Exploring the Secrets of the Deep Sea

The Research Vessel SONNE in the Service of German Marine Science
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The seas and oceans are huge, mysterious, and largely unexplored. As the largest reservoirs of heat and carbon in the Earth’s climate system, they play a major role in our lives. But how intensively can they be used, how can their resources be exploited, and how can we preserve them as a natural environment? Marine sciences can help us answer these questions.

In 2014, German marine science entered on a new era with its new research vessel SONNE. With a length of 116 meters and a beam of 21 meters, SONNE not only significantly exceeds the size of her predecessor, she also sets new technological standards. Thanks to innovative marine technology and improved methods, SONNE’s scientists gain access to previously uncharted ocean depths. Some of the vessel’s equipment includes state-of-the-art echo sounders and winches with cables up to twelve kilometers long, making measurements even in the deepest oceanic trenches possible. Several underwater robots can be used simultaneously to image the seafloor and to bring valuable samples back on deck. These samples can be analyzed directly on board in SONNE’s 17 laboratories.

Before SONNE took off on her first research expedition in the Atlantic in December 2014, the public had a chance to explore the ship and experience the fascination of marine science first-hand during a series of “open-ship” visits along the German coast. The Pacific and Indian Oceans are now the main areas of operation for the SONNE, where she provides a research platform for marine and Earth sciences. The German research fleet, which includes the research vessels POLARSTERN, METEOR, MARIA S. MERIAN, and another twelve mid-sized and small vessels in addition to SONNE, provides crucial information for international climate and ocean predictions. As a result, the fleet supports planning efforts for our society’s future well-being and is an integral part of the program “Research for Sustainable Development (FONA)”.

I wish the research vessel SONNE and her crew successful expeditions and groundbreaking discoveries.

Prof. Dr. Johanna Wanka
Federal Minister of Education and Research
EXPLORING THE SECRETS OF THE DEEP SEA

be used to deploy instruments even into the greatest depths of the ocean, that is, into the hadal zone starting at a depth of 6,000 meters. This is something that no other vessel has been able to accomplish to date due to the lack of sufficiently long cables. In other words, the German research fleet’s new cutting-edge member, which has its home at the Institute for Chemistry and Biology of the Marine Environment (ICBM) at the University of Oldenburg, is setting new standards worldwide in terms of capacity, performance, and the ability to meet the requirements of the future.

This all starts from the very basics, namely, the space on board: The new SONNE is considerably larger than its predecessor, meaning it provides enough working space for the broad variety of submersibles, drill rigs, and other oceanographic instrumentation that modern science requires for its work. It is environmentally friendly and designed to minimize vibrations, ensuring that samples can be analyzed and evaluated on board. In addition, it allows for the use of large equipment – more than one unit at the same time if necessary. But perhaps most importantly, it can

1. New Research Vessel

A platform for marine research in the Pacific and Indian Ocean

The changing of the guard on the other side of the world was an absolute success for the German research fleet, with the new SONNE starting its operations in the Indian and Pacific Oceans at the end of 2014. The German Federation’s deep-sea research vessel, which is just under 120 meters long and has a beam of 21 meters, will be the most important platform for German marine scientific research in the Indo-Pacific for the next decade. And its researchers couldn’t be happier.

“This vessel represents a quantum leap in terms of the research and exploration possibilities it offers,” said Gerold Wefer, founding Director of the Center for Marine Environmental Sciences (MARUM) in Bremen, after a test trip to the German Bight. The ship, whose home port is Wilhelmshaven, is perfectly prepared for the future challenges that await the field of marine science. It is environmentally friendly and designed to minimize vibrations, ensuring that samples can be analyzed and evaluated on board. In addition, it allows for the use of large equipment – more than one unit at the same time if necessary. But perhaps most importantly, it can

This all starts from the very basics, namely, the space on board: The new SONNE is considerably larger than its predecessor, meaning it provides enough working space for the broad variety of submersibles, drill rigs, and other oceanographic instrumentation that modern science requires for its work. It has even become apparent that it will be possible in the future for several of the complex machines to be on board at the same time and to be operated simultaneously or even in a concerted fashion, explains Thomas Kuhn, who works as a scientist and expedition manager at the Federal Institute for Geosciences and Natural Resources (BGR). “There are 40 berths available, meaning it’s possible to take the
technical personnel required to operate the instruments.” Not to mention that the people in charge of preparing the vessel for working with large equipment did a magnificent job: The old SONNE had already become well-known for its outstanding assortment of cranes and other lifting equipment, but the new vessel goes one step further. “Our experience with the large equipment used for research, and the fact that it keeps getting heavier and bulkier, led to the decision to equip the vessel with even better lifting equipment,” says Niels Jakobi, Operational Manager at the Control Station German Research Vessels of the University of Hamburg.

**Deploying two large pieces of gear? No problem!**

Accordingly, the entire deck can be reached with one of the seven cranes, two sliding beams, or the massive A-frame at the stern. This A-frame can handle loads of up to 30 tons and was especially designed to deal with heavy and unwieldy loads by means of a freely rotating cross beam that absorbs any swinging motions. “This has made deploying and recovering equipment much safer,” says Fritz Abegg, whose responsibilities at GEOMAR Helmholtz Centre for Ocean Research Kiel include the 3.5-metric-ton remotely operated vehicle (ROV) KIEL 6000.

Meanwhile, the large sliding beam can be used to deploy loads of up to 25 metric tons over the starboard side. It can also be raised and used as a crane, in which case it has a still-impressive capacity of ten tons. “We’re now able to work with two pieces of heavy gear at the same time,” comments Tim Freudenthal, who is in charge of the seabed drill rig at MARUM, “something which, until now, we could only dream of.”

The vessel also has a lot to offer below deck. There are about 600 square meters of workspace for all kinds of scientific work. This includes eight laboratories that can be cooled down to near freezing if necessary. Moreover, these laboratories provide researchers with the necessary basic infrastructure, featuring powerful information and communication technologies that are compatible with the users’ own IT equipment.
“Nowadays, everyone brings their own specialized equipment with them,” says Niels Jakobi. Upright freezers and a liquid nitrogen generator, enabling this important refrigerant to be produced on board, are available to biologists. SONNE is, after all, a research vessel intended for all marine sciences. There is also a large hangar with its own 1.5-metric-ton crane. Here, equipment can be serviced and reconfigured while being protected from wind and rain. The hangar can, however, also serve as a wet laboratory in its own right, for instance when water samples need to be taken from the rosette water sampler or cores need to be removed from the corer. “It’s really great that you can move equipment into a shady area or have a roof over your head, when there’s a torrential downpour in the tropics,” explains Sabine Kasten, who works as a researcher at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI).

**Even the greatest depths can now be sampled**

SONNE is currently the only German research vessel that has cables that can reach the lowest part of oceanic trenches, in the “hadal zone”. “The winch can handle 12,000 meters of cable,” emphasises Angelika Brandt, who works as a marine biologist at the University of Hamburg, “that means we can work in the hadal zone, which is something we weren’t able to do previously.” Brandt and her team put the deep-sea winch to the acid test on its first scientific expedition, and were able to use their equipment at a depth of 8,350 meters at the Puerto Rico Trench. Scientists who work with their instruments close to the ocean floor will find the main winch’s heave compensation system of particular interest. This system automatically compensates for the vessel’s rise and fall with the swell, ensuring that the scientific equipment being used will remain at the same constant height above the ocean floor. In addition, a similar quantum leap in terms
of engineering can be seen in the echo sounders on the vessel, which are far superior to the systems used before. "We can now detect ocean floor structures with a size of 30 meters at a depth of 4,200 meters. In comparison, the old system's resolution came in at a mere 120 meters," says Thomas Kuhn when reporting on his expedition to the "manganese nodule belt" in the Tropical Pacific.

Previously, the wealth of incoming data would have been simply too much for the computer systems on the vessel to handle properly, but in the meantime, maps of the floor can be produced with a previously unheard of accuracy, all the necessary IT capabilities are available directly on board. In addition to the improved computing power, a specially designed hull form is also responsible for these advances: its special geometry prevents air bubbles from the ocean surface from getting under the vessel and interfering with the sonar signals' reception.

Perfectly equipped for expeditions lasting weeks

The new SONNE also surpasses its predecessor when it comes to its accommodations. "You really feel that things were done with the people who live and work on the ship in mind," says Fritz Abegg, who is full of praise for the vessel's living quarters and amenities and spends many weeks a year on the high seas. And there is good reason for the improvements. After all, the people on the new vessel will see land a lot less than on the old SONNE. "All the cruises will be longer than they used to be," explains Sabine Kasten after taking a quick look at the schedule of upcoming cruises. The norm will be a minimum of five weeks on the new ship. Add to this that each expedition will be marked by intensive shift work on deck and in the laboratory and a dearth of free time and it quickly becomes obvious that providing a little privacy is the least that can be done for the vessel’s crew and researchers.
Another important advantage that has been confirmed by everyone who has been on the vessel so far is that it is extremely stable, even in high seas. "That's already a gigantic leap forward in comparison to other existing German ocean-going research vessels," says Fritz Abegg, ROV Manager at GEOMAR in Kiel. This excellent seakeeping ability is not just due to the vessel’s sheer size, but also to what is commonly called an “Intering system” – an enormous antiroll U-tube tank that is installed transversely in the vessel’s aft area above the three lower decks and is filled with 250 cubic meters of water. The water can either be actively pumped from one side of the ship to the other or can move based on centrifugal force with a certain delay relative to the vessel’s motion. “What this does is dampen the vessel’s roll motion,” explains captain Lutz Mallon, who commanded the previous SONNE for many years as well.

The vessel’s dynamic positioning allows for precise research deployments. The two fixed-pitch propellers are complemented by a retractable bow thruster, a retractable stern thruster, and a rotating pump-jet under the hull, providing more than enough maneuverability in high seas. “We were maneuvering in shallow water, where dynamic positioning is even more important,” says MARUM scientist Gerold Wefer while reporting on his test run with research vessel SONNE and the MeBo200 sea floor drill rig in a mud depocenter area close to Helgoland. “On top of that, the weather conditions were terrible, there was a strong tidal current, and wind conditions were all over the place. And even then, everything worked out perfectly.”

Given the fact that it is a research vessel owned by the German Federation, SONNE is also a way to showcase shipbuilding and marine engineering “made in Germany”. For example, special safety provisions in line with the „Safe Return to Port“ requirement were taken into account during construction – a first for a German research vessel. As a result, the vessel can return to a port unaided in case of emergency. “Even if parts of the vessel – including the bridge – were to catch fire, it would still be possible to steer it safely into port from a..."
different part of the ship,” explains Michael Schulz, Director of MARUM in Bremen and current Chairman of the Permanent Senate Commission on Oceanography at the German Research Foundation (DFG). The vessel can be steered this way up to 2,000 nautical miles, and emergency accommodation for its crew and scientific personnel are also provided.

**Travel with a Blue Angel**

It goes without saying that the vessel is also leading the pack when it comes to environmental protection. “The exhaust systems were all designed in line with Blue Angel certification requirements,” explains Niels Jakobi. It is not only that the vessel uses ultra-low-sulfur diesel fuel, but also that its exhaust gases are scrubbed in order to remove nitrogen oxide so as to keep emissions as low as possible. That means that the emission standards that are expected to come into effect in a few years time are already being complied with. The optimized hull design and the vessel’s diesel-electric propulsion both contribute to lowering fuel consumption, while a cutting-edge waste heat recovery design increases energy efficiency even further. And SONNE is also setting new standards in another critical area for research vessels: The noise and vibrations coming from the engines are reduced to a minimum. All the engines have anti-vibration mounts, ensuring that almost no vibrations are transmitted to the hull. This also means that the people on board barely notice the 6,500 kilowatts of diesel power working beneath their feet. “As a result, the marine fauna in the water column is also subjected to a lot less noise,” zoologist Angelika Brandt effusively, “and for all on board it is a totally new level of cruise comfort.”
In addition, building a new state-of-the-art research vessel with powerful capabilities as a replacement for the METEOR and POSEIDON will make it possible to quickly overcome any foreseeable scientific challenges in the future. This means that at the end of the modernization process, about 750 million euros will have been invested in new vessels that will make the German research fleet one of the most modern and impressive in the world.

Marine science is one of the keys to sustainability

“We rely on public funding, which of course means we need to explain exactly how taxpayers will benefit from our work,” says climate scientist Michael Schulz from MARUM. Schulz is also Chairman of the Permanent Senate Commission on Oceanography at the Deutsche Forschungsgemeinschaft, which, together with the BMBF and other vessel-operating organizations, has made a series of proposals aimed at implementing a standardized procedure for reviewing research proposals requesting ship time. The goal? To assign capacities on the basis of standardized criteria in the future so as to optimize vessel utilization.

“Marine science research is not a luxury,” explains Schulz, “three quarters of the Earth’s surface is covered by oceans, which means that studying them is a fundamental part of our sustainability research.” And that is how the German government sees things as well. “We’re facing a series of enormous challenges that we’ll only be able to overcome with state-of-the-art coastal, marine, and...
polar research infrastructure,” Wilfried Kraus asserts. Accordingly, the BMBF, together with the ministries for economic affairs, agriculture, transport, and the environment, has prepared a new program for coastal, marine, and polar research called Mare:N. One of the goals of this program is to develop the foundations for sustainable exploitation strategies for marine resources, which will make it necessary to take into account not only climate change, but also the increasing pressure that human activities are exerting on these resources. And it goes without saying that research vessels will continue to be an indispensable platform for these branches of science.

Climate change policies, ensuring sustainable use of marine resources, tapping into new sources of raw materials while at the same time protecting the environment for future generations – all these are policy areas in which the government depends on the findings of marine, climate, and polar research. “Improved climate models and qualified contributions to IPCC reports both provide important information to help politicians make the right policy decisions,” explains Wilfried Kraus. The IPCC, or Intergovernmental Panel on Climate Change, is the UN body in charge of consolidating the world’s expertise in this area. “In order to be able to have these things, we need more knowledge regarding the oceans’ storage capacity, the repercussions that the higher concentrations of carbon dioxide in the water will have on marine life, and so on,” says Kraus. This is why the government is taking serious steps to fund and promote marine, climate, and polar sciences. To understand the ocean, its function, and the functions of the organisms living in it we need high quality research. “Only when we understand the system as a whole will we be able to make the right decisions to protect it and ensure that it is able to continue performing its functions,” Wilfried Kraus points out.

When judged by this maxim, Germany has been enormously successful in terms of its marine science efforts, with scientists from its universities exploring the oceans together with research organizations such as the Helmholtz, Leibniz, Max-Planck, and Fraunhofer institutes and government research organizations as well. This is one of the reasons why German marine science is so comprehensive: “All disciplines – from the natural sciences to engineering disciplines – are represented, and in the past few years have become increasingly interconnected with the social sciences,” points out MARUM head Schulz.

Multi-purpose vessels designed for all kinds of scientific research

The research fleet reflects this. “These are multi-purpose vessels,” explains Schulz, “that can be used by many scientific disciplines.” In fact, the versatility behind these German vessels, combined with their presence on every ocean in the world, makes them superb platforms for international scientific collaboration. “If you want to play in the major leagues, you need to provide the necessary infrastructure,” says BMBF spokesperson Wilfried Kraus, “that’s the way to ensure that work will be internationally distributed in an effective manner in the long term.” This is absolutely essential, as large research projects would pretty much stop working overnight without international cooperation.

The way in which German science has succeeded in terms of networking is shown by the large number of foreign scientists aboard German vessels. In Europe, the OFEG (Ocean Facilities Exchange Group) system ensures very close cooperation by allowing scientists to schedule ship time on other countries’ vessels if this will enable them to better meet their objectives. The currency used to make this work consists of „barter points“ that take into account a vessel’s technical capabilities and size, as well as the relevant project’s duration. Over the course of several years, barter point credits and debits between the different partners need to balance.
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3. Test Run in the North Sea

SONNE research vessel successfully completed extensive testing

The new SONNE was not just tested to make sure it was up to the task – it was tested more thoroughly than any other German research vessel before. It completed five scientific test runs in the North Sea and in the North Atlantic before heading off for its first research expedition across the Atlantic. And the test runs took place during the fall months, giving the vessel the opportunity to prove its seaworthiness under adverse weather conditions: from absolute calm to violent storms, the new ship was exposed to all kinds of weather.

Researchers from the Federal Institute for Geosciences and Natural Resources (BGR) in Hanover, who brought a new seismometer system on board at the end of September 2014 in order to be able to survey the ocean floor three-dimensionally, had the best possible conditions for their vessel test. With the water as smooth as a mirror, they were able to deploy their complex instrument setup, and its seismic cables with a length of up to four kilometers, close to the Scottish coast and acquire a series of profiles. On the other hand, researchers from GEOMAR were caught by surprise by the other end of the weather spectrum on their journey from Aberdeen, Scotland to Bremerhaven: They were forced to brave wind gusts of up to Beaufort number 12, the top end of the scale. And the following tour with MARUM’s MeBo200 sea floor drill rig, during which a television crew was also on board, was no smooth sailing either. “Ex-Hurricane Gonzalo came through right during our test run,” reports MARUM Director Michael Schulz, “I can’t say it was a particularly pleasant experience, but I’d never been on a research vessel that was able to remain that stable under such conditions before.” Unfortunately, however, the Bremen crew was unable to complete every item on their work schedule during their nine-day run in October 2014, as the vessel had to...
seek shelter from the wind and waves close to Helgoland at one point. Despite this, however, the marine scientists on board certainly did not think of their experience as time wasted. “Sure, autumn is not the best time to travel to the North Sea in general,” comments Tim Freudenthal, who is responsible for the MeBo70 and MeBo200 sea floor drill rigs, “but we were more than happy to just have the opportunity to go.” More specifically, the trial run gave the MARUM team a chance to use the sea area around Helgoland to test how the brand new MeBo200 would work with SONNE.

**GOLDEN EYE sees right through the ocean floor**

The sensor used by the Federal Institute for Geo-sciences and Natural Resources (BGR) to “look” into the upper layers of the ocean floor is circular, bright yellow, and has a diameter of 3.6 meters.

Known as GOLDEN EYE, this device measures the electrical and magnetic properties of the sub seabed – methods that have been used for mineral exploration on land for a long time already. The BGR wants to use this sensor system to explore the massive sulfide ore deposits produced by black smokers in the deep sea.

**Fine motor control in the middle of the deep sea**

Remotely operated underwater vehicles such as GEOMAR’s ROV KIEL 6000 and MARUM’s QUEST are the workhorses of German marine research. The vehicle from Kiel can work at a maximum operating depth of 6,000 meters, and is connected to the research vessel on the surface by a cable that is only 19 millimeters thick. The vehicle is self-propelled when underwater and has a highly flexible and powerful arm, enabling it to bring up samples from the deep sea even under difficult conditions.

**Heave compensation test passed with flying colors**

The people in the second BGR team, who together with engineers from the University of Bremen and the cutting-edge GOLDEN EYE electromagnetic profiler were also along for the ride in the North Sea, also weighed in with positive comments. “It gave us a chance to try out the heave compensation system, which was doubly rewarding in that it worked perfectly,” reports Katrin Schwalenberg, who is responsible for the system at the BGR in Hanover. Its name comes from the bright yellow circular equipment cage that houses the various sensors. The instrument, which has a diameter of 3.6 meters, needs to be guided as close as possible to the ocean floor, and will be used to explore polymetallic sulfide deposits in Germany’s licensed areas in the Indian Ocean in the future.

The weather provided Schwalenberg and her team with the opportunity to test the automatic vertical ship motion compensation function during the trial run all the way to the “Devil’s Hole” east of Scotland. On certain days, the work needed to be cancelled completely due to poor conditions, while, on others, there were two-meter waves that could have definitely put an instrument being towed close to the ocean floor at risk. More specifically, GOLDEN EYE’s fiberglass frame can handle bumps up to a certain extent and, to boot, features rubber guards designed to protect it from impacts, but it was not designed to be constantly bumping into the seafloor or to be dragged across it. And thanks to the heave compensation system, neither the frame nor the rubber guards had to step in and save the day.
Such large instruments are essential tools in the field of modern marine science. They have become a de facto element of every research journey, and in many cases more than one needs to be used at the same time. “When there’s an expedition, researchers want us to actually get some core samples,” Tim Freudenthal comments, “they don’t just want to go on test runs.” That is why experts like him, who operate these instruments for the benefit of science, know how important it is to test how the work aboard SONNE can be organized and will actually flow in real-life before the instruments face their first real mission. “This, of course, means that we got a lot of invaluable data from the trial run,” comments MARUM founding director Gerold Wefer when giving his opinion on the trip to Helgoland, “we got a very good sense of how we should be planning and carrying out future expeditions with the vessel.”

In the next few years, the MARUM drill rig will be deployed more often on SONNE, which also applies to GEOMAR’s ROV KIEL 6000 remotely operated underwater vehicle. “We’ve already scheduled five trips on SONNE,” says Fritz Abegg, the team leader in charge of the ROV from Kiel, as he makes a short stop between two of these trips in his office, located on the eastern shore of the Kiel fjord. “The trial run was crucial in that it let us see how the ROV and the vessel work together.” The earth scientist and his eight-person team ran their tests in December 2014 as SONNE made a stop at Las Palmas in Gran Canaria on its journey from Germany. This would be the last stop in the eastern part of the Atlantic, and the vessel then headed off for its first research expedition towards the Caribbean.

Simulations went incredibly smoothly

Large instruments such as ROVs and the MeBos always come with a lot of “luggage,” and there has to be space on board for it. For instance, the ROV KIEL 6000 requires five standard 20-foot containers, while the seabed drill rig from Bremen needs as many as seven. “It goes without saying that you can use diagrams to see how it’ll work in theory,” explains Gerold Wefer, “but it takes a real-life test to iron out the kinks.” For example, the spot originally planned for a container may not be ideal because it results in a door being blocked.

Wirelessly on patrol

Autonomous underwater vehicles (AUVs) expand a research vessel’s working range tremendously. These battery-powered, torpedo-shaped devices can traverse the entire water column up to 100 kilometers and, once launched, follow their programming to perform their work independently, enabling them to explore areas that manned underwater vehicles are unable to access. German researchers have several AUVs at their disposal, some of which can operate at depths of up to 6,000 meters.
On top of this, a number of potential improvements were discovered on the test runs, making it possible to implement them before the vessel started its work in the service of science. For instance, the power-hungry machines required fuses with higher ratings, an adapter was needed in order to be able to deploy the ROV safely using the A-frame at the stern, and the core holding frame for the gravity corers, which was too weak, had to be reinforced. “In the end,” says Gerold Wefer, “the whole purpose of the test runs was to identify any weaknesses that still needed to be corrected.”

Ultimately, the simulations and the real-life tests that followed them went so smoothly that the Bremen and Kiel experts were taken by surprise. “In terms of its stability, the space on deck, and the A-frame’s load capacity, this research vessel is simply in a league of its own,” says Gerold Wefer, who was full of praise for the new SONNE – an opinion that certainly should not be underestimated, as he has been on every single German research vessel, not to mention numerous foreign ones, since the beginning of the 1970s. Fritz Abegg is also happy with the results: “All the work on deck is now much safer.” For example, the specially designed A-frame at the stern, which can move loads of up to 30 metric tons, has a freely rotating cross beam that prevents the 3.6-metric-ton ROV from swinging too much when it is deployed and recovered. “In addition, there’s much more space on the working deck,” Abegg mentions, “so you’re not getting in the way of someone else all the time.” Of course, this is especially important when it comes to ensuring safety on deck.

A frugal crawler

The tracked vehicle known as TRAMPER will be rolling across the ocean floor fully autonomously up to one whole year. It is being developed by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) as part of its ROBEX Helmholtz Alliance, and is intended to be used for a long-term exploration project in the Arctic. There, the vehicle, which weighs more than half a ton when on land but only 20 kilograms in water, will be taking ocean floor oxygen measurements on a weekly basis.
The Federal Institute for Geosciences and Natural Resources’ mobile 3D seismometer system may be one of the largest instruments used in marine science. The vessel tows two seismic cables with a length of up to four kilometers behind it, as well as the air guns used to fire signals into the ocean floor. The signals acquired by the cables are then used to recreate a three-dimensional image of the ocean floor.

When the Kiel ROV is on board, three of its containers are placed close to the stern: the one used to power the ROV on one side and the one with the command center from which Abegg’s team “pilots” the vehicle on the other, with the container housing the winch with the special cable for the ROV in between. This last container can even be placed transversally on the new vessel. “Doing that reduces the loads exerted on the winch tremendously,” explains the earth scientist from Kiel.

Even with this configuration, there is enough space left on the new vessel to accommodate one more instrument, such as an autonomous underwater vehicle, for example. In this scenario, the AUV can be used from the side of the ship, ensuring that both underwater vehicles can be used simultaneously and so complement each other: The AUV can, for instance, generate high-resolution maps that can then be used as a basis to bring the remotely operated underwater vehicle to its specific working location. In fact, this combination was already tested successfully on one of the first research expeditions with the new SONNE.
Lutz Mallon, who works for Leer-based ship management company Briese Schifffahrts GmbH & Co. KG, is the captain of the new SONNE research vessel. He learned his profession from scratch, starting as a sailor at Deutsche Seereederei (DSR) in Rostock in 1974, and has been working on German research vessels since 1996. He has been a captain since 2002.

What are your impressions after half a year of test runs and half a year of scientific expeditions?

If I could sum them up in a single word, it’d be “positive”. The trial runs went smoothly, and the scientific expeditions we’ve been on were completed without any major hitches. Now, it’s important to mention that we owe a lot of this success to our ship engineers, who do everything within their power to make sure everything keeps running smoothly so that scientists can do their research without having to worry about other things. On top of that, we really came out ahead in every single area with this new vessel. It’s a large, beautiful, state-of-the-art ship, and there’s no other research vessel as advanced as this in the whole of Europe. Take the multibeam echo sounder, for example: It’s the first with these kinds of technical capabilities to be installed on a research vessel. Or the fact that we have 12,000-meter coaxial cables on the winches, which enable us to work at depths of up to 11,000 meters. That’s much deeper than the oil industry can achieve, for example, and there’s only a handful of research vessels out there that can do that. Basically put, we’re blazing a trail. And it’s working! Sure, there are a few details here and there that can be improved, but we haven’t let down our guards at all, and are always optimizing things.

And how does the ship handle?

Maneuvering it is a delight – its seakeeping ability is truly something. I have to admit I was caught by surprise by how well everything works. I was already tremendously happy with the old SONNE, but the new one goes one step further. It’s very stable in the water and is easy to steer and position, which makes it great to work with. Also, the stabilizer fins and the Intering system, which help keep the vessel from rocking from side to side too much, ensure that the ship barely moves. It really outshines the old SONNE in that area.

The two retractable thrusters, the pump-jet, and the two fixed-pitch propellers provide so many options for the dynamic positioning that you can always keep the vessel perfectly stable. That’s really important when it comes to using ROVs or the new seabed drill rig, the MeBo200. For the latter, you have to be able to ensure that the ship stays on one exact position for 48 hours, otherwise it will rip the instrument out of the seafloor.

How’s life on the vessel? Have you all figured out your routines already?

When it’s hot outside, we’ll meet below in the hangar or on the main deck – or in the lounge if it’s already dark. Everyone loves it there. Sometimes we even open the bar and play some dance music. These expeditions can be really stressful, so getting the chance to unwind a little bit in the evening is really appreciated by everyone.

On the old SONNE, people always met next to the red fridge below deck – the one that was covered with stickers from many of the vessel’s research expeditions. That fridge was pretty much legendary among SONNE’s skippers. Did it make it to the new ship?

No, and it didn’t get a successor either. We wanted to at least keep the doors with all the great stickers from all the expeditions – I’m sure we would have found a place for them. Unfortunately, it didn’t work out.
5. A Diversified Program

Research projects in all disciplines mean that research vessel SONNE gets to travel to every corner of the Pacific and Indian Oceans.

The schedule for the new SONNE is always planned far in advance. The first 26 expeditions will take it virtually around the entire Pacific and then into the Indian Ocean. As a result of the way in which work is traditionally distributed in the German research fleet, these are the two areas where the vessel will be used primarily, just like its predecessor of the same name.

The circuit will first see the vessel travel from Central and South America to New Zealand through the Tropical Pacific. After that, it will be off to Japan via Alaska and Kamchatka and back to New Caledonia in the West Pacific. Finally, ports in New Zealand and Australia will mark the vessel’s journey to the Indian Ocean in 2017.

Unlike the first SONNE, however, the focus of the new vessel is not exclusively on earth sciences. “We’ve distributed things among research disciplines in biology, earth science, and climate research pretty comprehensively,” says Niels Jakobi, from the Control Station German Research Vessels of the University of Hamburg. With SONNE, METEOR, and MARIA S. MERIAN, the Control Station looks after three of Germany’s four large research vessels. And the fact that the new addition is considerably larger than its two counterparts means that there is enough space for multiple research teams that can simultaneously pursue goals that are independent from each other. Its first research expedition was a perfect example: During the trip across the Atlantic, geology and biology researchers shared the vessel while each team pursued different endeavors along the Vema Fracture Zone.

Versatile research in the Pacific

In the expeditions that followed, the focus was, once again, heavily on earth sciences. The second expedition was part of the British OSCAR project, which is researching hydrothermal and material flows between young oceanic crust and seawater in the Pacific Panama Basin. Together with British research vessel JAMES COOK, SONNE surveyed the ocean floor on the Costa Rica Rift using echo sounders and seismic methods in a two-ship operation. The next expedition had the vessel head off to Germany’s manganese nodule claim areas in the Tropical Pacific, where the ocean currents close to the seabed and the fauna that lives in and on the sediments were researched. Scientists are using these basic research projects to try and figure out what the consequences of mining the metalliferous nodules would be. Meanwhile, geochemical basic research on the flow of materials between the oceanic tectonic plates and the ocean, as well as its impact on climate, was at the center of the following two expeditions to the Pacific west of Mexico and to the Gulf of California. Finally, the expeditions to the Pacific west of Ecuador that followed revolved around the long-term effects of a concrete manganese nodule extraction opera-
A DIVERSIFIED PROGRAM

Announcement: In 1989, researchers had removed all the nodules from a manganese nodule field with the old SONNE, and subsequently returned several times to see how the fauna on the ocean floor had changed. After a long hiatus, the visit in 2015 picked up where the last one had left off, and researchers were able to determine that even 26 years after the seabed had been disturbed, the organisms living in the plow marks on the ocean floor were different from the ones in untouched areas. The Federal Ministry of Education and Research submitted these results to the G7 Science & Technology Ministers’ Meeting on the subject of deep-sea resources.

A trip through the most nutrient-poor ocean region in the world

During the following expedition, which took the vessel along the Peruvian and Chilean continental shelf all the way to Antofagasta, Chile, experts from the fields of chemistry, physics, and biology researched the role played by oxygen minimum zones in the ocean and in the production of trace gases that ultimately reach the atmosphere. After this, the last research expedition close to South America centered on mapping the faults close to the Chilean city of Iquique with utmost precision. For over 130 years, the earth there has not trembled, making it the last calm spot along a fault zone known for its powerful earthquakes. However, the area has two tectonic plates that slide past each other about 6.5 centimeters per year, leading experts to believe that Iquique’s long period of calm will not last much longer.

The long trip to New Zealand took the vessel through the most nutrient-poor region in the world’s oceans – the South Pacific Gyre. Despite this lack of nutrients, however, the microbial communities found there appear to play an important role in the global nitrogen fixation process. SONNE researched the nitrogen, phosphorus, and organic carbon cycles there and obtained samples from the entire water column and the topmost layer of the ocean floor. The expeditions that followed in the waters around New Zealand had a more tectonic inspiration: At the Chatham Rise, east of the two main islands, geologists studied the breaking apart of the supercontinent Gondwana, which existed in the Southern Hemisphere many millions of years ago. After this, it was off to the nearby Hikurangi continental margin in order to research submarine landslides triggered by tectonic motion.

The next expeditions alternated between biology and geology. During the trip to Alaska, the focus was on the bacterial communities in the water column, and then, in the Bering Sea, research shifted to the history of how this marginal sea between the Pacific and Arctic Oceans came to be. The subject then switched to the biological communities in the Kuril-Kamchatka Trench. After that, the subsequent expedition concerned itself with the tectonics in the earthquake-heavy trenches close to the Japanese main island of Honshu, followed by a case study of the largest documented lateral collapse in Ritter Island, close to Papua New Guinea.

As for the research expeditions taking place from December 2016 to February 2017, the focus will be on at the shallow submarine volcanoes around the Kermadec Islands north of New Zealand: Geologists, biologists, and chemists will study how the hydrothermal vents influence the surface layer of the ocean where almost all photosynthesis occurs and most primary production is generated. After that, SONNE will investigate how the Pacific basin changed over time by concentrating on the Vitiaz Kermadec Arc System, which was formed only until 50 million years ago, between New Zealand and Tonga. For now, that is the last scheduled expedition for SONNE in the Pacific.

After that, the vessel will travel through the Torres Strait between Australia and New Guinea, which will provide an opportunity to take sediment and coral samples and conduct paleoclimate research on the East Australian Current. The last point on the trip will be Sri Lanka’s capital, Colombo, after which SONNE will get to enjoy some much-deserved downtime on its first visit to a shipyard for maintenance and repairs. Additional expeditions will be scheduled accordingly and will be published on the German Research Vessels Portal (https://www.portal-forschungsschiffe.de/index.php?index=53).
6. A Wonderful Start

Surprises in the journey across the Atlantic

The trip from the Canary Islands to the Caribbean across the Atlantic was the new SONNE’s first scientific expedition. The vessel successfully completed it with a full crew and a geological and biological research schedule that gave researchers the opportunity to discover a lot of new things.

“As a researcher, the most exciting time is always when I’m at sea. I really enjoy every second of it,” Colin Devey, from the GEOMAR Helmholtz Centre for Ocean Research Kiel, says effusively, “that’s where I get the data I need and where I actually get to see the world that fascinates me before my very eyes.” The experienced geologist has almost lost track of the number of research expeditions he has already been on, but even then, the first one with the new SONNE was something special: “That really was the kind of expedition that takes you where no-one has gone before. We were a bit like pioneers, if you will,” he recounts weeks later in his office in Kiel.

The expedition, named Vema-TRANSIT, started southwest of the Cape Verde islands and took the vessel right across the Atlantic Ocean all the way to the Mid-Atlantic Ridge, over it, and west to the Puerto Rico Trench and then to the port of destination in Santo Domingo, in the Dominican Republic. The journey focused on the Vema Fracture Zone, a crack through the oceanic crust that extends from the Mid-Atlantic Ridge to the waters around the Cape Verde islands close to the African coast.

This was the first scientific expedition for Germany’s most cutting-edge research vessel. And despite all the thorough test runs that had been carried out previously, it was the vessel’s and crew’s true trial by fire for all intents and purposes. The 40 scientists led by Chief Scientist Colin Devey were all very impressed, and both he and his co-chief scientist, Angelika Brandt from the University of Hamburg, agreed that the ship was incredible – both the actual vessel and its crew. “There was so much that could have gone wrong, and yet nothing did,” Devey says as he provides his conclusions regarding the six-week expedition. The crew had the scientists’ backs at all times, even though the sailors...
also had to familiarize themselves with the new vessel at the same time. “They were thrown in at the deep end, but were still able to solve every single problem as it came up,” says the British geologist, who has nothing but good things to say about the crew. The expedition revolved around both earth science and biological questions. Devey and his team were able to see literally undiscovered land during the transatlantic journey, as the basins extending to the west and east of the mid-ocean ridge all the way to the corresponding continental shelves have never been fully charted before. Scientists had, up until then, mainly concentrated on the Mid-Atlantic Ridge, which runs north to south through the ocean basin. But in fact the uncharted seabed away from the ridge contains a record of the whole history of the world’s second largest ocean. “The ocean floor south of the Cape Verde islands is 120 million years old and dates back to the time when the ocean was born, right after Africa split from South America,” explains Colin Devey, “I was interested in seeing whether I’d be able to trace the ocean’s development using data from the ocean floor.”

**Fracture zone helps animals cross mid-ocean ridge**

While the earth scientists focused on studying the ocean’s evolution by looking at the ocean floor, the team headed by marine biologist Angelika Brandt was working on figuring out how the opening ocean has affected its inhabitants’ evolution. “We asked ourselves whether the Mid-Atlantic Ridge had isolated the animals in the western and eastern basins from each other,” says Brandt, “or whether the Vema Fracture Zone was functioning as a connecting passage for organisms.” Until that point, it was assumed that the ridge functioned as a barrier at least for less mobile animals, leading to different species evolving on each side of the underwater mountain system. To test this conjecture, the researchers examined small crabs that make their home in the ocean floor – and came across a bona fide surprise: “For certain species at least, our assumption was wrong,” Angelika Brandt recounts. More specifically, there were virtually no differences between the crabs that bury themselves in the ocean floor on one side and the crabs that do the same thing on the other.

“The results we obtained concerning their genes and morphology revealed very clearly that they were the exact same species,” says the biologist. A large part of the work, which was organized into day and night shifts on the vessel, was completed by the biologists on board already. “The laboratories were staffed 24/7. There was always someone taking pictures,” recounts Angelika Brandt, “others were classifying everything, and when, for example, identically looking species were found, the material was prepared for genetic analyses.” Brandt and her team used every bit of the state-of-the-art laboratories on the SONNE extensively, including the cryogenic freezers, where the specimens were frozen to a temperature of -80 °C so that they could be genetically analyzed back home later on. More than 10,000 invertebrates were processed during the research expedition. The geologists led by Colin Devey can only dream of getting results that quickly.
“We primarily collect data on board and have to pay attention to make sure that everything’s working properly, but we don’t really get to analyze anything until much later,” explains the earth scientist, “the only thing that we can show fairly quickly are bathymetric charts of the ocean floor.” Admittedly, however, these bathymetric charts have a level of detail that is seldom seen, as the echo sounder on the new SONNE has a significantly better resolution than the usual systems employed. The charts show the ocean floor divided into several segments that look markedly different. Normally, it would have furrows running from north to south at regular intervals, much like corrugated sheet metal. However, the charts show that this corrugated sheet keeps being interrupted by a stripe pattern running from east to west. “We’re running statistical analyses on that right now,” says Devey, “we’re seeing something no one expected, and we don’t have an explanation for it yet.” But one thing is clear: There is clearly a variety of mechanisms involved in the production of oceanic crust at the Mid-Atlantic Ridge.

Interestingly enough, however, a happy coincidence ensured that the geologist team would get one tangible result while still on board: About 400 kilometers west of the Mid-Atlantic Ridge spreading axis, they netted a large number of manganese nodules unexpectedly. The biologists’ epibenthic sled, an instrument with a sturdy steel frame that has two skids and can trawl along the seabed, had gotten stuck on the ocean floor while collecting samples for biological research. The sled features various mesh nets and containers designed to capture the inhabitants of the upper sediment horizon so that they can be brought to the surface. Instead of soft sediment, the sled had hit a hard substrate out of the blue, and recovering it had proved to be a difficult task. Once on the SONNE’s working deck, the load was something that took everyone by surprise: large manganese nodules. “We really weren’t expecting to run into those there,” says Colin Devey.

**Excellent teamwork between research teams**

SONNE’s first scientific expedition was also a test of how well different research teams with entirely different objectives would be able to work together aboard a research vessel. “I’ve been out with a number of teams throughout my career, and this was one of those rare occasions where everyone worked together smoothly,” Angelika Brandt summarizes. Colin Devey enjoyed the cross-discipline cooperation as well: “I learned a lot about how biologists work, and I think they know a lot more about us now as well.”

Since the new vessel is able to accommodate a much larger number of expedition members than its predecessor or the FS METEOR, journeys with multiple teams on board will take place more often in the future. And while these teams can use a mutually coordinated schedule, SONNE offers more than enough space for them to pursue entirely different objectives. In fact, there is even enough room for researchers from different teams to bring their own instruments and stow them on board on this type of shared expedition.

Devey is quick to point out, however, that this type of expedition also means a lot of work for expedition leaders. The reason is that there will continue to be only a single chief scientist who will not only be responsible for the science crew, but who will also act as the contact person for the captain. “When you have two completely different teams and a total of 40 scientists on a ship this big, you can bet you’ll have your hands full.” This is why the geologist wants to partake in the next expedition as a scientist only. “I’ll be able to focus on my own bit of research then.” At the end of the six-week Vema-TRANSIT expedition, he travelled to the neighboring island of Puerto Rico and more or less slept for three whole days. “And then I did something that I actually hate doing: I sat under a palm tree at the beach, just looking at the waves.”
We deployed the full eleven kilometers of cable the maximum working length. At the same time, we were able to check whether the Mid-Atlantic Ridge isolates the organisms in the western basin from the ones in the eastern basin. The ridge is an underwater mountain system that cuts across the ocean longitudinally, and fracture zones like the Vema Fracture Zone go right across it. Colin Devey from GEOMAR in Kiel wanted to explore the Vema fracture zone during the SONNE’s journey, so we simply decided to go there together. They’d be able to do their surveys and we’d get the chance to see whether these Fracture Zone systems function as a connecting passage of sorts for organisms. I’ve been on many expeditions with different teams, and this was one of those rare occasions where everyone worked together smoothly.

It sounds like you really enjoyed it!

When you’re on board, you work day in, day out, without time off on the weekends. It definitely wasn’t like going on a cruise. But for someone like me who works at the university and has little time left for research after taking care of their administrative and teaching work, it’s an adventure, if for no other reason than you get to focus exclusively on research for a whole six weeks. That’s like putting Christmas and Easter together!

As a biologist, what would you say are some of the things that stood out when working on the new SONNE?

Well, there’s a lot of space, superb laboratories, and a very helpful and cooperative crew. We always try to get as much information as possible before putting organisms in alcohol to preserve them, since, for example, doing so decolorizes them. That’s why we had someone at the lab 24/7 – there was always someone taking pictures, classifying things, or taking samples.
Accordingly, German marine scientists are not just present in every ocean in the world, but also view these bodies of water from an enormously broad range of perspectives. "When it comes to marine science here in Germany, we have a very comprehensive approach. Basically put, every single discipline is covered," says Schulz.

When it comes to the countries involved in oceanographic research, Germany is a major league player, which actually is not self-apparent. After all, the country is not historically a seafaring nation like Great Britain, Spain, or Portugal. Nevertheless, the fact that Germany is making a sizable investment in this field of research is evidence of a holistic approach: The oceans are not a self-contained system that is sealed off from the rest of the world, and better understanding them as the most influential factor in our Earth’s system will make it easier to comprehend how our planet works. "Oceanography is not a cheap endeavor by any means," says Schulz, "but we can argue for the need for these investments with a clean conscience because what happens in the world’s oceans affects a wide range of processes that also affect us on dry land."

Oceans play a key role in our Earth system

The oceans play a key role in our Earth system, and German marine science covers a wide variety of disciplines in order to account for this. In fact, the range of areas on which the scientists aboard the research vessels focus extends from climate sciences to the study of raw materials, which is one of the reasons German scientific research is renowned throughout the world.

Seen objectively, the world’s oceans dominate our planet. In fact, just under three quarters of its surface is covered with water. The more than 1.3 billion cubic kilometers that the ocean basins encompass are the largest habitat in the world and a crucial element of our climate system, storing about a quarter of the carbon dioxide emissions produced by humans. “The oceans are an essential part of our Earth system,” paleoclimatologist Michael Schulz summarizes, “studying them is not a luxury. It’s an absolute necessity when it comes to our research on sustainability and the Earth system.”
Marine sediments as climate records

A good example is Schulz’ own speciality: climate research. “These expeditions are the only means we have to get the ocean floor samples we need for paleoclimatology research,” he points out. In fact, the sediments at the bottom of the world’s oceans are where the best records of past climate behavior are found, and human-kind’s own records pale in comparison, with our scientific data extending 140 years into the past at most. That is simply not enough to analyze Earth’s climate system, which is why the scientific community uses other sources of information as well. This is where the ocean floor comes in: Layer after layer of climate information has been “stored” in marine sediments at perfectly regular intervals and in such a way that it has remained intact for millions of years. Core samples containing these sediments, together with comparable samples from continental ice sheets and certain lakes, from pot-holes, and even from coral and tree trunks, make up the small individual pieces that paleoclimatology researchers use to put together a mosaic of past climate states.

And their relevance goes beyond purely academic curiosity in reconstructing the past. Instead, paleoclimatic data series are what provide the standard measure that is used to calibrate the models intended to forecast the future of our global climate. Only when the complex computer programs are able to simulate past climate events the way science reconstructs them these forecasts be viewed as reliable. “There are definitely processes,” says Schulz, “that can still be improved in the models.”
Research on the fault zones in the Earth’s crust, that is, where tectonic plates abut each other, is of immense practical importance to humankind. Many of these fault zones, which extend across thousands of kilometers, are located in the oceans – for example, along the Ring of Fire, which surrounds the Pacific Ocean on three sides; close to Java and Sumatra; and in the eastern Mediterranean. Powerful forces can build up at these contact zones which then discharge as earthquakes, in some cases generating tsunamis. There are few deadlier natural hazards out there when it comes to humankind. More than two billion people live in Pacific coastal regions, and the assets in the zone add up to several trillion euros. This means that better understanding these phenomena is part of being able to prepare for future catastrophes, as well as an important source of information for large reinsurance companies.

A lot depends on researchers being able to correctly understand the various risks, as their findings and knowledge are used as a basis to develop safety and protection strategies. By using modern instruments such as ROVs and drill rigs, they can get extremely close to the zones where tectonic plates get stuck and accumulate destructive forces and study the various combinations in situ while safe on board. The core samples obtained this way, for instance, can be used to determine the composition of the ocean floor. In fact, one of the many plans as of this writing is to use a drillship in order to drill directly into the fault zone where tectonic plates jerk past each other and get stuck.

However, the depths of the oceans hold not only large risks, but also important opportunities. It is suspected that the ocean floor is a treasure trove of vast metal and energy resources, and extraction plans are already in the works. German marine science is currently engaged in the basic research required in order to better assess the potentials and repercussions of this deep-sea mining.

At the same time, Germany is also conducting concrete investigations to establish the base-lines that will make it possible to tap into these mineral resources while simultaneously protecting the environment as much as possible. In the Indian Ocean and the Pacific, the Federal Institute for Geosciences and Natural Resources (BGR) has acquired exploration licenses for various metallic mineral resources for the government. In the next few years, these areas will be a frequent destination for research expeditions. Admittedly, however, it is not possible at this time to foresee whether it will be possible to extract the mineral resources found there in a manner that is both cost-effective and environmentally acceptable.

**Seawater carries oxygen into deep sediments**

Even the apparently drab and barren regions of the deep sea seem to play a larger role in our Earth’s system than previously suspected. At any rate, indications that they are not just ooze-covered deserts are becoming more numerous. The researchers on one of the new SONNE’s first expeditions in the Central Pacific took a process that has never been incorporated into Earth system analyses before and studied it in greater detail.

“Not that long ago, we discovered that seawater circulates through fractures in the oceanic crust,” explains Sabine Kasten, Section Head of Marine Geochemistry at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research in Bremerhaven. It is believed that in these cases, there are two crust hummocks – which are referred to as “seamounts” in researcher lingo – that project from the sediment layers in the deep sea and that function as an inlet and an outlet. Between these seamounts, seawater circulates through the oceanic plate’s basaltic crust, penetrates very deeply, and during the process carries oxygen into the bedrock and the sediments above it. This represents a dramatic change for the lower, hypoxic sediment layers.
“For example, this means that the organic components that sink all the way to the ocean floor can decompose better,” explains Kasten. This could result in a change in the world’s CO₂ balance, as the carbon in organic material is released as CO₂ and rises to the water surface. There are other repercussions as well: The oxygen in the basaltic crust and in the sediment above it also changes the sediment chemistry for all other elements, such as the metals that are found in the form of manganese nodules across the endless deep-sea regions of the Central Pacific. “We calculated how much manganese goes into the nodules when it’s released from deep-sea sediments,” explains geologist Thomas Kuhn, who works for the BGR in Hanover and headed the SONNE expedition, “around one third of the manganese budget cannot be explained just based on the normal sediments.” This is where fluid circulation between seamounts would come in.

The water flow, which is driven by pressure and temperature differences in the ocean floor may be weak, but, taken together, the regions in the deep sea make up a gigantic area. “You can find these seamounts all over the place in the Central Pacific,” says Sabine Kasten, “which is why we’re assuming that this is an extended phenomenon and an important way in which material flows, and that it has a large impact on the geochemical reactions in the ocean floor and on element flows between the basaltic crust, sediments, and seawater.” This is even more significant when one considers that these cycles have likely been active for millions of years. Thomas Kuhn: “Once they start, they’ll continue as long as the hydraulic connection between the inlet and outlet areas exists.”

The largest habitat in the world is little studied

The world’s oceans are the largest region on Earth where life can flourish. And as part of them, the ocean floor is an area that has not been researched sufficiently and that has lower limits that can reach several hundred meters into the inside of the planet. To date, our knowledge is concentrated on a very small part of the seabed: the continental shelves and the mid-ocean ridges. “A lot of people think that the deep ocean floor is dead and that everything beyond the active plate boundaries, the spreading axes, and the mid-ocean ridges is a desert,” says Colin Devey, “but there are more and more indications that this isn’t actually the case.”

Instead, it may very well be that the floor of these endless deep-sea regions represents the largest contact surface between the inside of the planet and the organisms that live on its surface. “In principle, the plates must be full of life that is in the process of transforming this whole plate,” explains Devey. In fact, core samples obtained as part of the IODP Integrated Ocean Drilling Program contained bacteria that lives more than 1,500 meters below the ocean floor.
Since September 2009, Wilfried Kraus has been the Head of the “Sustainability, Climate, Energy” Subdepartment 72 at the Federal Ministry of Education and Research (BMBF). The lawyer started his career in 1988 in what was then the Federal Ministry of Research and Technology, and from November 2006 to August 2009 was in charge of the “Education and Research” Division of the Permanent Representation of the Federal Republic of Germany to the EU in Brussels.

The German Federal government will be providing a lot of money for new vessels in the next few years. What is being bought with it?

The BMBF will be spending between three quarters of a billion and one billion euros. In addition to the new SONNE, this money will be used to procure a successor for POLARSTERN and a vessel that will be replacing both METEOR and POSEIDON, that is, one large and one mid-sized research vessel. The tender process for the construction of the POLARSTERN successor is currently underway. As for the replacement for the METEOR and POSEIDON, we want to get started next year.

Why is there only one replacement vessel for both the METEOR and POSEIDON?

The new vessels will have more space for scientists. We’re talking about 40 instead of 25 in the case of SONNE, for example. The vessel that will be replacing METEOR and POSEIDON will be as large as the new SONNE, we simply decided it would be a good idea to reduce the number of ships and to equip the new one better to compensate for that. On top of that, the operating costs for each of the vessels across ten years are at least equal to the amount that will be spent on making the new one. These savings mean that we can direct more funds towards scientific pursuits. Paradoxically, we’ve had cases in which there was an expensive research expedition and there wasn’t enough money left for the scientific analysis later on. We’d rather have a little less ship and a lot more research.

Why is Germany so committed to the field of marine science?

As an industrialized country, Germany deliberately decided to afford this relatively expensive infrastructure, conscious of the fact that there are enormous challenges
out there that can only be overcome with marine, ocean, and polar research. Through basic research, science allows us to understand how the world around us works, and it also provides information that can help us make sound policy decisions. This not only applies to fighting climate change, but also to the sustainable use of resources and to protecting biodiversity. The world’s oceans and polar regions both play a crucial role in this context, and we need a strong presence in the oceans to be in a position to discuss these things scientifically and politically at an international level.

Today, we’re in a great situation in the sense that we have a research fleet with tremendous technical capabilities which we are systematically renovating. That makes us more internationally competitive and attractive as a collaboration partner. That’s enormously important, as the lifeblood of science is teamwork – especially at the international level. Basically put, if you want to play in the major leagues, you need to provide the necessary infrastructure.

With enough space for 40 scientists, the SONNE is pretty big. The coming successor for the METEOR and POSEIDON will be too, apparently. Does that mean that smaller research teams are being left behind?

No, not at all. We’ve established a selection process that is open to any research institution and that we’re using to allocate ship time to projects for which an application is submitted. Now, you have to remember that the ships not only have a lot of space for scientists, but are also equipped with extensive, state-of-the-art scientific instrumentation, so several research teams can work on different goals at the same time. In fact, one of the primary considerations when it came to sizing SONNE was to make sure that it could be used for a lot more projects. Having said all that, it’s important to mention that the critical thing is not for every single spot on the vessels to be occupied, but rather for as much research as possible to be conducted.

If there are spots still available, we can, for instance, offer them to students so that they can acquire some hands-on research experience. As it happens, that’s something that’s done regularly on our research vessels. Whenever there’s capacity available, we always try to give young scientists the opportunity to do research work in that type of environment.

**Does the BMBF provide some sort of assistance to help smaller teams get on the large research vessels?**

That’s exactly what the selection process I just mentioned is for. In fact, in the future we’ll be applying that process as a standard for all the research vessels for which we’re responsible. On top of that, we’ll also have to consider whether it would be a better idea to pool the entire infrastructure of underwater vehicles, measuring instruments, and drill rigs together so that scientists can then make use of them as necessary. That’s something that the British do, for example. Now, we need to keep in mind that these things are developed for specific purposes and require maintenance and trained operating personnel, so while it sounds great in theory, it can get really complicated in practice. But it’s definitely worth a look.
The German Research Vessels Portal is where all parties interested in requesting ship time on a research vessel need to submit their application (https://www.portal-forschungsschiffe.de/index.php?index=53).

Expedition proposals can be submitted on the portal until September 30 of every year. After this, the proposals are distributed to the organizations in charge of allocating ship time for the various vessels. This approach has several important advantages not only for applicants, but also for the institutions in

10. Ship Time Requests

A standardized procedure ensures optimum vessel utilization

Ship time is an expensive and scarce resource. And even though the German fleet is one of the largest in the world, the number of project applications submitted still exceeds the vessels' capacities by far. Because of this, a standardized request procedure has been implemented in order to allocate space on ships in such a way as to maximize scientific output.

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Expedition proposals can be submitted on the portal until September 30 of every year. After this, the proposals are distributed to the organizations in charge of allocating ship time for the various vessels. This approach has several important advantages not only for applicants, but also for the institutions in
Various expert committees are in charge of selecting proposals from among the numerous applications, using scientific quality criteria as the basis for their choice. This ensures that vessel capacities and the need for ship time are optimally aligned.

When a project is selected, it normally takes about two years before it is assigned the corresponding ship time on the vessels’ schedule. However, there are also cases in which scientists need to wait longer because the vessel they need will be in a different part of the world. The current schedule for SONNE ends in August 2017, and the ship time after that cannot be assigned yet because the vessel will be stopping at a shipyard for maintenance and repairs for the first time at that point.
11. Additional Information

**Research for Sustainable Development (FONA)**

The BMBF’s Research for Sustainable Development framework program is focused on coming up with information that can be used as a basis to make future-oriented decisions and on delivering innovative solutions to societal challenges. The spectrum ranges from basic research to developing ready-to-use applications. The BMBF promotes conservation and sustainability research within the scope of FONA.


**German Research Vessels Portal**

Scientists working at publicly funded research institutions can use this portal to submit expedition proposals for the research vessels POLARSTERN, METEOR, SONNE, MARIA S. MERIAN, POSEIDON, ALKOR, HEINCKE, and ELISABETH MANN BORGESE. In addition, the portal is used to publish current expedition reports.


**Control Station German Research Vessels of the University of Hamburg**

The Control Station German Research Vessels manages SONNE, METEOR, and MARIA S. MERIAN. On behalf of the BMBF and the DFG, it is responsible for the resource planning work for the expeditions on these vessels.

https://www.ldf.uni-hamburg.de/en.html

**Project Management Jülich**

Project Management Jülich is responsible for reviewing SONNE expedition proposals and recommending the ones with positive evaluation results to the BMBF.

www.ptj.de/forschungsschiffe

**Planet Erde**

The BMBF Planet Erde portal provides research results, background information, and expedition reports for everything having to do with earth sciences, oceanography, and polar research.

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