is much weaker." This is one explanation for the varying amount of silicon in the river over the seasons.

In addition, the researchers also revealed that the amount of silicon in the soil water – affected by vegetation and soil disintegration – itself varies. Soil disintegration results in the release of silicon while uptake by vegetation can temporarily hold it. The dominance of one process over the other is highly dependent on temperature and differs among the seasons. Yet, for a long time, there has been a balance between the uptake and release of silicon over the years in old forests. "It is not inconceivable that global warming can distort this balance in the future," reasons Clymans.

Exciting storms

More exciting than the rippling water during most of the year were the occasional storms. During these events, the team automatically collected samples covering the entire storm period. They found that during a heavy rain shower, the amount of silicon in the river did not decrease drastically. This may sound counterintuitive because we could expect that heavy rainfall, which can temporarily increase the volume of water leaving the catchment up to 100 times, would wash down the catchment and lead to a drop in silicon following the first rain peak. "We observed that the amount of silicon in the river water only drops slightly and recovers quickly after a storm," explains Clymans. "Thus, silicon is not merely washed out of the soil by rain water." The researchers realised that there should be a second mechanism in action, keeping the element at a roughly constant concentration in the river. When it rains, silicon-poor rainwater flushes 'old' silicon-rich soil water out of the soil and into the river water, which maintains the supply of silicon.

Despite this tendency towards a constant silicon concentration in the river, Clymans fears that disturbances of the natural balance can have a large impact. "From our study, it is clear that the age-old water cycle in the forest is the major control factor on the pathways of silicon. We, humans, can have a large impact on this through the expansion of agricultural land or climatic changes induced by the emission of greenhouse gases. This inevitably alters the transport of

Wim Clymans probing the forested 'silicon valleys' at Forêt de Houssière, Belgium. (Credit: L. Fondu)

silicon to the oceans. At the bottom of the food chain, changes in silicon supply can get a whole cascade going: a known consequence is the harmful bloom of algae, which lowers the oxygen in the river and leads to the death of fish."

And could these changes in the silicon cycle affect Silicon Valley, or at least the production of the silicon-based microchips used in our computers and smartphones? "No, they are quite unrelated, Clymans answers. "Our research focuses on the biological form of silicon while microchips are made of pure silicon crystals, which do not disintegrate easily and will probably never run out. But the biological form of silicon is of interest in our daily lives in another way. Humans profit from silicon uptake as it strengthens bone structure, lowering the incidence of osteoporosis and fractures. A principle dietary source of silicon is beer! Belgian colleagues of mine have shown that the complexity and length of the Belgian brewing process causes Belgian beers to be especially rich in silicon. So, cheers!"

Eline Vanuytrecht
PhD researcher at KU Leuven, Belgium

Reference

Clymans, W. et al.: Temporal dynamics of bio-available Si fluxes in a temperate forested catchment (Meerdaal forest, Belgium), Biogeochemistry, 1–17, 2013

Icequakes!

Scientists at the British Antarctic Survey are monitoring the rumbling of ice streams to discover what makes them flow

Antarctica is a hostile continent. For half of the year not even the Sun dares to show its face. On the surface the white wilderness appears frozen in time but underneath it there is a stirring world that scientists are only just beginning to uncover.

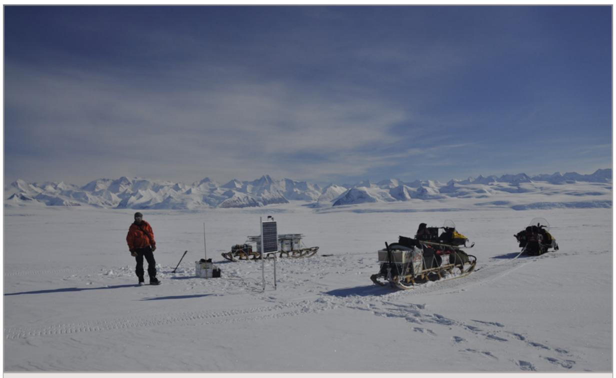
Woven through the giant ice sheet, which consumes an area bigger than Europe, are networks of ice streams. These are fast flowing passages of ice that, like arteries that move blood around the human body, are a main mechanism for transporting fresh water off the continent and into the ocean.

Ice streams and outlet glaciers are considered to be significant if not dominant causes of the recent Antarctic ice sheet mass loss (Rignot et al. 2008). Some suggest the flow could even speed up in response to warming oceans as ice streams are the fastest responding component of an ice sheet system.

Buried

Understanding the dynamics of ice streams is important to help predict their future contribution to global sea level rise. However, the

BACK TO CONTENTS



Recording icequakes at Rutford Ice Stream. (Credit: Andy Smith)

ice-bed interface, which accommodates the movement of the ice stream, is difficult to access. In situ measurements are challenging as the bed is usually buried under kilometres of ice.

Emma Smith, PhD candidate at the British Antarctica Survey (BAS) is using seismic data to study icequakes – microseismic movement – at the Rutford Ice Stream, West Antarctica. After starting a career in engineering, she moved into exploration geophysics and spent several years working in the oil and gas industry before returning to research.

Antarctica is divided into East and West by the stretch of the Transantarctic Mountains. The West Antarctic Ice Sheet reaches out like a tentacle to the southern tip of South America and contains enough water to raise global sea levels by five meters.

The Rutford Ice Stream is a typical Antarctic outlet glacier sitting in a deep trough. It moves about one meter a day.

"By far, it is not one of the fastest flowing," says Smith. For example the Pine Island Glacier, the longest and fastest moving glacier in Antarctica, can move almost 10 meters a day.

Varying in width from 20 to 30 kilometres and being over two kilometres deep in places, the Rutford Ice Stream flows for more than 150 kilometres before it reaches the Ronne Ice Shelf and starts to float. It drains a land area of 49,000 square kilometres in the West Antarctic Ice Sheet.

Listen closely

To study the stream, Smith uses a technique derived from classic earthquake monitoring called passive microseimic monitoring. It consists in placing geophones – devices that convert ground motion into voltage – on the ice stream surface to record the icequakes produced as it moves over its bed.

Using the data obtained in this way, Smith can then get information about the basal conditions and physical properties of the ice. Ice streams generally have water present at the bed. This water is either surface meltwater that has reached the base or results from the fact that the ice at the bottom is under so much pressure that it has melted at the pressure melting point. "The water allows movement of the ice by providing lubrication – otherwise the ice would be frozen onto solid rock," she says.

Rumbled

However, what the stream is sitting on also controls the speed of its movement. Motion at its bed can change depending on whether the ice stream is moving across soft sediment or sliding over hard rock. Smith found icequakes to be clustering at particular sources at or near the ice-bed interface. "This is telling us the mechanism for accommodating movement is happening in a repeating manner," she says.

Analysis of these data is allowing Smith to build up a picture of the mechanisms that cause the icequakes to occur, meaning she can then better understand how the stream moves. Using the information from the icequakes, Smith can also construct models to illustrate the basal dynamics over space and time.

Parts of the bed deform as the ice moves over and can form large mounds – some as high as 500 meters wide and 50 meters high. In other parts, the ice stream slides over its bed with little deformation. For example, areas of the ice stream bed interpreted as basal sliding show a greater roughness than those with a deforming bed. A rougher bed could be an indication of higher basal friction and so this could explain the increased levels of seismicity detected in those areas.

Looking back

For the past 25 years, BAS have been busy working around Rutford to try and create a full representation of what is happening in this polar area. "The research we are doing can be combined together to get a bigger picture of what's going on," Smith says.

Palaeo-ice streams could give us a glimpse into the future. Comparing present ice streams with previous glaciations can give clues on the Rutford Ice Stream condition. O'Cofaigh and collaborators found in 2005 that deglaciation of deep marine troughs can occur rapidly over just 100 to 1000 years.

However, there are significant differences between past and present. Past ice streams have exposed bedrock but no evidence has been found of this at Rutford. This could be by chance or it may indicate high erosion rates and deep scouring events that characterise the final demise of an ice stream. A process that palaeo-ice streams have already suffered and a fate the Rutford Ice Stream may have yet to come.

Becky Summers
Freelance science writer

References

Rignot, E. et al.: Recent Antarctic ice mass loss from radar interferometry and regional climate modelling, Nature Geosci., 1, 106–110, 2008
O'Cofaigh, C. et al.: Flow dynamics and till genesis associated with a marine- based Antarctic palaeo-ice stream, Quaternary Science Reviews 24, 709–740, 2005
Smith, A. M. and Murray, T.: Bedform topography and basal conditions beneath a fast-flowing West Antarctic ice stream, Quaternary Science Reviews, 28, 584–596, 2009

BACK TO CONTENTS