

On and Under the Sea

Research Vessels and Underwater Vehicles



On the Sea

Research Vessels



Research vessels are indispensable for the in-situ exploration of the oceans.

The knowledge gained from seagoing expeditions contributes to a better understanding of the biological, physical, geological and chemical processes in the ocean. They help scientists to develop better strategies against the impact of climate change, to develop economically effective and environmentally friendly uses of marine resources, and to better predict ocean-based hazards.

Marine scientists generally measure the oceanic processes with sophisticated technology: Remotely-controlled underwater vehicles, deep-sea autonomous robots, manned submersibles and bottom-moored systems are used for long-term detection of chemical and physical data. All these are typically deployed from research vessels. A modern and effective research fleet is therefore the essential basis for meeting the various needs of marine research.



Research Vessels

Kiel is presently the home port of two German research vessels, ALKOR and POSEIDON, as well as the research cutter LITTORINA and the research tender POLARFUCHS.



OPEN-OCEAN POSEIDON is primarily used in the North Atlantic, and sometimes in the Mediterranean, the Black and Red Sea.



REGIONAL ALKOR operates predominantly in the North Sea and the Baltic as well as along the Norwegian Coast.



LOCAL LITTORINA is used for excursions in the western Baltic Sea, and occasionally in the central Baltic Sea, North Sea and Elbe and Weser estuaries.



LOCAL POLARFUCHS is used exclusively for work off the coast of Schleswig-Holstein.







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01 POSEIDON working off the coast of Svalbard in the Arctic Ocean

02 The low working deck of the POSEIDON is particularly useful for the deployment of major equipment like JAGO, ROV PHOCA and AUV ABYSS

03 View of the engine room.

6 POSEIDON – European marine research

POSEIDON was built in 1976 and is classified as an open-ocean marine research vessel. Named after the Greek god of the seas, the ship is used mainly for longer expeditions in the North Atlantic, Mediterranean, Black and Red Sea. The ship is highly manoeuvrable and stable even in high winds and rough seas. She was refitted for expeditions to explore the deep-sea in the beginning of the 1980's.

POSEIDON is the second ship to bear this name. The original "Reich Research Steamer" POSEIDON was used primarily for fisheries research between 1902 and 1945. However, the research focus of today's POSEIDON is centred on oceanographic, marine biolo-

gical and geological investigations. POSEIDON is ideally suited for this purpose with its four laboratories and assorted winches, cranes and sounders. Some of her equipment, such as the multi-beam echo sounder and rosette water sampler, can also be used on other ships. In addition, POSEIDON is capable of deploying the manned submersible JAGO, the ROV PHOCA and the AUV ABYSS.

The ship is designed for the highest classification of German Lloyd and also for a temporarily unmanned engine room. It is built as a single-section ship and satisfies all stability requirements under permissible load conditions.



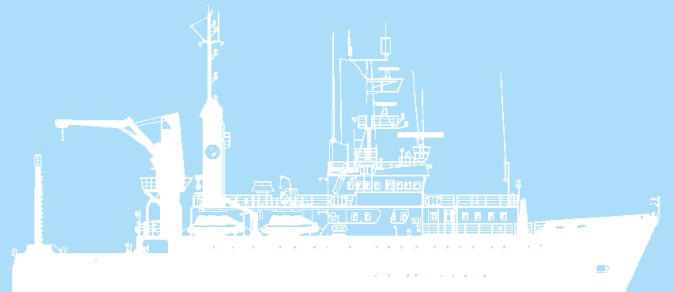
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RESEARCH VESSEL POSEIDON



It has highly effective stabilizing fins which still permit scientific work in rough sea conditions. Its Gill rudder provides for very good manoeuvrability. POSEIDON had major overhauls in 2009/2010 and 2014, where, amongst other improvements, all three engines were modernized to extend POSEIDON's sea-going capability to 24 days.

The ship is currently managed by Briese Shipping, located in Leer, Germany. The ship is scheduled for replacement in the next years.

SPECIFICATIONS

7

Owner: State of Schleswig-Holstein, **Home port:** Kiel

Operator: GEOMAR Helmholtz Centre for Ocean Research Kiel

Year built: 1976, **Tonnage:** 1105 GT, **Draft:** 4.9 m

Dimensions: Length: 60.8 m, Width: 11.4 m

Speed: 10.5 knots, **Operating range:** 7,500 nautical miles

Capacity: Crew: 15, **Scientists:** 11

Facilities for scientific operations: 4 labs 15-30 sqm, 1 vertical shaft, 1 container slot, various cranes, winches and cables, thermosalinograph, several sounders [deep-sea sounder, multi-beam depth sounder], data acquisition system DSHIP, ADCP

ALKOR –Regional marine research

ALKOR is a regional research vessel serving all disciplines in German and European marine research. ALKOR operates primarily in the Baltic Sea, the Kattegat and Skagerrak, the North Sea and off the coast of Norway. The 55 m long vessel has four laboratories to analyse air, water and sediment samples. The primary research disciplines which ALKOR serves are oceanography, biology, fisheries biology, geophysics and geology. The research vessel has capacity for 12 scientists.

This ALKOR is the successor to a research cutter of the same name which, after 24 years of service in science, could no longer meet the environmental standards required by 1990. ALKOR is named after a star in the Big Dipper constellation. ALKOR currently undertakes expeditions for German and European research groups.

8 In addition, she is used for teaching and internship trips, and she is capable of deploying the underwater vehicles JAGO, ROV and AUV ABYSS PHOCA. ALKOR is the sister ship to R/V HEINCKE in Helgoland.

The ship is managed by Briese Shipping, located in Leer, Germany. She is permitted for “short trips” and limited deep-sea fishing. ALKOR can remain at sea for 21 days. She was overhauled and modernized at the end of 2010.



RESEARCH VESSEL ALKOR

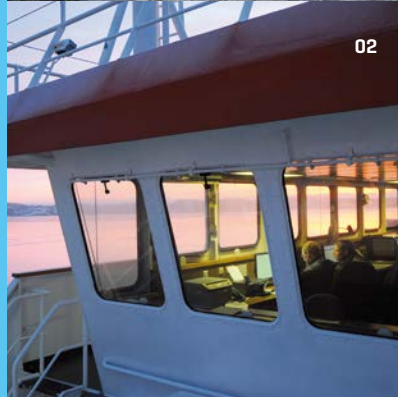


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01 Deployment of mesocosms in the Swedish Gullmarfjord for a long-term experiment on ocean acidification

02 View of the bridge

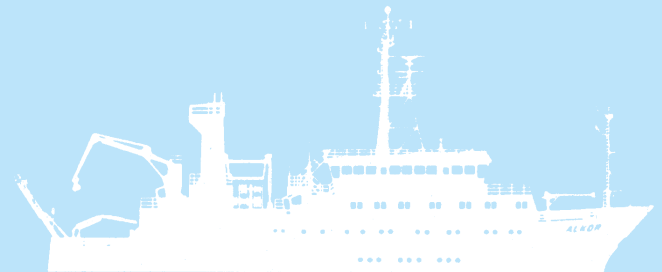
03 ALKOR with 9 mesocosms on board in Kiel Fjord at the start of an experiment



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SPECIFICATIONS

9

Owner: State of Schleswig-Holstein, **Home port:** Kiel

Operator: GEOMAR Helmholtz Centre for Ocean Research Kiel

Year built: 1990, **Tonnage:** 1322 GT, **Draft:** 4.16m

Dimensions: Length: 55.2 m Width: 12.5 m

Speed: 12.5 knots, **Operating range:** 7,500 nautical miles

Capacity: Crew: 11, **Scientists:** 12

Facilities for scientific operations: 4 labs 15–52 sqm, 1 vertical shaft, 1 container slot, various cranes, winches and cables; thermosalinograph, several sounders (sediment echo sounder, fish sounder, mobile multibeam depth sounder), data acquisition system DSHIP, ADCP

LITTORINA - Local marine research

LITTORINA is a research cutter owned by the University of Kiel and operated by GEOMAR. Construction costs were financed by the German Science Foundation (DFG) in order to avoid high charter costs on third-party ships. LITTORINA (named after a small sea snail) is mainly used for short expeditions in the Baltic Sea, North Sea and the Elbe-Weser estuaries - at definitely more than snail's pace: she reaches maximum speeds of 10 knots (18 km/h).

The research cutter can be used for all disciplines of marine research, specifically oceanography, biology, geophysics, geology and fisheries biology. LITTORINA has room for 6 scientists on overnight trips and 12 scientists on daytime trips. The technical equipment on board permits water and sediment samples down to 500 m. There is a diving room on board with diving equipment and space for up to 12 people. LITTORINA is thus frequently used for diving courses and research at the University of Kiel. Last but not least, scientists can utilize the modern shallow-water multibeam sounder.

The ship is managed by RF Shipping, located in Bremerhaven, Germany. LITTORINA can remain at sea for 14 days. She was overhauled and modernized at the beginning of 2012.

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01 Research divers in action

02 Hands-on marine research: GEOMAR's popular program for "Young Researchers" aboard LITTORINA allows school children to examine marine creatures from the Kattegat and the Baltic Sea

03 A gravity corer is deployed from LITTORINA to extract sediment samples from the seafloor

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RESEARCH CUTTER LITTORINA



Photo: B. Brockmann

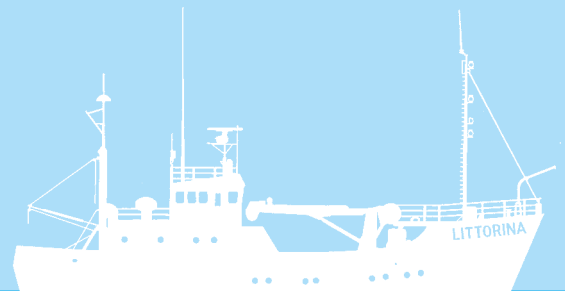


Photo: J. Zahlten

SPECIFICATIONS

11

Owner: University of Kiel, **Home port:** Kiel

Operator: GEOMAR Helmholtz Centre for Ocean Research Kiel

Year built: 1975, **Draft:** 3.0 m

Dimensions: Length: 29.8 m, Width: 7.4 m

Speed: 10 knots, **Operating range:** 2,500 nautical miles

Capacity: Crew: 5, **Scientists:** 6 [12 for day trips]

Facilities for scientific operations: 2 labs, 6-12 sqm; vertical shaft, 1 wet lab [10-foot container], various cranes, winches and cables, different sounders [fish sounder, multibeam depth sounder], ADCP



01 Ribbed jellyfish; *Mnemiopsis leidyi*

02, 03 Live specimens of the jellyfish were caught with a net off the aft frame of POLARFUCHS to analyse the distribution of ribbed jellyfish in the Baltic Sea

Photo: C. Howe



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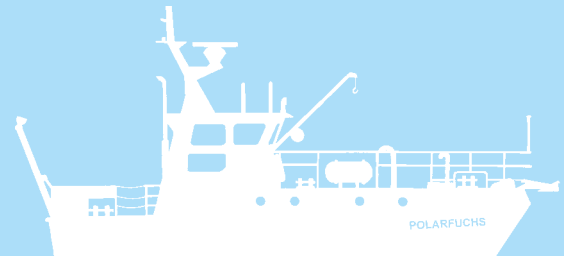


POLARFUCHS - Local marine research

POLARFUCHS was built in 1982 by the Fassmer Shipyard in Berne (near Bremen) as a laboratory tender to the research icebreaker POLARSTERN. She was used in ice-free areas near the mother ship but proved to be ill-suited for the harsh conditions of the polar regions. In 1996 she was detached from POLARSTERN and replaced with a new tender.

Following some remodelling work in 1997, POLARFUCHS was ready for new research tasks in the near-coastal areas of the Baltic Sea where she replaced the GEOMAR research tender SAGITTA. POLARFUCHS is now used for environmental research and teaching in the Kiel Fjord, Kiel and Eckernförde Bight, around the island of Fehmarn, the Kiel Canal and the Schlei estuary near Schleswig. She is equipped with a multi-purpose laboratory, an aft frame and a cargo boom. POLARFUCHS may remain at sea for several days if needed.

RESEARCH TENDER POLARFUCHS



SPECIFICATIONS

13

Owner: Alfred Wegener Institute in Bremerhaven

Home port: Kiel

Operator: GEOMAR Helmholtz Centre for Ocean Research Kiel

Year built: 1982, **Draft:** 1,35 m

Dimensions: Length; 12.7 m, Width; 4.4 m

Speed: 8 kn

Capacity: Crew: 2, **Scientists:** 6

Facilities for scientific operation: Aft frame to deploy nets and equipment (Winch 250 m, 6 mm wire on two drums, loads up to 350 kg), cargo boom on foredeck (winch 80 m, 5 mm wire 6 mm, for devices up to 100 kg), multi-purpose laboratory room, ELAC and Furuno echo sounders

Globally operating German research vessels

SONNE

An important research platform
in the Pacific and Indian Ocean



Photo: Thomas Badewien, ICBM, Universität Oldenburg

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The name SONNE is well known in marine research in Germany. Since 1978 a ship with this name served as an open [ocean-going] working platform for scientists of different disciplines in all oceans, in particular in the Indian and Pacific Ocean. After 36 years, the “first” SONNE went out of service in fall 2014. Already in 2009 it had been decided to replace the ship by a new one with the same name.

The keel-laying of the new SONNE took place in April 2013 at the Meyer shipyards in Papenburg, Germany and the first scientific mission started end of 2014. With a total length of 116 metres the SONNE has space for 75 people [amongst them 40 scientists] and 20 containers. Besides four dry labs, two wet labs and two “climate” labs a number of special rooms are available for the research tasks. Even more than its predecessor, the new SONNE fulfils the requirements of different disciplines such as marine geology, geophysics, biology, biogeochemistry or climate research and enables interdisciplinary research at sea. Multiple winches and cranes, amongst them an A-frame at the stern with a capacity of 30 tons, provide the sound basis for the use of large-scale equipment such as the ROV KIEL 6000. The ship’s custom-built hull prevents the formation of bubbles, which can interfere with the mapping of the sea floor by its sonar systems. Re-use of water, special waste separation systems and the usage of low emission fuels characterise the new SONNE as a particularly environmentally friendly ship. The ship was financed by the federal government and the five northern German states. The ship is managed by the Institute for Chemistry and Biology of the Marine Environment [ICBM] of the University of Oldenburg and managed by Briese Shipping, located in Leer, Germany.

MARIA S. MERIAN

Universal platform for scientific work at sea



When launched in 2006, MARIA S. MERIAN was regarded worldwide as the top-of-the line multidisciplinary research vessel. Based in Rostock-Warnemünde, her main research areas are the North Atlantic and adjacent oceans.

MARIA S. MERIAN is specifically equipped for research in the marginal ice zones of the North Atlantic. She is capable of breaking ice of up to 60 cm thickness, and she can move in between drifting ice floes. Precise manoeuvrability of MERIAN is provided by a special drive system underneath the hull with two 360° rotating propellers which allow the ship to accurately maintain any position. This is important, for example, when remotely controlled submersible equipment is operated from the deck. Two stabilization systems ensure a comfortable working platform and laboratories for up to 23 scientists, even in rough seas. The ship is managed by Briese Shipping, located in Leer, Germany.

METEOR

Multidisciplinary basic marine research

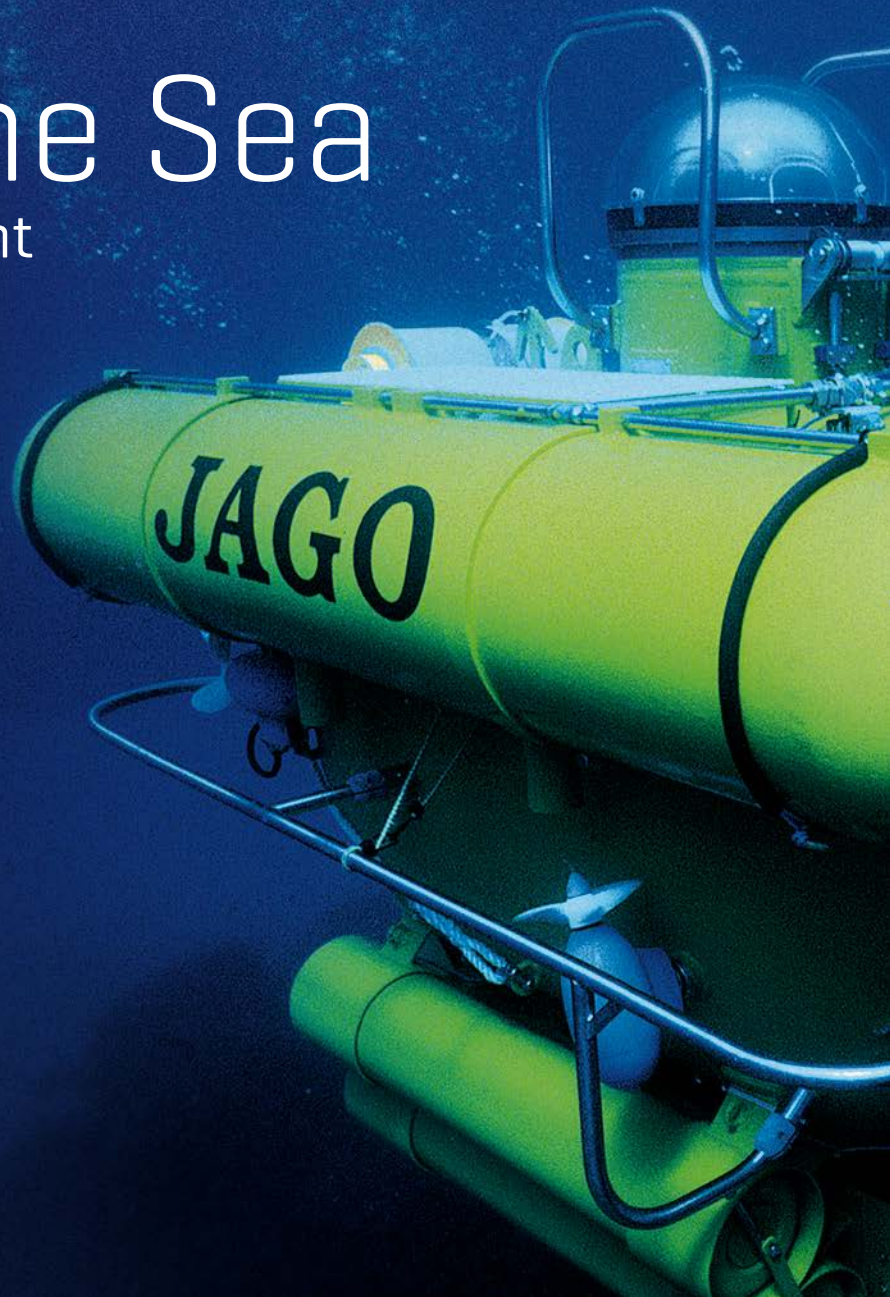


Research vessel METEOR is used worldwide. Scientists from different disciplines work closely together on expeditions, and international cooperation between scientists plays an important role in the day-to-day activities on board. Scientists from 68 nations conducted research on board R/V METEOR during her first 50 expeditions.

Most of the expeditions take place in the Atlantic Ocean, Mediterranean and Indian Ocean. METEOR can operate up to 50 days at sea without any port calls, allowing the up to 28 scientists on board enough time to use the 20 well-equipped laboratories. The ample deck space with 17 winches and cranes can be set up to satisfy the scientific needs of all scientific groups. Additional deck containers can be used as laboratories, and manned or unmanned submersibles can be deployed. METEOR and MARIA S. MERIAN are operated by the Control Station for German Research Vessels in Hamburg and managed by Briese Shipping, located in Leer, Germany.

Under the Sea

Research equipment
for the deep-sea





The oceans of the world are still vastly unexplored

More than half of the Earth's surface lies at water depths of less than 3,000 m, yet only a small part of the ocean floor is known in detail. Deep-sea exploration requires the use of advanced technology and may be comparable to space research: High pressure, low temperatures and complete darkness demand the utmost of high-technology equipment. To learn more about the deep-sea, advanced remote and autonomous robotic systems and underwater vehicles are used nowadays for such exploration.

Underwater vehicles

GEOMAR is home to the only manned research submersible in Germany, JAGO. In addition, GEOMAR operates large-scale infrastructure such as the remotely operated vehicles ROV KIEL 6000, ROV PHOCA and HYBIS and the autonomous underwater vehicle AUV ABYSS.



JAGO is a manned submersible for two people. It can dive to a depth of 400 m to explore and survey the seafloor.



ROV KIEL 6000 is an underwater robot remotely controlled through fibre and power supplied by copper wires. It is designed for dives down to 6,000 m.



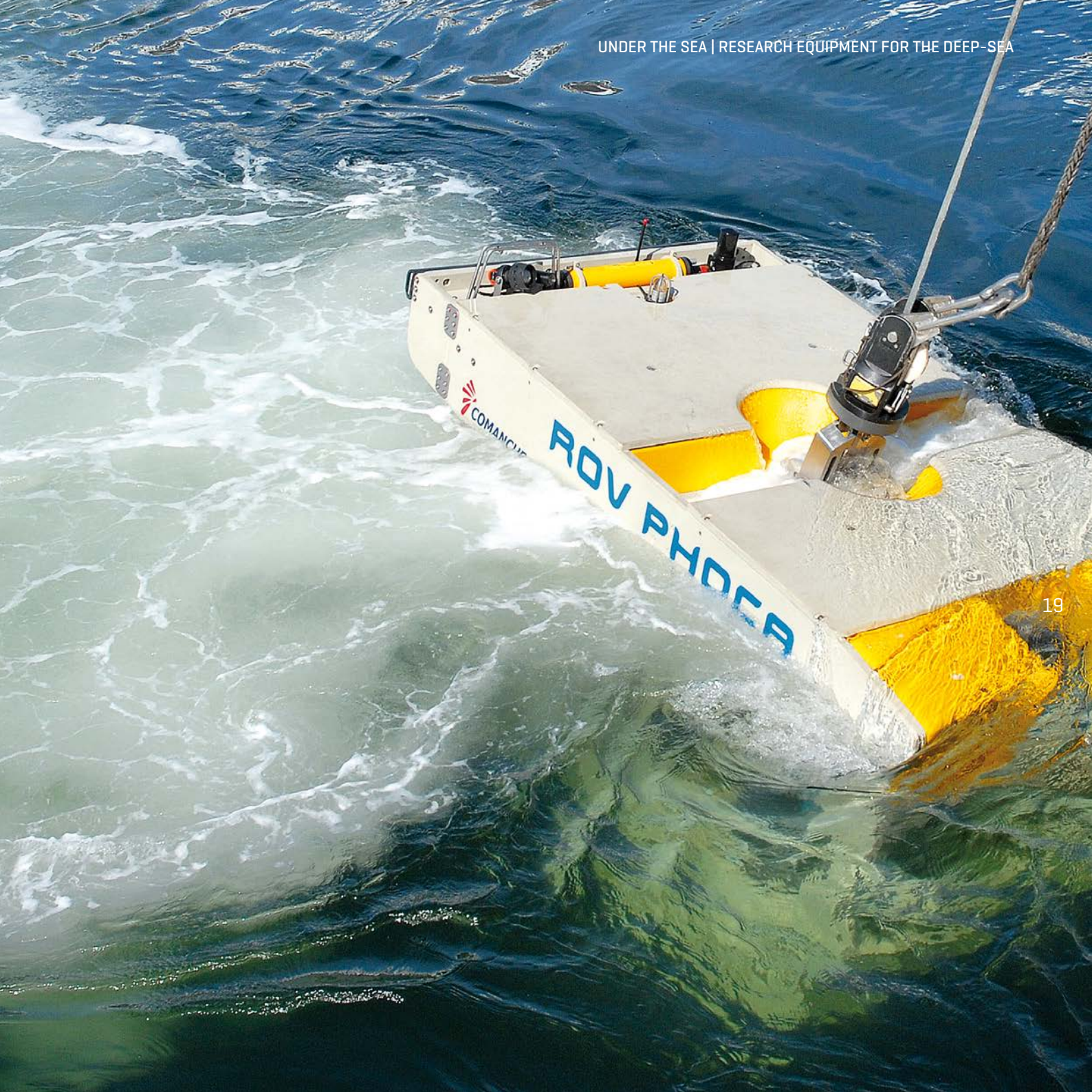
ROV PHOCA is a smaller and lighter underwater robot with a diving capacity of down to 3000 m. It can also be used on medium-sized research vessels and is therefore an excellent supplement to ROV KIEL 6000.



HYBIS is a universal deep-sea tool with limited ROV-capability [hydraulic arm] for sampling and deploying of instruments. Unlike other ROVs which require special LWL-cable winches, HYBIS can use the pre-installed LWL cables on the ship. Maximum operating depth is 6,000 m.



AUV ABYSS can dive up to 20 hours at a stretch with a programmed course through the water down to depths of 6,000 m. It is capable of mapping the seafloor in high resolution with the help of various echo sounders.



RESEARCH SUBMERSIBLE JAGO



SPECIFICATIONS

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Dimensions: Length 3.0 m, Width 2.0 m, Height 2.5 m

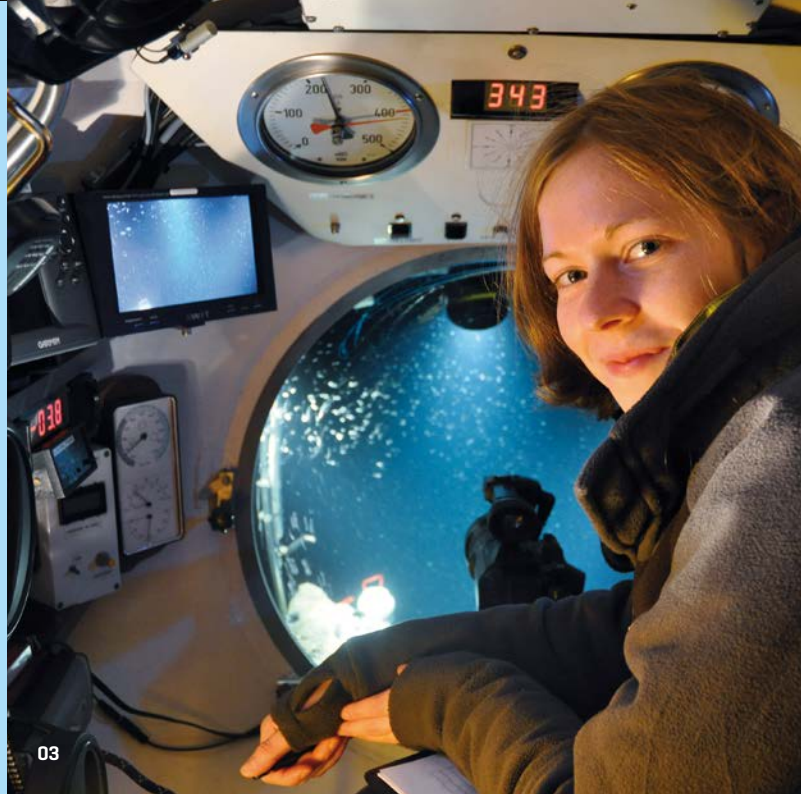
Weight in air: 3,000 kg, **Operation depth:** 400 m

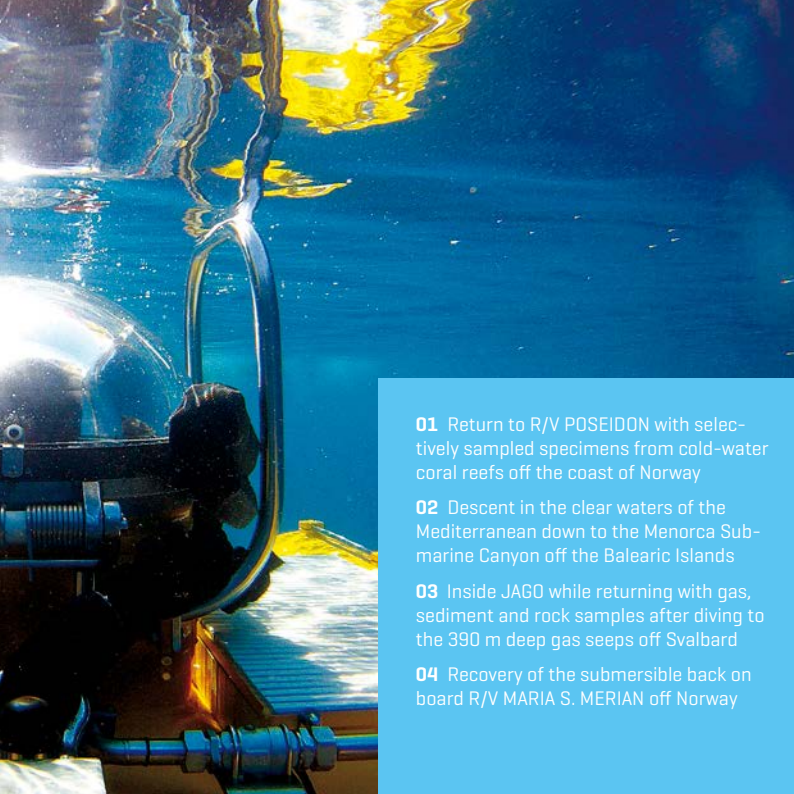
Cruising speed: 1 knot, **Crew:** 1 pilot, 1 observer

Transport: 20-foot container, **Pressure hull:** Steel, 18 mm

Power supply and propulsion: 6 batteries, total capacity 13 KW - 24 V DC, 4 reversible horizontal thrusters at stern, 2 rotational thrusters on starboard and port side, 1 front and 1 aft thruster

Systems and equipment: diving tanks (720 l), compensating tank (40 l), 2 oxygen high pressure cylinders; 3 pressure air cylinders, filters for CO₂ absorption, underwater navigation system (USBL); compass, depth gauge, vertical and horizontal sonar; underwater communication (UT), LED and Xenon lights, flashes, laser scaling, hydraulic manipulator arm; digital video and photo cameras; CTD; sampling devices for organisms, gas, fluids, sediments and rocks





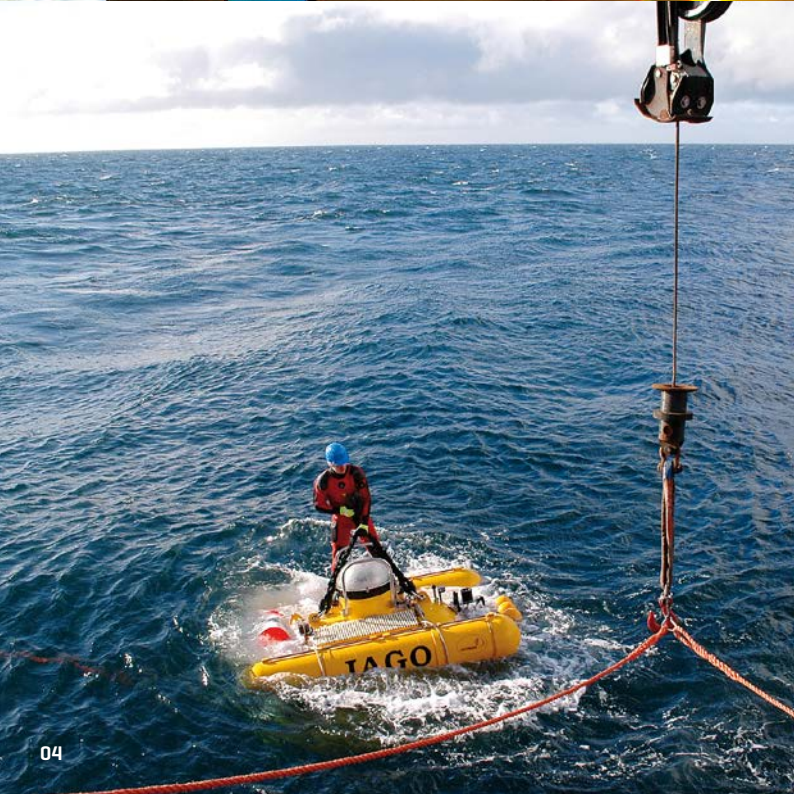
- 01** Return to R/V POSEIDON with selectively sampled specimens from cold-water coral reefs off the coast of Norway
- 02** Descent in the clear waters of the Mediterranean down to the Menorca Submarine Canyon off the Balearic Islands
- 03** Inside JAGO while returning with gas, sediment and rock samples after diving to the 390 m deep gas seeps off Svalbard
- 04** Recovery of the submersible back on board R/V MARIA S. MERIAN off Norway

JAGO - Where the action is!

JAGO is a manned underwater vehicle capable of diving to a depth of 400 m for exploration and research in all types of aquatic systems and habitats. The submersible moves autonomously underwater and is not connected by any cables to the support ship. It accommodates two people, a pilot and an observer. They have a wide view of the seabed through two large acrylic windows for detailed observations and selective sampling using a multi-functional manipulator arm.

Because of its compact size and relatively low weight of only three tons, JAGO can be deployed worldwide from on board a wide variety of vessels with sufficient crane capacity. It is transported in a single standard 20-foot container. Typical applications include observation and exploration of the seabed and water column, video and photo documentation, selective sampling, placement of sensors and measuring systems, underwater inspections, as well as location and recovery of objects.

JAGO is currently Germany's only manned research submersible. It is stationed at GEOMAR since January 2006 and was built in 1989, in compliance with the standards of German Lloyd, by the present operators at the Max Planck Institute for Behavioural Physiology in Bavaria.



REMOTELY OPERATED VEHICLE ROV KIEL 6000



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SPECIFICATIONS

22

Operating depth: 6,000 m

System weight (standard): approx. 65 t

Shipping containers: 5 (3 of them on deck)

Pilot / Technician: 8

Vehicle weight: 3.5 tons, **Footprint:** 4 x 6 m

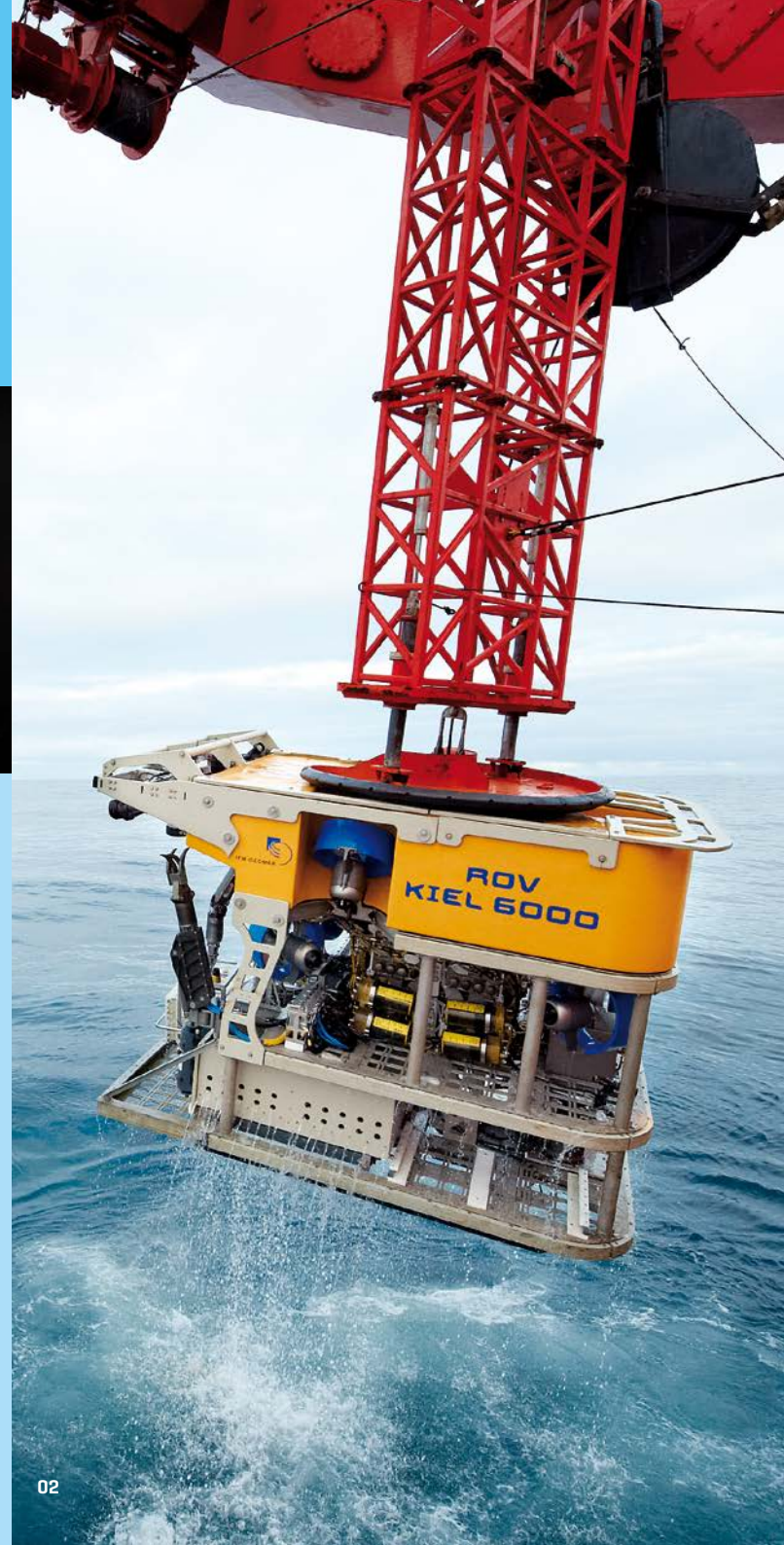
Manipulators: 1 ORION™, 1 RigMaster™

Scientific payload: 100 kg

Manufacturer: Schilling Robotics, LLC, Davis, USA

Platforms: All major national research vessels, plus the Irish R/V CELTIC EXPLORER, French N/O L'ATALANTE and the British RRS JAMES COOK. Adaptation to other platforms upon request.

Winches and cables: Floating cable (500 m), umbilical winch (2,500 m), umbilical deep-sea winch (6,000 m)



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- 01 View of the control container
- 02 Recovery of the ROV on board R/V SONNE
- 03 Octopus near the Cape Verde Islands
- 04 Black smokers with outflow temperatures of up to 400°C

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ROV Kiel 6000 – Discover the unknown world of the deep-sea

ROV Kiel 6000 is one of the most modern deep-sea diving robot systems used for scientific exploration worldwide. It is remotely controlled via a deep-sea fibre optic cable from a control container on board a research vessel. Two pilots operate the robot and video cameras for monitoring, inspection and documentation near the seafloor. More than 4,000 watts of lighting are available to ensure a clear view of the deep-sea. Pin-point samples are taken with the help of two manipulators, and various scientific equipment can be deployed, serviced and retrieved.

With a diving capacity down to 6,000 m, the diving robot is well suited for exploring 95 percent of the

seafloor worldwide and to help scientists in geology, geophysics, geochemistry, volcanology, chemistry and biology to investigate all areas, from the coast to the deep-sea.

ROV KIEL 6000 has been successfully used on various expeditions exploring hot vents on the Mid-Atlantic Ridge as well as volcanic regions near the Cape Verde Islands, the Caribbean, the Indian and the Pacific Ocean. The ROV was also deployed to investigate carbon dioxide and methane fields in the North Sea, active cold seeps in the Pacific and Arctic oceans, and seamounts in the Indian Ocean.

REMOTELY OPERATED VEHICLE ROV PHOCA



01 Front view of ROV PHOCA

02 Close up view of an Eddy Correlation System placed by ROV PHOCA on a coral reef

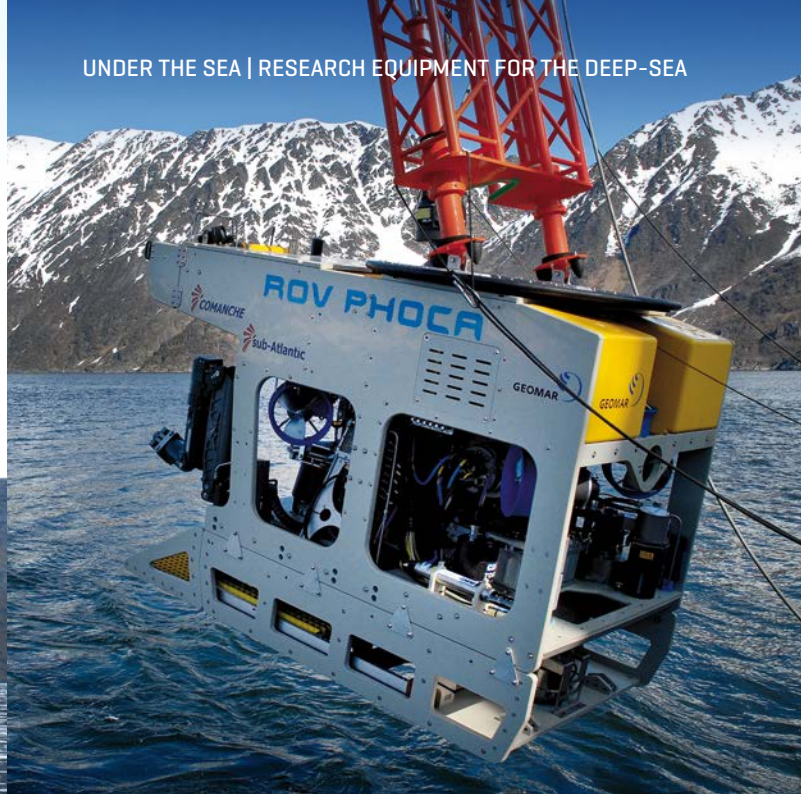
03 View of POSEIDON's aft deck during deployment of ROV PHOCA in Stjærnsund, Norway



ROV PHOCA - The flexible, multidisciplinary working platform

ROV PHOCA, similar to ROV KIEL 6000, is an underwater vehicle, remotely controlled via fibre optic cable and outfitted with various scientific equipment. Two pilots operate the vehicle from a control container on board a research vessel. Although also a category III work robot, the demands for power, payload capacity and space aboard the research vessel are much reduced in comparison to the ROV KIEL 6000.

ROV PHOCA permits research in the areas of geology, geophysics, geochemistry, volcanology, chemistry and biology from the marginal seas to water



depths of 3,000 m. ROV PHOCA was procured in the framework of the BMBF MoLab Project. Its inaugural expedition took place in the cold-water coral reefs in Stjærnsund in northern Norway.

Video and photo cameras are used for the observation, inspection and documentation of the seafloor. More than 4,000 watts of lighting are available to ensure a clear view of the deep-sea. Pin-point samples are taken with the help of two ORION manipulators (seven joints each), and various scientific equipment can be deployed, serviced and retrieved.

SPECIFICATIONS

25

Operating depth: 3,000 m

System weight (standard): 30 t

Shipping containers: 3 [one on deck]

Pilot / Technician: 5

Vehicle weight: 1.5 tons, **Footprint:** 3 m x 4 m

Manipulators: 2 x ORION™

Scientific payload: 100 kg

Manufacturer: Sub-Atlantic, Aberdeen, UK

Platforms: All large and medium sized national and international research vessels, such as R/V ALKOR and R/V POSEIDON. Adaptation to other platforms is possible.

Winches and cables: Floating cable [500 m], umbilical winch [2,500 m], umbilical deep-sea winch [6,000 m]

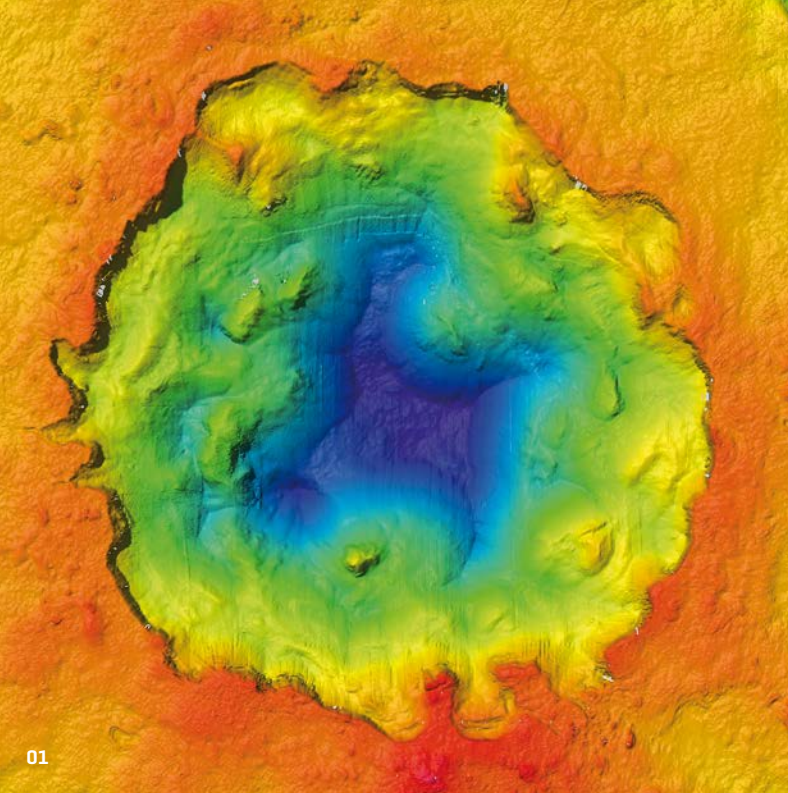
AUTONOMOUS UNDERWATER VEHICLE AUV ABYSS

AUV ABYSS - 3D magnifying glass on the seafloor

The torpedo-shaped autonomous underwater vehicle maps areas of the seafloor in high resolution with help from its various echo sounders. Additionally, its physical sensors allow the collection of samples from the water column. The name originates from Abyss, which is the term used to describe the ocean floor between depths of 2,000 and 6,000 meters. At these depths, AUV ABYSS glides close to the ocean floor with a speed of up to four knots while autonomously avoiding obstacles. The AUV can be used from all medium to large research vessels and utilizes a specially designed system (LARS) for deploying it off the ship's side or stern.

Prior to each mission, the autonomous vehicle is programmed with a destination, course and research task. Each dive takes up to 20 hours after which the AUV ABYSS surfaces on its own and is brought on board. Subsequently the lithium batteries are recharged for the next dive and the data is downloaded. Three-dimensional, high-resolution maps of the seafloor are generated from such data, indicating, for example, the location of volcanoes or ore deposits on the seafloor. Because of the AUV ABYSS's ability to detect objects as small as a shoebox, it was successfully used in the search for the wreck of Air France Airbus AF447 in the tropical Atlantic Ocean in 2011.





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01 Three-dimensional view of Franklin Seamount taken by the multibeam sonar of the AUV

02 The AUV is deployed using LARS [Launch and Recovery System]

03 Sonar image of a shipwreck in the Gulf of Cadiz

04 Once the AUV is lowered into the water, the distance to the ship must be increased



04

SPECIFICATIONS

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Dimensions: Length 3.98 m, diameter 0.66 m

Weight in air: 880 kg, **Operating depth:** 6,000 m

Speed: up to 4 knots, **Operating time:** up to 20 hrs.

Energy and power: 11 kWh lithium-ion batteries [12 hours charging time], **Max range:** Up to 100 km

Standard sensors: SBE 49 CTD, fluorometer and turbidity sensor, sidescan sonar 120/410 kHz multibeam sonar 200/400 kHz

Optional sensors: 4 megapixel b/w camera, sub-bottom profiler [4-24 kHz], eH sensor [by Dr K. Nakamura, AIST, Japan], microstructure sensor

LARS [Launch and Recovery System] with a hydraulically operated A frame

Transport: Two 20-foot containers

Additional research equipment

With its 10 oceanographic gliders, GEOMAR has one of the largest glider fleets in Europe. In addition to the gliders, GEOMAR owns 10 deep-sea observatories (Landers), a pool [100 units] of ocean bottom seismometers (OBS), the only German 3D seismic system (P-CABLE), and ten KOSMOS mesocosms developed in-house at GEOMAR.



Mesocosms are experimental enclosures to study the responses of marine life to ocean change.

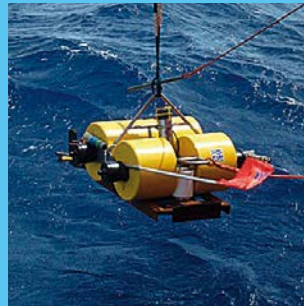


Gliders are used to investigate questions in ocean dynamics, the interaction between ocean and atmosphere, the distribution of oxygen, or the ocean's role in the carbon cycle.

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Landers are autonomous deep-sea observatories which can be customized in different configurations and are used for taking measurements and conducting experiments on the seafloor.



Ocean bottom seismometers (OBS) are used for recording seismic activity of the ocean floor caused by earthquakes.



The 3D Seismic System enables high resolution, three-dimensional images of the seafloor at depths down to 2,000 m.

KOSMOS MESOCOSMS



KOSMOS Mesocosms – A sea-going experimental platform

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The KOSMOS mesocosm facility is a mobile, sea-going experimental platform, which can be employed in moored or free-floating mode. By enclosing a non-disturbed water column of 25 m depths and 65 cubic metres, it allows to study the effects of ocean change on pelagic ecosystems and their impacts on biogeochemical cycles. The high level of scientific integration offered by KOSMOS mesocosm studies promotes cross-disciplinary collaborations and provides comprehensive data sets on community-level responses to ocean change. With the development of the KOSMOS facility, presently consisting of 10 mesocom units, GEOMAR has entered new territories: For the first time, long-term experiments with replicated treatments in open marine waters have been made possible.

OCEANOGRAPHIC GLIDERS



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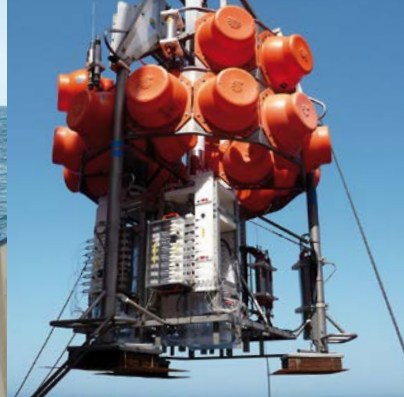
Gliders - Soaring through the oceans

Equipped with various sensors (for temperature, salinity, oxygen or fluorescence, among others), gliders “sail” through the upper 1,000 m of the ocean, largely independent of research vessels. Instead of using a propeller as the driving force, a high-pressure pump pumps oil between the interior and a bladder outside the pressure housing. Similar to a submarine, this pumping action changes the buoyancy of the glider and allows it to descend or ascend through the water column, while small wings convert the up and down to a forward motion. Since gliders are very energy efficient, a single battery charge is sufficient for several months and distances up to 2,000 km. Between each of the several hour long dives, gliders connect to the home base via satellite phone, allowing for data transmission and course corrections.

With its ten oceanographic gliders, GEOMAR has one of the largest glider fleets in Europe. These gliders can be used individually or in swarms in order to collect new data and answer questions about ocean currents, the interaction between ocean and atmosphere, the distribution of oxygen in tropical oceans, or the ocean’s role in the global carbon cycle.

GEOMAR’s glider operations can be followed in real-time on GEOMAR’s glider website <http://gliderweb.geomar.de>. The site provides summaries and maps of current and completed research missions together with displays of the respective measurements.

DEEP-SEA OBSERVATORIES LANDERS



Landers - Autonomous underwater laboratories

31

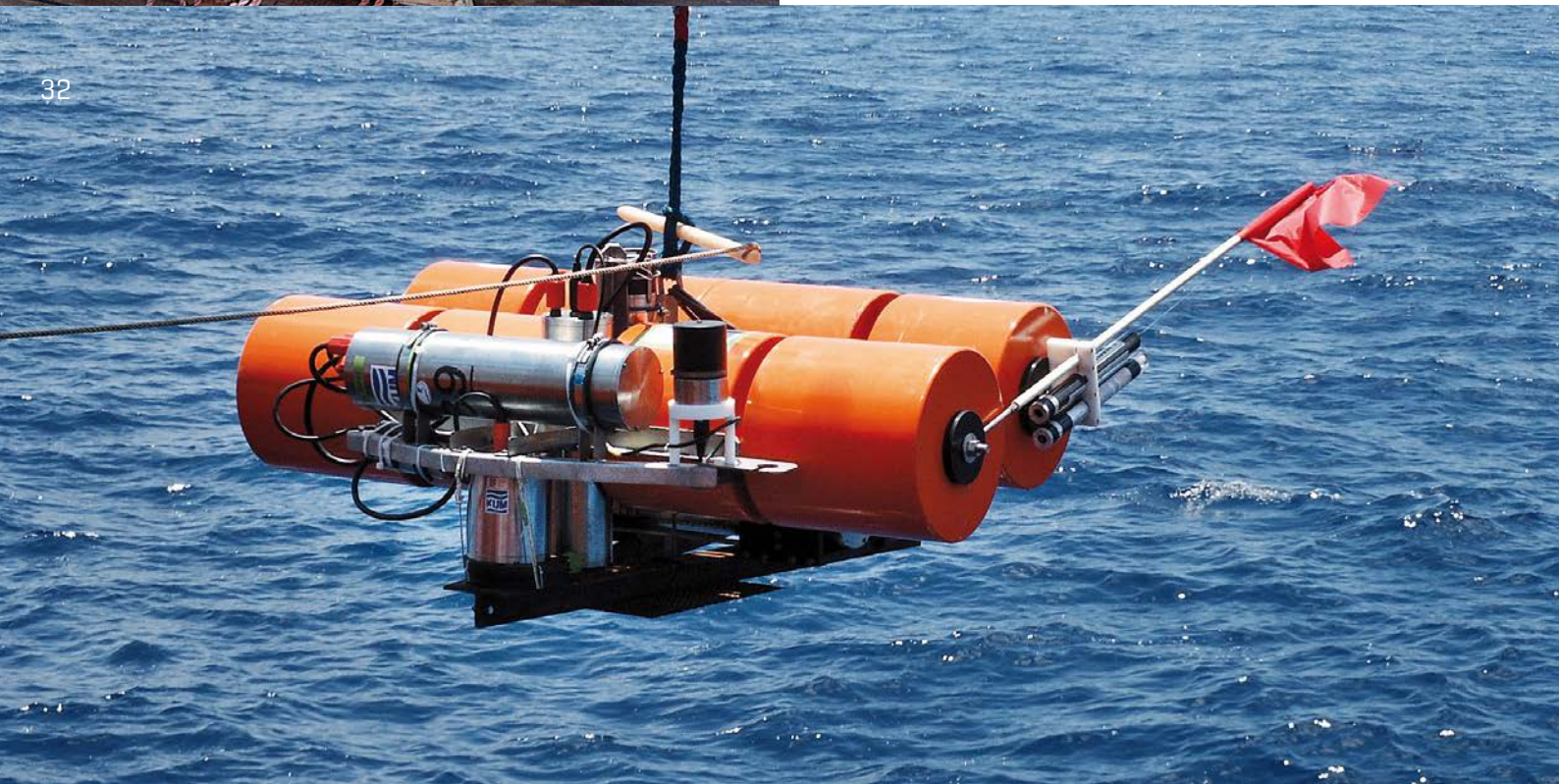
The Lander deep-sea observatories were developed by GEOMAR and can be customized in different configurations for measurements and experiments on the seafloor, depending on individual research objectives. The deployment length can range between days and months. With a weight of 1.3 tons (in air), the lander - outfitted with video cameras - is set down on the seafloor at depths up to 6,000 m. Ballast weights are attached to the lander's legs and keep the lander on the seafloor. Once the bottom weights are acoustically released, the lander rises to the sea surface with the help of glass buoyancy floats protected by plastic housing.

OCEAN BOTTOM SEISMOMETERS

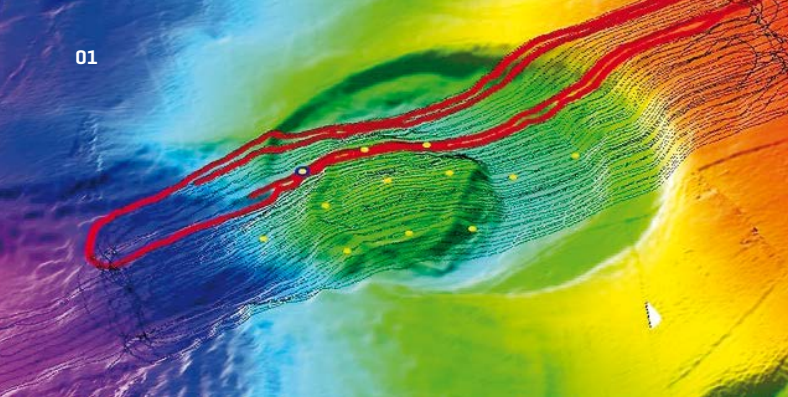
OBS

OBS - Taking the pulse of the ocean

An ocean bottom seismometer is used to record oscillations or vibrations of the seafloor caused by earthquakes. The OBS provides information on the location and depth of the earthquake, and also on the fracture behaviour. The OBS is lifted overboard and sinks to the seafloor at depths down to 8,000 m where it independently takes measurements and records data. At lesser water depths, the research vessel may additionally use airguns to generate sound waves which travel through the water column and penetrate the seafloor down to a depth of 50 km. The soundings of the seafloor provide information on the thickness and composition of the rock strata. The multitude of individual OBS measurements helps to form a coherent picture of the seafloor.



01



01 3D measurement of the North Alex Mud Volcano off the Nile Delta (POS388). The lines show the course of R/V POSEIDON.

02 Aerial view of P-Cable in operation

03 Application of 3D seismic system aboard R/V SONNE

02

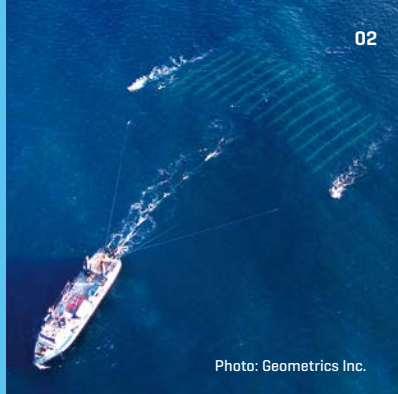


Photo: Geometrics Inc.

03



3D SEISMIC SYSTEM P-CABLE

P-Cable - Deep insight into the Seafloor

In contrast to conventional seismic systems which only show 2-dimensional sections of the seafloor, the new P-Cable technology offers 3-dimensional, high-resolution imaging of contiguous layers down to a depth of 2 km.

The imaging is carried out by towing up to 25 parallel chains with high pressure sensors, so-called hydrophones behind the ship. An airgun fires off underwater air pulses at precisely defined positions. These sound waves pass through the water and into the seafloor. Similar to an echo, the sound is reflected off the rock layers and returns to the sea surface where it is recorded by the hydrophones.

Sophisticated software allows scientists to interpret the signals and to generate detailed images of the region underneath the seafloor. The images can be used, for example, to estimate slope stability or to map gas hydrate reservoirs.

Innovative Technology for Marine Research

Marine research, specifically the exploration of the deep-sea, requires not only modern research vessels but also innovative technology. GEOMAR has undertaken considerable efforts in recent years to develop new technology, with an emphasis on robotic assisted technology for precise sampling and measurements in the deep-sea. Such new observation platforms provide the basis for new exploration in previously inaccessible areas in the world ocean. This will ensure that we are able to answer socially relevant questions regarding the effect of climate change, the future availability of resources, or marine natural hazards.

Germany, as a site of excellent research institutes and a high-tech nation, has the potential to play a leading role in marine research. This requires forward-thinking investments in underwater technology and the expansion of research capacities in marine research. Kiel's development into one of the world's leading centres for marine research is a step in the right direction and must be continued consistently. GEOMAR Helmholtz Centre for Ocean Research Kiel is ready and willing to make its contribution.

Imprint

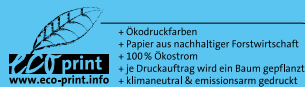
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