock salt is precipitating. So I do not have oxygen values throughout the geological record. I can only get at a time period when actually haylight is precipitating.

Henry Standage 17:03
You know, people who go to Kanye West concerts, the musician, they bring a ziploc bag and they zip it up after. And it's gone for as much as $2,000 on eBay, air from the concert, you're talking about atmosphere from how far back are we saying?

Nigel Blamey 17:22
My 2016 paper, is from 800 million years ago. The big question people have always posed to me is, how comfortable am I that was the original signal that was present, has the material not been modified. And I have a screening protocol that I use to determine the best material and you actually looking for primary structures that this has not been dissolved. And as the result of that I'm fairly confident in the data that I've got so from 800 million years, I'm estimating the oxygen was about 11%. Today we breathe 21% oxygen from the atmosphere.

Henry Standage 18:06
So we've doubled the amount of oxygen in the atmosphere. And is there a theory behind that? Is it something that's still a mystery? What's the cause?

Nigel Blamey 18:21
It's still being hotly debated. But I would say photosynthetic life is a key part to this to be able to reduce that amount of oxygen. Because when you compared to the Archaean when there was no photosynthetic life around, and now we have abundant photosynthetic life, it's been the photosynthesis of plants that have actually resulted in the oxygen we breathe today.

Henry Standage 18:48
How can we understand mass extinction events from a gas perspective?

Nigel Blamey 18:54
A lot of the research work that's been done on mass extinctions, all the geochemistry that's been done has been looking at stable isotopes, been looking at trace elements to understand from the rock what has actually happened that resulted in life being completely wiped out. A good example of this is the

Permian mass extinction were about 250 million years ago, 90 plus percent of the species in the ocean got wiped out. And the question is what has actually happened back then. There is evidence to show that carbon dioxide was released from volcanoes, caused greenhouse gas build up that caused methane to be released from gas hydrates. And the methane then is even more powerful greenhouse gas and co2. And as a result of that, we had super greenhouse conditions that the oceans warmed too much. And oceanic life got wiped out. So, from my perspective, I'm now looking at a number of these mass extinction events, to be able to say, what can we learn that actually happened to life as a result of the gases involved in the mass extinction? Are they a function of the mass extinction? Or did they cause the mass extinction? We still don't know the answer yet. But there's a number of mass extinctions we know of, for example, the end of the Cretaceous that was caused by an asteroid that struck the planet. But some of the other ones, we don't have the evidence for an asteroid strike. Other things have happened and it looks like heating, for example, is a key one. But we really need to do a lot more research on this.

Henry Standage 20:50
When I think of mass extinction, my mind doesn't think about gas. It thinks about tsunamis or like an asteroid strike in the Earth. What would a mass extinction from gas look like?

Nigel Blamey 21:04
Well, the big question again is, is the mass extinction, driving the change in the gases or the change of the gases driving the mass extinction? That's one of -

Henry Standage 21:14
Climate change would surely fall into this.

Nigel Blamey 21:18
Well, there's a number of manmade things that are happening. There's a number of natural things that happen. If were looking at something like the Cretation. If we're looking at the end Permian mass extinction at 250 million years. That really was driven by carbon dioxide from volcanoes. So we ended up with ocean being warmed to the condition where life was struggling to survive or certain species were certainly battling to survive.

Henry Standage 21:53
Now, a lot of people wouldn't know that you and a couple of other professors here at the school at actually have a band. So I was thinking for the outro music. We put a little shine on you guys.

Nigel Blamey 22:06
I'm fine with that.

Henry Standage 22:08
Right? All right, what's the band name again?

Nigel Blamey 22:12
We didn't actually give ourselves a name but we recorded and had a lot of fun doing so. I can send you the mp3 for that.

Henry Standage 22:23
All right. That's it from Western Science Speaks podcast and 1,2,3 here's the band.