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The Scientific Programme of the German Antarctic Expedition 1979/80 to the Filchner/Ronne Ice Shelf

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Summary: The sientific programme of the expedition concentrated on the site survey for the German winter-over base. The programme comprised mapping of the ice front, sea ice studies and glaciological investigations on the ice shelf, but also meteorological, oceanographic and marine-biological observations; these investigations can be regarded as the beginning of the German research work in this region.
Two alternative sites, one on the Filchner Ice Shelf at 77 °S, 50 °W and the other at the Atka Bay (70 °S, 08 °W), were selected for the construction of the station.
In addition to its own programme, the expedition carried out field work for other projects. These measurements comprised two XBT profiles across the equator and one profile across the polar front. A deep sea current meter was moored in the Scotia Trench and a drift platform was installed on an iceberg near the South Sandwich Island chain. One crab-eater seal and two Adélie penguins were taken for traces of pesticides and heavy metals. A Norvegian automatic weather station was serviced on Bouvet Island, where also a tide meter was moored. Seals and penguins were counted routinely during the whole cruise as part of an international observation programme.

Zusammenfassung: Das wissenschaftliche Programm der Expedition war auf die Standorterkundung für die deutsche Überwinterungsstation ausgerichtet. Es umfaßte die Aufnahme und Kartierung der Schelfeiskante, Meereisuntersuchungen und glaziologische Arbeiten auf dem Schelfeis. Diese sollten einmal die Voraussetzungen für den Stationsbau schaffen, zum weiteren waren sie aber schon den zukünftigen Massenbilanzstudien auf dem Filchner-Ronne-Schelfeis gewidmet. Darüber hinaus waren meteorologische, meeresbiologische und ozeanographische Studien in das Expeditionsprogramm aufgenommen. Die Arbeiten können als Beginn des Deutschen Antarktisforschungsprogramms in dieser Region gewertet werden.
Als Standorte wurden die Gebiete bei 77 °S/50 °W auf dem Filchner-Ronne-Schelfeis und bei 70 °S/08 °W an der Atka-Bucht ausgewählt und vorgeschlagen. Die Arbeiten der Expedition auf dem Filchner-Ronne-Schelfeis und vor der Schelfeiskante wurden einmal von einer kleinen Sommerstation bei 77 °09 'S/50 ° 38 'W und zum anderen von Bord des Expeditionsschiffes POLARSIRKEL aus durchgeführt.
Über die eigenen Aufgaben hinaus hatte die Expedition Arbeiten für andere Projekte übernommen. Darunter fielen zwei XBT-Schnitte über den Äquator und ein XBT-Schnitt über die Antarktische Konvergenz. Ein Tiefseeströmungsmesser wurde im Scotia-Graben verankert, und auf einem Eisberg wurden eine automatische Driftstation installiert. Eine Krabbenfresser-Robbe und zwei Adélie-Pinguine wurden für die Untersuchung von Schadstoffen zurückgebracht. Bei Bouvet Øya wurde eine norwegische automatische Wetterstation repariert und ein Gezeitenmesser verankert. Routinemäßig wurden auf der ganzen Fahrt Robben und Pinguine für ein internationales Beobachtungsprogramm gezählt.

The major emphasis of the scientific programme was posed on the site survey and related studies which comprised glaciological investigations relevant to the construction of the winter-over base but also to mass balance and ice dynamical studies. Along with the biological and oceanographical investigations the scientific programme of the expedition, as outlined below, can be regarded as the commencement of the German Antarctic Research Programme planned in this region.

Sea ice studies

The winter-over station should be built in an area west of Berkner Island. Since the heavy pack ice in the Weddell Sea makes the Filchner/Ronne Ice Shelf one of the most unaccessible areas in Antarctica, the pack ice conditions had to be studied carefully during the cruise. Hence, this specific project comprised observations of the pack ice cover, floe density and density variation as well as measurements of ice thickness, strength, elastic behaviour, salinity, temperature, age and crystal structure. In conjunction with satellite observations and aerial survey as much information as possible should be acquired on the access conditions during the austral summer and the seasonal behaviour of the shore lead along the Filchner/Ronne Ice Shelf.

Survey of the ice front

The front of the ice shelf usually forms a vertical cliff of 30 m to 40 m altitude. Since the future base will

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be supplied by sea transportation, lower ramps in the barrier had to be found. Such structures are required for docking, loading and unloading of supply goods. Therefore, the expedition programme included a detailed survey of the barrier from ship as well as from the helicopter. The measurements should provide an accurate figure of the topography and the position of the ice front.

Bathymetry and ice thickness measurements
Bathymetry data are rare in the southern Weddell Sea. The bottom morphology is nevertheless of major importance for the run-off and circulation of the Antarctic bottom water. Routine bathymetric profiles should, therefore, be taken continuously.

The thickness of the ice shelf is basic glaciological information. Ice thickness data are required for any mass balance considerations and the assessment of the dynamical behaviour of the ice shelves. Air-borne radio echo sounding measurements were consequently planned at various points on the Ronne Ice Shelf.

Crevasse-survey
Crevasses are hazardous for ground transportation especially when covered by snow bridges. Usually, crevasses occur in the marginal areas, whereas crevasses are rare in undisturbed central zones. An intensive helicopter-survey, visual as well as by the radio echo sounding was part of the programme in all areas of interest to map the crevasse distribution.

Geodetic determination of movement and deformation
The absolute movement of the ice shelf controls the distance from the barrier at which stations can be built to be safe enough against unexpected break-off. The movement and flow of the ice shelf had to be measured by satellite positioning methods to a high degree of accuracy. Since horizontal deformation of the ice may affect the stability of the station, strain rates were to be investigated applying conventional geodetic methods.

Glaciology
Basic glaciological parameters have to be known for the outline and construction of the station. Among these, accumulation, density and temperature distribution in the upper 10 m are most important because they control the bearing capacity, strength and settlement rate of the snow. Consequently, the programme comprised the measurement of these parameters in areas which appeared to be suitable for the construction. Besides this basic information, additional investigations on controlled snow settlement, snow strength, and the behaviour of snow anchors were incorporated into the programme.

Climatology — meteorology
Climatological and meteorological observations on the ice shelf during the short summer season can only give a hint of the climatological regime in the station area. Nevertheless, synoptic observations together with measurements of temperature, pressure, humidity and radiation should provide first informations on the climatic conditions. Furthermore, drift observations were planned to acquire basic data on the snow transport.

Marine biology
The expedition's programme comprised marine biological investigations to study the distribution and ecology of krill and different Antarctic fish species. Special emphasis was placed on the investigation of genetic and morphological differences within the same species. Fishing was planned south of the polar front on the way to and back from the Antarctic and along the ice shelf front.

Physical oceanography
The Weddell Sea plays a major role in the formation of Antarctic Bottom Water. The hydrographical conditions should be investigated from board the ship along the edge of the Filchner/Ronne Ice Shelf and on profiles perpendicular to the continental margin by CTD-Sounding (CTD: Current, Temperature, Density).

Water samples should be taken for $^{18}O/^{16}O$ and Tritium analyses. Additional informations are expected from these measurements on the formation and circulation of the bottom water in this region.

Field work for other projects
Besides its own programme, the expedition supported other scientific projects by carrying out the relevant measurements, installing automatic data platforms as well as servicing and recovering already existing and operating automatic stations. The field work was done by expedition members.

The first project of this kind comprised temperature measurements of the upper 700 meters by XBT-soundings (XBT: Expandable Bathy-Thermograph — Investigator: Dr. Zenk, Institute for Marine Science, Kiel). The first profile covered the section from Cap Vincente to the Canari Islands and from Cap Verde to 5 ° N. 94 probes were launched by N. Slotsvik at hourly intervals. The second section crossed the equator close to the African coast and was measured by Miss Henke who came on board in Cape Town.

At the position 52 ° 52,33' S, 48 ° 19,19' W a deep sea current meter (Investigator: Dr. Zenk, Kiel) was moored at 3048 metres depth in the Scotia Trench on 23 December 1979. The instrument was expected to record the ocean durrent at two different levels close to the bottom. The meter was recovered by RS METEOR in 1980/81. It had operated successfully over one year.

A third XBT-profile was measured across the Polar Front from about 55 ° S 32 ° W to 71 ° S 13 ° W to investigate the structure of the convergence. This project is part of the oceanographic studies in the southern Atlantic of the German Hydrographic Institute (Hamburg).

As part of current investigations on the drift of icebergs (IFF, Paris) a data platform was installed on an iceberg of 850 m length and 690 m width at 57 ° 35' S and 26 ° 20' W (Fig. 1) on 27 December 1979. The

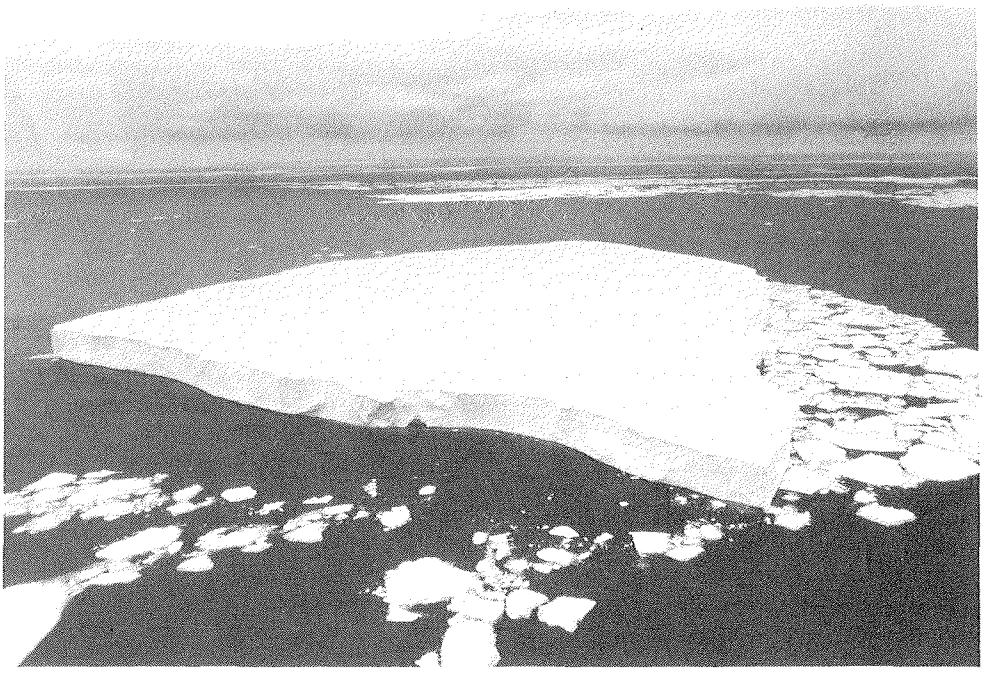

Fig. 1: Iceberg „Paul" on which the drift platform was installed.

Abb. 1: Eisberg „Paul", auf dem die Driftplattform installiert wurde.

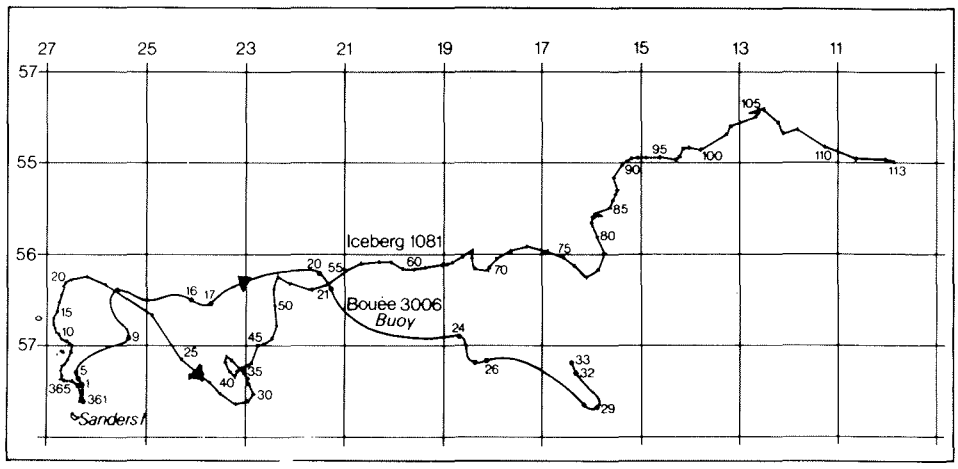

Fig. 2: Drift tracks of the iceberg platform and the oceanographic buoy (from MAUVIEL & DHALLUIN, 1981).

Abb. 2: Driftwege der Eisbergplattform und der ozeanographischen Boje (aus MAUVIEL & DHALLUIN 1981).

platform recorded relevant meteorological and climatological data, measured tilt, internal deformation as well as position of the iceberg and transmitted these data via satellite (Argos) to Paris. The major objective of this programme was to follow the iceberg drift in the northern Weddell Sea and to obvserve its decay. Besides the iceberg an oceanographic drift buoy was launched into the sea to study the partial influence of the ocean current on the iceberg's track.

The Norsk Polarinstitutt had requested support for the maintenance of an automatic weather station and for the replacement of an oceanographic data buoy at Bouvet Island which was planned to be carried out on the way back to South Africa.

One crab-eater seal and two Adelie penguins were killed and brought back to Kiel, for biological studies. Dr. Drescher from the Institute for Domestic Animal Research, Kiel investigated the contents of pesticides and heavy metals.

An automatic observation buoy installed by the Norwegian expedition in 1978/1979 was recovered from an iceberg near Cape Norwegia on 15 February 1979.

When passing Bouvet Island on the way back an automatic weather station was repaired and serviced on 23 February 1980. A tidal current meter was moored on the shelf of the island in 552 metre depth at 54° 21' S, 3° W. Both instruments belong to the Norwegian Antarctic Research Programme.

On request of SCAR seals and penguins were counted during the cruise. These data are required for an international and Antarctic wide survey to keep track of the seal and penguin populations.

References

Mauviel, F. & M. Dhalluin (1981): Antarctic iceberg drift correlation with environmental factors. — ARGOS Newsletter 10, Toulouse.