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History of the Geological Research Expeditions to the Heimefrontfjella (East Antarctica) and Chronology of the Geological Mapping Programme.

by Gerhard Spaeth[1]

Abstract: In 1939, Heimefrontfjella was discovered on a photogrammetric flight of the Deutsche Antarktische Expedition 1938/39 under the leadership of Alfred Ritscher, but it took 23 years until the first British expedition investigated the mountain range. After a short period of British topographic and geologic surveys in the mid 1960s, systematic geological studies began with the German 2nd Neuschwabenland-Expedition in 1985/86. In the following years until 2000/01 the whole range was mapped at a scale of 1 : 10,000 resulting in a number of geological maps at a 1 : 25,000 scale.

Zusammenfasung: Die Heimefrontfjella wurde während der von Alfred Ritscher geleiteten Deutschen Antarktischen Expedition 1938/39 bei einem fotogrammetrischen Vermessungsflug entdeckt. Es dauerte jedoch 23 Jahre bis die erste britische Landexpedition mit der Erforschung des Gebirges begann. Nach einer kurzen topographischen und geologischen Erkundungsphase begann die systematische geologische Erforschung 1985/86 mit der deutschen 2. Neuschwabenlandexpedition. In den darauf folgenden Jahren bis 2000/01 wurde die Heimefrontfjella im Maßstab 1:10.000 kartiert, woraus das Kartenwerk 1:25.000 resultiert.

DISCOVERY OF HEIMEFRONTFJELLA

In 1938/39, the German Antarctic Expedition under the leadership of Alfred Ritscher investigated the Atlantic sector of Antarctica east of the Weddell Sea between 10 ºW and 20 ºE (RITSCHER 1942). During the first reconnaissance flight on January 20, 1939, the crew of a Dornier Wal airplane discovered several mountain ranges and isolated nunataks in the hinterland of the Kronprinsesse-Märtha-Kyst. The whole area between 10 ºW and 20 ºE was named "Neuschwabenland", but is better known today as western Dronning Maud Land (DML). The northernmost parts of the mountain range at c. 9º30' W, 74º20' S, today known as Milorgfjella, was named Kottasberge after the captain of the expedition vessel, A. Kottas. During the Norwegian-British-Swedish expedition to DML from 1949-52 a photogrammetric programme led to the discovery of the southwestern parts of the Heimefrontfjella. The oblique aerial photographs taken during the southern summer 1951/52 were used for the production of Norwegian topographic maps at a scale of 1 : 250,000. The individual parts of the mountain range from NE to SW were named Milorgfjella – XU-Fjella – Sivorgfjella – Tottanfjella on the two map sheets finally published in 1988.

The southernmost nunatak group Tottanfjella was spotted again in 1957 during a flight undertaken by Sir Vivian Fuchs, at that time leader of the Trans-Antarctic Expedition (TAE), and D. Dalgliesh, the head of the British research station Halley Bay. They named this part of the range Tottan Hills after the British research vessel "Tottan" (FUCHS 1982). A British overland expedition, comprising C. Johnson, the head of Halley Bay, and D. Ardus, a surveyor, set out from Halley Bay with dog sledges for the Tottan Hills. After a 400 km traverse they were the first people ever to reach the nunataks of Tottan Hills. They arrived on 14 November 1961 and stayed there for four days.

FIRST RECONNAISSANCE PHASE BY BRITISH GEOLOGISTS AND SURVEYORS

D. Ardus was the first surveyor in the southern Heimefrontfjella but he also made biological, geomorphological and geological observations. He reported the existence of metamorphic rocks (augen gneisses and schists) and collected a number of rock samples in spite of the very limited transport capacity (ARDUS 1964). Later, these rock samples were described petrographically by J.W. Thomson as *"some basement complex rocks";* however, she also stated that the sampling locations were too scattered to prepare a detailed geological map (THOMSON 1968).

In the three following austral summers from 1963 to 1966, the geography and geology of Heimefrontfjella was explored. Field parties started from Halley Bay using dog sledges and tractors. The data of this survey resulted in a topographic map at a scale of 1 : 100,000 (two sheets), which was prepared by M. Samuel and G. Lovegrove.

The first geologist who worked in the Heimefrontfjella was R. Worsfold. He spent two seasons, 1963/64 and 1964/65 in the southern and central Heimefrontfjella (Tottanfjella and Sivorgfjella) for petrographic studies of the metamorphic basement. His first publication, however, covers the physiography and glacial geomorphology of the range (WORSFOLD 1967a). The first three publications (ARDUS 1964, THOMSON 1968, WORSFOLD 1967a) are very brief summaries. They were followed by a detailed geological PhD thesis, which was never published (WORSFOLD 1967b). This thesis contains a geological overview map at a scale of 1 : 100,000, showing six lithological units of metamorphic and igneous rocks.

The geological exploration was continued in the northern part of the range (XU-Fjella and Milorgfjella) by L. Juckes in the summer seasons of 1964/65 and 1965/66. His work covered not only the metamorphic basement, but also gave a first

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detailed description of a Palaeozoic-Mesozoic cover in the northern Heimefrontfjella. This cover consists of sedimentary rocks and basaltic flows and sills. The study included petrology and geochemical whole rock analyses that formed a fundamental part of his PhD thesis, but the results were also published as a report of the British Antarctic Survey (JUCKES 1972). This report also contained the first age determinations based on palaeontological and radiometrical analyses, which proved an earliest Permian age for the sedimentary rocks and a middle Jurassic age for the basalts. The geological map in this report was based on a 1 : 100,000 scale topographic map reproduced at a 1 : 250,000 scale showing six different lithological units.

In October 1965, an accident happened at Milorgknausane, later renamed Mannefallknausane, approximately 70 km west of Tottanfjella. A tractor dropped into a crevasse and three members of a British field party were killed (FUCHS 1982). All attempts to recover the bodies failed and also several field notes were lost. The survey of the mountain range was nevertheless completed. In the following summer 1966/67, another traverse was made to the Heimefrontfjella to repair a tractor that was abandoned during the disastrous previous season. This was the last documented British activity in the Heimefrontfjella.

SECOND PHASE OF GEOLOGICAL RESEARCH BY GERMAN AND SCANDINAVIAN EXPEDITIONS

A second phase of geoscientific activities in the Heimefrontfjella started in the early 1980s, based on the newly established German wintering station in austral summer 1980/81 Georg von Neumayer Station (GvN) at Atka Bay in western Dronning Maud Land. Heimefrontfjella became the major target for German geologists as a result of the selection of the station site and the research preferences of the scientists. During the German Antarctic Expedition 1979/80, led by H. Kohnen, several potential sites for a wintering station were investigated. The feasibility study was favourable for a site located on the Filchner-Ronne ice shelf; an alternative site was chosen at the Atka Bay in the event that the first alternative was not accessible during the forthcoming season. The investigation of the Atka Bay site, however, was less detailed due to time restrictions. KOHNEN (1982) gives a comprehensive view of the site selection and the dramatic events that occurred during the construction of the station.

Western Dronning Maud Land was well chosen as a research area for three reasons:
(i) Relatively easy access from South Africa and/or South America.
(ii) Only a few other Nations had stations in this area.
(iii) A variable topography with mountain ranges in the hinterland, grounded ice sheets and sea-ice would keep scientists of various disciplines occupied over a certain period.

Historical reasons may also have played a role, since this Atlantic sector had already been a target area for the second and third German Antarctic expeditions by Wilhelm Filchner in 1911/12 and Alfred Ritscher in 1938/39, respectively.

The German Science Foundation (DFG) invited interested scientists to a round-table meeting in March 1980 to plan further activities at or in the surrounding area of the new station. Taking into account that the new station should be built on the Filchner-Ronne ice shelf, W. Buggisch (Darmstadt), G. Kleinschmidt (Darmstadt) and G. Spaeth (Aachen) considered field research in the Shackleton Range, the Pensacola and the Ellsworth Mountains. H. Behr and K. Weber (both from Göttingen) also expressed their interest in these regions, however, along with W. Schubert (Würzburg), they preferred the mountains of western and central Dronning Maud Land as their primary scientific target.

In a compilation of the already established priority programme (Schwerpunkt) of the DFG from January 1981, the Shackleton Range and the Ellsworth Mountains were suggested the first key-target areas for geological investigations. Neither Western Dronning Maud Land nor the Heimefrontfjella were specifically included at that stage since it was considered that the German wintering station would be located on the Filchner-Ronne ice shelf. Scope for further geoscientific studies was outlined. Within the frame of the same programme, it was also stated that large-scale topographic maps would soon be needed for the presentation of geoscientific results, which was a call for surveyors and cartographers to make contributions to these geoscientific filed studies.

At the same time, however, a message arrived in Germany that the new station was under construction at the alternative site on the Ekström ice shelf near Atka Bay. Prevailing difficult sea-ice conditions in the region of Gould Bay at the Filchner-Ronne ice shelf made the construction at the preferred site impossible. So the expedition leader decided to establish the new station at the site of "second choice" in a very narrow time window. The basic construction of the station, named Georg von Neumayer Station (GvN), could be completed in this summer season so that the first wintering of a small scientific crew was possible in 1981. However, additional work at the station and detailed geophysical and glaciological investigations on site were necessary in the summer season 1981/82, which didn't allow an extensive geoscientific programme to be carried out in the surrounding area.

During the DFG Colloquium on Geoscientific Antarctic Research in Frankfurt/M. in October 1981, new preferences had to be restated by taking into account the new site of the station in western Dronning Maud Land (DML). Research in this region was given preference in intermediate terms. The main focus of geoscientific research, "Structure and Dynamic of the Pacific Margin of Gondwana", was not changed, but a new key topic within this frame was phrased "Petrology and Deformation of the Precambrian Basement at the Western Margin of the East Antarctic Craton". A direct comparison with the Ross Orogen in the Transantarctic Mountains was also emphasized since geologists of the Federal Institute of Geosciences and Natural Resources (BGR) have been running a geoscientific programme in northern Victoria Land since 1979/80. A cooperation between K. Weber, H. Behr (both Göttingen) and G. Spaeth (Aachen) on studies in western DML was agreed. W. Schubert (Würzburg), however, was more interested in central DML. During this meeting, H. Kohnen (Bremerhaven) explained the logistical potential of the station and the newly established Polar Research Institute (Alfred Wegener Institute for Polar Research, AWI) for ground parties operating in the

surrounding areas. The outcome of the meeting was a plan for an expedition to the mountains of western DML in the 1982/83 season.

Four meetings were held at AWI between November 1981 and November 1982 in order to select some research projects from a large number of proposals for western DML and to prepare the logistics for these expeditions. Unfortunately, the icebreaker MS "Polarbjørn" chartered for the 1982/83 season had only very limited transport capacity, which required reducing or dropping planned projects.

The geological programme, however, continued; the four geologists H. Behr, M. Peters, K. Weber (all from Göttingen University) and G. Spaeth (Aachen University) were supported by a logistics crew from AWI. The main target was the Heimefrontfjella, and some reconnaissances to Mannefallknausane and Vestfjella (Kraulberge) were considered. Expeditions to the mountain ranges of Ahlmannryggen, Borgmassivet and Kirwanveggen, all somewhat closer to GvN Station, were not included since South African geologists had already been operating for some years in these ranges from their station SANAE. In contrast, the Heimefrontfjella and surrounding nunatak groups had not been visited since the mid-1960s. Based on WORSFOLD'S (1967a, b) and JUCKES' (1972) first studies, the new investigations would focus on tectonic, metamorphic evolution and geochronology. The field studies would be logistically supported by two helicopters and the icebreaker MS "Polarbjørn", operating close to the ice edge 300 km west of Heimefrontfjella. A large Bell 212 helicopter would supply the field party from the ship. The expedition leader was H. Kohnen.

On January 04, 1983, MS "Polarbjørn" arrived at the edge of the Riiser-Larsen ice shelf. On the first reconnaissance flight, the larger of the two helicopters (Bell 212) crashed during landing and was irreparably damaged. With the loss of this most important backup system, any expedition more than 450 km away from the logistics base was impossible. Therefore, the plans to work in Heimefrontfjella had to be abandoned. Within a few days, the field studies were re-scheduled and the team selected the northern Vestfjella (Kraulberge) as a target for the ongoing season since these nunataks are located much closer to the ice edge. It was the only exposed area accessible under the new circumstances. According to the available literature (HJELLE & WINSNES 1972), these nunataks are composed of a thick pile of basalt flows and some mafic intrusive bodies. The field work was carried out with Ski-Doos, Nansen sledges and supported by the smaller helicopter (Bell 206). Before heading eastwards to the mountains, MS "Polarbjørn" had to return to GvN Station to obtain additional supplies and sledges. Without any further problems in the field, the geologists worked for a few weeks in Vestfjella (BEHR et al. 1983). On their way back from the field the expedition team got the opportunity to visit RV "Polarstern", the new German research icebreaker, anchoring at Atka Bay on its maiden voyage.

In 1983, the director of AWI, G. Hempel, invited interested geologists to submit new proposals for scientific expeditions to DML. Several proposals focussed on an expedition to the Heimefrontfjella to realize the failed attempt of the previous season. K. Weber, and H. Behr (Göttingen), G. Spaeth (Aachen), H. Kohnen (Bremerhaven) and Heinz Miller (Munich) combined their plans and submitted a research proposal titled "Geological-geophysical section from Kottasberge (Heimefrontfjella) via Kraulberge (Vestfjella) to the eastern Weddell Sea (Explora Wedge)". The programme of this traverse could be based on the scientific results of the 1982/83 expedition, which found evidence for rift-related structures. The aim was to show that western DML was the western margin of the East Antarctic craton, which had been fragmented during a Mesozoic rifting process. The main target area for the onshore part of the expedition was the Heimefrontfjella, with a focus on the tectonic, petrological and geochronological investigation of the crystalline basement. This highly ambitious programme required a detailed topographic map based on new aerial photographs. Unfortunately, the aerial photography, planned for the 1983/84 season, was completed much later.

A planning meeting was held at AWI in March 1984 in order to coordinate geoscientific activities in Antarctica for the period of 1984–1987. During this meeting the aforementioned combined geological-geophysical research proposal was discussed and it was decided that the programme would be realized in the season 1985/86. In December 1984, the now more advanced plans with a short project description were presented at the meeting on Geoscientific Antarctic Research, Weddell Sea and Neuschwabenland, held in Bremerhaven. Several other studies such as an aerial photogrammetric project were added to the geological and geophysical investigations. The tasks for the geology team were summarized under the topic Geological Evolution of the Kottasberge (Heimefrontfjella). It also included a detailed geological mapping project, which was not realistic at that time due to the lack of large scale topographic maps as base material.

The expedition to the Heimefrontfjella (Kottas traverse) in austral summer 1985/86 was part of the AWI Antarctic Expedition ANT-IV/3 (ARNDT et al. 1987). Field campaign was carried out within seven weeks from late December 1985 to mid February 1986, scarcely interrupted by bad weather conditions. The whole field party comprised four geophysicists, one glaciologist, two men of the logistic staff and five geologists: K. Weber, N. Arndt and M. Tapfer from Göttingen University (the last two only temporarily seconded to Göttingen) as well as G. Spaeth and W. Fielitz from Aachen University. The leader of the field party was the geophysicist Heinz Miller. The traverse to the field area was carried out with 'heavy' logistics, i.e. several tractors (Pistenbulli) with accommodation containers on skids and cargo sledges transporting most of the equipment. The tractors were accompanied by small Ski-Doos pulling Nansen sledges. The latter were used for geological fieldwork and for reconnaissance teams exploring the route to the mountains. To ensure a safe return trip, this 400 km long route was marked every 500 m with bamboo poles. To date, this route to the northern tip of the Heimefrontfjella is still used, although locally, slightly modified.

The over-snow party was temporarily supported by helicopters and planes, especially during the reconnaissance phase for the route. A combination of heavy and light logistics was excellent for the purpose of an expedition with multiple tasks and led to similarly equipped expeditions in the following years. The main advantages were a high transport capacity in combina-

tion with mobility and flexibility in the working area.

The geological working programme covered the whole mountain range from Milorgfjella/Kottasberge in the North to Tottanfjella in the South, with even a short trip to Mannefallknausane being possible in the given time. Only XU-Fjella was not visited. Numerous petrographical and tectonic field records and rock samples for geochronology, petrology and geochemistry were collected. The results had to be plotted on old British topographic maps from 1963–1966 (1 : 100,000, enlarged to a scale of 1 : 50,000) and on a provisional 1 : 250,000 map, based on oblique aerial photographs from 1951/52, drawn and provided by the "Institut für Angewandte Geodäsie" (IfAG), a small-scale map, which was never intended to be published. For the preparation of large-scale maps an aerial photographic program was organised by the IfAG within the same field season. Most results were however published, based on the preliminary small-scale map, which presented only six mapping units (e.g. SPAETH & FIELITZ 1987, JACOBS 1991).

In total, approximately seven tons of rock samples were collected for laboratory analyses, and 5000 structural measurements were recorded. The field observations and laboratory analyses proved that the Heimefrontfjella is part of a medium to high grade metamorphosed orogen of late Mesoproterozoic age with polyphasse deformation. This was significant scientific progress, and a lot of information could be added to the first reconnaissance studies of WORSFOLD (1967a,b) and JUCKES (1972). It was no surprise then that on the return cruise of RV "Polarstern" the expedition members discussed several hypotheses on how this previously unknown orogen might fit into a greater Gondwana context. Plans were made for further, more detailed mapping campaigns which would result in geological maps at 1 : 25,000 scale as a base for additional studies. It was already clear at that stage that such an ambitious project would require more than just one field campaign.

The next expedition to Heimefrontfjella followed in austral summer 1987/88 as part of ANT-VI/3 of AWI. It was an international field team with Swedish, Austrian and German scientists, supported by German but mainly Swedish logistics. After the encouraging experiences of the 1985/86 expedition the same combination of tractors, freight-sledges, accommodation-containers and Ski-Doos was used (Fig. 1). The team was led by G. Patzelt, an Austrian glaciologist and mountaineer from Innsbruck University. The Swedish team led by O. Melander had it's own scientific programme, focussed on glaciology, geomorphology and palaeomagnetism (JONSSON et al. 1988, LARSON & BYLUND 1988). G. Poscher from Austria studied the stratigraphy and sedimentology of the late Palaeozoic cover (POSCHER 1988, 1989), B. Jäger (Göttingen) collected field data and samples for his ore petrological PhD thesis (JÄGER 1991), and J. Jacobs (also Göttingen) investigated mylonitic rocks from Sivorgfjella and Kottasberge. G. Patzelt was not only an expedition leader, he also found some time for glaciological and glacimorphological studies in XU-Fjella and Sivorgfjella, respectively (PATZELT 1988). It should be noted that for the latter studies the first contour map 1 : 25,000 based on the aerial photogrammetry of 1985/86 was made available by IfAG. The Swedish summer station SVEA was built in Sivorgfjella, which was, together with numerous stocks already deposited there, a base for further Swedish campaigns in central Heimefrontfjella.

Fig. 1: Heavy logistical equipment with tractors (Pistenbulli) and freight sledges with mounted living containers was the preferred transportation mode during the expeditions 1985/86 and 1989/90. Here, the traverse at the start from Georg von Neumayer Station in December 1985.

Abb. 1: Schwere Logistik mit Pistenbullis und Wohncontainern auf Schlitten wurde während der Expeditionen 1985/86 und 1989/90 bevorzugt. Hier die bereitgestellte Traverse beim Start von der Georg-von-Neumayer-Station im Dezember 1985.

THE GEOLOGICAL MAPPING PROGRAMME

During the Swedish expedition SWEDARP 1988/89 (Swedish Antarctic Research Program), SVEA station was used by two German guest scientists, J. Jacobs, Göttingen and S. Kreutzer, Aachen (JACOBS & KREUTZER 1990). The expedition started from the edge of the Riiser-Larsen ice shelf via the northern part of Vestfjella, where another Swedish summer station was established. The logistics were based on tractors, sledges and also helicopters. One helicopter transported the German scientists to SVEA but they returned by sledge traverse. Within a short three-week campaign, geological fieldwork was carried out in northern and southern Sivorgfjella. It was the first campaign that was expressly focussed on detailed geological mapping, but with such a small number of participating geologists it was more a pilot phase for the following seasons. Geological mapping was based on three new (preliminary) topographic maps at a scale of 1 : 25,000, produced by IfAG by processing of the 1985/86 aerial photographs. In the field, enlarged copies at a scale of 1 : 10,000 were used to record 2200 field observations at 250 localities. Most of northern Sivorgfjella could then be mapped at the envisaged scale (Fig. 2).

The next mapping campaign was part of "Polarstern" expedition ANT-VIII/5 in austral summer 1989/90, and it was combined with an extensive geophysical programme (MILLER & OERTER 1991). The number of participants and duration of the expedition made it the largest ever to Heimefrontfjella, which attracted public interest. A journalist accompanied the expedition and wrote an article for the popular journal GEO Wissen (PIETSCHMANN 1990).

Among the geological mapping team (J. Jacobs and G. Zarske from Göttingen University, S. Kreutzer and G. Spaeth from Aachen University, U. Schnellbach and P. Schulze from Bremen University) were three "newcomers" to Antarctica,

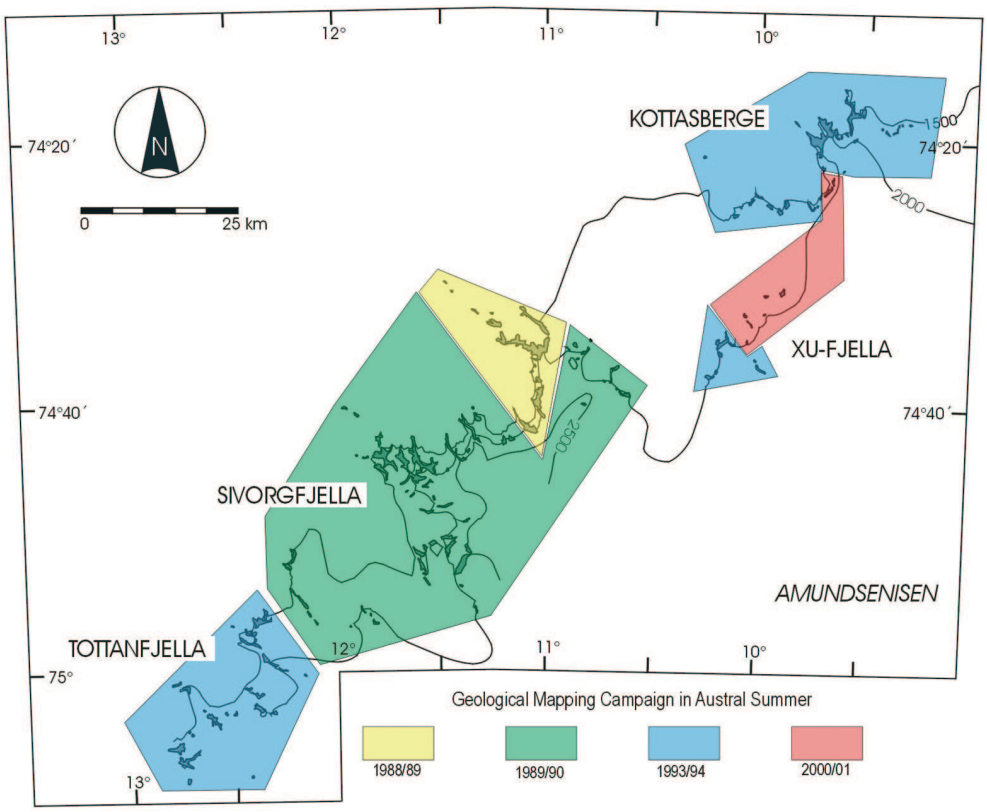

Fig. 2: Map of Heimefrontfjella showing the areal coverage of the four geological mapping cam-paigns between 1988/89 and 2000/01.

Abb. 2: Karte der Heimefrontfjella mit den geologischen Kartierungsgebieten der Expeditionen zwischen 1988/89 und 2000/01.

therefore several training and preparation meetings had to be held in 1988 and 1989, the most important ones having been:
• July 1988: Meeting at IfAG, Frankfurt/M., to obtain necessary topographic maps;
• November 1988: Meeting in Göttingen to discuss scientific programme and prepare topographic base material;
• Coordination meeting at AWI Bremerhaven for the whole ANT-VIII/5 expedition;
• Preparation workshop with all involved geologists in Göttingen to discuss mapping units and present additional research projects.

During the preparation phase in 1989, the 1 : 25,000 topographic contour maps, issued by IfAG, were edited, using orthophotographs of the same scale to transfer the outline of ice-free areas like nunataks, debris, or moraines. The maps produced were enlarged to a scale of 1 : 10,000 in order to obtain field slips. The final geological manuscript maps were also drawn at that scale. An important task during the preparation meetings was the presentation of rock specimens to define mapping units for the newcomers. This was to ensure some consistency in nomenclature and avoid problems that had been experienced by different expeditions over the years. This led to a preliminary description and definition of approximately 20 mapping units. In this context, it should be mentioned that the final geological maps at 1 : 25,000 scale show, dependant on size of outcrops and geological complexity, 6 to 18 different rock units, and on average about 13. The total number of rock units in the whole Heimefrontfjella map series accumulated to 32.

The field team under the leadership of G. Patzelt left GvN Station at the end of December 1989 and returned to the station at the end of February 1990 (Patzelt 1991). Within that period, weather was extremely favourable so that only three days were lost due to snow-drift and white-out conditions. The journey to the mountains followed the, by then well known, route of 1985/86 with the same logistics (Pistenbulli, freight sledges, accommodation containers) transporting 21 team members in total plus the voluminous equipment for the geophysicists. In the mountains the geologists worked in two-person teams with Ski-Doos and Nansen sledges.

The first target of the expedition was southern Sivorgfjella with a base camp at the entrance of Kibergdalen, a large, glacier-filled valley. The position of the base camp also allowed working in northern Tottanfjella. After two-thirds of the field campaign, the base camp was moved to the Swedish station SVEA in Scharffenbergbotnen; from this base, northern Sivorgfjella was mapped. Except for a few inaccessible cliffs, the whole central region of Heimefrontfjella could be mapped (Jacobs et al. 1991). The main task of the geologists was to visit all accessible nunataks, identify the exposed rocks, classify them into mapable units, to follow geological contacts and record tectonic elements. Some participants collected rock samples for additional research projects: P. Schulze for his PhD thesis on the petrology of metamorphic rocks, U. Schnellbach for fission-track studies to resolve the exhumation history and J. Jacobs for his PhD thesis on the structural evolution of Heimefrontfjella and also for apatite fission-track analyses to describe the cooling history of the basement.

After a three years break in scientific expeditions, partly due to extensive logistic work in the area of GvN Station related to the construction of a new German wintering station, the next mapping campaign was planned for the1993/94 season.

In 1993, the first map sheet “Scharffenbergbotnen” was

published (JACOBS & WEBER 1993), which appeared in contrast to the other sheets as an aerial photographic geological map. However, this cost-intensive result was not completely satisfying – e.g. large areas with dark shades – so this layout was not chosen for the other sheets.

The mapping campaign was part of RV "Polarstern" expedition ANT-XI/3. The first planning meeting was held in December 1991 at AWI and the final coordination meeting to discuss the logistics also took place at AWI in July 1993.

The main task was the geological mapping of central and southern Tottanfjella, Kottasberge (Milorgfjella) and XU-Fjella using the same methodology as the previous expedition. This campaign would complete the geological mapping of the whole mountain range. The geological team included J. Jacobs (now at University of Bergen), G. Spaeth (Aachen), and K. Weber (Göttingen), and the three newcomers W. Bauer (Aachen), S. Siegesmund (Göttingen), and R.J. Thomas (CGS Pietermaritzburg, RSA). The expedition was again led by the experienced mountaineer and glaciologist G. Patzelt, supported by H. Wohltmann, an AWI technician. The geologists worked in the field in three teams of two.

Regarding the logistics, this expedition was quite an experiment because of the use of light equipment such as tents, Ski-Doos and Nansen sledges (Fig. 3) without heavy tractors and accommodation containers. This concept was chosen to save time on the journey to and from the mountains and to be more flexible in the working area, but it required a fuel depot that was set up some years before. This logistic experiment was generally very successful, but it used Ski-Doos and sledges up to their absolute technical limits (THOMAS 1994, BAUER et al. 1996).

The expedition left the new Neumayer II Station on January 15, 1994 and returned on February 23; within that time, only four weeks of fieldwork were available. Half the time was spent in the southernmost part of the range (Fig. 3) and, after two relocations of the base camp, the remaining time was spent in Kottasberge (Fig. 4). Almost eight days of storms with snow drift and white-out conditions prevented the completion of the fieldwork. Such a relatively large number of days with bad weather conditions had not been experienced by any expedition in Heimefrontfjella before. Nevertheless, about 95 % of the mapping programme was completed. Only northern XU-Fjella remained unmapped due to time restrictions caused by the poor weather conditions.

In addition to geological mapping, some special topics were studied, which were accompanied by a limited sampling programme. The Göttingen working group was interested in the granulite-facies rocks of southern Tottanfjella. The Aachen group focussed on the tectonics of Kottasberge; the results were published in the PhD thesis of W. Bauer (BAUER 1995). Most of Kottasberge was identified as a separate terrane, different in terms of structures and petrology from central and southern Heimefrontfjella, which led to a significant increase in the number of lithological units appearing on the map series.

The mapping programme was considered complete after that campaign. A geological overview map in three parts with

Fig. 3: The first base camp of the 1994 expedition at the Cottontoppen, Tottanfjella. This expedition was equipped only with Ski-Doos and Nansen sledges.

Abb. 3: Das erste Basiscamp am Cottontoppen/Tottanfjella im Januar 1994. Diese Expedition war nur mit Ski-doos und Nansenschlitten ausgerüstet.

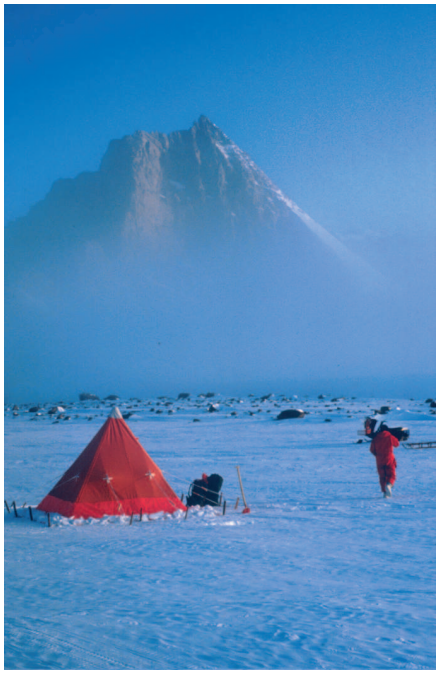

Fig. 4: February 1994, the second base camp in Kottasberge; in the background the Wallnerspitze in the mist.

Abb. 4: Februar 1994, das zweite Basislager in den Kottasbergen; im Hintergrund im Dunst die Wallnerspitze.

simplified topography was published at scales of 1:200,000 and 1 : 220,000 (JACOBS et al. 1996). After a compilation phase (BAUER et al. 1998), twelve sheets of the 1 : 25,000 map series were published in 1997, and a further sheet followed in 1998. Together with the sheet Scharffenbergbotnen from 1993 a total of 14 sheets were composed. They were made available online on the PANGAEA server in 2004.

In the southern summer 2000/01 during ANT-XVIII/3-4, the last areas of the Heimefrontfjella were geologically mapped by J. Jacobs, R. Schmidt (both Bremen University) and W. Bauer (Aachen University). The expedition focussed not only on geological mapping, but geophysical and tectonic studies in

the northeastern part of the range (Fig. 5) were also part of the programme (JACOBS et al. 2003). The logistics were quite comfortable for the geologists, regarding transport to the mountains and back. All of the equipment including an "Apple Hut" (fibreglass hut, mounted on a sledge, Fig. 6) was transported by a sledge traverse to the ice drilling site of EPICA. One week later the geologists were flown by POLAR 4 from Neumayer Station to the mountains and were picked up by this plane after five weeks. The scientific programme focussed on measurements of the susceptibility across the Heimefront Shear Zone, accompanied by tectonic investigations, a geochemical sampling programme on metavolcanic rocks, and the geological mapping of northern XU-Fjella (Fig. 5), which had never been visited since Juckes worked there 35 years before. The mapping and sampling of these eight nunataks were completed in three days, and after these efforts a whole mountain range in Antarctica had been geologically mapped on a 1 : 10,000 scale for the first time.

Fig. 5: Fly camp in the northern XU-Fjella, January 2001.

Abb. 5: Außencamp in der nördlichen XU-Fjella, Januar 2001.

Fig. 6: An apple hut and tents were used for the small 2000/01 expedition; February 2001 at "Windy Corner", Kottasberge.

Abb. 6: Eine so genannte „Apple-Hut" und Zelte dienten als Unterkünfte während der kleinen Expedition 2000/01. Februar 2001 bei "Windy Corner", Kottasberge.

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