Dr Nina Keul from the Institute of Geosciences looks for clues about climate history in samples from the ocean floor. Her most important evidence: the shells of tiny wing snails. They have much to tell us.

The influence of a high acidity: on the left, a pteropods shell is seen in an advanced stage of dissolution. On the right is a healthy shell.

**20,000 years under the sea**

For scientists and politicians, stopping climate change is one of the most important challenges of the 21st century. Today, politicians particularly want to know how much CO₂ their countries can emit, said Dr Nina Keul from Kiel University, and are able to be able to ‘cry stop’ in time - she investigates core samples from the ocean depths.

This is because CO₂ (or carbon dioxide), the most famous greenhouse gas responsible for climate change, is soluble in water. If the concentration of gas responsible for climate change, is already at 400 ppm, explained Dr Keul, the most famous greenhouse gas responsible for climate change, is already at 400 ppm, explained Dr Keul. And more carbon dioxide in the water means an increase in acidity (or pH level).

In order to demonstrate how significantly the temperature and carbon dioxide levels have changed over the millennia, the biologist makes use of creatures only a few millimetres in size: wing snails. These have existed in all the oceans on earth for many thousands of years. And because their shells consist mainly of chalk (calcium carbonate), they are very vulnerable to acidification of the oceans. Under an electron microscope, Keul examines the surfaces of ancient shell snail shells. Most recently, these were collected from nets used in a research expedition in the Labrador Sea between Greenland and Canada.

“If the snail shells have a smooth surface, this is an indicator of a low saturation of the water with carbon dioxide during the creature’s lifetime. Today, it looks completely different: the current samples show clear signs of disintegration, and they don’t look smooth under the microscope, but a bit like cauliflower”, she explained. By conducting chemical analysis of the composition of the shells, the post-doctoral researcher aims to establish correlations with sea water temperatures. Then, by using these wing snails, she can draw conclusions on the historical water temperatures.

Dr Keul carries out her research as part of the paleoceanography working group at the Institute of Geosciences. A team of scientists from different disciplines - ranging from physics to climate science right through to fisheries biology - is striving to improve the scientific methods applied worldwide. This is because, to date, such investigations have mainly been carried out using so-called “foraminifers”, which are single-celled organisms with a similar shell to the snails. These are more common, and therefore easier to investigate. The use of wing snails as climate indicators has been able to support the previous assumptions in certain regions, and to make them more precise.

In contrast with foraminifers, which only survive for a few months, wing snails can live for up to a year. Therefore, they can also enable conclusions on seasonal temperature variations.

“It all comes down to the antennae”

Ingenious antenna technology is a key to wireless internet access of the future. The Faculty of Engineering at Kiel University leads the way.

According to Höher, the problem could be solved by coding, the speciality of Professor Höher.

“Like with the IBAN, it is calculated based on the contents of the individual messages. If the checksum doesn’t match due to an incorrect input, one is requested to repeat the process.”

Expanding the internet of the future – which today already is working in a similar form, using the shells of wing snails can easily simulate this at home. You just need a bit of eggshell or a kind of sea snail shell. Both eggshells consist of chalk, and are therefore very similar to the very acidic snail shells of wing snails.

“We are trying to also bring other universities and research institutions on board with our research, and thus be able to draw conclusions on all geographic regions.”

The global approach of the team is important, because the saturation with CO₂ is not the same in all regions of the ocean, due to physical effects such as waves. Therefore, work is being carried out to obtain the most precise results possible, we want to establish wing snails as an uniform global indicator for climate change.”

According to Höher, signals which contain information in the form of bits, and thereby comprise sequences of the characters 0 and 1, inevitably get mixed up on their way to the receiver. Therefore, they must be individualised with additional parity bits (check bit) and a checksum, so that they can be uniquely identified and not confused with each other. To do this, Höher and his employee Niklas Dose, from the Further Development of Coding Theory, everything is organised based on the division of labour: “Each sub-project focuses on different key areas, but of course we exchange ideas and information on areas that overlap.”

The topic of antennae, which the scientists in Kiel are researching, is definitely important for an even faster mobile internet. Especially as it’s not just a slight increase in speed, but a giant leap. Transmission rates of up to 100 Gigabits per second are being discussed – which is a hundred times the performance of the best currently available and affordable smartphones.

The antennae technology was initially investigated from two different angles in Kiel, Professor Dirk Manteuffel, who has since moved to Hannover, was focusing on the hardware. The core idea was and remains the principle of an antenna array. Many antennae are distributed in an area, so that they can simultaneously send and receive more and different signals.

This becomes tricky if it has to be taken place in a small space as possible. “Of course, a smartphone can’t look like this, the space is not increased, but here much more goes. Therefore, work is being carried out on further developing the technology that is already being used in these devices for reception. The difference is that instead of the current system where individual antennae are placed on the circuit board, the entire circuit board functions as a transmitter, and is transformed into an antenna array by mathematical processing. While work on this already advanced process is now continuing in Hannover, Kiel is tackling an important related problem. If many signals are under way at the same time and on the same frequency, it can result in a chaotic mixture of waves. The individual signals no longer remember which antenna they’re supposed to go to. This problem can be solved by coding, the speciality of Professor Höher. According to Höher, signals which contain information in the form of bits, and thereby comprise sequences of the characters 0 and 1, inevitably get mixed up on their way to the receiver. Therefore, they must be individualised with additional parity bits (check bit) and a checksum, so that they can be uniquely identified and not confused with each other. To do this, Höher and his employee Niklas Dose, from the Further Development of Coding Theory, everything is organised based on the division of labour: “Each sub-project focuses on different key areas, but of course we exchange ideas and information on areas that overlap.”

The coding has decisive advantages. Firstly, Höher is ‘fully convinced that an antenna array system will not work without coding’ and, secondly, it is a purely software-based process, which means that in future, smartphones and other computers can be updated to the latest standard, and not quickly become electronic scrap. In particular, the Kiel approach has another advantage over many other sub-projects: they are working in a similar frequency range to the current mobile technology – instead of times the frequency of today - so the signals can much more easily travel through walls. Why the internet of the future – which should already be a reality by 2020 – is being talked about as “Massive MIMO”, can be explained by another special feature due to the high-performance but also highly-complex reception technology, the majority of the hardware and software will be hidden in the respective access point, i.e. in a Fritzsche or other router. Therfor, smartphones or notebooks can remain as they are: cheap, small, elegant and energy-saving.

Marin Gent