Major methane release is almost inevitable

- 19:00 21 February 2013 by **Michael Marshall**
- For similar stories, visit the **Climate Change** Topic Guide

We are on the cusp of a tipping point in the climate. If the global climate warms another few tenths of a degree, a large expanse of the Siberian permafrost will start to melt uncontrollably. The result: a significant amount of extra greenhouse gases released into the atmosphere, and a threat – ironically – to the infrastructure that carries natural gas from Russia to Europe.

The Arctic is warming faster than the rest of the planet, and climatologists have long warned that this will cause positive feedbacks that will speed up climate change further. The region is home to enormous stores of organic carbon, mostly in the form of permafrost soils and icy clathrates that trap methane – a powerful greenhouse gas that could escape into the atmosphere.

The Siberian permafrost is a particular danger. A large region called the Yedoma could undergo runaway decomposition once it starts to melt, because microbes in the soil would eat the carbon and produce heat, melting more soil and releasing ever more greenhouse gases. In short, the melting of Yedoma is a tipping point: once it starts, there may be no stopping it.

For the first time, we have an indication of when this could start happening. Anton Vaks of the University of Oxford in the UK and colleagues have reconstructed the history of the Siberian permafrost going back 500,000 years. We already know how global temperatures have risen and fallen as ice sheets have advanced and retreated, so Vaks's team's record of changing permafrost gives an indication of how sensitive it is to changing temperatures.

Stalagmite record

But there is no direct record of how the permafrost has changed, so Vaks had to find an indirect method. His team visited six caves that run along a south-north line, with the two southernmost ones being under the Gobi desert. Further north, three caves sit beneath a landscape of sporadic patches of permafrost, and the northernmost cave is right at the edge of

Siberia's continuous permafrost zone.

The team focused on the 500,000-year history of stalagmites and similar rock formations in the caves. "Stalagmites only grow when water flows into caves," Vaks says. "It cannot happen when the soil is frozen." The team used radiometric dating to determine how old the stalagmites were. By building up a record of when they grew, Vaks could figure out when the ground above the caves was frozen and when it wasn't.

As expected, in most of the caves, stalagmites formed during every warm interglacial period as the patchy permafrost melted overhead.

But it took a particularly warm interglacial, from 424,000 and 374,000 years ago, for the stalagmites in the northernmost cave to grow – suggesting the continuous permafrost overhead melted just once in the last 500,000 years.

At the time, global temperatures were 1.5 °C warmer than they have been in the last 10,000 years. In other words, today's permafrost is likely to become vulnerable when we hit 1.5 °C of global warming, says Vaks.

"Up until this point, we didn't have direct evidence of how this happened in past warming periods," says Ted Schuur of the University of Florida in Gainesville.

It will be very hard to stop the permafrost degrading as a warming of 1.5 °C is not far off. Between 1850 and 2005, global temperatures rose 0.8 °C, according to the 2007 report of the Intergovernmental Panel on Climate Change. Even if humanity stopped emitting greenhouse gases tomorrow, temperatures would rise another 0.2 °C over the next 20 years. That would leave a window of 0.5 °C – but in fact our emissions are increasing. What's more, new fossil fuel power stations commit us to several decades of emissions.

Soggy permafrost

What are the consequences? The greatest concern, says Tim Lenton of the University of Exeter in the UK, is the regional landscape. Buildings and infrastructure are often built on hard permafrost, and will start subsiding. "Ice roads won't exist any more."

The increasingly soggy permafrost will also threaten the pipelines that transport Russian gas to Europe. "The maintenance and upkeep of that infrastructure is going to cost a lot more," says Schuur.

As for the methane that could be released into the atmosphere, Schuur estimates that emissions will be equivalent to between 160 and 290 billion tonnes of carbon dioxide.

That sounds like a lot, but is little compared to the vast amount humans are likely to emit, says Lenton. "The signal's going to be swamped by fossil fuel [emissions]."

He says the dangers of the permafrost greenhouse gases have been overhyped, particularly as much of the methane will be converted to carbon dioxide by microbes in the soil, leading to a slower warming effect.

Schurr agrees with Lenton that the methane emissions are "not a runaway effect but an additional source that is not accounted in current climate models".

Journal reference: *Science*, DOI: 10.1126/science.1228729