Expedition Blog

Helmholtz Centre for Environmental Research UFZ Leipzig (Germany)

written by *Roman Kroke*

during the MICRO-FATE Expedition SO 268/3 across the Pacific Ocean on board of the German research vessel SONNE

30 May 2019 - 5 July 2019
Vancouver (Canada) - Singapore

Roman Kroke was mandated by the UFZ Leipzig to accompany this scientific expedition as an artistic mediator: for details on his mandate see page 68-71 (under “10. Outreach”) of the official

- Cruise Report

One of his tasks consisted in disseminating the contents of the expedition to a broader public by writing the official UFZ Travel Blog[1]: not only about the scientific research questions, diverse ocean probes and daily challenges on board but also about the people behind the expedition: insights into the biographies of the scientists and the ship's crew. The following article is the English translation of the original text (written in German). You find the original article of Roman Kroke in the online archive of the UFZ Leipzig:

- Hänsel und Gretel Part I
- Hänsel und Gretel Part II

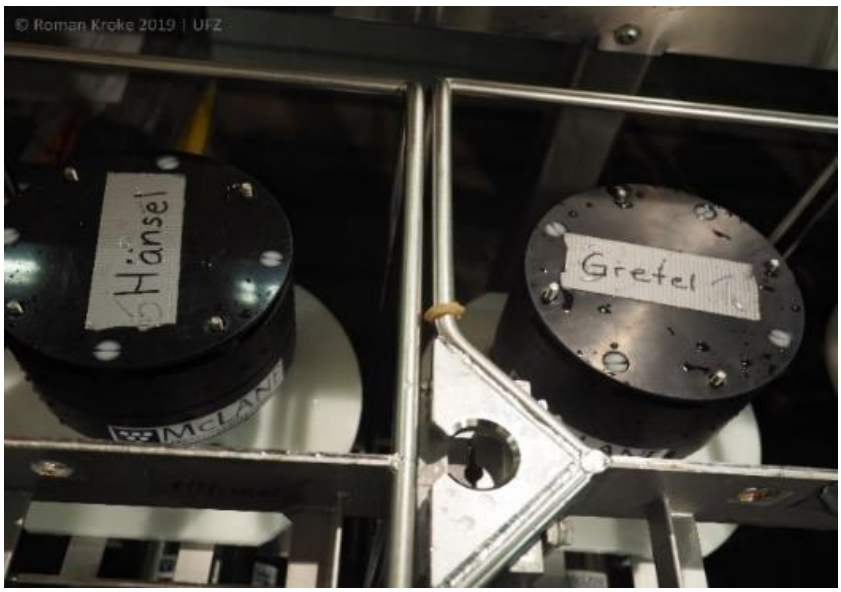
By clicking in the following text on blue underlined words (like, on this page, “Cruise Report”, “Mut zur Lücke!”, “PRIZE”) you will be led to online pages which are also hyperlinked for the readers of the original (online) article in German.

[1] The workshop concept developed on the basis of these articles was distinguished with an environmental-educational PRIZE.

31 July 2019

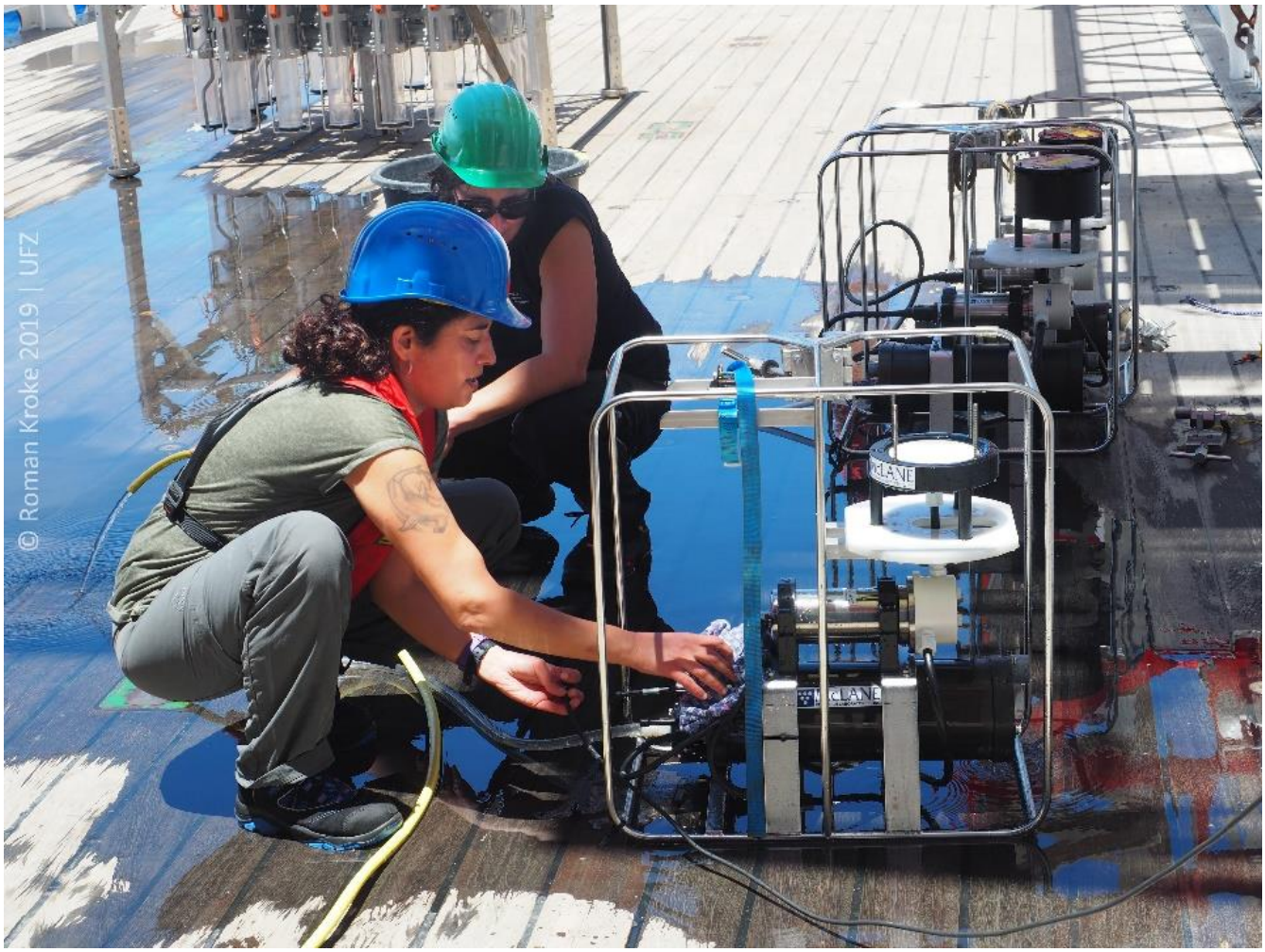
Hansel and Gretel

There are not breadcrumbs scattered on the deck of the ship leading to the brother and sister. Numerous thin rivulets run like veins across the planks. With every second, more and more water pulses through them - as if the ship's hull suddenly came to life. My eye wanders upstream along the waterways, back to the source. And there they stand, freshly brought up from the depths of the Pacific Ocean: the two fairy-tale figures of the Brothers Grimm. They look out at me from a metal cage frame. However, no one is asking them to stick their fingers out through the bars. Instead, a hose dances merrily over their heads and sprinkles them with fresh water.



The in situ pumps Hansel and Gretel.

"Exposing the in situ pumps to salt water longer than absolutely necessary would mean greatly accelerated corrosion," Mine Banu Tekman, a PhD student at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) in Bremerhaven, explains to me. "It's sensitive, valuable equipment that you have to take care of." During the last sampling, I had already been able to observe with fascination how she gives her protégés several hours of attention each time, with an almost ceremonial air. "On the SONNE I have an unbelievably enthusiastic partner in Annika Jahnke," Mine says, referring to the coordinator of our MICRO-FATE project. Watching the two of them at work, it is indeed hard to shake the impression that two scientific soul mates have found each other here: Two pairs of hands guided by one mind. Before the salt crystals can dry, they first rinse the in situ pumps from the outside with salt- and particle-free water after each sampling. Then they send the pre-cleaned water through the inside of the devices in several pumping cycles, and finally polish each individual component meticulously with a cloth. The scientists pay special attention to the sealing rings that protect the electronic part of the battery-driven pumps from salt water penetration. "A single hair and they are dead," says Mine, underlining the importance of meticulous dedication here.



Mine Banu Tekman (AWI Bremerhaven, foreground) and her UFZ colleague Annika Jahnke (MICRO-FATE project coordinator) cleaning the in situ pumps..

"Dead" - the word echoes through my head and I look at the adhesive strips attached to the filter heads: Hansel and Gretel. They got their names from their owners, Mine's colleagues

at the Max Planck Institute for Marine Microbiology (MPI-MM) in Bremen. Since 2016, the MPI-MM has provided the AWI with the in situ pumps for sampling every year. "I love the names! Plus, they are super practical," Mine explains. "The in situ pumps are quite complex devices, each of them with specific features, separate device boxes, spare parts. So when exchanging ideas with other scientists, it's very helpful to be able to clearly differentiate which device you're talking about via simple name assignments."

A few years ago, it was by no means foreseeable that Mine's career would one day take her to a German research vessel. Originally, the Turkish woman who grew up in Istanbul studied technical computer science, then worked as a software programmer and finally as a regional sales manager for Hewlett Packard. The trigger for the career change was her passion for diving, which she discovered in 2006. "I travelled all over the world for it and was fascinated to learn all about the flora and fauna of the underwater world. I took my diving instructor's licence and initially even wanted to work in this field." However, seeing her passion jeopardised in the day-to-day professional life of a diving instructor, Mine ultimately decided on a career change that combined oceans and scientific work. "While studying in the field of marine environment, I then got to the AWI in Bremerhaven via my master's thesis," Mine recalls. "I had read a publication by marine biologist Melanie Bergmann, who works there, about her macroplastics research in the Arctic and applied to the institute as a result." Melanie is now supervising Mine's doctoral thesis and is also part of our research group on the SONNE.

And how did Mine come to work on our research vessel SONNE specifically on the topic of microplastics, I want to know. "It all started when I was researching macroplastics on the seabed in the Arctic with Melanie," Mine recalls. So-called macroplastics are larger pieces of plastic; in distinction to this is the term microplastics, which refers to plastic particles with a diameter of less than 5 millimetres. The AWI studies have taken place annually since 1999 in the so-called "HAUSGARTEN" (“Housegarden”), an Arctic deep-sea observatory consisting of 21 measuring stations in the Fram Strait between Greenland and Spitsbergen (LTER - Long-Term Ecological Research - Observatory). "As part of a long-term study there, we observed a more than 20-fold increase in waste on the seabed at one location. At a depth of 2500 metres!" If the measurements at the northernmost measuring station N3, located in the ice edge zone of the Hausgarten, in 2004 still resulted in 346 pieces of rubbish per square kilometre, extrapolated, ten years later it was 8,082. "With regard to sediments, Melanie had already regularly collected measurement data since 2015 within the framework of the Arctic Long-term Observatory FRAM. What was missing, however, was corresponding data on the plastic occurrence in the water column above," Mine describes the situation in retrospect. "For this reason, we started working with the in situ pumps in the Arctic and now want to explore something comparable for the Pacific Ocean as part of the SONNE expedition."

As we talk, the water veins have grown into stately river courses, so numerous that a veritable delta has formed on the deck. The sky is now reflected in the adjacent lake plateau. In the reflection, both elements begin to unite in my mind's eye. Birds and clouds fly through the water - fish swim through the air.

A fusion of the elements on the deck of the ship - air and water united.

The flying fish that have accompanied our ship for some time seem to me like visionary border crossers, mediators between reality and fantasy. The shift in perspective, the first symptoms of which I felt shortly after our departure from Vancouver - the horizon, a dividing line in the process of dissolving, slumbering ships in a united place of both otherwise clearly separated spheres ... - seems to be progressing further.

Flying fish - border crossers between the elements (Photo: Gritta Veit-Köhler).

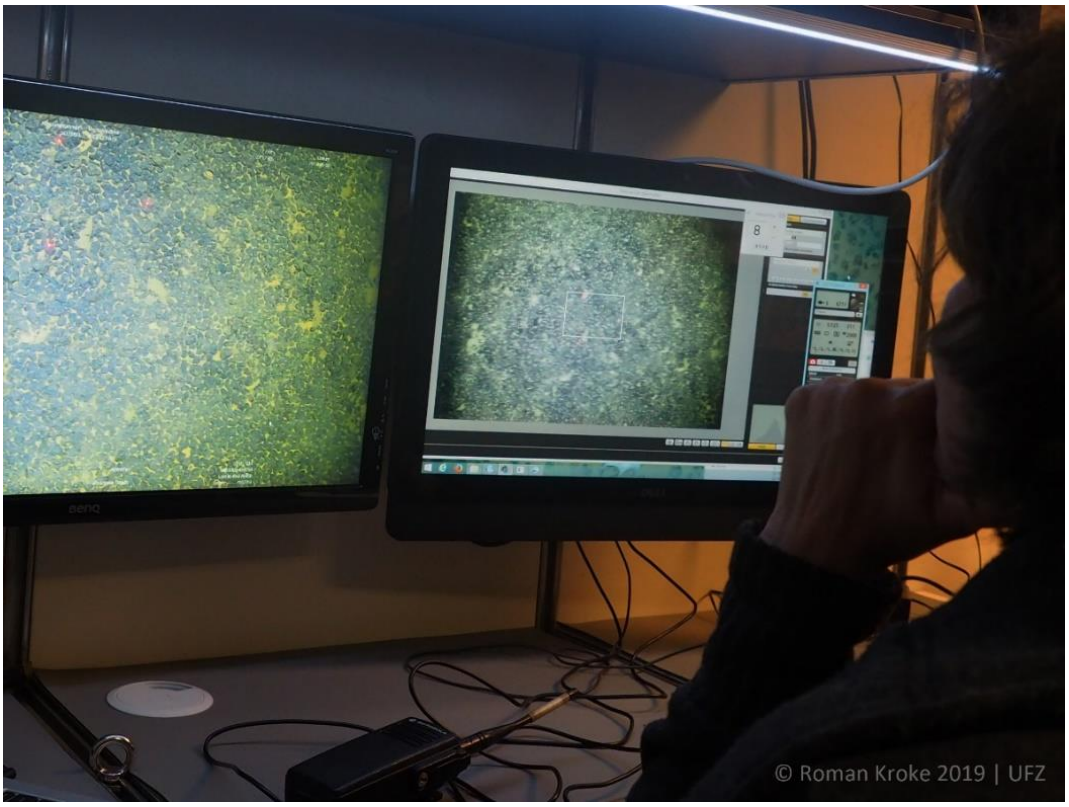
My photo “Unity”, taken shortly after our departure from Vancouver.
The horizon, usually a dividing line between the realm of air and that of water,
is in the process of dissolving.
Ships slumbering in a united place of both spheres ...
Do you see the flag suggesting a united world of water and air?

I have to think of our interdisciplinary group of scientists. On the one hand, there are the plastic researchers from the MICRO-FATE project, whose view of the world is directed downwards from the surface of the sea; on the other hand, there are the colleagues from the MORE-2 team, whose attention is directed skywards to explore the world of aerosols - a mixture of solid and liquid suspended particles - and greenhouse gases. To what extent does the intermingling of both worlds on our SONNE expedition offer both research camps the opportunity to break through the boundary of the water surface in the other direction in order to derive inspiration for their own working methodology in the neighbouring element?

Another reflection in our lake plate brings me back to reality: a colossus of a steel frame hanging from a rope.

The remote-controlled camera system OFOS (Ocean Floor Observation System).

The remote-controlled camera system OFOS (Ocean Floor Observation System) is the same kind of instrument which Mine and Melanie used in the Arctic to uncover the significant increase in macroplastics. Our scientists on board of the SONNE also have such a “deep-sea eye” at their disposal, which hovers about 1.5 metres above the seabed when in use. Its most important element is a still camera that takes a still picture every 20 seconds. Three red laser dots are always projected onto the seabed - each at a distance of 40 centimetres. This allows the scientists to correctly classify the size ratios on the photo and thus the "fingerprint" of the seabed. Melanie analysed more than 5,000 of these photos in the SONNE computer room during the expedition. "For me, the results are surprising," is the marine biologist's first conclusion. "Many manganese nodules, bizarre life forms, but surprisingly little plastic. Especially in the area of the Great Pacific Garbage Patch, I personally expected more sightings, especially because in our study area in the Arctic we have always seen the most rubbish on the seafloor." So even after our expedition, one central question will continue to haunt the researchers: Where exactly in the ocean is all our plastic waste?

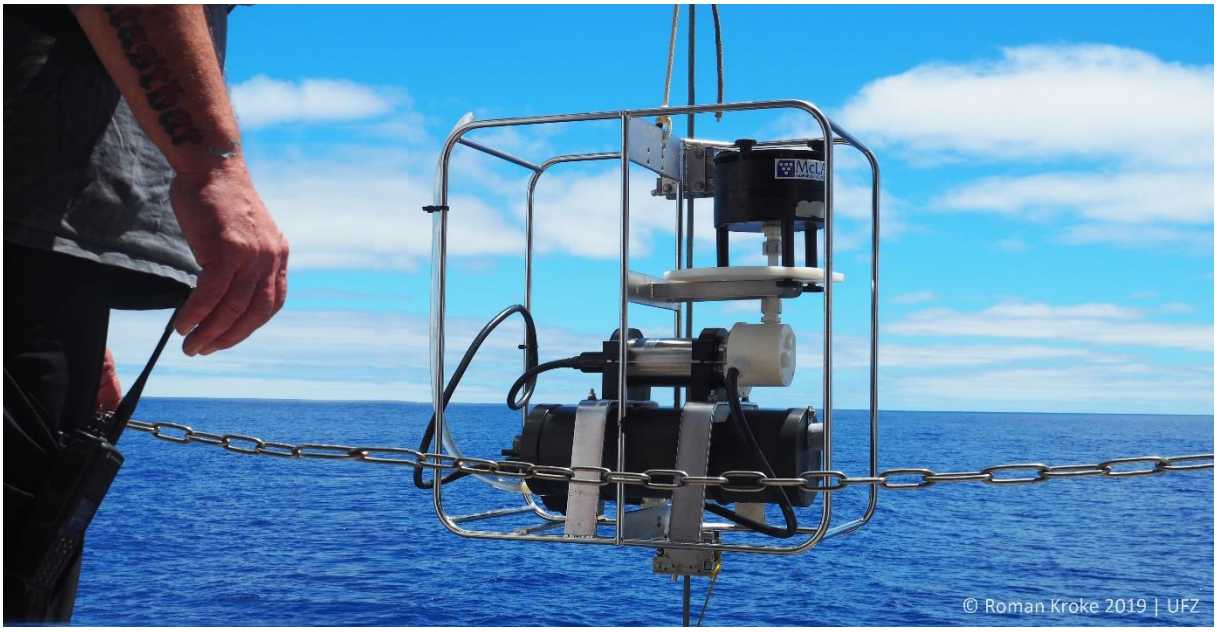


Melanie Bergmann (marine biologist from AWI Bremerhaven) evaluates on the SONNE the OFOS photos with a view to the sighting of macroplastics.

A seabed littered with manganese nodules. The three red laser dots allow a correct classification of the size ratios.

Our “deep-sea eye” OFOS comes back from the
seabed with photos from more than 5000 metres depth..

My attention swings back to our two in situ pumps. As Mine explains to me exactly how they work, I realise that, on board of our research vessel, the Brothers Grimm's fairy tale has undergone a dynamic transformation: In addition to Hansel and Gretel, two other protagonists belong to the research project comprising a total of four in situ pumps: Hulda and Jimmy.



Hulda, a new protagonist in our adapted fairy tale of the Brothers Grimm.

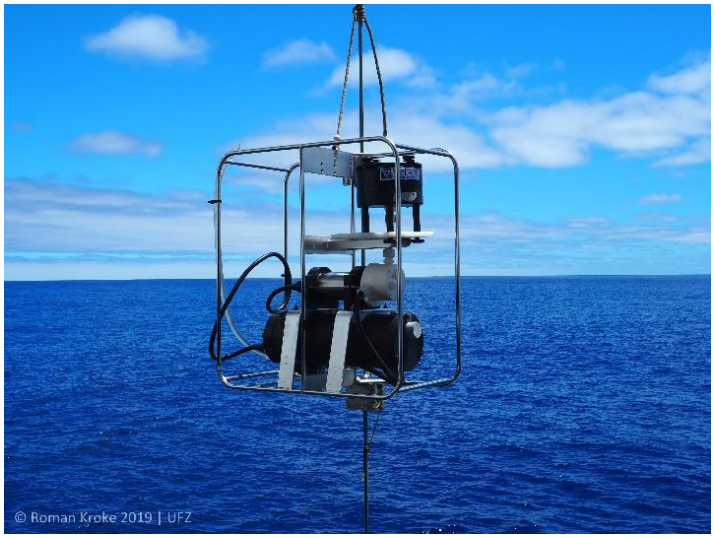
The scientific aim of using the in situ pumps is to determine the amount and type of plastic particles at different depths in the water column. The division of labour between the four pumps is as follows: Gretel takes care of the deepest filter level, which is about 70 metres above the seabed at each station on our itinerary. The next higher segment at 2,500 metres belongs to her brother's area of responsibility. Hulda then sits at 300 metres, and Jimmy finally takes on that area where the so-called "deep chlorophyll maximum" is located. Before I discuss these filter levels separately, I would first like to take a closer look at some basic characteristics of the in situ pumps:

A significant advantage of this system is the large volume they can filter. Unlike, for example, our CTD rosette the in situ pumps are not based on the principle of water samplers. They filter the water on site (in situ) at the exact depth that is to be investigated. Every hour, each pump chases a volume of at least 200 litres through its internal filter system, which is equipped with mesh sizes of 35, 10 and 0.45 µm (micrometres). "Since we can filter a total of up to 400 litres per pump at each station in this way - in comparison, the CTD rosette only scoops about 60 litres per depth - this allows us to conduct a more representative study closer to reality in terms of microplastic findings," Mine explains. In this respect, it should be taken into account that the scientists always extrapolate the detection of microplastic particles to the internationally common volume unit of one cubic metre (1,000 litres) in their final analysis results in order to ensure comparability of different studies. Accordingly, the in situ pumps achieve a higher accuracy and reduce the risk of outlier measurements that tends to exist with more selective sampling.

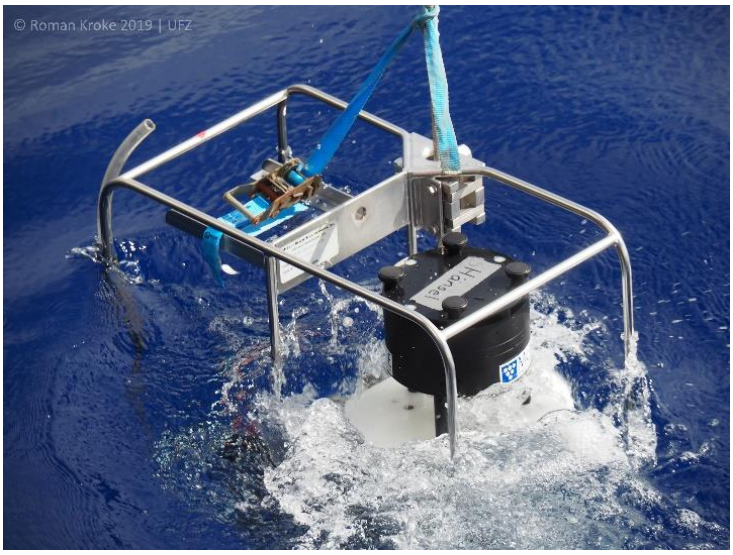
Torsten Kruszona alias "Union" and Annika Jahnke (UFZ Leipzig) at the release of Hansel.

Unlike our CTD rosette, the in situ pumps cannot be triggered remotely from on board. This has far-reaching consequences in terms of handling: "The moment the pumps go into the water, we lose control to a certain extent," explains Mine. "That's why we have to programme them beforehand via the laptop according to our research goals. First of all, we have to determine the exact moment when all four devices should start pumping at the same time. In addition, we also use the programming to determine the flow rate as well as the pumping duration - between one and two hours on this expedition." The last point in particular illustrates why functioning electronics and thus especially careful cleaning of the sealing rings is absolutely vital for Hansel, Gretel & Co: "If the devices don't stop pumping after the set period of time, but are still in operation when the water comes out, this could damage them permanently." It is also important to note that the pumps themselves have no sensors to measure their respective water depths. This means they have no way of stopping

independently at the desired location in the water column. To ensure that the four pumps can nevertheless be placed correctly, the scientists on the SONNE proceed as follows: The four in situ pumps are always sent down the same rope together with the CTD rosette.

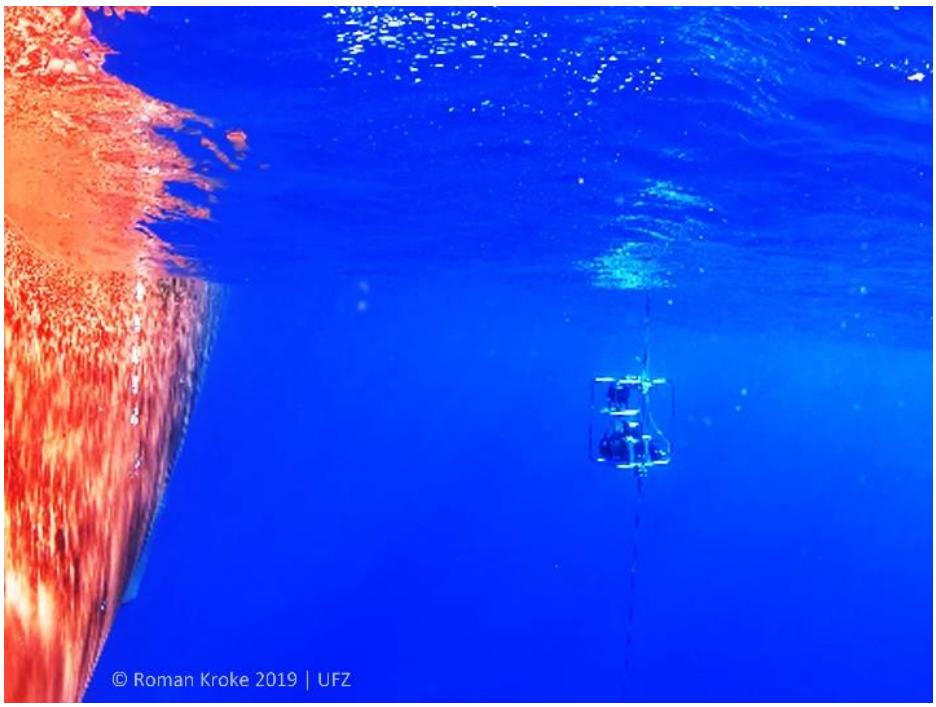


Thanks to an echo sounder measurement, we know the respective distance to the seabed; accordingly, the first step is to measure the required cable length for the CTD, whose first station should be just above the ocean floor. In addition, we can use the average speed of the cable winch to the CTD rosette (approx. 0.7 m/second) to calculate how long it will take the probe to reach its deepest station. Let's assume that the calculation showed that the CTD takes 2 hours to reach the seabed. In this case, Mine would programme all four in situ pumps before leaving the ship to start filtering approximately 2 hours and 30 minutes from the time the CTD left the ship's deck. According to the respective desired filter depth, the distance with which all four pumps must be fixed above the CTD is then measured on the cable. In order to assure that the rosette and the pump with the deepest filter station (Gretel) do not get in each other's way, the latter is always placed about 20 metres above the CTD. The simultaneous use of CTD and in situ pumps has the additional advantage of saving valuable station time.



Hansel getting his feet wet.

At this point, the special merit of the ship's crew must be emphasised, without whom we would not have lost Hansel, Gretel & Co in the forest, but probably long ago in the ocean. "Their help and expertise were of indispensable value to us," Mine emphasises. "Because of their experience, they know exactly how to securely fasten the pumps, which weigh 60 kilos each, to the cable - and in such a way that they are still hanging on the rope when you retrieve it after the filtering process is finished!"



Hansel's aquatic fairy tale begins:
Any breadcrumbs under water?
Or just microplastics?

Next, I am interested in the reasons behind the sampling depths chosen for the four pumps. "The station above the seabed allows us to compare the amount of plastic in the lowest part of the water column with the sediment layer adjacent to it," Mine explains. I will tell you about our multicorer, a sampling device that the scientists use to punch sediment samples out of the seabed, in an upcoming blog. "We chose Hansel's filter depth of 2500 metres because it allows us to compare it with the AWI studies in the Arctic that we mentioned earlier, which we conducted at that very depth." The two remaining depths can only be understood in conjunction: The last in situ pump (Jimmy) is - as already mentioned - always placed in the water segment where the so-called "deep chlorophyll maximum" (DCM) is located. This is the area of the water column with the highest chlorophyll concentration, i.e. the main mass of phytoplankton, which builds up its body substance (biomass) from carbon dioxide and nutrients with the help of photosynthesis. This "phytoplankton" mainly includes algae (e.g. diatoms, green and golden algae), "armoured flagellates" (dinoflagellates) and cyanobacteria. The exact location of the DCM in the water column can vary greatly depending on the region and flow conditions. Here lies another advantage of coupling the use of the in situ pumps with the CTD rosette. "To find out the exact depth of the DCM for Jimmy, we wait for the data that the CTD rosette gives us on its way to the seabed. After its PAR (Photosynthetically Active Radiation) sensor has given us the location of the strongest

photosynthetically active radiation, we still have enough time to attach Jimmy to the appropriate part of the rope." And why is this area so interesting for microplastics research? "We still don't know exactly how microplastics are transported from the water surface to the seabed," Mine tells me, explaining the current state of research. "There are different explanations: For example, by sinking together with dead plankton, via consumption by zooplankton or faeces of aquatic organisms." This also explains Hulda's filtration depth at 300 metres. "In this water segment, the lightless area begins, where consequently no more phytoplankton can exist," Mine explains. "Measurement data on the development and possible change of the microplastic occurrence in the water segment between the deep chlorophyll maximum and the lightless area can therefore give us important information on how microplastic is integrated into the biological processes there."

Since Gretel has just returned from her trip on deck, I have the opportunity to directly follow the further treatment of the filter samples obtained. In a first step, Mine causes all the salt water still in the pumps to be flushed out by programming command via the connection of her laptop. "If there is still too much water in the unit, there would otherwise be a risk of the plastic particles being washed up when the filter gauzes are removed and thus being lost," she explains.

After opening the filter heads, the mesh nets are carefully folded up with a pair of tweezers and put into a glass container.

To prevent particles that have stuck to the tool from getting lost and falsifying the measurement, Mine and Annika then rinse the cutlery again over the glass vessel with ultrapure water. Finally, the two scientists freeze the vessels at -20°C in a freezer so that they are safely preserved for the journey to the UFZ laboratory in Leipzig.

In the meantime, the water veins on the ship's deck have disappeared. The lake land has been completely absorbed by the ship's planks. The fish are swimming in the water, the birds are flying in the sky. Everybody is back at its place, just as it "should" be. At the end of our expedition, the SONNE researchers will also return to their ancestral research areas of air and water. And what about me? Charcoal pencils, linen fabric and oil paint will be waiting in my atelier. And there will be the challenge of extracting the coulor pigments from the deep sea sediments which I will take with me from the expedition; and the question how the experiment will turn out of mixing them with the Pacific water samples to create drawings addressing topics of marine conservation …

And what remains for the child of the fairy tale once the words have faded away

"And if they have not died, they will still be living happily ever"?