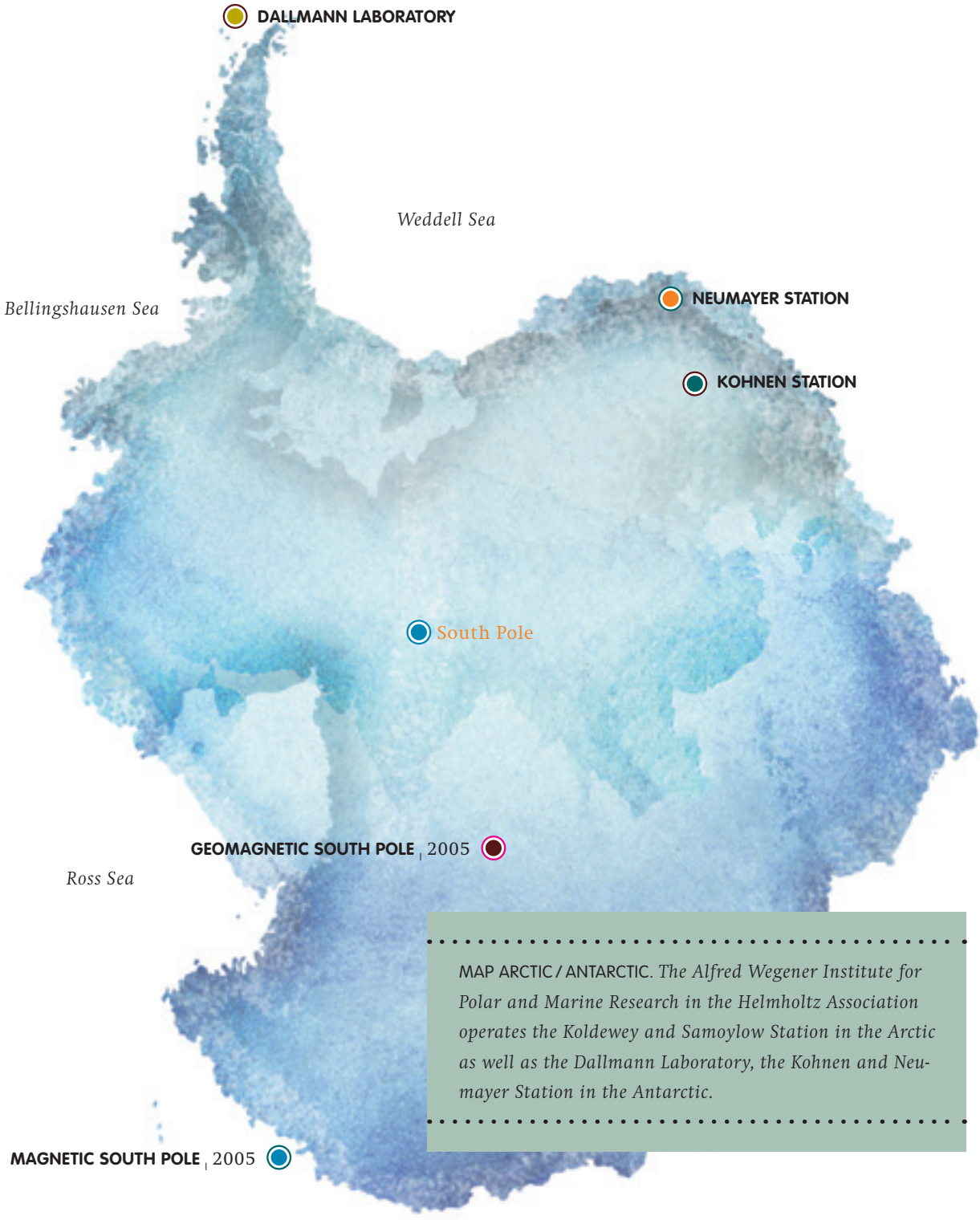
AWI

ICE | WHITE

1980 ~ 2005 | Years of discovery

MAP DESIGN | *GfG / Gruppe für Gestaltung based on*
C. B. Cogan, G. König-Langlo, B. Loose, Alfred Wegener Institute



MAP ARCTIC / ANTARCTIC. *The Alfred Wegener Institute for Polar and Marine Research in the Helmholtz Association operates the Koldewey and Samoylow Station in the Arctic as well as the Dallmann Laboratory, the Kohnen and Neumayer Station in the Antarctic.*

ICE | WHITE

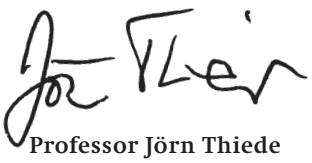
01 | *Sea ice in the Arctic*

1980 ~ 2005
Years of discovery

Let us take a look at the history of the Alfred Wegener Institute. For 25 years, we have been dedicated to the exploration of the Arctic, Antarctic and the oceans of the temperate latitudes. At the AWI, natural scientists from all disciplines work together, including biologists, chemists, physicists, oceanographers, meteorologists, geologists, geophysicists and glaciologists. 2005 is a very special year for the Alfred Wegener Institute: We celebrate not only the 25th anniversary of the institute but also Alfred Wegener's 125th birthday. The German geophysicist, after whom the institute was named, carried out several expeditions to Greenland early in his life, and developed the theory of continental drift. Nowadays, scientists of the AWI are still fascinated by ice and oceans and pose questions which they address with curiosity, enthusiasm and patience.

We would like to express our gratitude to all sponsors and partners in cooperation who have supported and helpfully accompanied our institution through the 25 years since its establishment. This magazine gives insight into the 25 year history and associated research highlights of the Alfred Wegener Institute.

Enjoy this »expedition«!



Professor Jörn Thiede
Director, Alfred Wegener Institute

PROF. JÖRN THIEDE
Geologist and palaeontologist Professor Jörn Thiede has been Director of the Alfred Wegener Institute since 1997. He is also current president of the International Scientific Committee on Antarctic Research (SCAR).

Page 08 | Impressions – More than pure science characterizes the research areas of the Alfred Wegener Institute.

Page 26 | Polarstern – the worlds most effective scientific ice breaker visits both the Arctic and the Antarctic.

Page 38 | *Euphausia superba* – krill has a key function in polar food chains.

CONTENT

Page 49 | Hightech – modern equipment fascilitated the discovery of submarine volcanos.

Page 58 | Cooperation – The Dallmann Laboratory was the first scientific station in Antarctica that was jointly operated by different nations.

Page 76 | Education – promotion of young talents starts early in the institute.

02 | *Sea ice in the Arctic*

PHOTO GALLERY | *Polar and marine research are fundamental to the understanding of natural processes and their changeabilities on our planet. The extreme environments of the polar regions and the oceans significantly influence global climate events. Scientifically based global environmental management can only be meaningful if natural and anthropogenic changes to the global environment are better understood.*

03 | *The extreme conditions in the polar regions set highest requirements of humans and equipment.*

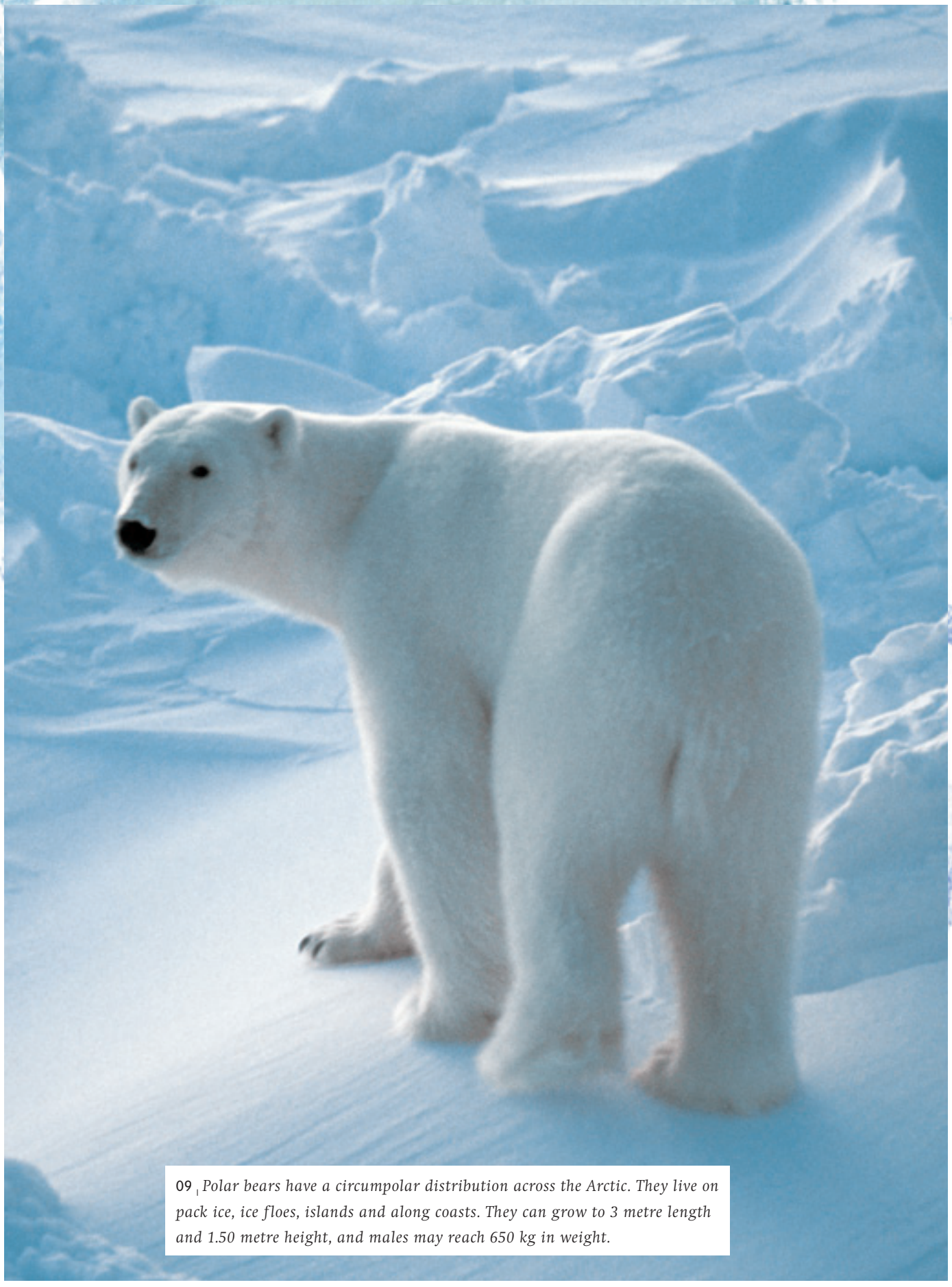
04 | *Penguins are flightless birds. In Antarctica, eighteen different species are found.*

05 | *Polarstern is a double-hulled research icebreaker. She is capable of work at ambient temperatures down to -50 °C and can, if necessary, over-winter in the ice of the polar seas.*

06 | *Iceberg in the Antarctic Ocean*

07 | *Alfred Wegener and his team during the last phase of the Greenland traverse in 1913. Wegener has gone down in history as one of the greatest German polar researchers and geoscientists. His reputation is based primarily on the theory of continental drift, which he co-founded and publicised.*

08 | *Sun dog in the Arctic*



09 | *Polar bears have a circumpolar distribution across the Arctic. They live on pack ice, ice floes, islands and along coasts. They can grow to 3 metre length and 1.50 metre height, and males may reach 650 kg in weight.*

10 | *Aerial photograph of tidal flats in »Königshafen« to the north of Sylt; with Blue Mussel beds noticeable as dark areas, the island of »Uthörn«, and the meandering tidal channel in Königshafen Bay.*

11 | *The new building of the Alfred Wegener Institute, inaugurated in May 2004, is located near the »Fischereihafenschleuse« in Bremerhaven. On 7,600 square metres, the building houses offices as well as biological and chemical laboratories for 240 employees.*

THE ALFRED WEGENER INSTITUTE

for Polar and Marine Research has reason to celebrate…

25th

1980

Text TIM SCHRÖDER

On July 15, 1980, the Alfred Wegener Institute (AWI) was inaugurated in Bremerhaven. A quarter of a century later, the institute has four locations in Germany: the main headquarter in Bremerhaven and satellite stations in Potsdam, on Helgoland and on Sylt.

In addition, the institute operates six research vessels (Polarstern, Heincke, Uthörn, Aade, Diker and Mya), five field stations (Neumayer, Koldewey, Dallmann, Kohnen and Samoylow) and two aircraft (Polar 2, Polar 4). Currently, the AWI has 780 employees. An institution of this size requires substantial services and administration: logistics management, computer centre, administration, library and public relations department all contribute to a support structure which facilitates successful research. For polar and marine researchers, expeditions under adverse conditions are equally part of their work routine as laboratory studies at home. Cooperation with many national and international partners, training and instruction of upcoming scientists, participation in international

committees and research projects are all integral components of their work.

The Alfred Wegener Institute is a member of the Helmholtz Association of German Research Centres and operates on a budget of approximately 100 million Euro. It is funded jointly by the German Federal Ministry of Education and Research (90%), by the state of Bremen (8%) and by the states of Brandenburg and Schleswig-Holstein (1% each). The AWI is the largest extramural research institution in the state of Bremen. Owing to its establishment, it was possible to expand marine research at the University of Bremen, and to found further institutes. With this network, Bremerhaven is now one of the most important locations for marine research in Europe.

Founding Director Professor Gotthilf Hempel recalls how the AWI came to Bremerhaven and how it received its name.

Why was Bremerhaven chosen as the site for the Alfred Wegener Institute?

Prof. Gotthilf Hempel: The choice of Bremerhaven as a location for the AWI was really not so much a scientific decision but a consequence of regional politics. During the mid 70s, Horst Grunenberg, social democratic MP from Bremerhaven, explored the Antarctic Treaty and the possibilities for fisheries and resource development at the South Pole. This caught the attention of the federal government. Subsequently, a science council commission assessed which location would be best suited for a German polar research centre. It decided on Kiel. However, within the Federal Ministry of Research at the time, an agreement was not reached as promptly. The cities of Kiel as well as Bremen and Bremerhaven all had their advocates. In addition, a dispute arose between the sister-cities of Bremen and Bremerhaven. During this discussion over structural politics, then-chancellor Helmut Schmidt tipped the balance by siding for Bremerhaven, which effectively ended the argument. Nowadays, the old dispute is water under the bridge and the AWI has become an integral part of the old seafarer town.

And how did the Alfred Wegener Institute get its name?

Prof. Gotthilf Hempel: Alfred Wegener is one of the few really prominent German polar researchers. He was an experienced explorer and died in 1930 on the inland ice of Greenland during a relief expedition. Wegener was a geophysicist, meteorologist and glaciologist and, in those capacities, not only a great research traveller and observer but also a distinguished theoretician. He developed the first in-depth ideas about the drifting of continents. Because his theories appeared far-fetched at the time, he was met with hostility by his colleagues. It was not until the 1970s that Wegener's theory was proven correct. In his capacity as expedition leader, Wegener was very highly respected as a person. All in all, Alfred Wegener was the most appropriate candidate after whom to name Germany's largest polar research institution. ✸

12 | *Over the past 20 years, Professor Gotthilf Hempel (to the left of Federal Minister for Research and Technology, Professor Heinz Riesenhuber) has been instrumental in developing marine research in Germany as a high-performance and internationally recognised field of science. Between 1980 and 1991, Hempel, a biologist, was the first Director of the Alfred Wegener Institute.*

13 | *Neumayer Station is resting on an Antarctic ice shelf, 200 metres thick and almost completely level. It is fully snow-covered. From a distance, only the ventilation chutes and satellite antenna are visible above the snow.*

POSITION:

70° 39′ S, 08° 15′ W

25th

1981

Text KAROLINE SCHACHT

Conducting research in the Antarctic means dealing with extreme conditions. The German Neumayer Station provides scientists with a good base for this purpose: it is where they find the cleanest air on earth, are able to record earthquakes from around the globe, can work towards reconstructing the planet's climate history from amidst the ice and study the ozone hole.

No-one shows up here accidentally. Getting here is expensive, risky and extraordinary. The German research station »Neumayer« is located on the Ekstroem Ice Shelf at the north-eastern edge of the Weddell Sea, in the centre of the Antarctic ice desert. Although, at Neumayer, one is still 2155 kilometres from the South Pole, average winter temperatures of −25°C allow only one conclusion: this is the end of the world.

Since 1981, the »Georg von Neumayer Station« has been situated at the north-easterly shelf edge, buried inside the ice: in contrast to the research facilities of other nations built on rocky ground and erected on stilts, German polar researchers have, over the years, dug themselves in by several metres. From year to year, a growing mountain of snow has weighed down the station. In the end, it reached nine metres, with the ice continually moving, tearing and pushing. Eventually, in 1991/92, it was time for a new station building. The name »Neumayer Station« persisted and utilisation of the facility for scientific activities was secured for the next 15 years. However, the new structure is also gradually sinking into the snow and is exposed to the tremendous forces of the ice. The snow continues to accumulate at a rate of approximately 80 centimetres per year, increasing weight on the station further. Occasionally, one can hear cracking sounds inside the station, a clear indication that the ice continues to shift, deforming the two corrugated iron pipes underneath the ice from their original round into an oval diameter. However, before they will be flattened, »Neumayer III« will be in place. This third Neumayer Station will start operating in 2008. Subsequently, the old station will be uncovered and dismantled, all functional contents will be moved to the new building, and all other materials will be disassembled into smaller parts for transport and disposal by ship.

Twelve metres below the ice, the Neumayer station houses a kitchen, a mess, wash- and living rooms, a hospital and technical as well as research laboratories, all within two 90 metre pipes connected by a passage. This might sound luxurious, but is far from it. Only about one third of the 2200 square metre station is heated to room temperature by diesel generators. Also, for at least eight of the 15 months of their stay, members of the station team experience what it means to be completely isolated. At least nine occupants stay at the station throughout the year: A physician who also acts as station manager, two meteorologists, two geophysicists, an engineer, an electrician, a radio-operator (electronics technician) and a cook constitute the over-wintering team each year. »Compared to the capacity of other stations, Neumayer Station operates with much fewer personnel«, says Dr Hartwig Gernandt, head of logistics at the Alfred Wegener Institute.

Scientists at Germany's southernmost work place carry out a long-term research programme. Various observatories are available for this purpose. One is used for meteorology: Changes to the overall radiation budget on our planet and their effects on climate are central to the scientific investigations. Optical observations are taken every three hours. Once a day a weather ballon gets launched. These particular data are added to the global network of the World Meteorological Organisation, facilitating weather forecasting. The second observatory is dedicated to geophysics. It is where seismic data are collected and where all major and minor earthquakes from around the globe are recorded. Neither movements of shelf ice nor changes to the earth's magnetic field go unnoticed. The third of Neumayer's observatories is the most strenuous to reach, especially during bad weather: the data re

cording station of the air chemistry observatory measures trace gases, such as ozone, but also minute dust particles in the air. Since this recording site requires extremely uncontaminated air conditions it is located 1.5 kilometres south of the inhabited station. In addition, substances that travel from the ocean into the atmosphere are traced here. Last but not least, the fourth observatory, opened in 2003, contains an infrasound array. As one of four infrasound observatories in the Antarctic it is part of the international »Comprehensive Test Ban Treaty« (CTBT) on nuclear weapons. Hence, Germany contributes to the internationally conducted surveillance of the treaty requirements.

FINALLY: SUMMER GUESTS

Summer guests provide a welcome break in the icy monotony: they usually arrive in November and stay until March. During this time, up to 50 scientists enliven the station. Another positive aspect of the summer season is that scientists and technicians can now get to Neumayer Station within a few days through excellent plane connections from Cape Town in South Africa, rather than having to take a long voyage by ship. The flights operated by »Dronning Maud Land Airway Network« (DROMLAN) first stop at the Russian base Nowolazarewskaja, and from there continue on to Neumayer Station. During the summer season, Neumayer Station also functions as a logistics headquarter for the operation of the polar aircraft as well as for the vehicles travelling the 750 kilometres to Kohnen Station across the inland ice.

At least once a year, the research ice breaker Polarstern calls at Neumayer Station and delivers new supplies, in particular food, equipment and fuel. In addition, Polarstern takes back all of the waste accumulated throughout the year, thus fulfilling one of the requirements of the international »Protocol on Environmental Protection to the Antarctic Treaty«, ratified in 1998. As the 1961 Antarctic Treaty requires all member nations to coordinate their operations and exchange scientific results, the logistics managers also meet at international conferences. The »Council of Managers of National Antarctic Programmes« (COMNAP) provides a forum for the coordination and management of activities, ship times and supply of stations. For Neumayer Station, collaboration with South Africa, Russia, UK and Norway is of particular interest as the research facilities of these countries are located in the vicinity of the German station. However, the term »neighbourhood« is relative in the Antarctic: Nearest neighbours at Neumayer Station are the scientists from South Africa – approximately 200 kilometres away.

THE FUTURE ABOVE THE ICE

Starting in 2008, life at Neumayer Station will change considerably, because »Neumayer III« will be constructed differently from its predecessors: With the station resting on stilts, hydraulic presses will maintain it at a constant elevation above ground, hence compensating for variable snow levels. Two air-conditioned floors of 1640 square metres each will house lounges, offices, technical work spaces and laboratories. The significant increase in space will accommodate even more scientists in the future. »Neumayer III« will have an aerodynamic exterior design to protect it against wind and to prevent accumulation of snow in the immediate vicinity of the station. The hydraulic adjustment will take place once a year, thus ensuring operation of the new station for 25 years to come. ✸

HIGHLIGHTS | *from 24 years of monitoring*

Highest wind speed	*36.5 m/s (July 10, 2001) = 131.4 km/h*
Lowest temperature	*– 47.3 °C (August 19, 1992)*
Highest temperature	*+ 4.3 °C (January 22, 1992)*
Daily sunshine duration during summer	*24 hours (polar day – from Nov. 19 to Jan. 24)*
Daily sunshine duration during winter	*0 hours (polar night – from May 19 to July 27)*
The most memorable Christmas	*»Before there were flights to Neumayer Station, members of the over-wintering team often stayed by themselves over Christmas and enjoyed this very much. Nowadays, Christmas at the station is often hectic, busy and usually rather unromantic.« (quote by Dr Gert König-Langlo)*

Construction of the new station Neumayer III

14 | *Atmospheric trace gases, such as ozone and minute air-borne dust particles, are measured in the air chemistry observatory. The observatory's isolated location makes it an invaluable recording site with pristine air conditions.*

POLARSTERN –

Indispensable for research at sea

25th

1982

Text KAROLINE SCHACHT

Since 1982, the ice-breaking research and supply vessel Polarstern has been the highest performing polar research ship in the world. Although she has travelled more than one million nautical miles she is still far from the end of her life of polar marine research expeditions.

In December 1982, Polarstern began her first voyage to the polar regions. Soon after the research ice breaker had been taken in commission, it was headed towards Antarctica. Since then, Polarstern has been travelling every year on a South Polar expedition from November to April, and has spent the summers in the Arctic Ocean.

On January 22, 1983, Professor Dieter Fütterer, marine geologist at the Alfred Wegener Institute, came aboard the vessel in Cape Town and accompanied the polar maiden voyage of the new ship. Exactly 20 years later, on January 21, 2003, he left Polarstern for the last time, once more in Cape Town. Between these two dates, he spent a total of three and a half years aboard what he considers the »most important tool« for German polar research. »A ship like Polarstern represents a world of its own«, the widely travelled scientists reminisces. »Far beyond going to sea, there are many aspects that may work well on the drawing board at home, but turn out to be an altogether different kettle of fish aboard a swaying platform in cold surroundings.« Apart from her solid technical facilities, Polarstern especially offers excellent working conditions for a maximum of 60 scientists and is owned by the Federal Ministry of Education and Research. It is crucial for the researchers to be able to maintain constant work efficiency throughout the long expedition segments of 60 to 70 days because the operation of the floating research institute is also expensive.

Nine laboratories on board house the scientific equipment for all sorts of oceanographic, biological and geo-scientific studies. Cold-storage rooms and aquaria ensure the safe transport of samples and live marine animal collections back home. Additional large equipment may consist of a fishing net dragged from the stern of the vessel. Alternatively, it might be a »streamer« which, by means of hydrophones on board, can record a seismic profile of the seafloor. Or perhaps »Victor 6000« is involved: The French underwater four tonne heavy-weight robot requires a crane to be placed in position. Polarstern provides sufficient space and power for all of these and other, highly variable, demands. Occasionally, scientists have encountered the rumour that they were travelling a luxury liner. Though the reality is different. Since the vessel offers such outstanding working conditions, research results have been excellent too. Ever since Polarstern's maiden voyage in December 1982, scientific projects

15 | *Polarstern is able to pass through ice of 1.5 metre thickness at a speed of approximately 5 knots. Stronger ice has to be broken by ramming.*

conducted aboard continue to provide interesting and significant insights into the polar worlds above the ice and under water.

KEY ASPECT: THE CREW

Polarstern was designed for operation in the polar oceans and spends almost 320 days per year at sea. For both, the crew and the captain, an expedition segment may last up to 90 days, a truly high-performance commitment. Nevertheless, during 23 years in operation, fewer than 10 captains have guided Polarstern. »The skippers undergo extensive qualifying training«, says Jürgen Fischer, head of personnel at Laeisz shipping company. »Usually, the master candidates are deployed initially in a position of reduced responsibility for two voyages«. As additional nautical officer they have the opportunity to get used to travelling through thick layers of ice, because guiding Polarstern is fundamentally different: »The unusual destinations of the vessel are one thing«, explains Dr Martin Boche, former captain of Polarstern from 1999 and 2002, who currently coordinates the vessel's activities from ashore, »but also the ship's operational management is different. As a captain, one collaborates with a chief scientist of the trip, and the whole endeavour represents an expedition.« Members of the crew do not undergo specific training. However, the sailors rapidly grow into specialists through hands-on experience on board. Everyone is employed by Laeisz Shipping Company which has been servicing Polarstern for the Alfred Wegener Institute since 1996.

In contrast to other polar research vessels where science plays only a secondary role, Polarstern follows a clear scientific mandate. This means that a maximum of 44 crew personnel and up to 60 scientists can go on each expedition. By spring of 2005, more than 7,000 scientists from over 35 countries had travelled aboard the vessel. On average, about one third

16 | *Polarstern has tied up to sea ice in Atka Bay to supply Neumayer Station.*

17 | *From the control desk, engineers are guiding the vessel's 20,000 horsepower.*

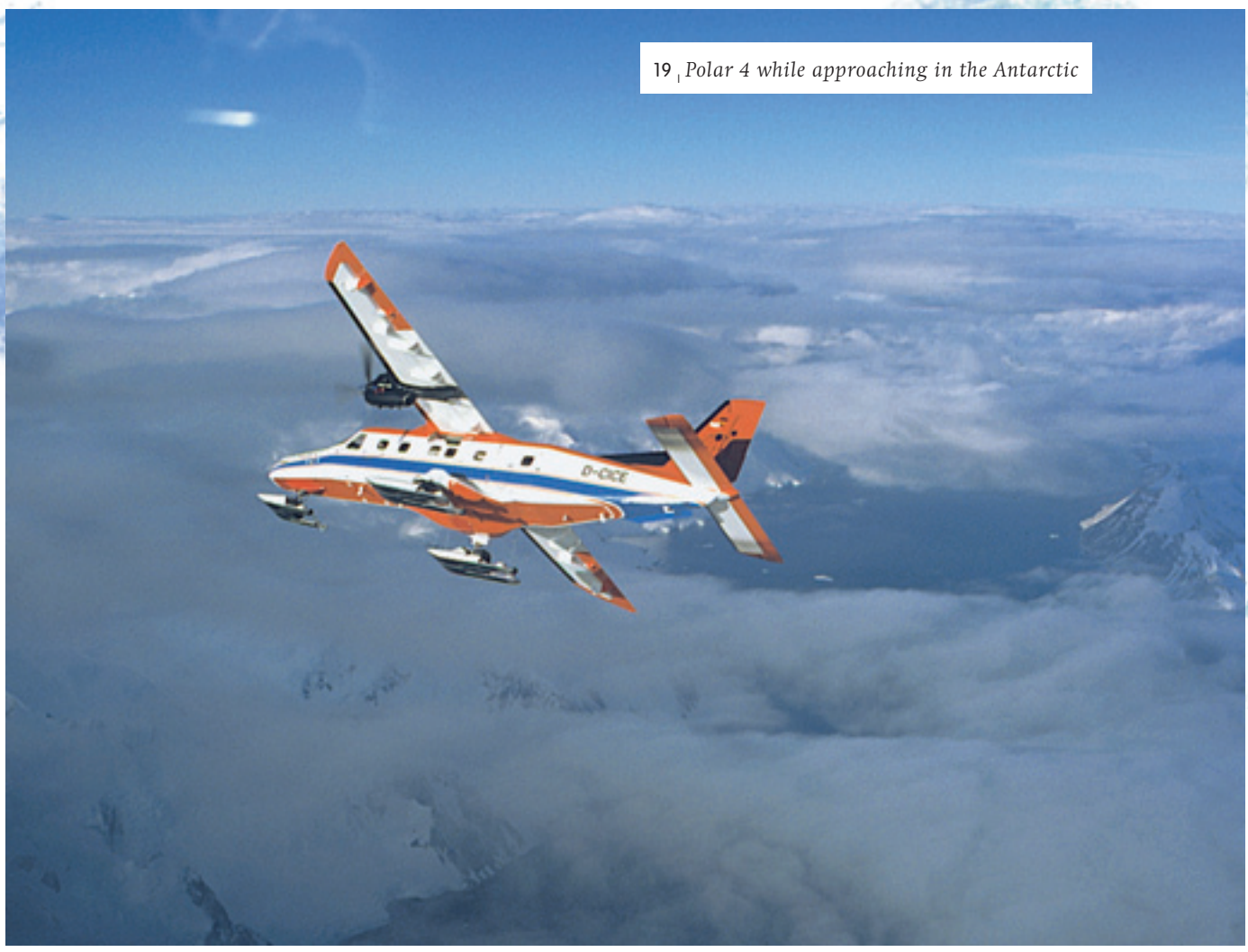
18 | *Scientists enter arctic sea ice.*

of researchers are visiting scientists from international project partners, the second third comes from German universities and research institutions, and the remaining third is represented by scientists from the Alfred Wegener Institute itself.

Polarstern is capable of almost everything – except travelling to the Arctic Ocean in the middle of winter. In order to close this gap and to extend the scientific programme to include drilling of deep sea cores from continually ice-covered ocean regions, European engineers have been working towards the design and construction of a new polar multi-purpose vessel: The Aurora Borealis will be used specifically for research in the central, permanently ice-covered Arctic Ocean. The European multidisciplinary project has a monetary volume of 250 Million Euros and includes numerous scientists, engineers and technicians from the Alfred Wegener Institute and many other institutions. With an overall length of 178 metres and 50 megawatts engine power, the Aurora will be much more powerful than Polarstern. Furthermore, she will be equipped to travel the Arctic Ocean all year round. The mobile drilling rig is particularly exceptional in that it will allow drilling 1,000 metres into the sea floor while already at a water depth of 4,000 metres. ✸

TECHNICAL SPECIFICATIONS | *for Polarstern*

Constructed	*Howaldtswerke / Deutsche Werft (HDW), Kiel; Werft Nobisburg, Rendsburg*
Ice Breaker Design	*Hamburgische Schiffbau-Versuchsanstalt*
Ice Breaking Performance	*Ice of up to 1.5 metre thickness can be passed at 5 knots, up to 6 metre thick layers of ice are broken through ramming.*
Overall length	*118 metres*
Maximum beam	*max. 25 metres*
Height to main deck	*13.6 metres*
Draught	*max. 11.21 metres*
Maximum displacement	*17,300 tonnes*
Light weight	*11,820 tonnes*
Engine power (4 engines)	*approx. 14,000 kW (20,000 bhp)*
Maximum speed	*16 knots*
Maiden voyage	*1982*
Travelled nautical miles	*> 1.1 million nautical miles since commissioning*



19 | *Polar 4 while approaching in the Antarctic*

VIEW FROM ABOVE –

Flying across the vastness of the ice

25th

1983

Text KAROLINE SCHACHT

By employing the two polar aircraft Polar 2 and Polar 4, the Alfred Wegener Institute has been able to close major gaps in the methods available for scientific data collection. The aircraft have become invaluable for polar research.

In 1996, when Polar 2 conducted one monitoring flight after another, the scientists really had a different objective: they were searching Dronning Maud Land for the most suitable site for the European ice drilling project EPICA (European Project for Ice Coring in Antarctica). In order to collect information about the climatic history of the past 300,000 years, the scientists were planning to retrieve drill cores from an ice sheet of several kilometres thickness. Using so-called radio echo-sounding technology (RES) special type of ice radar aboard Polar 2, ice of up to 4000 metre thickness can be screened from above and its vertical extent as well as inner structure can be mapped. However, instead of the expected basins, the computer monitor suddenly displayed the topography of a solid, gigantic mountain range from underneath the ice: its dimensions were equivalent to the Alps, with several valleys below sea level and some peaks rising to 3000 metres above chart datum! Such discoveries would be impossible without the use of aircraft. However,

this is not the only reason why Polar 2 and Polar 4 have been firmly established as part of the research infrastructure of the Alfred Wegener Institute. Since 1983, both aircraft have made an average of three extended expeditions annually to the Arctic and Antarctic. The company »Optimare Sensorsyteme AG« from Bremerhaven services and maintains the equipment on site. The German Aerospace Centre (DLR) provides the pilots. Both aircraft are well equipped for assignments in extreme environments: with their combined wheel-ski undercarriage they are able to start and land on both concrete and snow runways. There are de-icing systems for the wing panels, heating pads for the gearbox and batteries, and even during adverse weather conditions, the planes return safely to ground. Despite all those features, however, starting becomes impossible during extreme gales and at -54°C.

Depending on the nature and demands of the research mission, scientists or engineers and various measuring systems are aboard. Records of the air flow in the polar atmosphere, for instance, are fed into the latest climate models. Using remote sensing systems in Polar 2, it is possible to map the earth's magnetic and gravity fields. Polar 4 concentrates more on aerial chemistry: Trace gas and aerosol recordings can be carried out directly with spectro- and photometers from aboard the plane. In addition, both aircraft collect routine data sets on temperature, humidity and barometric altitude, thus complementing the land based measurements from the scientific observatories. Similar monitoring routines are also used in the Arctic. In 2004, the first scientific recording of ice cover by plane took place between

Spitsbergen, Greenland and Canada. The measurements were synchronised with the ground based stations of the Cryosat programme. The satellite Cryosat maps ice thickness in the Arctic and Antarctic. Analysis of the data will reveal whether the ice cover is decreasing or expanding.

Aircraft are also indispensable as a logistic tool in polar research. Supply of Kohnen Station, a summer base located approximately 700 kilometres inland from Neumayer at an inhospitable 3000 metres of altitude, would be impossible without the aeroplanes. And as this problem arises for other polar research nations too, the »DROMLAN« project (Dronning Maud Land Airway Network) has been established in the Antarctic. In this project, Scandinavian, Russian and Japanese research institutions organise their expeditions together with the Alfred Wegener Institute. However, in future, Polar 2 and Polar 4 will be relieved from their logistic tasks in this project: »The aircraft are too valuable, and we would like to put them to scientific use as much as possible«, says AWI geophysicist Dr Uwe Nixdorf. ✸

20 | *System check during whiteout conditions in the Antarctic. Using a starter generator, one of the two engines (starboard side) is being fired up for the purpose of testing the aircraft's geophysical recording equipment while still aground.*
21 | *Re-fuelling of »Polar 4« at the South African summer research station E-base on Fimbulisen, Antarctic*

22 | *The prominent building designed by Oswald Ungers has enriched Bremerhaven's cityscape since 1986.*

FROM A MODEST BEGINNING

to becoming the centre of German polar and marine research

25th

1984

Text ANDREAS WOHLTMANN

The revival of polar research in Germany starts under crowded conditions. At the time of the official inauguration of the institute in 1980, scientists, technicians and administration of the Alfred Wegener Institute for Polar Research initially all share two floors of the Columbus-Centre in Bremerhaven. Although, in the following years, additional buildings are rented, the land-based infrastructure does not meet the demands.

In November of 1984, the topping-out ceremony for the new building of the institute promises relief. Oswald Matthias Ungers, one of the best known contemporary German architects, combines a traditional brick construction with modern ship design. The award-winning concept does not only succeed in integrating the Columbus Centre into the urban structure, but, simultaneously, creates a reference to the maritime research focus in the disciplines of geosciences, biosciences, climate sciences and new technologies. However, not only scientists need space. The logistic servicing of the polar stations and research vessels is also organised here. Furthermore, Bremerhaven is a convenient location for the Alfred Wegener Institute because it allows access to the harbour – home port of Polarstern. Maintenance of large scientific equipment takes place in the harbour storehouse and the polar aircraft are based at the regional airport Luneort.

With areas of study such as climate research becoming ever more topical, the scientific tasks and logistic demands grow even more rapidly than anticipated. In 1987, as the new building, devised for 150 staff members, opens its doors, the space problems are far from solved. Soon afterwards, at the end of the 80s, an additional extension building is planned and approved. After the German reunification, development of the research unit in Potsdam in 1992 represents a new priority so that the new building for 240 employees in Bremerhaven, located at »Handelshafen«, is only completed in 2004. Advanced systems for energy and rain water usage are integral components of the »Sustainable and Ecological Building« concept that is realised here. Through courtyards and tower constructions, renowned Munich architect Otto Steidle has been able to create a reference to shipping also for this building.

Space will be needed in the future, too. Currently, the Alfred Wegener Institute in Bremerhaven has approximately 600 employees. The harbour storehouse, used for storage and maintenance of equipment and large gear, is almost at capacity. Furthermore, it is planned to establish small businesses associated with polar research here, as well as the proposed »Institute for Applied Marine Research« with its focus on fisheries biology, bionics and technology development. The Alfred Wegener Institute intends to work in close collaboration with these groups. ✸

TOPPING-OUT CEREMONY OF THE NEW BUILDING IN 1984
Architect Oswald Ungers, Bremen mayor Hans Koschnik, Board of Trustees president Wolfgang Fincke, Institute Director Gotthilf Hempel, Bremen science senator Horst-Werner Francke.

23 | *Cod suffers from anoxic conditions in the North Sea.*

25th

1985

OCEAN DWELLERS OUT OF BREATH

Text NADINE QUERFURTH

Bremerhaven has potential – especially for marine research. With the integration of the Institute for Marine Research (IfMB) in 1985, the Alfred Wegener Institute not only adopted a cotton shed more than 100 years old, but also the Victor Hensen. From aboard this research vessel, scientists made a challenging discovery.

August 25, 1981: After a routine sampling trip to the area outside the mouth of the Elbe estuary, the Victor Hensen headed northwest. Near Helgoland, a disconcerting discovery was made: a large water body almost depleted of oxygen – for the first time identified offshore in the North Sea. The oxygen saturation was only 40 percent – too low for any fish or other sensitive organism to last. Normal values in seawater are approximately 90 percent. One of the scientists aboard the ship that day was Dr Eike Rachor who, already in 1978, had predicted oxygen deficiency for specific regions of the North Sea. »I was ridiculed at the time«, remembers Rachor. Areas of oxygen depletion in the ocean are identified by water saturation levels of 50 percent or less compared to normal values. Fish and many other ocean dwellers literally cannot breathe

under those conditions. Eike Rachor worked at the Institute for Marine Research in Bremerhaven at that time. Since 1985 it has been amalgamated with the Alfred Wegener Institute for Polar Research. Subsequently, the renowned institution carried the new name Alfred Wegener Institute for Polar and Marine Research, a way of acknowledging that marine research would represent an additional priority.

ALARMING CHANGES ON THE SEAFLOOR

Only one month after the discovery, a storm at sea put an end to the incident. Through the strong winds the sea water was enriched with oxygen even at greater depths. However: »In the 1980s, we detected similar phenomena on three different occasions, sometimes associated with a die-off of many bottom-dwelling animals. And in 2003, saturation values, once again, dropped almost to critical levels«, says Rachor. The scientist links the oxygen deficiency to pollution and eutrophication of the oceans. Until 1980, sewage sludge was often disposed into the sea, and waste water input via rivers, as well as intensive agriculture contribute to the effect. Hence, humans are largely and in many cases responsible for the problems of oxygen deficiency. As a result of increased nutrient input, planktonic algae form large blooms which are decomposed during and after sinking to the seafloor, a process that requires enormous amounts of oxygen. »Calm weather conditions with little wind facilitate the development of oxygen depleted areas in deeper waters«, explains Eike Rachor. For bottom-dwelling animals, oxygen deficiency can be fatal.

Since 1969, Eike Rachor has documented the changes of the seafloor. Such long-term monitoring series of bottom fauna were already a focus of the Institute for Marine Research and have been continued at the Alfred Wegener Institute for Polar and Marine Research. The dramatic outcome of this long-term and other research work in the German Bight: About 200 species of invertebrate animals are now on the »red-list« of endangered species, including sea urchins, snails, bivalves, lobster and worms. Presently, the pollution of the North Sea has declined somewhat: sewage and other waste dumping is prohibited and rivers have become cleaner. However, the long-term effects of agriculture on marine ecosystems and the impacts of fisheries on seafloor organisms remain severe. »The most significant changes are nowadays caused by the heavy fishing gear of the bottom fisheries; the seafloor is literally ploughed«, explains Rachor. His colleague, Dr Alexander Schröder, sees the fact that there is hardly any place in the German Bight which

24 | Scientists monitor the development of fish populations in the North Sea through regular sampling

HEINCKE

As a result of its versatile equipment (winch and crane systems, telecommunications facilities and sounding devices), the research vessel Heincke may be used for a broad spectrum of biological and hydrographical research projects in the North Sea.

25 | Blue mussels and hydrozoa at the research platform FINO1

not fished as the biggest problem. »There simply is no refuge for exploited fish populations to recover and for the bottom fauna to stabilise«, says Schröder.

STRATEGIES FOR SUSTAINABLE FISHERIES

The EU-funded project »RESPONSE« aims to address exactly this question: How will the fauna of the seafloor change if there is no more fishing? At several European sites, i.e. in the German Bight, the Irish Sea and on the Mediterranean coast, scientists observe the seafloor and the animals living there. Alexander Schröder from the AWI coordinates the project component for the German Bight. The research platform FINO1 is located near the island of Borkum. For security reasons, an area of 0.5 kilometre radius around the platform is excluded from all traffic and fishing. This area is used for for investigations within the RESPONSE project. Scientists hope to be able to assess the medium and long-term effects of bottom trawls and other fishing gear on seafloor organisms. This might allow the development of improved guidelines and policies for sustainable fisheries.

FINO
In the autumn of 2003, the research platform FINO1, located 45 kilometres north of Borkum at 28 metre water depth, started operating. The wind-recording tower is 100 metres high.

UNDERWATER IMAGES – JUST A MOUSE-CLICK AWAY

From their desks in Bremerhaven, scientists are able to remotely control a camera and video system installed on the research platform FINO1. For this purpose, they log into the computer and, by mouse-click, steer a camera into the water. With another click, the camera takes digital underwater images at various water depths. These activities contribute to another BMU-supported North Sea project coordinated by Alexander Schröder of the Alfred Wegener Institute: BeoFINO assesses the ecological effects of future offshore wind parks on the marine environment. The pillars of wind turbines are secured in the seafloor and hence represent an enormous change to the ecosystem which is otherwise dominated by soft sediments: Hard substrata suddenly become part of the habitat. They can be colonised by organisms which are typically rare or absent in a soft sediment community, for instance species of sea anemones, bivalves or barnacles.

INVESTIGATION PERIOD TOO SHORT

Scientists have had little more than a year's time to document how the underwater structures of the FINO1 platform are colonised by organisms. It became apparent that the hard substrata have a strong impact on the species communities. Increasingly more predators, such as sea stars, colonise the structures and feed on the fouling assemblage. The species composition not only varies seasonally but also annually and presumably takes several years to stabilise. BeoFINO will be continued for another three years. This will allow scientists to monitor the effects on species communities over an extended period of time. Further emphasis will be placed on predicting cumulative effects using computer models. Wind parks comprise not just individual turbines providing additional hard substrata but hundreds of them. ✸

26 | *Typical examples of the North Sea bottom fauna: Crab, sea stars, sea anemone.*

HOW DO KRILL MAKE IT THROUGH

the winter?

25th

1986

Text KAROLINE SCHACHT

Astounding results about the life and ecology of the Antarctic krill (Euphausia superba) have emerged since the mid 1980s from the work of AWI scientists. After the utilization of krill as a suitable source of protein was ruled out for the near future, the scientific questions have focused on the krill's survival strategies during winter.

Had UWE not come and taken those beautiful pictures, it might have taken many more years before krill research at the AWI had made its break-through: For the 1986 Polarstern expedition to the South Polar Sea, the first over-winter stay of the vessel in the Antarctic pack ice zone, the scientist Hans Peter Marschall was on board. The krill researcher had brought UWE, »his« Under Water Explorer with integrated film camera. UWE was employed as a diving robot and could place optical equipment underneath the ice sheet. The images taken showed vast numbers of krill below the ice! Previously, scientists had assumed that the shrimp-like animals only occurred free-swimming in open water, i.e. that they were pelagic. Now they were forming dense clusters underneath the ice.

Subsequent experiments invalidated other preconceptions: Algae-covered glass sheets were grazed by the small crustaceans as if scraped clean. Hence, krill were not only filter feeders, obtaining their food while drifting through the water, but also crawled across the underside of ice floes, scraping off small algae. »This was the first clue as to how krill survive the long Antarctic winter«, says Professor Sigrid Schiel of the Alfred Wegener Institute who was also onboard Polarstern in 1986.

Apparently, Euphausia superba has found itself a true niche: the earlier hypothesis that krill, on the one hand, seek refuge from predators such as seals and penguins underneath the ice, and, on the other hand, find excellent living and feeding conditions in this habitat, is still valid. As food for marine mammals and sea birds krill play a central role in the Antarctic ecosystem. However, some aspects of their ecology are still unknown.

WHICH QUESTIONS DOES SCIENCE HAVE FOR THE KRILL?

The insights from 1986 and subsequent years made one thing very clear: The world still knew far too little about krill. The AWI collaborated in the international BIOMASS programme which was initiated in 1976

KRILL EXIST IN VAST NUMBERS. *Currently, 85 species of krill have been described. However, just the biomass of Euphausia superba alone is estimated at 265 million tonnes. Since krill occur in massive swarms, the idea to utilize this unlimited resource as a new source of protein seemed obvious. However, the plan was dropped quickly because the small crustaceans turn into an inedible pulp very soon after being caught when their own aggressive enzymes digest the animals themselves. Furthermore, the fluoride content in the carapace is much too high. Nowadays, a machine strips the meat of the freshly caught krill from the carapace within minutes of coming out of the water. Otherwise, the largest percentage of the catch ends up as krill meal in aquaculture. In Japan, krill is highly sought after as bait for (sport) fisheries.*

27 | *Krill is a Norwegian term for »whale food«. The animals grow to six centimetres in length, two grams in weight and probably six years old.*

with the object of providing »a deeper understanding of the structure and dynamics of the Antarctic ecosystem as a basis for future utilization of its living natural resources«. The AWI had practically committed to conducting krill research: When the German federal government signed the »Convention on the Conservation of Antarctic Marine Living Resources« (CCAMLR) in 1980, it also committed itself to regular research contributions about krill and fish populations.

Scientific activities following the 1986 discoveries were concerned with the krill's faecal pellets (matter) which contain(s) an unusual amount of organic material, i.e. almost undigested food items. The krill faeces rapidly sink towards the seafloor, hence exporting the organic material into other habitats deeper in the ocean. How many krill are there, anyway? When estimates of the overall krill biomass hit the one million ton mark, the numbers began to rouse the interest of the commercial fishery. Nowadays, approximately 100,000 tons of the estimated 65 to 265 million tons of krill are fished annually from the polar ocean. The maximum harvest limit is regulated internationally by CCAMLR.

Globally, krill is also of interest in a completely different context: »Despite the fluoride, chitin from the krill's carapace is much purer than from an insect carapace«, says Professor Dr Ulrich Bathmann, chair of the department of Biological Oceanography. »The pharmaceutical industry is interested in krill chitin in order to utilize it in ointments and for medical wound healing.«

INTERESTING STRATEGIES

During winter, there is not much food for the krill because the dark season limits algal growth, and the remaining prey items also withdraw – how, then, do krill survive those meagre times? Do they lower their metabolism, utilize fat reserves, or do they even shrink? AWI researchers know: All of these strategies actually occur. In July, 2006, a new krill expedition will set out to the Antarctic and address these questions. ✸

25th

1987

MICRO-WORLD COLLECTION

Text JÖRN HILDEBRAND

All of the triangles, rods and rollers follow a strictly symmetrical design. Some of the species bear resemblance to space ships or to the facet eyes of insects. The diatoms, unicellular algae, all follow the same principle of construction in which a box is covered by a lid, but have evolved a remarkable range of variation on this principle. 1987 saw the publication of the »Atlas and Catalogue of The Diatom types of Friedrich Hustedt« by Dr Reimer Simonsen. Hustedt was the foremost specialist in these organisms for most of the 20th century and his work forms a major foundation for modern research on them.

Diatoms have established successfully in most aquatic environments on earth, including sea and fresh water systems and the liquid films on trees. The cool-aesthetic structures, however, represent only the formal aspect of these organisms. Due to their enormous biomass in the world's oceans, the photosynthetically active unicellular algae are major players on the global climate stage: »Roughly 25 percent of primary production comes from diatoms. Their significance for global oxygen and carbon budgets is comparable to tropical rain forests«, says Dr Klaus Valentin of the Alfred Wegener Institute (AWI).

DIATOMS INDICATE CHANGE – FROM THE PAST AND PRESENT

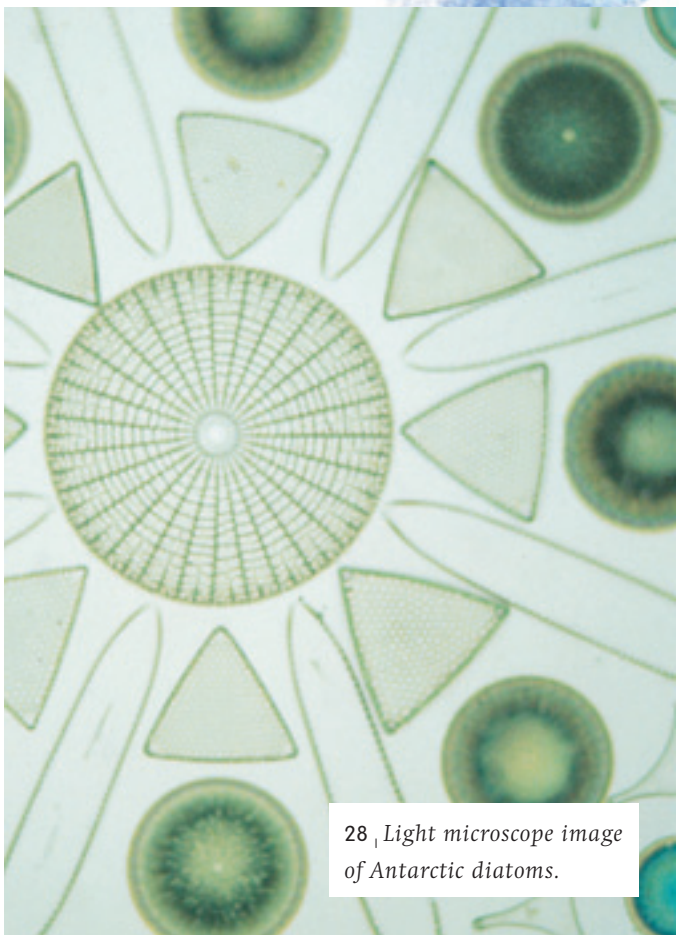
For more than 50 million years, diatom shells have rested at the bottom of oceans and lakes, undisturbed and as perfect as on the day they were formed. They offer information about ancient climate histories on earth. In addition, diatoms also provide current evidence of changes to water quality caused by humans.

In order to make use of such »services« by diatoms, researchers have to revert to collections: the preserved type material gives reference points that are crucial for the correct identification of specimens.

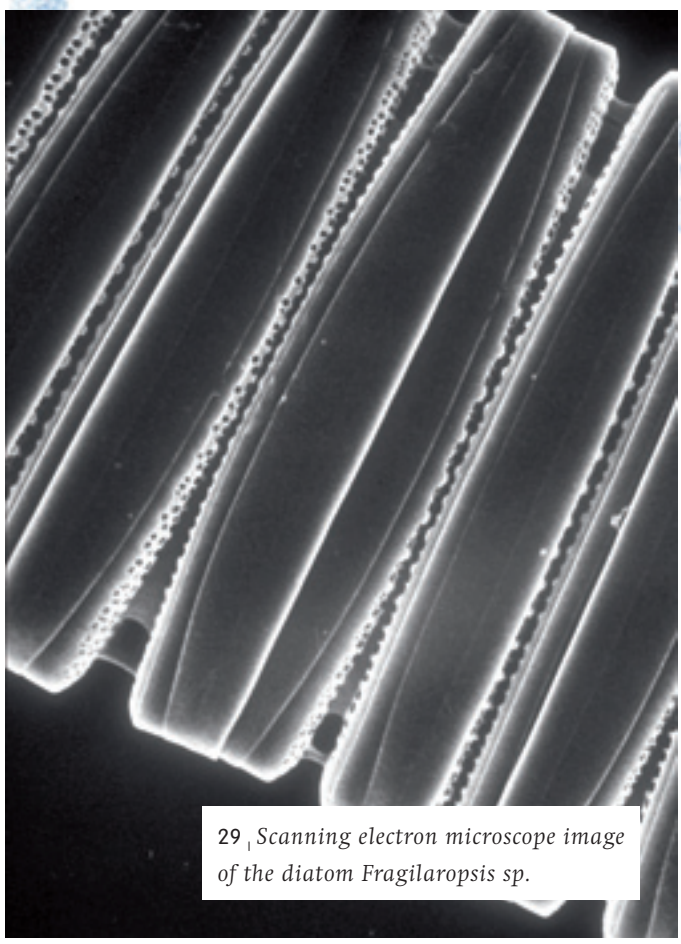
THE HUSTEDT STUDY CENTRE AT THE AWI – INVALUABLE RESOURCE FOR DIATOM RESEARCH ACROSS THE WORLD

Friedrich Hustedt (1886-1968), school principal from Bremen, was fascinated by diatoms throughout his life. He created one of the largest collections in the world which was integrated into the former Institute for Marine Research, predecessor to the AWI. Hustedt, one of the leading diatom researchers of the 20th century, described more than 2000 taxa, i.e. more than many of his colleagues would even have seen in their entire lifetime. The first curator of the Study Centre, Dr Reimer Simonsen, together with technical assistant Friedel Hinz, accomplished the lengthy and difficult task of finding and photographing all of Hustedt's type material. In 1987, the three volume atlas of his extensive type material set was published. It represents a rare collection of information and images. Today, the AWI stores approximately 80,000 microscope preparation slides and 30,000 samples of material at its Hustedt Study Centre.

Apart from type material from other diatom researchers being continually added to the collection, a data base



28 | *Light microscope image of Antarctic diatoms.*



29 | *Scanning electron microscope image of the diatom Fragilaropsis sp.*

has been established: in this way, images and information about species, locations or publications can be accessed from across the world. »We have already photographed approximately 7500 microscope preparation slides with a digital camera and placed them on the internet«, explains Dr Richard M Crawford, current curator of the Friedrich Hustedt Study Centre at the AWI.

GENETIC DIATOM RESEARCH – SERVICE TO MAN

Nowadays, genetic methods have been added to the spectrum of biodiversity research on diatoms: The working group under Dr Linda Medlin uses gene sequencing to unravel the phylogeny and evolution of the whole diatom division, providing a significant complement to the collection at the study centre.

However, molecular genetic diatom research at the AWI also facilitates man's utilization of the »Fruit de Mer«. Over the past 20 years, toxic algae which may cause major damage in mariculture operations have occurred more and more frequently. Among them are also diatoms. However, species identification of the toxin-producers is difficult. Often, they are only recognised when it is already too late. This is where gene sensors can help: they unequivocally identify toxic algae by specific DNA sequences, before they can cause harm.

The species-rich world of diatoms holds tremendous potential which, to date, has hardly been explored: Nanotechnology has become interested in the minute »muscle fibres« operating in the diatoms' double shell. And the algae also provide a service to the food industry: Omega-3 fatty acids, which strengthen particularly the nervous system in humans, are extracted from their metabolism. »The AWI is integrated in this kind of research«, elaborates Klaus Valentin, »because we decode which diatom gene produces these valuable fatty acids.« ✸

30

31

25th

1988

GREEN FINGER, BLUE HOUSE AND WHITE BALLOONS

Text NADINE QUERFURTH

At 32 kilometres altitude, it has fulfilled its mission: A white, helium-filled weather balloon. As the air pressure keeps declining, its volume increases 60fold. Eventually, the rubber wall gives in, and the balloon simply bursts. The attached measuring equipment, roughly the size of a shoe box, plunges into the sea and is irretrievably lost. By this time, however, a radio transmitter has sent all important data instantly to the Koldewey Station in Ny-Ålesund on Spitsbergen.

Such balloon launches are part of the monitoring routine at Koldewey Station on Spitsbergen. In 1988, researchers of the Alfred Wegener Institute started working in Ny-Ålesund, a former mining settlement with the world's most northerly pit train. Since 1991, Koldewey Station has been occupied continually, and the »Blue House« with working and living space constitutes its heart.

By means of the balloon sensors, scientists record standard weather parameters such as temperature, air pressure, humidity and wind speed, as well as important data for ozone research which has been emphasised at the station for a long time. In a dedicated observatory building, instruments such as the »Lidar« (Light Detection And Ranging) find their application. The multi-wavelength lidar is one of

the most expensive research tools at the station and sends a visible green laser beam into the sky: The »green finger«. By analysing the small amount of backscattered radiation, captured by a telescope, researchers are able to calculate the concentration of suspended particles – the aerosols – at various altitudes. In lower layers of the atmosphere, aerosols influence the climate, whereas in higher strata they are important for chemical reactions that play a major role in ozone depletion. In 1989, the researchers made an important discovery: Using the lidar of Koldewey Station, scientists observed, for the first time, so-called polar stratospheric clouds (PSC) over Spitsbergen, a special effect of aerosols in the atmosphere.

Since the measurements at the observatory are exceptional and will be continued in the long term, Koldewey Station has been a member of the global »Network for the detection of stratospheric change« (NDSC) since 1992.

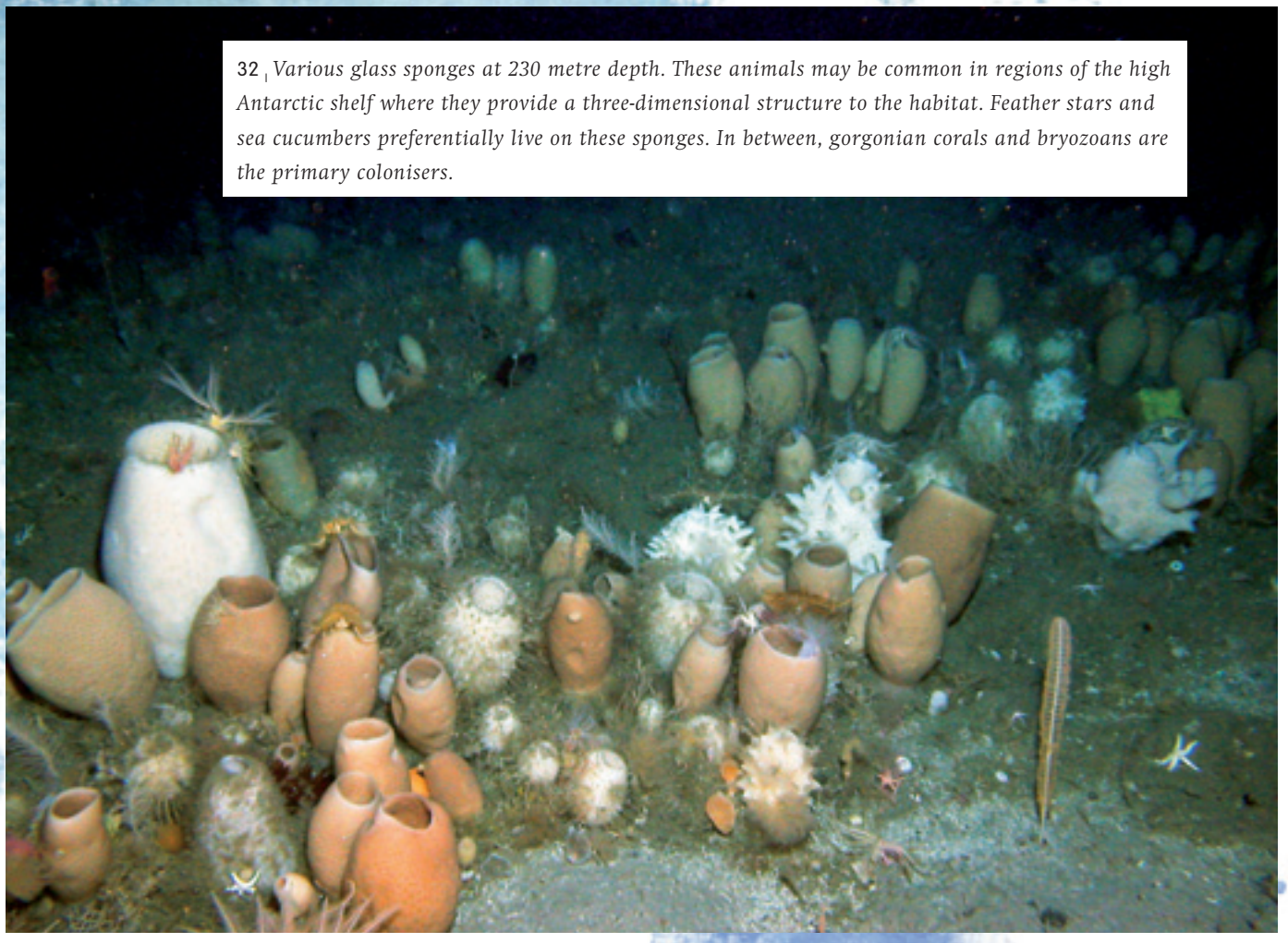
In Ny-Ålesund, the common language is »MultiCulti«. The research village consists of 12 scientific stations with researchers from many different countries: Norway, Sweden, UK, Holland, Spain, Italy, USA, Japan, China, Korea, Germany and France. The international collaboration provides the basis for a remarkably successful research location. Since the German Koldewey Station joined forces with the French station »Charles Rabot« and amalgamated into the French-German Arctic research base in 2003, Spitsbergen has been animated by new spirit. Both institutions – the German Alfred Wegener Institute and the French polar research institute IPEV (Institute Polaire Français Paul Emile Victor) – recognise the benefit of previous logistic facilities and equipment from both stations superbly complementing one another. The German contribution includes snow mobiles, a car, an electronics workshop and an atmospheric research laboratory, whereas the French have a large supply of tents, sleeping bags, and – crucially important – guns for the protection against polar bears. The research base will encourage researchers from both nations to jointly prepare, fund and realise their projects. The fields of investigation at the station are manifold: during winter and spring, atmospheric processes take priority, whereas biological studies are at the top of the agenda during summer. Research topics addressed range from glaciological, chemical and geophysical enquiries, to the exploration of seaweed communities in the Kongsfjord and of bacteria living in permafrost soils. The French-German research base is probably the only station in the world where the effects of ultraviolet radiation on organisms is studied across such a wide spectrum, i.e. at 32 kilometres altitude through balloon measurements and down at 20 metres underwater depth through diving excursions.

One highlight in Ny-Ålesund is the inauguration of the newly constructed international marine research laboratory in June 2005. This joint project is a prime example for the international collaboration typical for Ny-Ålesund. New opportunities created in this state of the art laboratory provide new impulses for marine research. ✸

30 | *Launch of a balloon-borne ozone sensor. The routine launchings of weather and ozone balloons are part of the daily recording tasks of the station manager. A helium-filled balloon is launched at Koldewey Station to take an ozone sensor up to 30 km altitude.*

31 | *The NDSC observatory with the green laser beam of the Lidar system for optical measurements in the atmosphere.*

THE BLUE HOUSE, *oldest building of the French-German research base, represents the heart of Koldewey Station. In the past, the Blue House accommodated the administration of Kings Bay Kull Company.*



32 | *Various glass sponges at 230 metre depth. These animals may be common in regions of the high Antarctic shelf where they provide a three-dimensional structure to the habitat. Feather stars and sea cucumbers preferentially live on these sponges. In between, gorgonian corals and bryozoans are the primary colonisers.*

BROKEN SILENCE

in cold and darkness

25th

1989

Text JÖRN HILDEBRAND

White glass sponges, more than one metre tall, light up. Feather stars with five slender waving arms are attached to their surfaces. Bivalves have tied up to the solid spines of a pencil sea urchin. And the tentacles of bristle worms and sea anemones are dancing with the currents.

The 1989 EPOS (European Polarstern Study) voyage to the Antarctic dedicates one full expedition leg to the benthos of the south polar seafloor. The researchers use video- and still camera equipment for their investigation. »Animals that used to be collected with nets, grabs and cores, were often squashed or collapsed before they reached the surface. The photographs and videos provided us with a completely new sense of what life is like on the bottom of the Antarctic Ocean«, remembers Dr Julian Gutt of the Alfred Wegener Institute (AWI), who was on board in 1989. An estimated 17,000 species constitute the benthos around the South Pole – compared to only about 1,000 species in the North Sea a very diverse environment.

DIVERSITY IN ADVERSITY

Animal diversity extends across three dimensions at the Antarctic seafloor: hardly a sponge that does not accommodate other species as lodgers, hardly a rock that is not overgrown. Fish like to rest on stalked sea squirts or lollipop sponges. From such look-outs, they can keep an overview and save en-

ergy by »sitting down«. Conserving resources makes sense where conditions are so inhospitable, i.e. freezing cold and constantly dark. The food supply ultimately comes from above, through planktonic algae in the upper, light-flooded, zone – at least throughout the short Antarctic summer.

Under extreme conditions, when temperature and salinity remain highly stable over time – would one not expect species communities with large-scale replication of distribution patterns? »The more images we saw from below, the more surprised we were: Areas densely covered with life kept alternating with bleak deserts of little diversity«, Gutt elaborates. The photographs show planes with small mounds around the edges – how do such areas develop?

MASSIVE DISTURBANCES CHARACTERISE THE COLD DAILY ROUTINE IN THE DEEP

As part of Antarctic everyday life, ice blocks that break off the edge of glaciers or the ice shelf start moving around. The ones that are large and heavy enough to extend to the seafloor simply clear the three-dimensional diversity like gigantic planes. »These icebergs cause lasting disturbances in the ecosystem«, explains Gutt, »because the faunal community of sponges, echinoderms and many others needs a long time to recover.«

The patchwork of life continues to recreate itself. However, only when large, one-metre sponges are back, has the final phase of re-colonisation been reached. Currently, the time frame and details of this process are unknown and are being studied within the »benthos disturbance experiment« (BENDEX): The seafloor is cleared through trawling in an area of 1,000 x 100 metres, thus simulating scouring by icebergs. Over subsequent years, researchers will monitor the developments following »time zero«.

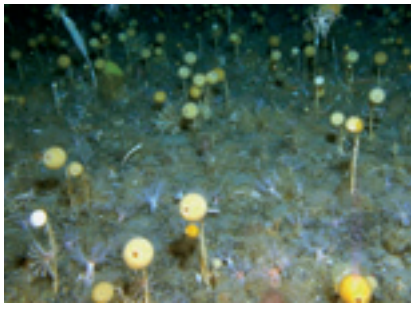
Iceberg scouring occurs again and again in different places, creating adjoining fields of old and new disturbances. Quite literally, iceberg dynamics repeatedly interrupt the stability of silence and cold.

»Spatial modelling helps us in understanding biodiversity«, clarifies Gutt. »Modelled after nature, the computer-simulated scenarios that are especially colourful have the highest biodiversity. These are areas with several older iceberg scours in close proximity of one another.«

The Antarctic seafloor offers unique opportunities for ecological research: It is characterised solely by natural disturbances and almost free of human impacts. However, this could change in the future because global warming affects even the depths of the Antarctic Ocean: The frequency of iceberg calving and subsequent seafloor scouring could increase – exceeding the recovery potential of this diverse world of cold and darkness. ✸

33 | Glass sponges are utilised by many feather stars as attachment substratum.

34 | A sponge community at 300 metre depth, dominated by ball sponges.



35 | Stalked »lollipop sponge« in an area, that has been devastated by iceberg scouring.

AN OCEAN of numbers

25th

1990

Text TIM SCHRÖDER

In order to understand the processes that shape earth's climate, one must fathom the oceans' currents because both are closely linked. Above all, this requires powerful computers that are fed with equations and countless data points. With the assistance of computers, the world becomes transparent. So in 1992, the Alfred Wegener Institute raised attention by publishing the multi-coloured atlas of the South Ocean, both in printed format and as the first internet project.

Professor Dirk Olbers is one of those people that try to approach the world through numbers. Ocean currents, those mighty conveyer belts that are responsible for heat transfer across the seas, are the oceanographer's hobbyhorse. The scientist works on mathematical models describing these processes. Some of his numerical frameworks contain more than 100,000 equations. Sometimes, the AWI computers need months to produce a result. It has been known that there are various water masses in the oceans. These are gigantic coherent water bodies with almost uniform temperature, salinity and density. So-called Antarctic Bottom Water, for instance, is formed in the Weddell Sea. Because of severe cooling at the surface, the seawater freezes to ice. Since the ice contains very little salt, the seawater salinity rises, and consequently its density. It becomes heavier and sinks to great depths at the bottom. This water body is one of the heaviest in the world. Like an avalanche in slow motion, it spreads from its relatively small region of origin to the bottom layers of all oceans. Inconspicuous changes in salinity and temperature can be sufficient to bring an ocean to the boil. In the Arctic, for instance, cold water masses sink and thus contribute to the activities of the Atlantic circulation pump and the Gulf Stream: While cold water sinks, warm water replaces it at the surface. The ocean works like a colossal heat machine which contributes significantly to thermal transfer across the globe. »The challenge, however, is not the simulation of the largest ocean currents«, says Olbers, »really difficult is the representation of small turbulent processes«. The oceans are full of those. High ocean ridges stretch across the deep sea floors, acting as ob-

MODERN DATA HANDLING. *The Computer Centre is the brain of the AWI. All information converges in its enormous data bases – data records from expeditions, including hydrographic, meteorological and seismic data. In the early days of the AWI, the Bremerhaven scientists used high performance computers at the University of Stuttgart, connected to the institute through a then exclusive and expensive data line. At first, mainly data records from Polarstern expeditions were collected. The enhancement of oceanographic projects and the beginning of computer modelling in the 80s, however, required an independent powerful computer centre. Since then, simultaneously operating high-power computers in Bremerhaven have performed complex simulations or calculated disturbance models. Furthermore, a working group for scientific computing was established at the AWI in the mid 90s. This group makes extensive use of the Computer Centre. For several years, the computers have also been employed in bioinformatics. In this context, they facilitate genetic fingerprinting of marine organisms or the genetic decoding of proteins.*

36 | *The standard piece of equipment for recording water properties is the CTD sensor*
37 | *An oceanographic mooring with a top buoy and a transmitter leaves the ship. Several thousand meters of cable, assembled with a variety of instruments, are going to follow.*

stacles within the currents and causing them to rotate. Turbulences lead to intermixing of different water bodies alongside their boundaries. They redistribute heat, salt and nutrients and, therefore, have a major effect on conditions in the ocean environment. However, it is difficult to pin them down mathematically.

As it turns out, these types of turbulences are particularly pronounced in the Antarctic circum-polar current. Driven by strong westerly winds between 40 and 60 degrees southern latitude, which once frightened sailors around Cape Horn, the Antarctic water body circulates clockwise around the Southern Continent. Until some years ago, experts assumed a relatively steady movement onto which small-scale disturbances, so-called eddies, were superimposed. Olbers was one of the researchers who demonstrated with their theoretical calculations that the current would not exist without these countless small elements of turbulences. A few years ago, their existence was proven. From satellites, eddies of up to about two hundred kilometres diameter could be tracked for months. Such insights considerably affect the understanding of ocean dynamics and their significance for our climate.

Although Olbers juggles with immense formulas and computer calculations, he primarily trusts paper, pencil and human judgement. »This is the best way to understand the fundamentals of the processes«, he says. »Only if you have a grasp of the principle, you will be able to interpret complex computer models correctly.« However, he admits that, without high-power computers, his work would not be possible.

Just as in 1990, when Olbers, together with two Russian colleagues from the Arctic and Antarctic Research Institute in St. Petersburg, started a true Sisyphean task – the production of the »Hydrographic Atlas of the Southern Ocean«. The researchers assembled data from research expeditions of the past 90 years that had been collected by various international research institutions. Overall, they checked and tabulated roughly one million data points for salinity, temperature and oxygen concentration. Two years later, the enormous piece of work was printed – the first atlas of its kind produced with computer graphics. Previously, it had been customary to use hand-drawn maps. In addition, the immense data base was intended to be accessible to scientists all over the world. The internet – still in its infancy at the time – offered an ideal medium. In 1992, the Hydrographic Atlas was published as the first internet project of the Alfred Wegener Institute. And whoever feels like it can still check where the old research vessel »Deutschland« took its samples in 1911. ✸

38 | *A special event: Oden at the North Pole*

A VOYAGE INTO THE UNKNOWN

25th

1991

Text UTE KEHSE

In late summer of 1991, the research vessel Polarstern set out for an unusual expedition: Together with the Swedish »Oden« she reached the North Pole as the first conventionally powered research ship. Scientifically, the journey was also a success: both ships brought home a rich data harvest about the geology of the Arctic Ocean. The expedition is still bearing fruit today.

In September 2004, Kate Moran from the University of Rhode Island and Jan Backmann from Stockholm University announced an unparalleled success: Together with an international team of researchers they had been able to drill 410 metres deep into the seafloor of the Arctic Ocean, only 220 kilometres from the North Pole. Whereas scientific deep drilling in other oceans has become standard by now, the drilling expedition into the ice-covered High Arctic was definitely an adventure: While the ice breaker Vidar Viking – converted into a drill ship – worked at the actual drilling of the hole into the seafloor, the Russian ice breaker Sowjetski Sojus (powered by a nuclear reactor of 75,000 horse power) and the Swedish Oden joined forces to crush drifting ice floes that were approaching the site. All the efforts were rewarded with 55 million year old sediments. They provide insight into the climate history of the Arctic and revealed that the Arctic was glaciated for the first time 15 million years ago.

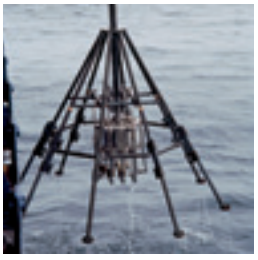
The preparations for the drilling expedition go back 14 years: At that time, the ice breaker Polarstern and Oden had ventured into the merciless maelstrom of the Arctic pack ice. For a long time only the Russian nuclear ice breakers had risked the trip into the ice desert; research vessels avoided the region. Therefore, knowledge about the geological structure of the ocean floor between Greenland and Siberia,

39 | *Joy upon reaching the North Pole*

Spitsbergen and Canada was very sketchy until 20 years ago. »To this day, nautical charts of the Arctic are notoriously unreliable«, reports AWI geophysicist Dr Wilfried Jokat. It would be entirely possible for the true position of an underwater mountain range to deviate one hundred kilometres from the chart, or for the ocean to be 2000 metres deeper than mapped.

When Polarstern left Tromsø on August 3, 1991 and set course for the Arctic Ocean, it was a journey into the Unknown for the 53 researchers aboard the ship. »We knew basically nothing«, summarises Professor Dieter Fütterer, scientific leader of the Arctic 91 expedition, recalling the poor state of knowledge about the geological history of the Arctic Ocean at the time. Right at the beginning, the expedition seemed cursed by bad luck: Four days after departure, the Oden had a severe engine problem which was repaired in record time on Spitsbergen. Nevertheless, she was only able to follow Polarstern twelve days later. The American 80,000 HP ice breaker Polar Star, also expected to participate in the journey, arrived late in Arctic waters and, finally, had to give up entirely – a broken port side shaft forced her to return.

At first, especially the geophysicists aboard Polarstern were sentenced to inactivity by these incidents: They would have needed a second ship for their measurements to free Polarstern's way through the pack ice. Since seismic recordings require a ship to tow various instruments, the same vessel cannot, simultaneously, break the ice. During seismic investigations, so-called air guns produce sound waves under water. The



MULTICORER
In order to obtain intact sediment samples, a so-called »multicorer« (MUC) is used. This instrument is lowered to the seafloor, and eight or 12 plexiglass tubes retrieve sediment cores of up to 50 cm length. Operating the MUC in great water depths (> 4000 m) may take several hours.

40 | *In order to obtain large volume samples from the seafloor, a box corer is used. The ship's winch facilitates retrieval of the instrument, sample included. After opening of the box, the sediments are sampled.*

BATHYMETRIE (SURVEYING OF THE SEA FLOOR). *As soon as Polarstern leaves port the scientific measurements begin. The multibeam sonar Hydrosweep DS-2 is integrated into the hull and uses high frequency sound waves to scan the seafloor. The swath covered by the sonar beam is twice as wide as the water depth. The signal intensity also allows conclusions about bottom irregularity. While on the ship, researchers of the AWI working group »bathymetry« already receive a 3-D contour model. The depth data are also relevant for researchers from other groups, for example, when planning deployment of a diving robot or seismic recordings.*

waves penetrate into the seafloor and are reflected by boundary layers. These echoes from the ocean floor are recorded by sound receivers (hydrophones) that are located in a tube of several hundred metres length, the so-called streamer, also towed by the vessel. On the outward journey, geophysicists were only able to record two data profiles on windless days, whereas the geologists hauled in one sediment core after another. Not until September 3rd, more than one month after departure from Tromsø, Oden and Polarstern met again, just to begin the return journey immediately. They were the first conventionally powered vessels to reach the North Pole on September 7.

Despite the early glitches, both research ships brought home a rich data harvest that continues to benefit researchers today. »The value of the Arctic 91 expedition cannot be overestimated«, says Wilfried Jokat, »it was the first major attempt to conduct geo-scientific research in the Arctic. And it became clear that it makes sense to take two ships. You simply get more results«, recounts Jokat. The seismic measurements, for instance, that were finally taken with support of the Oden, provided the basis for deep drilling in 2004.

Wilfried Jokat was even compensated for the idle outward journey. In 2001, the geophysicist was able to make up for his missing measurements. Along Gakkel Ridge, an extension of the gigantic underwater mountain range stretching across the Atlantic, Jokat and his colleagues were surprised to discover a series of active volcanoes. ✸

41 | *Research on the geological history of various ocean regions involves, at least on a soft sediment seafloor, a Kasten corer of up to 12 m length. Once the corer is back on board, the very heavy box is taken to the sediment laboratory. This is where the core is described and sampled for various geological analyses.*

WILDERNESS, WIND & WAVES:

building blocks for a climate model

25th

1992

Text NADINE QUERFURTH

No more than 3.5 by 2.7 metres along the sides make it small. In fact, a real dwarf: the research raft Helga. Many polar expeditions of the research unit Potsdam include the smallest vessel of the Alfred Wegener Institute. Its advantages are obvious: It is compact, light and therefore can be transferred to Siberia on a single helicopter flight without major logistic effort. The story of the vessel's name goes back in time: the raft's crew would have been fully cut off in the Siberian wilderness if it had not been for secretary Helga's old GDR telex machine. Helga was the only one who knew how to operate it and made contact with home. Reason enough to name the research raft after her.

Professor Hans-Wolfgang Hubberten has been directing the Alfred Wegener Institute's research unit in Potsdam since its establishment in 1992. He and his colleagues are concentrating primarily on one major research goal, i.e. the understanding of the global climate system and global climate changes with their impacts. Emphasis is placed on Arctic land masses, a destination regularly explored by the Potsdam scientists on their research expeditions. In the past, the Alfred Wegener Institute in Bremerhaven had its research focus on oceans and inland ice sheets of polar regions. »The terrestrial component was missing« according to Hubberten. »Since, here in Potsdam, we also include this region, the AWI is now the only institute in the world that investigates all aspects of polar regions – ocean, ice, atmosphere and land – and their interactions«, summarises Hubberten.

READING THE LINES OF HISTORY

In order to understand current climate and be able to make predictions for the future, scientists in Potsdam have to explore the climate history and the environment of the past. Figuratively speaking, researchers read the climatic history books in archives. In this regard, Siberia is a key region. As the largest terrestrial polar region, it consists to 50 percent of permanently frozen soils – the »permafrost«. As in a deep-freezer, everything inside the soil is preserved at below-zero temperatures and can be used to re-construct the environment from the past. Along the Laptev Sea coasts, such valuable archives are fairly accessible as ice wedges and frozen soils in cliffs, 20 to 30 metre high. The Potsdam scientists take their samples with chain saws, ice drills, hammer, axe and hoe.

HELPING HANDS ON HELGA

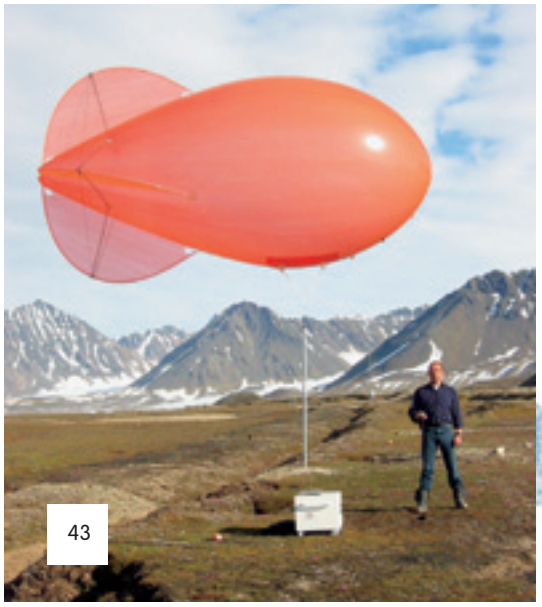
Other valuable archives in Siberia are lakes. Lake sediments tell the story of the lake's origin by providing an unbroken record of continually deposited pollen, minerals and animal remains. This may go as far back as in the case of Lama Lake in Siberia, i.e. 18,000 years. In order to retrieve the sediments from the bottom of the lake to the surface, the Potsdam scientists need Helga. A drill rig with winches is mounted

42 | *The research raft Helga near Kong Oskar Fjord in East Greenland*

aboard the »drill ship«. Everything is operated manually as engines would only increase Helga's weight unnecessarily. Finally, a sediment core is brought up. It »tells« who and what lived in the lake's vicinity many thousand years ago. Even various colours in a drill core provide information and are the result of certain environmental conditions. Pollen from spruce or birch trees, for instance, leaves distinctly different traces than grasses. Using the wealth of information contained in both archives, the scientists have been able to reconstruct climate and environmental conditions from the last glaciation in Siberia: lakes and peat landscapes alternating with dry and desert-like areas were characteristic of the region. Insects and small mammals frolicked in the grasslands, and mammoth and bison herds roamed the lush, grassy tundra.

FROZEN SOIL RESERVOIRS

Siberia's permafrost does not only hold valuable information that enables Potsdam scientists to understand the past climate. It is also a reservoir of organic material with major significance for future global climate. Every summer, the ice within the top 0.3 to 1.5 metres of permafrost soil starts thawing. Microscopic soil organisms begin to convert organic material into the green house gases methane and carbon dioxide which can be released into the atmosphere. The scientists suspect that continued global warming may provide access to a carbon reservoir which has been frozen for 80,000 years. Over the past six years, the developments have been monitored at a field station in the Lena Delta.



43 | *By means of a captive balloon, meteorological instruments are taken to three kilometres altitude over several hours.*

REALITY IN A CLIMATE MODEL

The geoscientists provide the monitoring data from the field, including temperature and other basic parameters, to their colleagues working in the research area of »Arctic Climate Simulations«. Professor Klaus Dethloff in Potsdam leads this group and is interested in understanding the major interactions of the climate system. Apart from field studies, standard methodology includes the use of mathematical models simulating current Arctic climate. Once this is successful, scientists will also be able to model future climate. »It is complicated, however, to represent reality in a model because the climate is so complex and chaotic that it is difficult to predict«, says meteorologists Dr Annette Rinke. »In addition, the climate is not only influenced by phenomena such as CO_2-emissions caused by humans, but also by natural fluctuations.« For 10 years, the Potsdam researchers have worked with a regional climate model for the Arctic. However, the permafrost data are only a fraction of what represents meat on the bones of the model. The Arctic cannot be described by the geographical distribution of land and sea alone. Its high complexity requires that atmosphere, ice, ocean, permafrost and land be considered together in this specific case. Among these systems, there are feedback mechanisms controlling the Arctic climate. One of them is the »ice-albedo« feedback. This is the term describing the reflective capacity of snow and ice surfaces. Approximately 80 percent of the incoming radiation is reflected by such surfaces. Although the ice-albedo feedback mechanism has been incorporated in climate models, current global models are still too inaccurate to simulate the Arctic climate.

POLAR RESEARCH IN POTSDAM – A LONG STANDING TRADITION. *Polar research in Potsdam has had a long tradition through the former »Königlich-Preußische Observatorien«. During the GDR era, polar research was coordinated in the Potsdam »Central Institute for Physics of the Earth«. Immediately after the German re-unification, the future of Potsdam was uncertain. However, through the inauguration of the research unit Potsdam as part of the Alfred Wegener Institute on March 11, 1992, it has been possible to sustain Potsdam as a location for polar research. This success is largely due to the efforts of Professor Gotthilf Hempel, Director of the AWI at the time. The new objective was to build on the valuable experience of Antarctic research gathered in the former GDR. Previously, the Alfred Wegener Institute had explored primarily the polar oceans, and the East German scientists had concentrated on ice-free regions of the Antarctic. Therefore, the establishment of the research unit Potsdam did not lead to overlap of research objectives. Instead, as Gotthilf Hempel phrased it, the »two arms of the river that is German polar research« complemented one another perfectly.*

A GLIMPSE INTO THE FUTURE

Therefore, the exciting question for Professor Klaus Dethloff and his colleagues is whether Arctic processes, like the ice-albedo feedback, influence the global climate. Investigation of this link is the objective of the European research project GLIMPSE (Global Implications of Arctic Climate Processes and Feedbacks), coordinated from Potsdam by Professor Dethloff. Within the GLIMPSE framework, a more realistic representation of the backscattered solar radiation from ice and snow surfaces (albedo) has been integrated into a global model, and the global effects calculated. The consequences for global climate are enormous. They can be felt even in the tropics. »The Arctic becomes colder and temperate latitudes start warming up«, Rinke explains the brand new results. What happens is this: Usually, it is cold in the Arctic and warm in the tropics. There is a continual exchange of air masses between the two regions: Warm air is transferred from the tropics to the poles by large scale circulation. A change in the ice-albedo feedback mechanism in the Arctic will influence the circulation in the whole atmosphere.

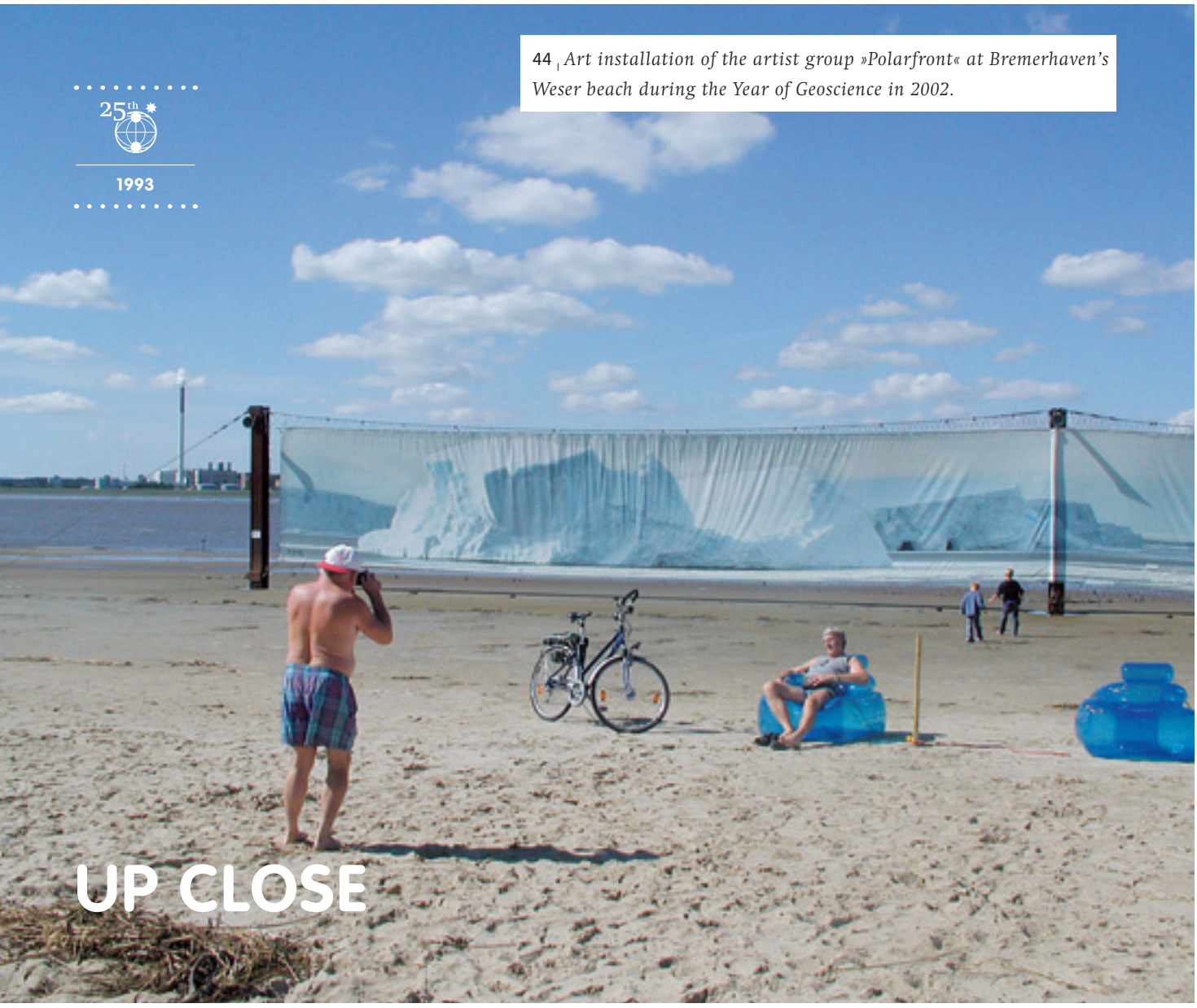
RELIABLE DOCUMENTATION OF CLIMATE CHANGES

»Not until we combine the information from regional and global models«, says Rinke, »will we be able to document changes in climate reliably«. In the context of GLIMPSE, this has been achieved successfully. The data which will be fed into the models in the future continue to come from the field stations and expeditions in Siberia, as well as from satellites or the Alfred Wegener Institute in Bremerhaven. And, of course, from Helga. Over the years, Helga has advanced from a small research raft to a geophysical monitoring vessel, Professor Hubberten says with a smile. Helga is now graced with some decorative metal plates, an engine and various high-tech recording instruments. Nevertheless, she remains the smallest research ship of the Alfred Wegener Institute. ✸

THE NEW LABORATORY BUILDING
of the AWI research unit Potsdam was inaugurated in 1999.

25th

1993



44 | *Art installation of the artist group »Polarfront« at Bremerhaven's Weser beach during the Year of Geoscience in 2002.*

UP CLOSE

Text KAROLINE SCHACHT

Being in touch with research: With regular and special events, such as exhibitions and presentations, excursions and interactive campaigns, the Alfred Wegener Institute makes contact with the public.

Media and public relations work has been a consideration at the Alfred Wegener Institute right from the beginning, just as it has been common practice in the Helmholtz Association (then AGF Working Group of Large Scale Facilities). »Polar Research then and now« was the title of the first exhibition that travelled nationally, and, in 1986, a seminar series was established together with Bremerhaven's Adult Education Centre »Volkshochschule«. Nowadays, the programme of public relations work can only be accomplished through the efforts of a full team, especially considering times like the Year of Geosciences 2005 (Jahr der Geowissenschaften) and the institute anniversary in 2005 when Bremen and Bremerhaven have also been designated as »City of Science« in 2005.

What does media and public relations work mean for a research institution? »This institute spends public funds«, describes Margarete Pauls, »and it is our job to show the public how the money is spent and why it is necessary to do so.« Some of her department's daily routine tasks include making contact with the media and uploading of general

and current information to the AWI internet pages. In addition, all public documents, such as biannual reports and information brochures, are produced here. But also the seminar series of the institute, the documentary film »Ice and sea«, and rotating exhibitions are developed by the group. One of the first highlights of this work was the special exhibition »125 years of German polar research« with the German Maritime Museum which went on the road in 1993, starting in Bremerhaven and visiting Frankfurt, Potsdam, Bremen, Bonn and Rostock. This kind of work guarantees genuine direct contact with the public, and, to date, has reached remarkable dimensions.

What is successful media and public relations work? »Success is not easily measurable for us«, says engineer Pauls. »Getting a strong media response after a press release is one measure of success.« Another one is the increasing size of the press collection over the years, or the rising number of requests for information by media and journalists.

Moreover: »Our media and public relations work depends on the collaboration of everyone in the institute. This is essential for us to be successful«, adds Pauls.

The AWI has long had a reputation for organising unusual activities with and for the public. The Polarstern expedition for high school in 1998, the publication of expedition reports on the internet, the book »Eiskalte Entdeckungen« (published at Delius Klasing), and fine arts projects such as the »Library of the Ice« are just some examples. Science communication has had a long standing tradition at the Alfred Wegener Institute, but has changed considerably over the past 25 years. The institute has embraced this challenge and still remains in close touch with its community. ✸

TO MAKE SCIENCE UNDERSTANDABLE. *Apart from scientific publications, the AWI also produces information material for public interest. Leaflets about the institute, its research vessels and the polar stations provide an overview over the facilities and infrastructure. Subjects of particular interest are profiled through illustrative brochures. The extensive biannual report includes updates from the scientific working groups, as well as information about expedition programmes, logistics, international cooperation, budget development and a list of publications for that period.*
Guided tours of the institute are offered by appointment. For this purpose, please contact Press office,
Tel: ++49 (0)4 71 / 48 31 - 11 12 or
email: awi-pr@awi-bremerhaven.de
In addition, further current information is available on our website: http://www.awi-bremerhaven.de.

45 | The travelling exhibition »125 years of German polar research« at its Potsdam station

46 | Children are easily captivated by exhibition objects associated with polar research.

47 | The Cologne artist Lutz Fritsch during the installation of the «library on the ice« at Neumayer Station

25th

1994

ICE-FREE in the Antarctic

Text ANDREAS WOHLTMANN

Sheltered bays are rare in the Antarctic. The German polar researcher Eduard Dallmann also knew this and, sailing aboard his ship »Grönland« at the end of the 19th century, sought refuge from polar storms in Potter Cove on King George Island. Today, this is where the Alfred Wegener Institute for Polar and Marine Research has established the Dallmann Laboratory, named after the navigator and skipper.

Based at the first Antarctic research station that is operated jointly by several nations, scientists have been investigating the cove's ecosystem since January 1994. »Cooperation not only exists on paper; currently a German-Argentinean research duo jointly investigates algal resistance against ultraviolet solar radiation«, says Professor Christian Wiencke, scientific coordinator of the laboratory at the Alfred Wegener Institute. The Dallmann Laboratory is affiliated with the Argentinean Jubany Station. The Argentineans also look after the food supply and, if necessary, arrange for medical support. The Netherlands are the third associated partner. During the Antarctic summer, up to twelve scientists share accommodation and work space at Dallmann Laboratory, by the end of 2005, the number of spaces shall increase to 14.

The cove, which is ice-free in summer, provides excellent opportunities for the exploration and understanding of Antarctic ecosystems, last but not least on account of the diving facilities present. Aquaria, as well as wet and dry laboratories, enable corresponding studies under standardised conditions. »We started with an inventory of the organisms in the cove, then we investigated

48 | *Interior of the Dallmann Laboratory*

49 | *The Potter Bight, place of the Dallmann Laboratory at Jubany Station on the Antarctic Peninsula*

their interactions, and now we are analysing the impact of human interventions, using computer models to assess them«, Wiencke describes the research approaches. In this context, the disturbances by scientists working in Potter Cove are of minor interest compared to global phenomena such as increasing green house gases and depletion of the protective ozone layer. Hence, the effects of rising UV radiation on macroalgae (seaweeds) are studied in the cove. »Macroalgae are very important primary producers here, and we hypothesise that they are more sensitive to UV radiation than their Arctic cousins«, Wiencke explains. »A major decline of seaweed populations would have dramatic effects for all life in the cove because the algae are at the base of a complex food chain.«

Currently, Potter Cove ranks among the best studied ecosystems in the Antarctic, and the scientific progress has been documented in masses of publications. Nevertheless, the interactions between organisms as well as the stability of the overall system remain only partially understood, and further research is necessary. For the international Polar Year 2007 to 2008, it is planned to examine the effects of accelerated glacial melting. Large amounts of sediments are washed into the water by ice masses and are deposited on the seafloor. Animals with little ability to move, such as sponges, can be virtually buried by this load. As a result of increased turbidity, light cannot penetrate as far into the water, probably affecting the photosynthetically active algae.

However, it is not only the algae's role in the Antarctic coastal ecosystem that is exciting. The pharmaceutical industry has expressed interest in the seaweed's ability to protect itself, within limits, against UV. Their search for better UV blockers in sunscreen lotions also stimulated collaboration with scientists of the Alfred Wegener Institute. ✸

SURVIVAL STRATEGY

in the cold

25th

1995

Text UTE KEHSE

Among all mammals, Weddell seals have ventured furthest into the cold south. The seemingly lazy animals are masters of energy conservation. Using sophisticated measuring equipment, AWI biologists gain insights into the ocean mammals' behaviour and into the marine ecosystem at the edge on the Antarctic ice shelves.

50

Dr Joachim Plötz and Dr Horst Bornemann are considered as somewhat exotic among biologists of the Alfred Wegener Institute. Most of their colleagues study marine organisms that are only centimetres and often microscopic in size, such as unicellular plankton or small crustaceans. Plötz and Bornemann's research objects are considerably larger: Adult Weddell seals grow to three metre length and weigh roughly half a ton. In their search for food in the sea, the animals are primarily active at night. In the early morning hours, the visibly exhausted heavy-weights pull themselves through the narrow cracks onto the ice and take a long rest. During several expeditions since 1985, Plötz and Bornemann have investigated which food is preferred by the seals and where they find their prey. Every two to three years, and together with two or three other colleagues, the scientist duo has spent up to eight weeks in the Antarctic ice: Five red glass-fibre igloos, called tomatoes, served as bedroom, kitchen and storage space.

Their research area is Drescher Inlet, a 25 kilometre opening in the Riiser Larsen Ice Shelf, roughly 400 kilometres southwest of Neumayer Station. The two-metre layer of ice in the inlet remains closed until late in the Austral summer. This is ideal for the researchers, but also for the Weddell seals: On the fast ice, the animals are protected from killer whales and leopard seals and find secure resting places for lazing around, as well as for giving birth and rearing their pups. Whatever else is needed in a seal's life happens under water: Hunting prey, battling rivals and mating, all takes place beneath the ice.

Weddell seals often return to the same resting places after their underwater excursions. The researchers take advantage of this habit in that they are able to retrieve recording sensors that were previously attached to the seals, when they re-capture the animals after a few days. »The microchip technology has developed at an enormous rate; the instruments that we use today are worlds apart from the ones ten years ago«, says Horst Bornemann. During the Drescher expedition in 1995, depth recorders were used to document the ups and downs of the seals under water. Even those simple measurements yielded unexpected results: the researchers found that the seals hunted their prey either in shallow water above 150 metres, or near the sea floor at approximately 450 metres depth. »Apparently, food is distributed unevenly in the ocean, and only certain strata are worth the fishing effort for the seals«, explains Joachim Plötz. The diving behaviour of the seals is influenced by a physical phenomenon: The so-called thermo- or halocline is characterised by an equally abrupt decline in temperature and increase in salinity at approximately 150 metre depth. Above this stable boundary, the water body is slightly warmer and large quantities of sinking ice algae and other organic particles accumulate here – an attractive food source for small crustaceans, fish and fish predators such as Weddell seals. In the upper »floors« of the ocean, only one species is of significance in the seals' diet: the Antarctic silverfish. The herring-like fish represent small but fatty snacks of an average 30 grams. Occasionally, they travel along the coast in larger schools below the sea ice.

More recently, the diving routes of the seals have been recorded in three dimensions. The new recording system was first used in December of 2003. For the first time, the collected data revealed information about the seals' speed, direction and body inclination while swimming, as well as about their hunting behaviour.

Three animals were even equipped with small cameras by a team of AWI researchers, together with biologists from Kiel and Tokyo. It turned out that seals are also able to find food underneath the ice shelf at just over 150 metres water depth. »This is where many small animals »hang out« that are eaten by the prey fishes of the seals«, suggests Bornemann. The next step will be to take advantage of the seals in exploring the underside of the ice shelf further. ✸

50 | *Weddell seals remain on the fast ice until late in the Austral summer for safe rearing of their pups.*

PREPARING BLACK BEAUTY

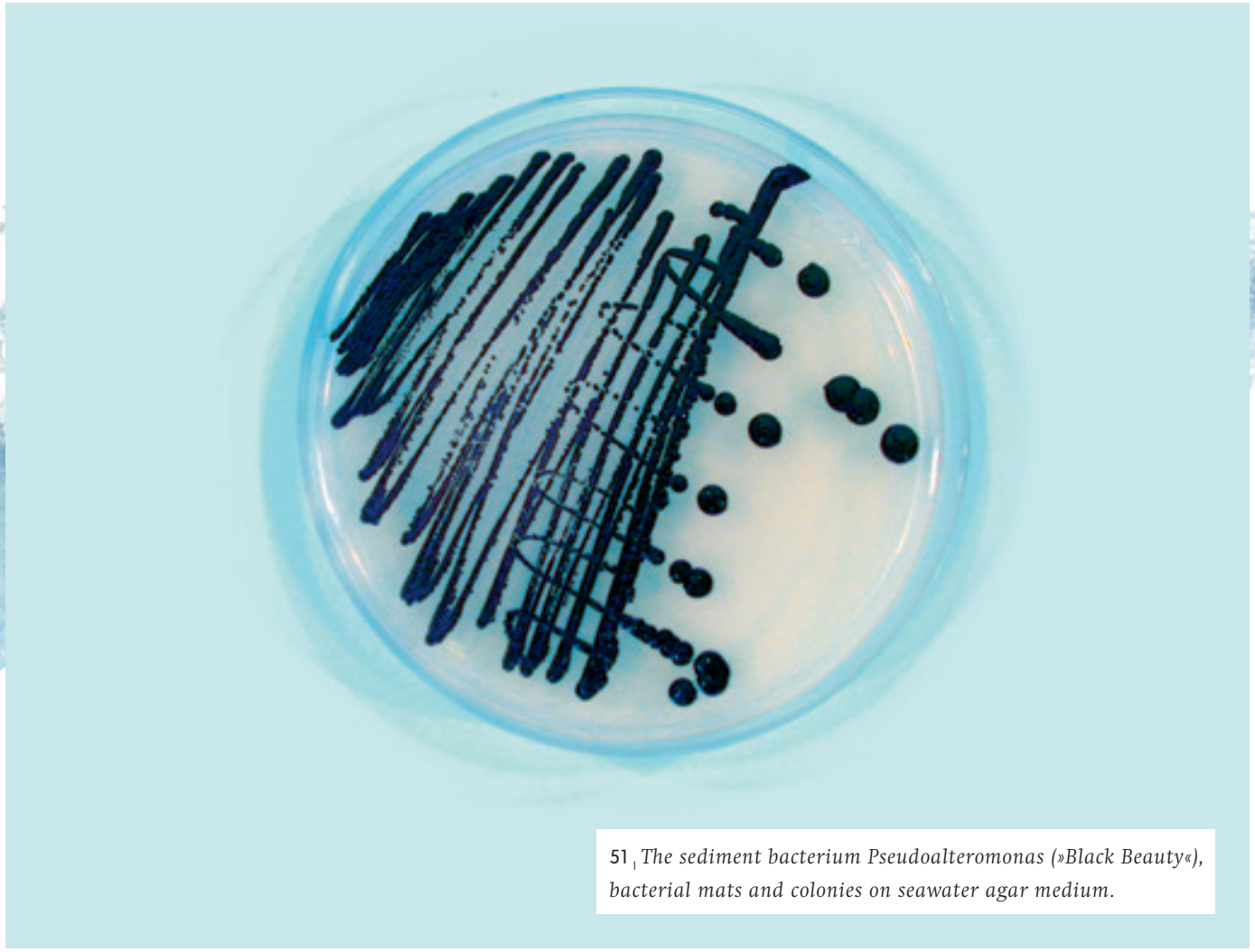
to join the race

25th

1996

Text TIM SCHRÖDER

For several years, the Alfred Wegener Institute has been promoting technology transfer. The number of patent applications is on the rise. This is a result of black-violet pigments from the ocean, or home-made marine technology, also stirring the interest of industry. Since the establishment of the first private spin off company in 1996, a number of employees have taken the first steps towards an independent business.



51 | *The sediment bacterium Pseudoalteromonas (»Black Beauty«), bacterial mats and colonies on seawater agar medium.*

No question about it: the Alfred Wegener Institute conducts fundamental research. From Bremerhaven, scientists venture into the most remote corners of the planet. They strive to decipher the rules of the climate game and seek to unravel the complexities of ocean currents. However, the AWI is more than a research power house. The institute is also a forge for ideas and a technological development laboratory. As extreme as the environments of the polar regions and the deep sea, as relentless are the demands placed on the technical equipment. Instruments for challenging work assignments are not available off-the-shelf. Often it is necessary to custom-design and -build specific equipment. In this process, AWI employees have created many instruments that are also useful for others. Hence,

for some time the AWI has supported the marketing of particularly promising innovative developments. »Even though we cannot manage the foundation like an industrial enterprise«, says Dr Eberhard Sauter, currently technology transfer representative at the AWI, »we still make sure that our good ideas are secured through patents.« In 1988, Dr Helmut Tüg filed the first AWI patent application: a particle counter, his own invention. Whereas, ten years ago, the institute filed only about one patent application annually, in 2004, there were already 10. This is partially a result of Sauter's efforts. The geochemist spends half of his working hours finding promising innovations within the AWI and encouraging colleagues to file their inventions. »In some cases, we can generate additional funds from licences«, says Sauter. »However, more important for us is the structural development of our region, i.e. the creation of employment through good ideas.«

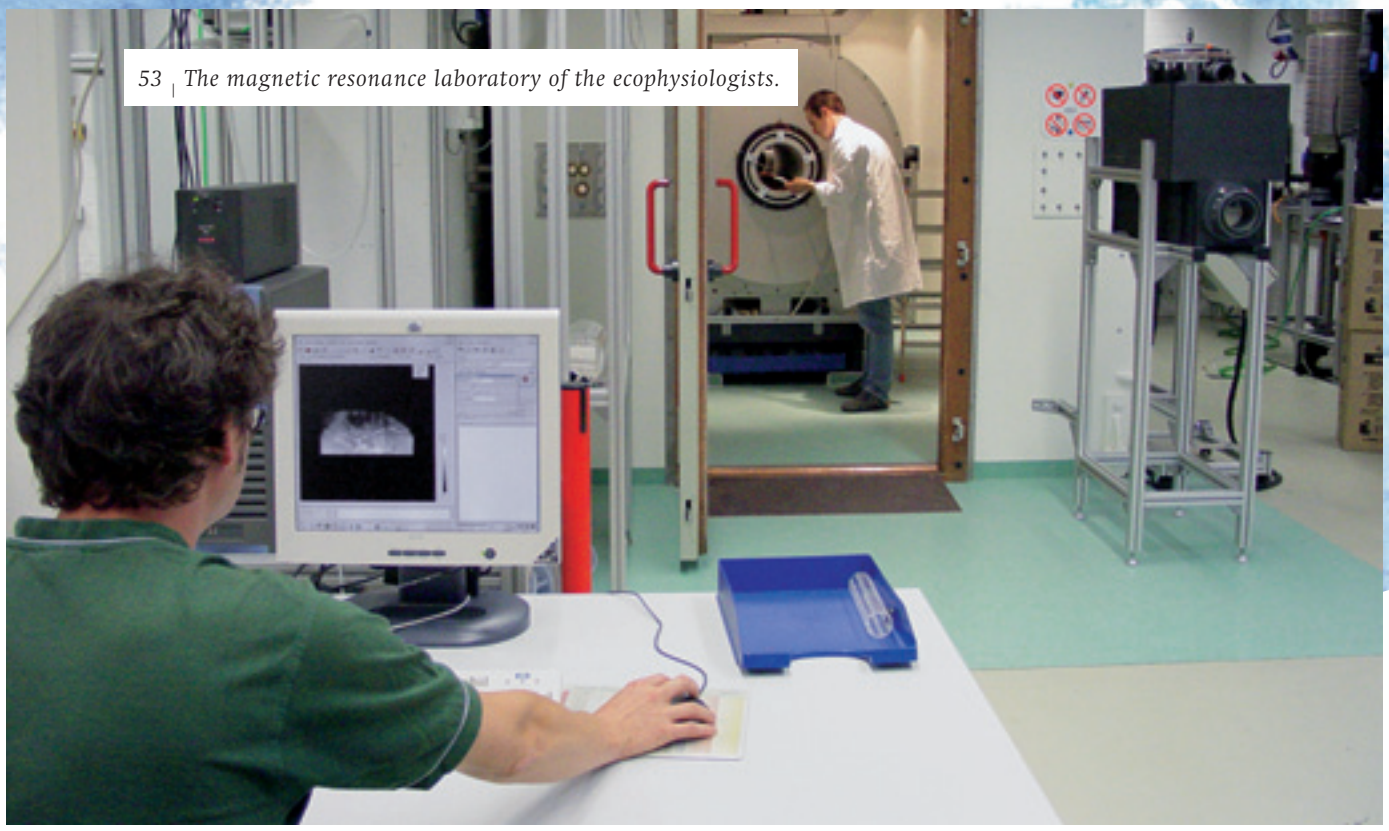
Over the past years, AWI scientists have repeatedly established independent businesses with innovative ideas. In 1996, the first of a series of such enterprises was the company iSiTEC that specialised in sensor- and control technology. The firm continues to design scientific equipment, such as solar radiation simulators, for the laboratory. In addition, however, the company presently also offers monitoring instruments, sensors and control units for other sectors.

The AWI has filed roughly 80 patents to date. One of them is the breeding of Black Beauty. This bacterial strain from the ocean floor produces a black-violet pigment in previously unmatched concentrations. The substance is non-toxic and provides a welcome alternative for the red-blue colouring agent Monascin, nowadays banned in the food industry. In the future, even toys and textiles will be able to glisten in black-beauty brilliance.

At present, the AWI is in the process of planning an »Institute for Applied Marine Research«. Research results with practical application potential will be marketed more efficiently through the new institution, e.g. within biometrics. In this field, biological function patterns are transferred to practical applications. Researchers have transferred the construction design of diatoms, for example, to technical products. The intricate architecture of the circular diatom genus Arachnoidiscus was used as a model for an elegant and robust, ultra-light car rim. Aside from other projects within the aquaculture field, staff members of the AWI intend to increasingly offer scientific appraisals. Within this context, new marine products could be tested for their suitability in the food sector, and the effects of anthropogenic pollutants in the marine environment could be investigated.

Together with colleagues of the new institute and other partners, the AWI is planning to enhance the utilisation of enzymes from polar marine organisms over the next few years. Among these substances are proteins, for instance, which boost metabolic processes at extremely low temperatures. Of particular interest is the application of these in the food and pharmaceutical sector. Processes which currently require relatively high temperatures to run would then be able to operate at room temperature – an easy method to conserve energy. ✸

52 | *Dr Helmut Tüg (right) was responsible for technology transfer at the AWI from 1988 to 2003 and therefore one of the very early pioneers.*



53 | *The magnetic resonance laboratory of the ecophysiologists.*

THE LIMITS OF LIFE

25th

1997

Text TIM SCHRÖDER

The climate has a significant impact on the distribution of species in the ocean. Professor Hans-Otto Pörtner and his colleagues of the division Marine Animal Physiology investigate the parameters involved. For this purpose, the ecophysiologist not only records oxygen concentration and pH inside an animal's body but since 1997, he has also used magnetic fields to study live organisms in a less intrusive way – entirely without a scalpel.

The oceans appear endless. However, for most marine organisms the vastness has its limits, i.e. invisible boundaries which are, nevertheless, insurmountable. Almost no species can exist everywhere – in warm and cold, in shallow and deep waters. Hans-Otto Pörtner is one of the experts investigating physiological limits of species distribution. The ecophysiologist wants to find out how marine animals have adapted to their habitats and why they, like captives in an enormous cage, are only able to survive there. Why, for instance, does the Antarctic bivalve Limopsis marionensis die of heat shock at only 2 degrees Celsius? How has the climate actually influenced the evolution and geographical distribution of species?

In order to answer these questions, Pörtner and his colleagues do primarily one thing: they compare. In their laboratories, they keep eelpout from Antarctica and the Wadden Sea as well as bivalves from the Irish and the South Polar Seas. Among other data, the scientists record at which temperature the animals grow best and produce the most offspring. For a long time, the effects of temperature fluctuations have been unclear. »Meanwhile we have found that the capacity for oxygen uptake and distribution in the body is limited to a certain temperature range, primarily determining the thresholds of temperature tolerance«, Pörtner says.

Until several years ago, Pörtner was making use of classic physiological investigation methods. Animals were ex-

posed to certain environmental conditions, such as oxygen deficiency, and examined subsequently. As part of this procedure, organs were removed and the concentration of particular substances was identified. »The disadvantage of this method is that organs are often studied in isolation«, Pörtner says. »Furthermore, trial animals die in the process.« In 1997, everything changed with the establishment of a magnetic resonance laboratory. This type of technology is more commonly known from medical diagnostics as Magnetic Resonance Imaging (MRI). The apparatus with a tube sizeable enough to accommodate larger fishes makes use of strong magnetic fields to stimulate hydrogen atoms inside the body. Atoms from different tissues respond distinctly to the stimulation. Most importantly: the machine provides images from living organisms. The impact of temperature changes can be observed directly. Using this method, Pörtner and his colleague Dr Christian Bock were able to demonstrate that low temperatures caused a significant reduction in blood flow through particular organs of Lyre crabs from the English Channel. In addition, the magnetic resonance image shows oxygen enriched tissues with high blood flow. Admittedly, Pörtner's MRI machine is smaller than the one in the hospital. The tube measures only 20 centimetres in diameter. However, it is sufficient to run trials on animals submersed in small, water-filled chambers.

The work of the ecophysiologists, however, is not limited to the parameters temperature and oxygen. Since the establishment of the working group in 1992, the experts have been studying the impact of carbon dioxide (CO_2) on the metabolism of marine organisms. Initially, emphasis was placed on the question how sediment dwellers, such as lug worms, tolerate high carbon dioxide concentrations. Meanwhile, this particular work by AWI researchers has gained extra significance since scientists, at the end of the 1990s, have added deep sea disposal of the greenhouse gas CO_2 to the agenda of marine research. Pörtner: »Carbon dioxide not only acts as a greenhouse gas, but also changes the ocean's water chemistry, especially the pH.« In experiments it was demonstrated how this interferes with calcium carbonate production in marine animals, such as bivalves. In addition, CO_2 affects the organisms' metabolism, icluding deep sea and Antarctic species with low metabolic rates. Under the influence of carbon dioxide, the animals go into a kind of hibernation from which they may never recover. Growth and reproduction are slowed down.

The rate at which chemical reactions run inside the animals is of interest to the ecophysiologists for yet another reason. Apparently, it significantly affects the age of the organisms. It has been known that deep sea organisms and many species from Antarctic waters grow much older than their relatives from temperate latitudes. »To date, we still have not resolved the physiology of aging«, Pörtner sums up, »but we have evidence that certain antioxidants, i.e. substances absorbing aggressive oxygen radicals inside the body, play a major role in animals that age slowly.« It is now widely accepted that the oceans' seniors lead their life in slow motion. Pörtner: »They develop more slowly, reach reproductive maturity at a later stage and have to grow older in order to achieve a sufficient reproductive output.« All these attributes could render them highly susceptible to climate-related changes in their environment. With such a slow reproduction, there is little room for flexibility to respond to new environmental conditions. For Pörtner, this represents an additional motivation to explore the secrets of cold adaptation in animals from the polar regions. ✸

54 | *In the magnetic resonance laboratory, metabolic processes of organisms can be recorded without harming the animals.*

PIGGY-BACK into the Wadden Sea – new residents near Helgoland and Sylt

25th

1998

Text NADINE QUERFURTH

Wadden Sea – low tide. Sylt scientist Susanne Diederich has to concentrate and work fast. Within two to three hours, her outside »work place« will be covered with water again. Only when the coastal mussel beds are exposed during low tide, is the biologist able to record the oyster population. Within one square metre, Diederich sometimes counts up to seven hundred animals. She selects certain oyster individuals, brings them back to the laboratory at the Wadden Sea Station, scrapes off the barnacle overgrowth and uses blue boating paint to mark each shell with a number. The scientist then returns the labelled oysters back to the tidal flats and observes their growth throughout the summer.

55

The oysters that Susanne Diederich counts and measures on tidal flats around Sylt are not the native European species of oyster that used to be common around here. Extensive harvesting destroyed the populations in the 1920s. In order to replace the European Oyster, another species, the Pacific Oyster from Japan was introduced to the Wadden Sea for aquaculture purposes. Survival of the warm water adapted Japanese oyster in the cold North Sea waters seemed unlikely at the time. However, contrary to all expectations, the newcomers not only survived but also spread quickly by means of mobile larvae. A series of warm summers led to an invasion of Japanese oysters. They overgrew the native Blue Mussel beds and turned them into oyster reefs.

BLUE MUSSEL BLUES?

Susanne Diederich and her colleagues are worried that the Japanese oyster could replace the native Blue Mussel from the Wadden Sea around Sylt. This is one reason why Diederich monitors the populations and investigates whether a comeback for the Blue Mussel is still possible. The climate is a critical factor: the colder the water, the fewer crabs – predators of Blue Mussel spat – reduce the mussel populations. According to climate predictions, winters with freezing temperatures will become less frequent. The scientists on Sylt think that Blue Mussels would suffer from such a development whereas oysters would spread further.

RAPID INCREASE OF IMMIGRANT FAUNA

Professor Karsten Reise, Director of the Wadden Sea Station on Sylt, has been studying the Wadden Sea ecosystem for more than two decades. The rapid increase of introduced species, so-called »neozoa«, and their potential effects on native communities has been a major focus of his interest. Karsten Reise estimates that at least 80 species from all over the world have found a new home in the North Sea. The slipper limpet, for instance, piggy-backed from the North American east coast to the North Sea where dense carpets of the animals are now covering the seafloor. The slipper limpet, a filter feeder, lives attached to bivalves. In its second home, it has selected mainly Blue Mussels to grow on. Hence, Blue Mussels face a dual problem: overgrown with oysters on the one hand and covered by slipper limpets in addition, the doubly-troubled mussels grow more slowly than usual and die earlier. Humans and shipping traffic both contribute to the introduction of species

55 | *A biologist investigates Blue Mussels; their aggregations, mussel beds, are considered oases of species diversity within the Wadden Sea.*

SYLT OYSTERS – THE BEGINNINGS OF THE WADDEN SEA STATION. *They even landed on the dinner plate of Csarina Katharina II in distant St Petersburg: oysters from Sylt. During the mid 19th century, the delicacy was so popular that populations of the European oyster were entirely overexploited. In 1925, the oyster harvest in the North Sea was shut down for economic reasons. One year earlier, the first trials to cultivate oysters in large tanks on land had been initiated – the beginning of the Sylt Oyster Laboratory which, in 1937, gave rise to the Wadden Sea Station as a satellite post of the Helgoland Biological Institute. Since 1998, the station has been part of the Alfred Wegener Institute for Polar and Marine Research. A modern laboratory complex, outside seawater tanks and the research catamaran »Mya« represent excellent facilities for research.*

from other waters. Within the framework of international projects, results from this research will be integrated into a concept for sustainable coastal management.

Apart from investigations at the Wadden Sea Station on Sylt, long-term monitoring studies of the Helgoland Biological Institute also demonstrate changes to the species communities in the North Sea. The institute is the marine research establishment with the longest tradition in Germany. As early as 1873, the first regular measurements in the North Sea were initiated. Not only scientists repeatedly characterise the rocky island of Helgoland as an »oasis« in the south-western North Sea. Professor Friedrich Buchholz, Director of the Helgoland Biological Institute, believes there are obvious reasons why marine research near the island is extraordinarily successful: »We are able to conduct research right in the North Sea all year round, and with more than one thousand species, the Helgoland »oasis« houses the richest flora and fauna of the German coast. Helgoland, as it were, is a hotspot of biodiversity.« Such ideal conditions enable scientists to develop an ever-increasing understanding of the complex ecosystem and the interactions between organisms.

HELGOLAND BIOLOGICAL INSTITUTE
In the middle of the North Sea, on Helgoland, AWI biologists enjoy optimal research conditions.

WORLDWIDE UNIQUE: LONG-TERM OBSERVATIONS

Since 1962, technicians and scientists have been collecting ocean data on all working days. The almost unbroken monitoring series over such an extended period of time is scientifically invaluable. The Helgoland researchers have been using these records to address new questions and analyse them in different contexts to make predictions about the future development of the North Sea ecosystem. The monitoring data will provide a major contribution to the political decision making process, regarding marine resource utilisation. Professor Heinz-Dieter Franke has been concerned with the changes to biodiversity around Helgoland for a long time. »Our long-term observations in-

HELGOLAND BIOLOGICAL INSTITUTE – 150 YEARS OF MARINE RESEARCH. *Helgoland has always attracted scientists from all over the world – among them Alexander von Humboldt and the evolutionary biologist Ernst Haeckel. One of the first important observations was the discovery of fluorescence in the ocean by Christian Gottfried Ehrenberg in 1835. Ten years later, Johannes Müller established plankton research on Helgoland. In 1892, the Prussian ministry of education inaugurated the »Königliche Biologische Anstalt« as a permanent institution. The areas of research were extended from the exploration of the Helgoland marine flora and fauna to include the North and Baltic Seas and the Arctic marine regions. The »Königliche Biologische Anstalt« rapidly matured into an internationally renowned institution for marine biological research. It was destroyed in the Second World War, but re-opened in 1956 as »Biologische Anstalt Helgoland« (BAH). During his tenure, Professor Max Tilzer, Director of the Alfred Wegener Institute at the time, promoted the integration of the Helgoland Biological Institute into the AWI structure in 1998. The institute operates an aquarium as well as the research vessels »Aade«, »Diker«, »Uthörn« and »Heincke«. The BAH's educational and training facilities are extensive: it offers university classes, marine biology courses, scientific diving training and research opportunities for visiting scientists.*

dicate a link between climate change and species diversity«, describes Franke. Over the past 40 years, the water temperature has risen by 1.1 degree Celsius, and salinity has also increased. Introduced species are becoming more common, native species are disappearing, reads the balance. Overall, however, diversity is higher than before, because several species are just extending their distribution. One of the new inhabitants of the rocky shores of Helgoland is Idotea metallica, a sea slater with a metallic glimmer. It was first discovered off Helgoland in 1994. The slaters live on drift wood and reproduce during the summer. Although the species is unlikely to become a permanent resident of the North Sea, scientists use it as an indicator organism to detect the effects of the warming ecosystem.

56 | *Scientists investigate the decline of the Helgoland lobster population.*

HELGOLAND'S SECRET HERALDIC ANIMAL

Helgoland's secret heraldic animal is the lobster, because the island is the only location in Germany where the species occurs naturally. At the end of the Second World War, the populations declined drastically and, even now, have not recovered. In order to save the North Sea lobster from extinction, another research focus of the scientists on Helgoland is the lobster's natural history. Researchers suspect that, apart from destruction of the crucial rock dens, the rising concentration of pollutants is responsible for the dwindling population. Attempts to enhance the population with laboratory-reared lobster larvae have been unsuccessful. Helgoland scientists have found that water temperature determines the timing of mating and the hatching of larvae. Higher water temperatures, documented by the long-term monitoring series of the Helgoland Biological Institute, may cause larvae to hatch too early so that they starve because they do not find enough food.

In view of the highly diverse and complex connections in the North Sea ecosystem, the words of the first Director of the Helgoland Biological Institute, Friedrich Heincke, are more relevant than ever: »The ocean is large, and one cannot approach it by small means.« ✸

IN THE FLOW OF ICE

Text VERENA RADEMAKER-WOLFF

25th

1999

57 | *In 1982, Filchner Station was established on one of the largest ice shelf plates of the Antarctic in the southern Weddell Sea. After dismantling the station, certain parts were re-used for the construction of Kohnen Station.*

For more than ten years, Filchner Station served as a summer base for expeditions to the ice shelf. Until the ice broke.

OCTOBER 13, 1998
PRESS RELEASE, ALFRED WEGENER INSTITUTE

By means of satellite imagery, scientists of the British Antarctic Survey detected an iceberg of 150 by 35 kilometre dimensions that detached from the Ronne Ice Shelf at 77° S and 50° west. This iceberg carries the German Filchner Station. (...)

Wilhelm Filchner knew that he was standing on floating ice. In 1911/12, he was sailing in the Antarctic Weddell Sea aboard the »Deutschland«, searching for a passage through the continent alongside the ice edge. When he decided on a location for the base camp, he was still full of hope »that the ice island a (figure 72) would not drift away, especially since it had been glued in place for many years (...)« (W. Filchner: To the sixth continent, pp. 220). He had a wooden cabin

built. Wind came up. The ice broke, and suddenly the camp was moving on a floating iceberg. Filchner »fled« northward with the »Deutschland«.

Almost 70 years later, scientists of the Alfred Wegener Institute in Bremerhaven were seeking a suitable place for an over-wintering station on the Filchner-Ronne Ice Shelf. Several potential locations alongside the ice edge had been identified. A landing site in the southern Weddell Sea appeared to offer the best conditions. However, one year later, when construction was scheduled to begin, the place was inaccessible and, hence, Neumayer Station was built 800 kilometres further northeast in Akta Bay. A collection of containers served as a logistic base until the station was completed in 1981. Simultaneously, preparations were carried out for a large-scale project, the »Filchner-Ronne Ice Shelf Programme« (FRISP). It was dedicated to the exploration of the dynamics and mass budget of the colossal Filchner-Ronne Ice Shelf. FRISP was lacking an operational base on the ice edge in the southern Weddell Sea. This is what prompted the shipping of the former construction containers to the original, treacherous landing site, and Filchner Station was established 20 kilometres inland.

FEBRUARY 2, 1999

DISMANTLING OF FILCHNER STATION, DAY 3

Used chainsaw to cut free remaining area of van garage. VW minivan is completely ice-covered, roof is caving in under weight of snow. Nevertheless, engine starts after preheating without problems (...).

Extending over 500,000 square kilometres, the Filchner-Ronne Ice Shelf is the second largest on earth. Moving 1400 metres per year, three gigantic ice streams flow alongside the edge of the Ronne Ice Shelf towards the Weddell Sea, constituting one quarter of the total ice drained in the Western Antarctic. Only 700 kilometres further inland, at the so-called »grounding line«, the ice loses contact with the ground below, drifting on sea water. Whereas it is still 1400 metres high at first, at the shelf edge it measures only 200 metres and is relatively unstable. Gigantic icebergs and ice islands break off frequently.

During the FRISP summer expeditions, ice drill cores were obtained from the ice shelf. The main finding: the thickness of the drifting ice shelf is not only determined by the inland ice and the snowfall onto the ice shelf, but a large portion is marine ice. Where the ice shelf separates from the ground, the sea water below melts the ice on its underside. Circulation below the ice forces the water upward where it crystallises and attaches to the shelf from underneath. Through this interaction between the ice shelf and the ocean, large quantities of very saline cold water are formed. The process contributes significantly to the development of cold Antarctic bottom water and is thought to be the origin of the bottom water current that controls the flow conditions of the world's oceans. However, the ice dynamics, particularly on the shelf underside, remain largely unexplored. After work on the Filchner-Ronne Ice Shelf had been completed, Kohnen Station was established as another location for further expeditions, and the containers were reassembled. This time, though, they were positioned on the inland ice.

FEBRUARY 11, 1999

DISMANTLING OF FILCHNER STATION, DAY 12

(...) Two VW mini vans make one last trip to the station to pick up the bivouac boxes that could not be moved to Polarstern during the night. At the site of the former Filchner Station, only the support beams anchored in the ice and the platform (longitudinal and cross beams with the welded walkway grates) were left behind. ✸

FRIENDSHIP ON THE ICE

Text TIM SCHRÖDER

For almost twenty years, Russian and German polar researchers have explored the Arctic and Antarctic together. Five years ago they moved into a joint home – the Otto Schmidt Laboratory.

58 | *The Russian-German research camp at Levinsson – Lessing Lake; Taimyr Peninsula*

For many decades, the cradle of the Arctic ice has been inaccessible for Western researchers. It is located on the Siberian coast, in the Laptev Sea, where large Russian rivers such as the Lena run into the ocean. A major portion of the Arctic ice is formed here. It drifts across the North Pole to the coast of Greenland. Hence, the key to the gigantic northern ice mass, its coming and going, its impact on climate and marine currents, should be sought in the Laptev Sea. With the fall of the iron curtain in the early 90s, this finally became possible. Scientists from the Alfred Wegener Institute and experts from Kiel took advantage of this opportunity and made contact with their Russian colleagues. In 1993, the cooperative research on the Siberian coast began through the joint project »Sys-

tem Laptev Sea«. Within this project, not only the marine regions are investigated, but also the Siberian land areas. The scientists have used ice cores to drill into the permafrost. They retrieved soil samples that provided information about the changes in climate over the past thousands of years. Together, scientists were able, for the first time, to record meteorological data throughout a full year. They have monitored parameters such as temperature, wind speed and precipitation continually and thus have collected information that is crucial for the understanding of Arctic climate. For five years, the German-Russian cooperation has been well established. In October 2000, the AWI and the Russian Arctic and Antarctic Research Institute jointly inaugurated the Otto Schmidt Laboratory in St Petersburg. Here, German and Russian colleagues collaborate permanently in cooperative projects – especially in the further investigation of the Laptev Sea. In addition, the international university degree programme »Applied Polar and Marine Research« was launched in St Petersburg. Lecturers from both nations contribute to the educational training of upcoming specialists. On the South Pole, the German-Russian collaboration was established much earlier than in the Arctic. Contacts had existed for many years, because GDR researchers were able to participate in Soviet expeditions to the Antarctic. Since the foundation of the AWI, German and Russian researchers have been working together – both on the collection of physical and meteorological data and on the transport of scientific equipment. In autumn of 1989, for instance, Polarstern and the Russian ice breaker »Akademik Fedorov« went on a joint expedition to the Antarctic Weddell Sea. Together with experts from other nations, their goal was to record the transport of warm water, salt and sea ice within the so-called »Weddell Gyre«. The monitoring expedition was the overture to a four-year international research programme. The fact that German and Russian researchers tackle issues jointly has become almost a matter of course. The Russian colleagues have been operating an airline that uses Iljuschin transporters to fly researchers from Cape Town directly into the Antarctic. This

represents an enormous relief for conducting research at the most southerly continent, previously only accessible by ship. ✸

59 | *Iljuschin 76 with Polar 2 during the DROMLAN campaign at the Russian station Nowolasarewskaja in the Antarctic, December 2002*
60 | *German-russian permafrost expedition group in Siberian island of Bol'shoy Lyakhovsky in 1999*

61 | *2892 metres above sea level: Kohnen Station*

MYSTERIES REVEALED

in yesterday's snow

25th

2001

Text UTE KEHSE

On January 11, 2001, Kohnen Station on the Antarctic inland ice celebrated its inauguration. To date, researchers of the Alfred Wegener Institute (AWI) have drilled down to 2565 metres at this site, retrieving ice more than 200,000 years old. The ancient snow, condensed into clear ice, represents a unique climate archive.

At the intersection of the 75th southern parallel with the prime meridian, the landscape looks no different than anywhere else in Antarctica: snow, snow and more snow stretching to the flat horizon; above an endless sky that sometimes radiates a clear blue, sometimes shimmers in a silvery grey and sometimes is enveloped in heavy snow storms. Nevertheless, this place is special. Right here, in the centre of the remote Dronning Maud Land, in the little explored Atlantic sector of the Southern Continent, there is an intersection of three ice divides, separating massive ice streams.

At this location, the ice is 2780 metres thick and only moves 80 centimetres per year towards the South Polar Sea. Furthermore, the ground is relatively level so that the snow in this region accumulates from year to year in even layers instead of being deformed by structures on the surface below. All of this makes for an ideal location to study Antarctic climate: the layers of snow built up over hundreds of thousands of years document past climate records like an archive. This is the reason why The European Project for Ice Coring in Antarctica (EPICA) has chosen exactly this site to

carry out one of two deep drillings through the Antarctic ice shield.

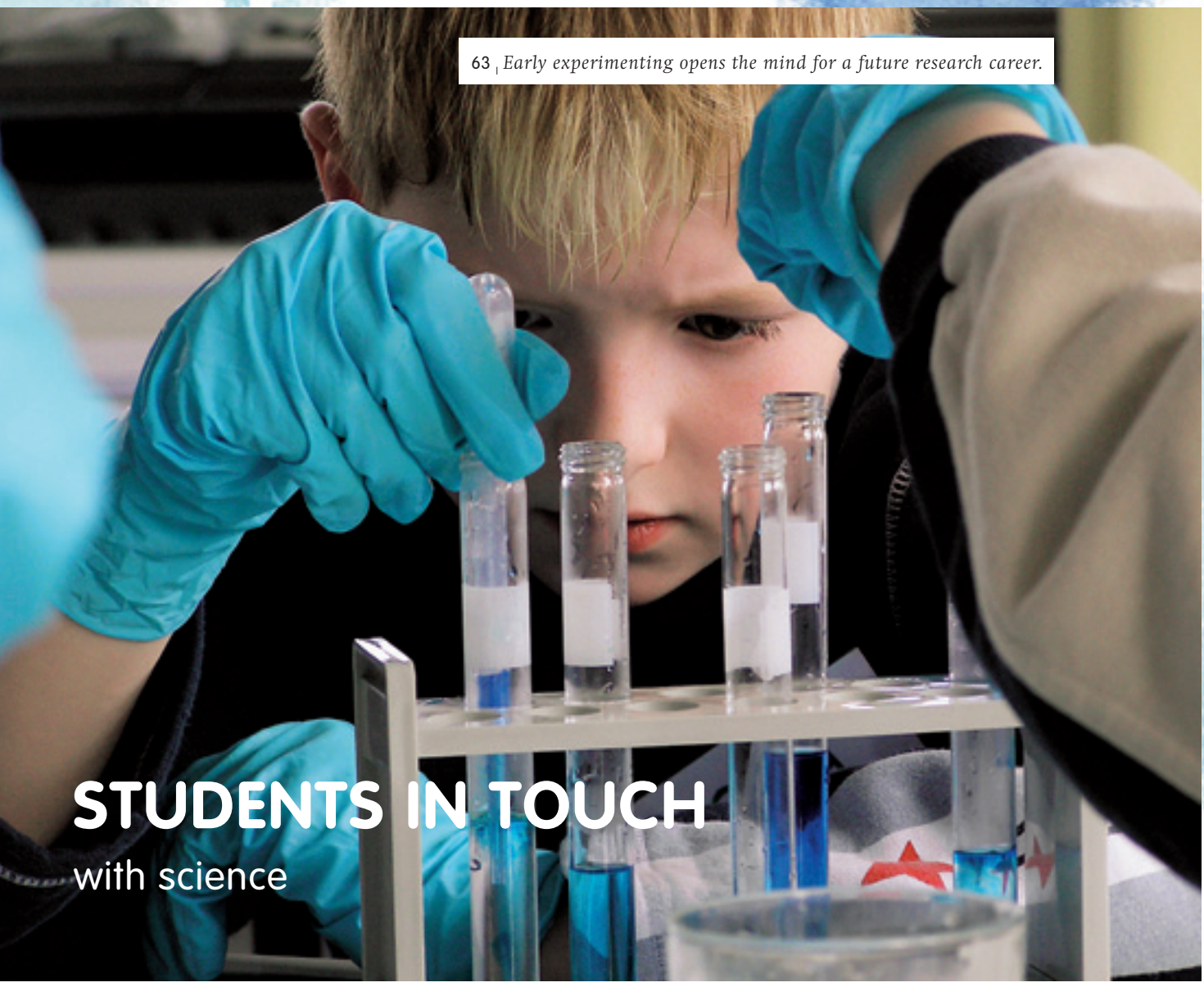
Since the austral summer 1999/2000, the ice divide intersection has become clearly distinguishable from other locations in the Antarctic: At that time, Cord Drücker and his colleagues of the AWI logistics team, within just a few weeks, erected a container station on stilts. It includes a radio transmission shed, a workshop, wash rooms, a mess and a generator (with the waste heat being used to melt snow to supply water for drinking, cooking and washing). In the following summer, another four containers were added and the AWI staff excavated a trench of 60 metre length, 6 metre depth and 4.5 metre width for the drilling system. By January 11, 2001, Kohnen Station was finished and the researchers could begin drilling to retrieve cores of three metre length and 98 millimetre diameter from the Antarctic ice shield.

»The big question that we are addressing is whether glaciations began in the Arctic or the Antarctic« says Dr Hans Oerter. The polar researchers analyse the past climate through air bubbles, dust and other substances that are trapped inside the annually deposited layers of ice. From air bubbles, for instance, the concentration of the greenhouse gases methane and carbon dioxide in previous cold and warm periods, can be deduced. The amount of accumulated air-borne dust particles provides information on wind conditions in the past. High concentrations of sulphate ions which increase the conductivity of ice indicate major volcano eruptions, and hence enable the calibration with other climate archives. The ratio of two oxygen isotopes in the snow – the rare, heavy type (atomic weight 18) and the lighter version (atomic weight 16) – is particularly revealing. It allows the reconstruction of previous temperatures on the icy Southern Continent.

The second drilling under the EPICA project took place at dome C in the Pacific sector of the Antarctic and already produced a temperature chart for the past 740,000 years. It reaches twice as far back in time as the previously oldest ice core from the Russian Wostok-Station, and it allows travel through time, covering eight ice ages with the intermediate warm periods. The data even allow some cautious predictions for the future: according to the data from Dome C, a very interesting warm period began 440,000 years ago and lasted 28,000 years, i.e. more than twice as long as all other recent warm periods. Similar to today, the earth travelled in a nearly circular orbit. Since this will continue for another 15,000 to 20,000 years, the present warm period, the Holocene, might persist for many thousands of years to come.

The EDML drilling does not go as far back in time as the Dome C drilling. »However, since there is more snowfall at DML05, the temporal resolution of the first 80,000 years is much better«, explains Hans Oerter. »We were particularly interested in recording the latest cycle of ice ages with a high level of precision.« The first data analysis revealed that climate shifts were not as drastic as on the other side of the planet, in Greenland. »Overall, the temperature sequence at DML05 is similar to Dome C«, says Oerter. He plans to return to Kohnen Station in 2006 to participate in the drilling through the last 200 metres of ice above the rocky ground below. ✸

62 | *Work in the EPICA ice laboratory at Kohnen Station*



63 | *Early experimenting opens the mind for a future research career.*

STUDENTS IN TOUCH
with science

Text JÖRN HILDEBRANDT

The green algae in the rain barrels are dividing again and again. The barrels contain seawater with different nutrient concentrations – a simple model to simulate conditions of the North Sea. Once a week, 22 students from a high school in Bremerhaven measure growth of the algae and plot the results on charts.

25th

2002

CONTACT

For further information about school projects at the Alfred Wegener Institute please contact Winfried Hebold-Heitz, Tel: ++ 49 (0)4 71 / 48 31 - 13 54 email: whebold@awi-bremerhaven.de

This ecological experiment generates its own associated questions: How do unicellular algae reproduce? In which form are nutrients dissolved in the water? Which equations describe the algal growth pattern? – Topics which equally integrate knowledge from biology, chemistry and mathematics.

HIGHSEA PROMOTES EXPLORATORY LEARNING

The long-term experiment is part of the school project HIGHSEA which, since 2002, has been using the AWI as an unusual study location outside the school. HIGHSEA is an acronym for »HIGH School of SEA« and was developed as a cooperative project between the AWI and the Bremerhaven school board. It offers students at the senior high school level the opportunity to study the subjects of biology, chemistry, mathematics and English prior to graduation. Currently, 66 students from grade 11 to grade 13 work with the HIGHSEA project. And in 2005, the first high school graduation will be celebrated at the AWI.

Since PISA (Programme for International Student Assessment), the weaknesses of German students have become obvious. Universities and research institutes are lamenting the German students' deficiencies compared to their international peers. The purpose of HIGHSEA is to counterbalance this predicament. »We start by setting problems, just as in the reality of every day research life«, explains Dr Susanne Gatti from AWI, who manages and coordinates the project.

New approaches are characteristic for the lessons: the classic divide into subjects has disappeared, and the learning is self-organised, under close guidance from teachers and scientists. The HIGHSEA project offers four topics: The Wadden Sea ecosystem, renewable energies, current methods in genetic engineering and molecular biology, and a subject complex integrating neuro-, sensory and behavioural biology. With this approach, the HIGHSEA project reverses the methods of conventional school teaching where the subjects exist like »islands of knowledge« separately and disconnected from one another. Simultaneously, the instruction complies with given standards, such as the uniform exam requirements (EPA) of the Standing Conference of the Ministers of Education and Cultural Affairs. As part of the project, the students are trained in a new kind of time management of their learning: Lessons are not separated into 45 minute units, schedules are not fixed – instead, learning and breaks alternate according to the work requirements.

NEW CHALLENGES FOR STUDENTS, TEACHERS AND SCIENTISTS

However, the new team work is also demanding: »Scientists often have to learn to make their research area comprehensible for non-experts. And teachers have to be open to new forms of cooperation, and adjust to co-teaching«, Gatti elaborates.

Conducting research inspires the students, fuels their curiosity: »It is apparent that, on AWI days, hardly any student skips school«, says Susanne Gatti. A final product at the end of each project, for example a presentation in English as the science language, or a home-made game on evolution, also helps boost the students' motivation.

HIGHSEA has already established first links with other learning sites: The topic of »nutrient loading in aquatic systems« is being investigated simultaneously by a high school in North Rhine-Westphalia and one far away in Alaska. This will allow students to compare their own results with those from other regions.

For six weeks, a grade three primary school class has also been visiting the AWI on a regular basis. The children can carry out their own experiments addressing »floating and sinking«. And when they see and understand how and why ice floats on water, the first mental links are established to research topics which are also a focus of the AWI. ✸

PHD CANDIDATES, DIPLOMA CANDIDATES AND APPRENTICES AT THE AWI. *In contrast to the school project, which is still young, the educational training of apprentices as well as PhD and diploma candidates has had a long tradition at the AWI. Over the past 20 years, the institute has supervised a high number of apprentices from trade and technical professions. An average of 90 junior scientists, annually complete their university diploma with a diploma thesis from the AWI. Since the AWI's foundation, 500 natural scientists have carried out their doctoral research at the institute. Polar and marine research at the Alfred Wegener Institute would not be possible without the 120 PhD candidates currently employed.*

CORPORATE EXPEDITION

into the deep sea

25th

2003

Text TORSTEN FISCHER UND FRANK POPPE

The steering rod is manipulated carefully. The control room is nearly dark. Only the control panel lights and the reflections of the monitors illuminate the facial features of German and French marine researchers, concentrating aboard the german research vessel Polarstern: The scientists are manoeuvring the french deep-sea robot Victor 6000.

In the summer of 2003, 150 scientists, engineers, technical staff and students from seven European countries boarded the German research vessel Polarstern. Also present was star guest Victor 6000 – the diving vehicle of the French marine research institute Ifremer (Institut français de recherche pour l'exploitation de la mer). To date, the joint deep sea expedition to the high North has been the highlight of a research partnership between the Alfred Wegener Institute and the French institute Ifremer, going back more than ten years.

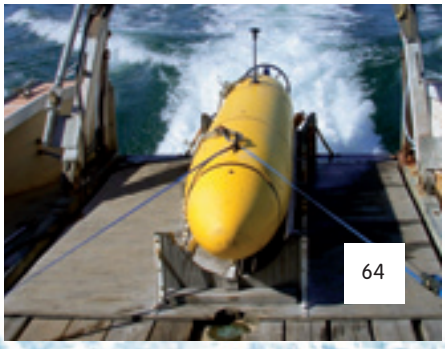
Polarstern was setting course for Porcupine Seabight, an ocean area west of Ireland. A recent discovery revealed that corals form reefs here which stand several hundred metres tall. The scientists aboard Polarstern, viewing the ocean floor at more than one thousand metre water depth, were presented with a display of colours that is otherwise known only from tropical coral reefs. The deep sea corals grow colossal porous rock structures that are also of interest to the oil and gas industry as they are suspected to contain natural resources. The commercial fishery, however, is putting these structures at risk because fish for the food sector are increasingly caught at great depths causing severe damage of the fragile coral colonies and their associated fauna.

MUD VOLCANO AT THE OCEAN FLOOR

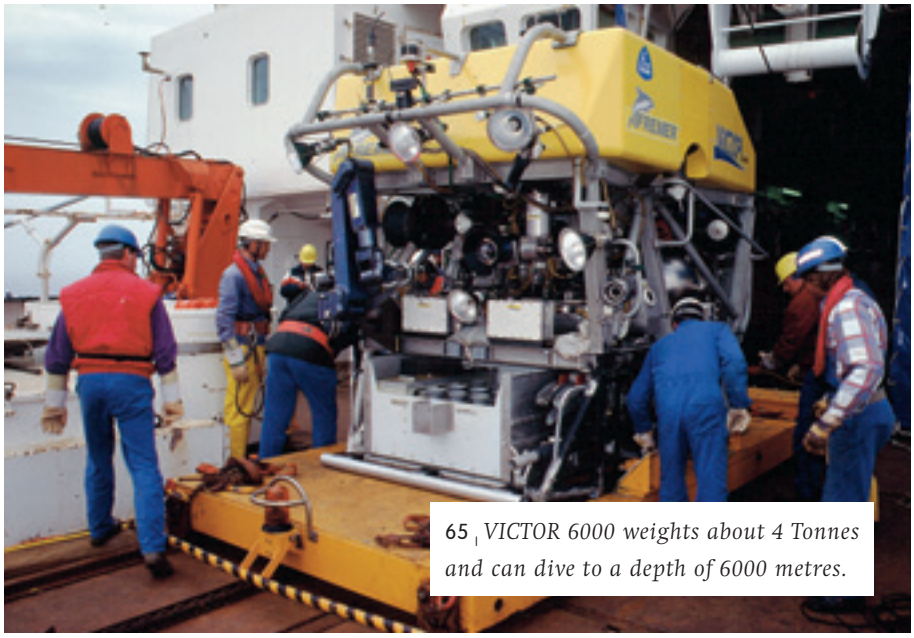
Northwest of Norway, approximately 1250 metre below the sea surface, biologists and geologists of the second cruise leg were observing the Håkon Mosby mud volcano at the next station of the expedition. Although this geomorphological structure does not dis-

AUTONOMOUS UNDERWATER VEHICLES. *Other than ROVs (remotely operated vehicles), autonomous underwater vehicles (AUVs) are not connected to a ship by cable. Because of their free manoeuvrability, they are particularly suitable for research operations in ice-covered regions of the ocean. The AUV carries out pre-programmed measurements following a set protocol at certain water depths and directions. At the end of its mission, the AUV is retrieved onto the ship.*

In order to be able to address as many scientific questions as possible with one AUV, it is designed to carry so-called payload modules. The modules consist of an array of multiple scientific instruments which can be added and removed individually for specific recording tasks on single diving expeditions. In close collaboration with the Ifremer, the deep sea working group at the AWI is currently working towards the technical development of such payload modules.



64 | *Autonomous diving vehicles facilitate research in inaccessible regions, such as the ice-covered underwater seascapes in the Arctic and Antarctic.*



65 | *VICTOR 6000 weights about 4 Tonnes and can dive to a depth of 6000 metres.*

charge lava like a typical volcano, it still spews gas, water and sediments from the depths of the earth to the surface of the seafloor.

In 2003, the international team of scientists under the expedition leadership of Dr Michael Klages, Head of the deep sea research group at the Alfred Wegener Institute, made a brand new discovery. With the assistance of Victor 6000, the researchers observed, for the first time, areas of the Håkon Mosby where the greenhouse gas methane trickled out.

»Methane in the form of gas bubbles is released from the seafloor under very high pressure and is subsequently converted to gas hydrate. Methane can reach the upper water column and even the atmosphere«, explains geologist Professor Michael Schlüter.

METHANE IS RELEASED

The expedition members record the amount of gas leaking from the seafloor over a certain period of time. The high concentrations of methane at the mud volcano are the reason for the development of specialised assemblages of bacteria that act as a bio-filter in utilising methane as a carbon source to produce energy chemosynthetically, thus totally independent from sunlight and photosynthesis.

AT HOME IN THE ARCTIC DEEP SEA

The last leg of the expedition took the participants of the third scientific party closer to home. In 1999, the Alfred Wegener Institute established a deep sea long-term observatory west of Spitsbergen. The so-called »Back Yard« (»Hausgarten«) consists of fifteen stations between 1000 and 5500 metre water depth that are sampled regularly and where Victor 6000 has been used to carry out experiments on the seafloor. The scientists pursue two goals: by means of long-term monitoring they document the changes of numerous environmental parameters, and they wish to discover why the deep sea is home to so many different species.

Mostly, these are comparatively small organisms, i.e. bacteria and invertebrates such as roundworms, crabs and molluscs. The results of the expedition with Victor 6000 demonstrate that minute changes to the structure of the seafloor can have a measurable effect on the species composition and abundance of these small creatures. If, for instance, a large worm ploughs through the sediment, it leaves behind a miniature landscape of hills and valleys which, on a very small scale, can influence water flow and deposition patterns of sedimentary food particles.

In future, the deep sea researchers plan to explore other, almost completely unknown, environments. For this purpose, an un-tethered underwater vehicle is currently in the trial phase (see info-box »autonomous underwater vehicles«). The high manoeuvrability of the vehicle enables missions under the Arctic pack-ice or even beneath the Antarctic ice shelf that is otherwise impossible to access. The region is the place of origin for cold water masses, contributing significantly to the global system of ocean currents and hence impacting the earth's climate. ✸

THE REMOTELY OPERATED VEHICLE VICTOR 6000. *Victor 6000 is a so-called ROV (remotely operated vehicle) of the French marine research institute Ifremer. With a maximum diving depth of 6,000 metres, it can reach approximately 97 percent of ocean floor anywhere on earth. The vehicle has several cameras and can be outfitted with a variety of measuring equipment. With one of its remotely operated manipulator arms, a grasping claw and a suction tube, Victor 6000 is able to pick up organisms, as well as water and sediment samples. Real-time data transmission via a fibre optics cable from the vehicle to the control desk aboard the ship produces high quality imagery and data records and allows the research mission to be intercepted at any time.*

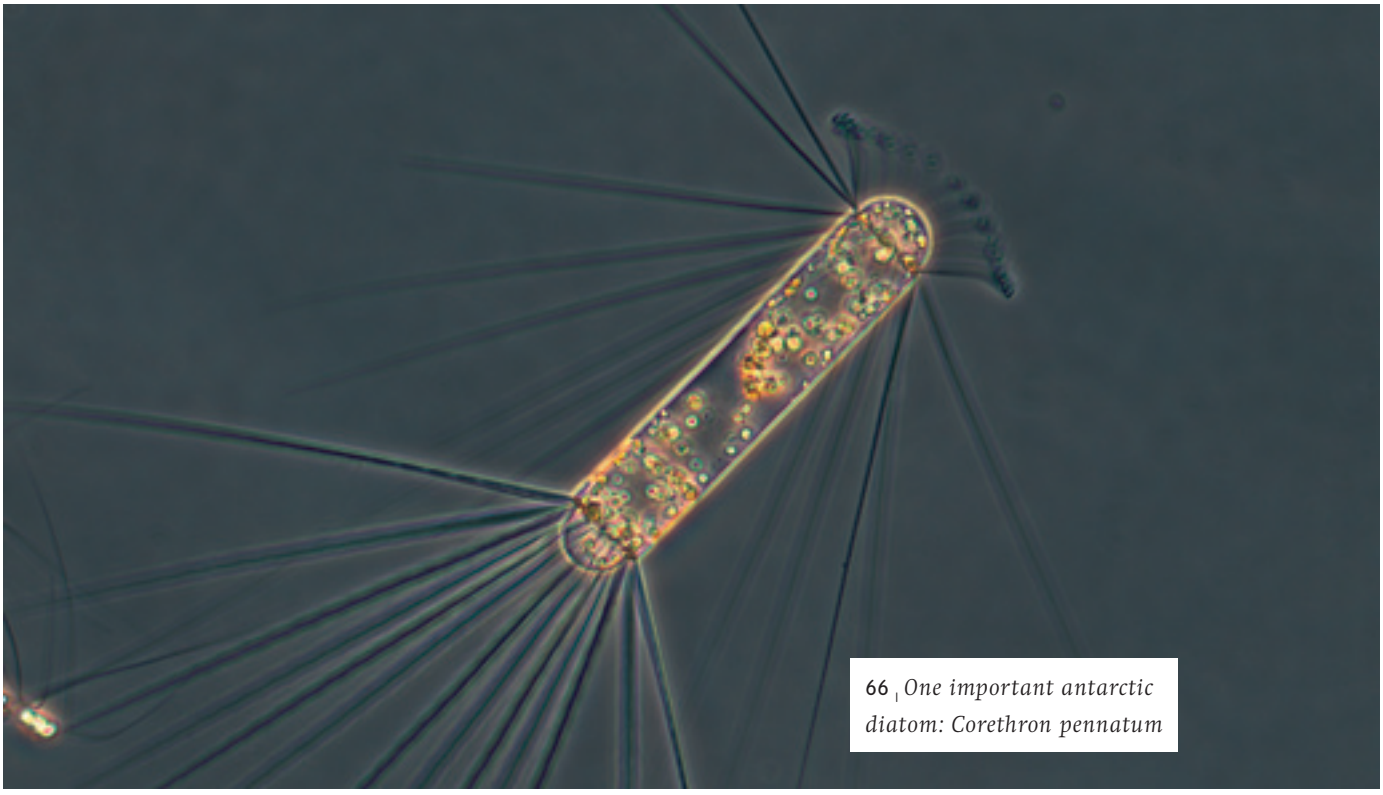
IRON RAIN FOR THE OCEAN

25th

2004

Text NADINE QUERFURTH

The search for a suitable offshore »site of action« was completed within one week: A stationary ocean eddy within the Antarctic Circumpolar Current of the South Polar Sea, 1,500 kilometres south of Africa was selected for the purpose. On board the research ice breaker Polarstern, women and men clad in protective suits gradually released 12 tons of dissolved iron sulphate, available from garden supplies as lawn fertilizer, into the vessel's wake. The ship's propeller conveniently acted as a mixer, and Polarstern spread the solution across an area of 150 square kilometres by navigating a spiral around the »eye« of the eddy.

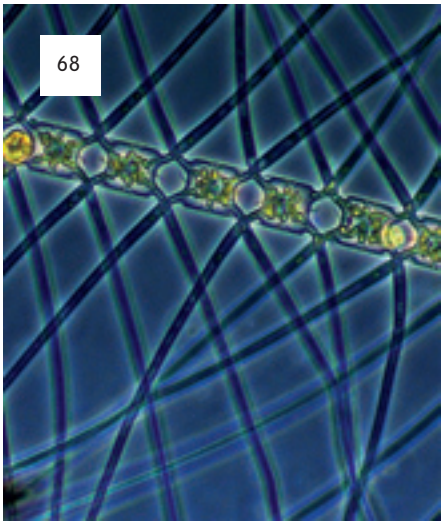


66 | *One important antarctic diatom: Corethron pennatum*

What happened aboard Polarstern in early 2004 was not at all illegal. Instead, it was expedition EIFEX, the »European Iron Fertilisation Experiment«. Fourteen institutes and three companies from seven European countries contributed to the project. Scientists of the Alfred Wegener Institute for Polar and Marine Research organised and directed the nine-week experiment.

FROM BRILLIANT-BLUE TO GREEN-TURQUOISE

Previous experiments have identified iron deficiency as one reason why, in offshore areas of the Southern Ocean, phytoplankton (unicellular plankton algae in the ocean) are limited in their growth. Targeted iron fertilisation in iron-limited ocean regions can generate plankton blooms which, within a few weeks, increase the algal biomass many times over. As a result of the intense algal growth, the colour of the seawater changes from a brilliant-blue at first to a green-turquoise thereafter. In the upper layers of the water column, the algae consume enormous quantities of carbon dioxide (CO_2). The deficit is balanced by atmospheric CO_2 dissolving the water. The interesting question is what happens to the



67 | *With a multi net it is possible to sample plankton in different depths.*
68 | *Algal plankton is the basis of the marine food chain; here the diatom Chaetoceros atlanticum.*

algal bloom after the fertilisation with iron. Do bacteria and animal plankton break down the algal biomass in surface waters, with CO_2 returning into the atmosphere – hence an overall zero-effect? Or does the biomass sink into deeper ocean layers and remain removed from the atmosphere for centuries or longer?

INTO THE DEEP SEA

Expedition EIFEX provided the answer: The biomass of the algal bloom sank down to depths of 3,000 metres and more. »As far as we know, EIFEX is the first experiment documenting in detail the fate of an iron-fertilised algal bloom« summarises expedition leader Professor Victor Smetacek from the Alfred Wegener Institute. Smetacek and his colleagues witnessed a process that is of phenomenal significance for geochemistry, i.e. a natural mechanism removing CO_2 from the atmosphere, thus regulating the climate. Through fertilisation of the whole South Polar Ocean, a maximum of only 15 percent of global annual CO_2 emissions could be fixed. Therefore, large-scale ocean fertilisation is no permanent solution for the global CO_2 problem.

WHO LIVES IN A PLANKTON BLOOM?

Instead, targeted iron fertilisation represents an ideal tool for the scientists to understand fundamental ocean processes. The researchers are able to determine when and where to produce an artificial plankton bloom. This allows the detailed investigation of a bloom with regard to the sequence of events, the interactions in the planktonic food web and the identification of animal and plant species within the plankton. »Up to now, we have measured the total chlorophyll content of the plankton, i.e. we treated the plankton as one large unit and did not study individual species. By means of iron fertilisation, we are now able to investigate the basic features of various plankton species«, says Dr Philipp Assmy from the Alfred Wegener Institute. Once scientists know more about individual species, they will be able to develop sensors with which such species could be detected during routine monitoring expeditions.

HOPE FOR ENDANGERED SPECIES?

The iron fertilisation had an additional positive effect: the bloom facilitated growth of organisms consumed by krill. This crustacean, several centimetres in size, represents virtually the only food source for many species of whales, seals, fish, squids and birds. Could local iron fertilisation increase the abundance of krill and, consequently, lead to a recovery of the endangered Blue Whale population? For the scientists, the prospect of producing more food for endangered species populations is worth a try. Therefore, the Alfred Wegener Institute is planning a long-term investigation north of the Antarctic Peninsula during the International Polar Year 2007/2008. Professor Smetacek is convinced: »If one carries out commercial iron fertilisation, it should at least be done in areas, where the marine fauna can benefit.« ✸

69 | *Pancake ice in the Antarctic*

UNDERSTANDING THE UNDERSIDE

25th

2005

Text VERENA RADEMAKER-WOLFF

Every year, an ocean area the size of the USA freezes and thaws again. Every year, organisms from warmer, nutrient rich waters make their way here and continue life under extreme conditions. Sea ice represents a vast habitat and a factor for global climate.

For a long time, sea ice was only considered an evil, a curse of the cold. Forever unstable, obscurely deep and sharp-edged, it led many explorers astray, caused ships to rupture and provided no security for the stranded. Hardly any scientist had able to investigate the formation, let alone the characteristics, of sea ice before the first polar expedition with the new research vessel Polarstern in 1982. The researchers of the Alfred Wegener Institute were the first to describe the structure of unusual types of ice, such as the »pancake ice«.

When Polarstern's bow broke through the pack ice for the first time, the researchers were intrigued by the greenish-brown colouration at the underside of the ice fragments. They discovered that the colouration derived from minute organisms trapped in the ice. At the end of the 80s, ice drillings allowed, for the first time, the systematic assessment of sea ice thickness in polar regions, and first estimates of the energy balance of pack ice were released. Slowly, scientists recognised the important role that the variable ice-cover of polar oceans played for global and regional climate processes. Consequently, sea ice research became the centre of scientific interest.

At that time, sea ice biology offered another surprising insight: despite the extreme conditions, ice represents a productive environment for organisms living there. Scientists from Bremerhaven, for instance, recognised the important role that the ice plays as a grazing ground for krill dur-

ing the winter, and they calculated that one fourth of the primary production of ice-covered regions is generated in sea ice.

In the early 90s, sea ice physicists of the Alfred Wegener Institute made a scientific breakthrough with the development of an electromagnetic sensor (EM) for measurements of sea ice thickness. Initially, the EM was towed across individual ice floes from aboard a kayak; nowadays it can assess ice thickness across large areas while suspended from a helicopter. It was demonstrated that, in the decade from 1991 to 2001, ice thickness between Spitsbergen and the North Pole in the Arctic Ocean declined by approximately 20 percent. Whether this is an indication of global climate change is still uncertain. During the ISPOL expedition (Ice Station POLarstern) from December 2004 until January 2005, Polarstern was tied up to an ice floe and spent five weeks drifting through the western Weddell Sea. Fifty-five scientists (meteorologists, biologists, glaciologists and oceanographers) aboard the research vessel made use of drillings, scoops and helicopter flights to observe changes of the sea ice throughout the onset of the austral summer. These alterations are considered a major component of the oceanographic, meteorological and biological processes in the world's oceans. And ISPOL rendered baffling results: Sea ice in the western Weddell Sea is thicker than in the Arctic. In the near future, CryoSat, a satellite of the German Space Agency, will measure sea ice thickness as well as the surface evaluation of the ice shields and ice shelves across the whole Arctic and Antarctic. For at least three years, the satellite will provide data to an international scientific community, including scientists from Bremerhaven. It will enable the first near-simultaneous systematic assessment of ice thickness at both poles: An »over-view« that might answer fundamental questions of climate research. ✸

70

CAPTION

PANCAKE ICE: *As seawater freezes, it first forms an ice pulp on the surface which, gradually, takes the shape of plate-like ice discs. This pancake ice continues to be compacted by wind and waves to floes, and by rafting to pack ice.*

ICE AND CLIMATE: *The capacity of ice to reflect solar radiation is five times higher than that of open sea water. If this so-called »albedo« decreased through additional melting of the ice cover, global climate would be fuelled even more.*

HABITAT SEA ICE: *During the first stage of sea ice formation, primarily diatoms and bacteria are trapped in the ice slush. Particularly the solidification of fresh water crystals rising to the surface causes organisms to be sieved out of the water. If fresh water continues to freeze within the ice, highly concentrated brine is formed which accumulates in a ramified network of so-called »brine drainage channels«. Well adapted to these harsh conditions, the organisms that previously inhabited the open water column, survive the winter in this environment. As long as sufficient light and nutrients are available, some of them even reproduce. At the end of the winter, the ice underside can virtually be covered in »algal gardens«.*

70 | *For five weeks, an ice floe serves as a work place for scientists from all over the world.*

ALFRED WEGENER INSTITUTE:

Centre of German polar and marine research

Text TIM SCHRÖDER

25 years of discoveries have significantly expanded our understanding of the system earth. Nevertheless, intensive research continues to pose new questions so that the work of the Alfred Wegener Institute is far from over. Professor Jörn Thiede, Director of the institute, looks back on a quarter century of polar research in Bremerhaven and ahead to the questions that scientists will be addressing in the future.

Despite the fact that the Alfred Wegener Institute is located far from the Arctic and Antarctic, it has been conducting research in the polar regions of the earth since 1980. For a long time, the institute has been among the most reputable of its kind. What is the reason for this involvement?

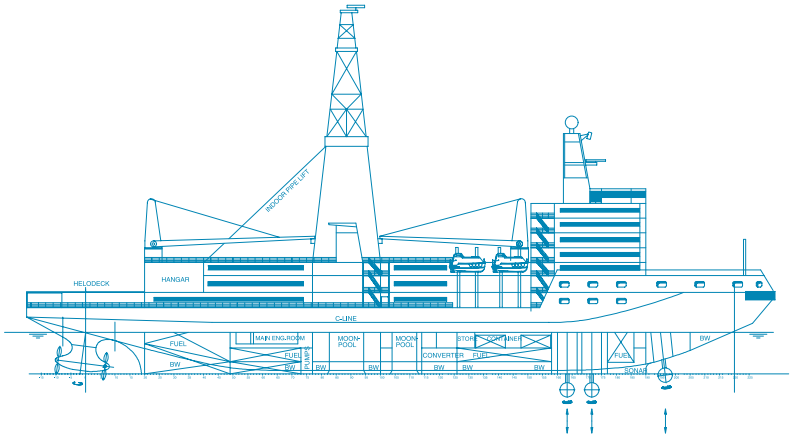
Prof. Jörn Thiede: Initially, Germany's motivation clearly was the desire to investigate, on par with the United States and other nations, Antarctica as the last great unclaimed continent, and to join the Antarctic Treaty. One basic condition, however, was a German national research programme with our own vessels and our own Antarctic station. The inauguration of the AWI as the centre of German polar research, the construction of Polarstern, and the establishment of the Georg von Neumayer Station in the Antarctic were the three fundamental steps that made this dream come true. Right from the beginning, our research also provided the context for our involvement in the Arctic.

And what is the goal of your work in these extreme environments today?

Prof. Jörn Thiede: Our research provides a contribution to global environmental science and to understanding the qualities of the most extreme habitats on earth. The dynamics and the rate of climate change are particularly well visible at the poles. Using drill cores from the Greenlandic and Antarctic ice sheets, for instance, we have been able to identify climate specifics from a period of several tens of thousands of years with a resolution of individual years. One of the most important insights from this was that climate can vary between glacial and temperate conditions within a period of just several decades.

What does this mean for current research?

Prof. Jörn Thiede: The challenge will be to establish whether recent changes in climate are exceptional or whether they represent natural phenomena within the range of historic variation. We know that sea ice cover in the Arctic Ocean has decreased by approximately 20 percent over the past 15 years. We have to clarify whether this is unusual. Our goal is to understand how the earth functions as a system and how atmosphere, biosphere, the oceans and the polar regions interact. This is why



71

our research has always been interdisciplinary, and physicists, oceanographers, geologists and biologists have been working hand in hand.

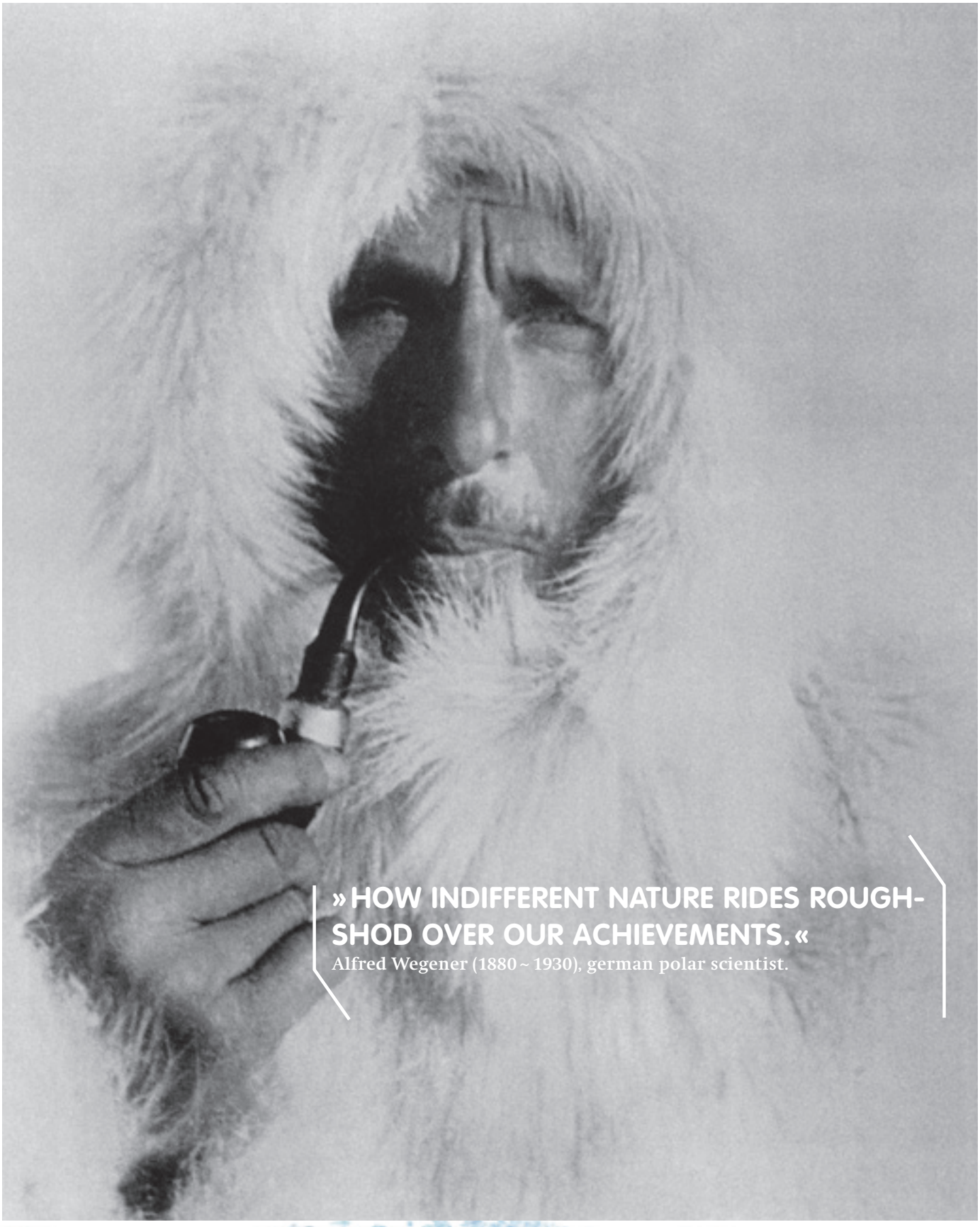
How was it possible to unite experts from such a variety of disciplines under one roof?

Prof. Jörn Thiede: This is partly the result of the AWI's amalgamation with other institutes. In 1985, the Institute for Marine Research in Bremerhaven became part of the AWI. It has been concerned especially with investigations of the Wadden Sea, and coastal regions and their pollution in general. In 1998, under the leadership of then AWI Director Professor Max Tilzer, the »Biologische Anstalt Helgoland« with its station in List on Sylt joined the institute. Of major significance was also the unification of professional competency from Western Germany with expertise from the previous GDR after breakdown of the Berlin wall. Since the early 70s, the GDR had established an extensive polar research programme. GDR scientists had acquired a vast knowledge that occasionally invoked some envy in their West German colleagues. Much of their experience found its way into the AWI's research unit in Potsdam which was founded in 1992.

How do you envisage the AWI's work for the coming years and decades?

Prof. Jörn Thiede: If we want to understand and be able to recognise in time the seemingly sudden and significant changes in climate, we need to increase the presence of researchers in the polar regions. Our assessment abilities from satellites are still insufficient and do not provide all the information necessary. This is why, among other activities, we have been involved in the construction of a large European ice breaker – the »Aurora borealis«. This ice breaker will be the first vessel strong enough to stay in the Arctic over winter and break through winter ice layers of several metres thickness. It will enable us, for the first time, to measure crucial parameters continually throughout the winter. In the Antarctic, we will continue our projects in the new research station »Neumayer III«, scheduled to be completed by 2008.

71 | *Aurora borealis. The projected European scientific ice-breaker is provided with a complete drilling equipment and will operate even in the Arctic winter sea ice.*



»HOW INDIFFERENT NATURE RIDES ROUGH-SHOD OVER OUR ACHIEVEMENTS.«

Alfred Wegener (1880 ~ 1930), german polar scientist.

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