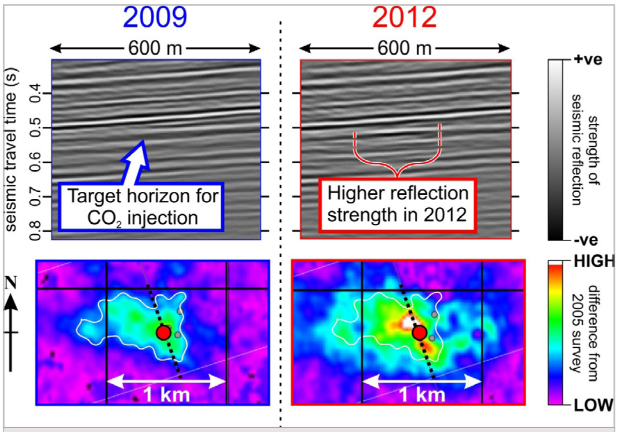


Time-lapse seismic data from the Ketzin CCS site, from 2009 and 2012 acquisitions (from Ivandic et al., in preparation). In cross-section (upper images), stronger seismic reflections are observed in the target aquifer but the rest of the data remains identical. This shows that the $CO_2$ volume in the aquifer has increased, but that it is contained. Map-view images (lower) reveal the size of the 2009 and 2012 $CO_2$ plumes compared to the 2005 baseline survey and suggested that it has migrated west from its injection site (red circle). The black dashed line shows the intersection with the cross-sections above.

Worldwide, interest in CCS is growing – something Ivandic has experienced first-hand. Many countries, including her homeland of Croatia, have no CCS operations but have estimated their potential storage capacity from data archives or from regional distributions of suitable reservoirs. Such estimates keep increasing, but The Worldwatch Institute suggests that today's seven active and planned CCS operations could only store 0.5% (35 million tonnes) of the $CO_2$ emitted in 2010 – hence CCS does not yet provide the answer to the global emissions challenge. Nonetheless, CCS expertise is in demand and, this year, Ivandic has completed a marathon schedule of workshop and conference attendance presenting $CO_2$MAN's latest observations (including at April's EGU General Assembly). Indeed, she was surprised to find that "the work and results attracted the attention of scientists not even involved in CCS projects!" Clearly, the world is becoming fascinated by grounded gas.

*Adam Booth*

*Post-doc at Imperial College London, UK*

## More information

Monika Ivandic obtained her PhD from IFM-GEOMAR (Kiel, Germany) in 2008, then worked back in her native Croatia on a variety of geophysical projects for geotechnical and civil engineering applications, and started her post-doc at Uppsala in 2011. For those embarking on a post-doctoral career, Monika has the following advice. "Be ready for short-term contracts. More than a third of academics are on temporary contracts, a situation which results in frequent changes of job and city." However, such diversity also brings rewards. "It brings a lot of excitement and dynamics to your life! And as for the science, that's always a new page in your career."

## References

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# The real Silicon Valley

## On the pathways of silicon on its way to the sea

Everybody knows Silicon Valley, but how many people can tell you about the importance of silicon in nature? One who surely can is Dr Wim Clymans. He is a young post-doctoral scientist at the Geology Department of Lund University in Sweden who dedicates his research to silicon and its biological role. "Silicon is highly underappreciated!" he starts. "People know oxygen, carbon, maybe nitrogen and phosphorus, but hardly anybody has heard of silicon as an important nutrient. Yet, it is vital for plankton in the oceans and other small forms of life in rivers. Silicon forms one of the base components for a well-balanced food system and is, therefore, very relevant," he explains. "Silicon travels from the land to the ocean via rivers and over-land flow in the valleys but, on its way, it can be fixed by vegetation. In our research, we delve deeper into the pathways of silicon on its road to the sea. This is important because, due to human interventions and climatic changes, the supply of silicon from the land to the sea may become distorted and the precious food system in rivers and seas may be altered."

Clymans and his colleagues have monitored several river catchments. In the old Meerdaal Forest in Belgium, for example, they took measurements for three years, equipping the area with devices to monitor the rainfall, the flow in the main stream and the presence of silicon in water samples. They examined this element in more than 800 samples of soil and river water that were collected in the course of this three-year period, which included some storm episodes.

Clymans detected notable differences in the amount of silicon in the stream in winter/spring and in summer/autumn. In a recent paper published in Biogeochemistry, he elucidated the reasons for this variation: "In contrast to larger and less densely forested areas, water stays only a few hours in the stream before it leaves our catchment and the stream is largely shaded. Biological activity in the river is thus low, and so is the uptake of silicon within the river. This led us to conclude that the seasonal variation must be related to processes that occur on the land, and to the connection between the land and the river." Moving the focus to the land, Clymans explains the varying link between the water in the soil around the stream and the stream itself: "In winter and spring, the soil water is in close contact with the stream because the soil is wet. Thus, rain easily drains via the soil to the river. In summer and autumn, the soil is drier and the connection between the soil water and the stream 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!"

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# 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