Fire and Ice

Dave McGarvie:
My name's Dr Dave McGarvie of the Open University. I'm a geologist who specialises in volcanic eruptions into glaciers. In this podcast, you're going to accompany me on a field trip to Iceland where I will be investigating the evolution of two quite different volcanoes. Working alongside me at the first volcano is Open University research student, Anne Forbes.

I'm here in Western Iceland and I'm down by the coast looking up at a magnificent snow-covered stratovolcano called Snaefellsjokull. Running down the flanks of the volcano are hundreds of lava flows. It's a bit like if you take a pyramid and pour chocolate sauce all over it, you'll see all these little channels where the sauce has run down and the lava flows here have come right down to the sea.

Snaefellsjokull is best known as the place where Jules Verne wrote the story, *Journey to the Centre of the Earth* where his intrepid explorers went down into Snaefellsjokull through ice caves and down into the volcanic crater and, from there, down into the centre of the earth.

Male narrator:

"To go down a blunderbuss, I thought, when it may be loaded and may go off at the slightest touch is sheer lunacy. But there was no going back."

Dave McGarvie:

Lavas that have flowed down from this volcano have come down and entered the sea, down at the foot of Snaefellsjokull and what we're trying to do is to understand something about how the lavas interact with water, ice and snow because that's what Anne's doing for her PhD project.

So, Anne, just describe for a moment what you see in front of you, please.

Anne Forbes:

So what I can see here is lots of very tall and thin lava bodies. They look impossibly tall and thin like they might almost topple over. And inside these it's a very kind of platey fracturing, it looks almost like lots of sheets of paper or plywood maybe.

Dave McGarvie:

These are rather weird looking features because they're about ten / fifteen metres high but they're only about four or five metres wide and the outer part of these ridges is filled with red, rubbly material which is partly welded together. The interior of these ridges is the most peculiar part of them. It's a grey lava, and this is nothing like Anne and I have actually seen anywhere we've been working in Iceland before.

Anne Forbes:

Yes, it's a bit of an enigma really. How do these strange plates form … why are they forming here where the lava flows into the sea, but they don't form elsewhere?

Dave McGarvie:

That's one of the fascinations of geology. We have what's in front of us; we then have to try to reconstruct what actually happened many thousands of years ago when this lava erupted.

Well, I have to say, Anne, I've worked in many places on lavas but I've never seen anything quite as strange as this. What we're looking at is a vertical face, about a couple of metres high, on the edges of one of these long linear ridges that go into the sea and the lava here has been crushed so it's almost like corrugated iron in a way.

Anne Forbes:

Quite frankly I'm baffled. They're so thin, these plates; some of them are paper-thin. There must have been some kind of force pushing these plates together to crinkle them like this.

Dave McGarvie:

Because when we look above and below the plates, we see the lava looks much more homogenous, not quite so highly fractured, if you like. So might that suggest that the lavas been moving much more in this area than elsewhere?

Anne Forbes:

Yes, I think you could almost call it accommodation zone. It's accommodating the stress of the lavas possibly moving, one part over the other part.

Dave McGarvie:

Well that's going to be extremely useful to us if we find these zones where things have moved much more rapidly than elsewhere. Thanks.

Anne Forbes:

I've found something and I think what we call this is a xenolith which literally means a foreign rock, something that's not like the rest of the lava here, quite square actually. Very angular, made of coarse crystals whereas the lava we've got here is very fine grained, you can't see the crystals at all with the naked eye.

Dave McGarvie:

What's the significance of this xenolith?

Anne Forbes:

Well, this is probably something that the lava picked up on its way through the Earth's crust so the minerals in here that we can identify – one of them seems to be a garnet and garnet is a mineral that's very typical of high pressure rocks.

Dave McGarvie:

A wonderful example of a little passenger that's travelled from the source region at which this magma was created deep within the crust. So, in other words, it's had a journey from the centre of the Earth.

Anne Forbes:

From the centre of the Earth, yes.

Dave McGarvie:

At this point I left Anne by the sea to continue her research while I went off to undertake the first study of a large and complicated volcano that's evolved over many glacial periods.

I'm here on the slopes of the Askja volcano, in Central Iceland. It's in the uninhabited interior of Iceland and probably as remote as you can get in the centre of Iceland. Askja itself is a spectacular volcano. In the centre of this donut shape of brownish material, [visbasult 0:05:27] erupted into glaciers, you have an absolutely beautiful blue lake about four kilometres in diameter. It's one of the deepest lakes in Iceland and it was formed in an eruption in 1875.

The 1875 eruption injected a lot of fine ash into the atmosphere, which, if it had happened today, would have seriously interrupted transatlantic air travel. This eruption also dramatically altered the shape of Askja. In the area around the volcano itself you find huge blocks of pumice, which are up to one and a half to two metres in diameter. So when these were falling down, this would not have been a comfortable place to be in 1875.

So what am I doing at Askja? Well, I'm with a group of Icelandic and American scientists and we're here to do the very first study of how Askja has actually grown during past glacial periods. It's the first attempt that anyone's ever made to reconstruct the geological history and evolution of what we call a central volcano.

There are a large number of volcanoes that exist beneath the ice caps of Iceland so by studying Askja, which is well exposed, we stand an opportunity of getting a better understanding of these other volcanoes and also of the potential hazards they may have in terms of future eruptions, particularly those that might affect the UK because when you've got eruptions into ice sheets you can end up fragmenting material much, much more than normal. And if that material can escape into the atmosphere into sufficient quantities, you can carry the ash a long, long way as we saw during the April 2010 eruption of Eyjafjallajökull.

Male newsreader:

It's a spectacular sight but the disruption it's causing is almost as dramatic as the views it's providing. The Icelandic volcano has grounded airliners, left passengers stranded and businesses suffering.

Dave McGarvie:

It's a bit of an added edge to working on an active volcano like Askja. It just makes you think a little bit about the forces nature when you see the very young lava flows streaming down from the flanks and they're very black and they're very rubbly and they're very fresh looking. The most recent eruption here was in 1961.

Now although you can hear a gently babbling stream in the background, this isn't typical of this part of Iceland. This part of Iceland is inhabited by bleak, barren, inhospitable wastelands. It would be quite easy to get lost out there and to die out there because there's no water to be had for kilometre on kilometre on kilometre.

We've now come round to another valley called [?? 0:08:21], which, to give it its full name, means Astronaut Valley, named after the astronauts who came here to train before the moon landing. And it's quite humbling, in a way, to be walking around this terrain thinking that the astronauts who actually landed on the moon once actually trained here.

Astronaut's voice:

One or two inches. Although the surface appears to be very, very fine grained as you get close to it. It's almost like a powder down there, it's very fine. I'm going to step off to land now. It's one small step for man.

Dave McGarvie:

I've just been walking up a stream on the Eastern side of Askja, following a very interesting contact because it tells us something about the difference between volcano ice interactions and what actually happens when you acknowledge they're around at all. On the right hand bank of the stream as I walk up it, I have a fairly flat lying lava flow, nice and slurry, easy to work on. It's a lava flow erupted into conditions very much like we have in the modern day, i.e.

no ice around at all. On the left hand bank I have quite a steep slope and within this I see a number of pillows. This is a pillow mound and this is good evidence in this area for volcano ice interactions.

We have some pillows that look strangely flattened that suggests that they may have actually encountered a little ice wall on the margins of a little lake which is within an ice cavity. That's one of the thrills of working in Iceland, you always find something a little bit new, a little bit interesting and it all adds to the sum of the knowledge.

After my time at Askja, I rejoined Anne in Southern Iceland where we encountered something rather unexpected.

The noise you can hear is that of a raging glacial torrent. It's a river called the Skafta and it's cutting down through a very young lava flow that erupted in 1783, the Laki lava. This river drains part of the Va Tnajokull Glacier and why it's quite exciting being here at the moment is we're just on the tail end of a glacial burst where a large amount of water has escaped from underneath the glacier. It's done that because there's a couple of geothermal areas where heat's escaping out of the ground beneath the thick outside of the glacier. And the water accumulates under these geothermal areas and every now and again it releases in a massive burst of water that comes verging down this river.

The effects of the 1783 eruption of Laki were felt across Western Europe with volcanic gasses causing widespread crop failure and many deaths. In Iceland, the impact was particularly devastating. About one third of the population died. Of particular interest to Anne's PhD project is that the Laki lava flowed down a river valley. I joined her as she examined the unusual features produced as the river water interacted with the flowing lava.

Anne Forbes:

So what we see is a lot of column-type features. We have an entablature towards the base. An entablature is where you get very variable directions; they're often quite small. They don't look like your normal columns that you might see, say, at the Giant's Causeway. They're much smaller, much more irregular. But then on top we see something more like the columns you might see at the Giant's Causeway, we would call a colonnade. So these columns are forming nice and slowly from the top downwards and coming to meet the entablature which is forming from the bottom upwards. But there's also other fractures coming in here, things that we would call pseudo-pillow fractures.

Dave McGarvie:

Okay this is fascinating because these pseudo-pillow fractures, just to clarify, they're straight, curvy, linear …

Anne Forbes:

Yes, they can go on for, sort of, five or six metres across the lava. And then forming off these perpendicularly are very small fractures.

Dave McGarvie:

I often think of an old-fashioned diagram of somebody being stitched up with a long cut and the stitches going across it. Is that a reasonable analogy?

Anne Forbes:

Yes, that’s quite a good one and also a long, curvy millipede with little legs coming off at right angles.

Dave McGarvie:

Okay, just to sum up, it seems a very simple story of a lava flow coming down a river valley and quite recent, in 1783, so some of this was witnessed. But, in detail, we’re saying the three main fracture types, if you like, you’ve got your colonnade, you’ve got your entablature and you’ve got your pseudo-pillow fractures going all over the place. And this, I think, highlights the importance of your research because there’s no real good diagnostic evidence within this to say this feature is characteristic of this environment. So what we need to do is to look at more examples to try to get a better handle on what is typical and what is not typical of particular environments.

Is that a fair way of …

Anne Forbes:

Absolutely, absolutely.

Dave McGarvie:

At this early stage in research projects there are always more questions than answers. But we’ve returned armed with notebooks filled with our observations and sketches and with many samples to measure and analyse. So over the coming months we will work away until we have more answers than questions.