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REPORT OF GERMAN GEODESISTS IN THE XVII INDIAN ANTARCTIC SCIENTIFIC EXPEDITION, 1997/98

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Introduction

In the austral 1997/98 a group of 3 geodesists of the Institute fur Planetare Geodasie of the Technische Universitat Dresden (IPG) took part in the XVII Indian Antarctic Scientific Expedition. These expedition members were :

Dr. Wilfried Korth	Staff member IPG	Group leader
Dipl.Ing. James Perlt	Staff member IPG	
Dipl.-Ing. Lutz Eberlein	Student at the TU Dresden (IPG)	

This was the beginning of a long-term co-operation between the Indian side and the IPG which is based on the minutes of a meeting between Department of Ocean Development (DOD) officials and the Head of the IPG, Prof. Reinhard Dietrich, in spring 1997.

The course of the expedition

The general course of the expedition of each member of the german group is compiled in the following table.

	W.Korth	J.Perlt	L.Eberlein	Remarks
02.01.98				arrival at the ice shelf rim
03.01.98	RS	RS	RS	
04.01, 07.01.98	PB	PB	PB	
08.01., 09.01.98	M	PB	PB	
10.01, 14.01.98	M	M	M	

15.01, 23.01.98	C1	C1	M	
24.01, 07.02.98	CM	M	M	
08.02., 24-02-98	C2	C2	C2	
25.02.98	RS	RS	RS	
26.02., 09.03.98	PB	PB	PB	
10.03.98				departure from the ice shelf

Abbreviation

PB	-	Polar Bird
M	-	Indian Station, Maitri
C1	-	Comp site at Wohlthat massive, Lake Obersee
C2	-	Camp site at Nivlisen ice shelf
RS	-	Russian discharge base at the rim of ice shelf

Coordinates of the two camp sites :

Camp C1 (lake Obersee)	71° 16'35"S	13°38'47"E
Camp C2 (ice shelf)	70° 23'23"S	12°18'29"E

The Indian geodesist V. Ravichandran from the Survey-of India (Sol) was also involved in the field work. He took part in most of the activities in the Schirmacheroase and in the second part of the Camp C1.

In addition we had a close co-operation with the group of scientists from the National Geophysical Research Institute (NGRI) in Hyderabad. The leader of this group was L. Prem Kishore.

Working program

The main objectives of the geodetic-glaciological field work were :

Re-observation of the existing GPS points of the SCAR Epoch GPS Campaigns 1995 and 1996 (FOR1, FOR2) and establishement of a new marker close to the Indian station Maitri and measurements on this marker (MAI1)

- Co-operation with the Indian side (NGRI group) for the establishment of a new marker for permanent GPS observations in the frame of the international IGS network.
- Re-observation of points of the regional GPS network in the mountain area south of the Schirmacheroase.
- GPS re-obervation of four corner reflectors for SAR-interferometry.
- Tide gauge measurements in some of the so called "epishelf-lakes" at the northern rim of the Schirmacheroase. Additional tide gauge measurements were planned in the open ocean close to the margin of the Nivlisen ice shelf.
- Measurements of height changes of the inland ice in the area between the Schirmacheroase and the Wohlthat Massiv along the geodetic-glaciological traverses.
- Measurements for the computation of geoid profiles along the traverses.
- Special experiments to investigate the Kinematics of the Nivlisen ice shelf north of the oasis.

  - Measurement of Kinematic GPS-profiles (IPG)
  - Measurements of deformation networks or figures by geodetic means (Sol)

Realization of the working plan

GPS observations in the frame of the SCAR Epoch. GPS Campaign 1998

Observations were carried out at the following markers :

Point	Observation interval	Remarks
FOR1	days 11-50 (11.01.-19.02.98)	old point GAP-95
MAI1	days 12-38 (12.01.-07.02.98)	new point GAP-98
USE1	days 17-22 (17.01. -22.01-98)	point of regional network GAP x-95 und GAP-96
MAI2	days 26-27 (26.01.-27.01.98)	pillar in the Indian station area of Maitri

The measurements at the marker FOR1 were supported by

the leadership and the staff of the Russian station Novolazarevskaya like in 1995 and 1996.

Observation of corner reflectors

During the GEOMAUND Expedition in 1996 four corner reflectors were established for SAR interferometry. The positions of these reflectors were re-observed.

The first one which is located on a moraine between lake Obersee and lake Untersee in the mountains was observed during the stay of W.Korth and J Perlt in the Camp C1. The locations of the other three reflectors were reached by helicopters on 2nd of February. The two reflectors on ice were found in good condition and were re-observed. The last one in the mountains in an altitude of abour 1800 m was obviously destroyed by a hard storm between 1996 and 1998

The measurements were carried out by GPS (position) and an electro-optical tachymetere (relative position of the reference point of the reflector to the GPS antenna).

Tide gauge measurements

Tide gauge measurements were carried out at the following locations.

Location	**Observation time**	**Device**	**Remarks**
Open ocean	ab 04.01	WLR8	(device lost)
Epishelf-lake cholodnoye	11.01. -27.02.98	WLR7	10-minutes-interval
Epishelf-lake Predgornoye	19.01.-27.01.98	WLR7	1-minutes-interval
Epishelf-lake Oschidaniya	28.01.-01.02.98	WLR7	1-minutes-interval

The tide gauge WLR8 was moored in a depth of about 60m close to the Russian discharge base. It was connected to a strong and heavy wooden frame outside the water by a steel and an

additional plastic rope. Nevertheless, the gauge was lost after cutting both ropes by moving sea ice. It is impossible to recover the device because it was probably moved by the ice to another unknown location.

At the end of the expedition kinematic GPS observations were carried out at the surface of the swimming ice close to the Indian discharge base to fill the gap in the tidal measurements (Feb/26-Mar/06). Unfortunately, it was impossible to link the measurements to the actual sea level by spirit levelling because of bad weather conditions.

The observations in the lake Cholodnoye are a continuation of the tide gauge series of 1991 and of 1995.

Tide measurements were performed in two other epishelf lakes, Predgornoye and Oschidaniya, in addition to the observations in lake Cholodnoye. These series were recorded to investigate possible phase differences in the tides, and to get series with a high (temporal) resolution. All observations were connected to benchmarks on rock either by GPS (Oschidaniya) or by spirit levelling (Predgornoye, Cholodnoye)

Kinematics of the Nivlisen ice shelf

The focus are of this investigation was the transition zone between the grounded inland ice and the floating ice shelf. The line where the ice begins to swim is the so called grounding line. There is a deformation zone with varying height changes north of the grounding line because of the effect of the ocean tides. Four kinematic GPS profiles were measured crossing this deformation zone.

The measured profiles ran from the grounded ice to the ice shelf and back. The location of the grounding line was found by analyzing the height differences between the two tracks.

It was also planned to establish special deformation networks and/or figures on the glacier close to the camp site. Unfortunately it was impossible to carry out this work. During our stay in the

camp we had to overcome a heavy blizzard (up to 45m/s wind speed) and a strong snow storm which lasted some days each. Helicopter flights were impossible to carry the necessary equipment and the two Indian colleagues (Ravichandran and Rajashekar). After the storm period, there was not enough time to carry out a first and a second measurement epoch.

The accomodation of the two Indians in our camp without additional equipment (tent, survival bag, etc.) was a safety risk. This decision was also accepted by the Indian leadership of the expedition.

Traverse measurements

Three geodetic-glaciological traverses exist in the region around the Schirmacheroase. The first one is the so called Untersee Traverse. It connects the Schirmacheroase and the lake Untersee in the Wohlthatmassiv. The second one is a traverse between the oasis and the NW-part of the Humboldt Mountains (""NW Insel"). This traverse is called Insel Traverse. The third and last one is the North Traverse along the convoy route from the oasis to the russian and/or indian discharge base.

During the last ten years these traverse were measured and remeasured several times. The results of these measurements are glacier velocities, accumulation and ablation rates and rates and surface height changes.

It was planned to remeasure at least the two southgoing traverses.

We have used the ride back by Skidoos from the first camp site (C1) at the lake Obersee to the Schirmacheroase for a re-observation of the signal positions and heights along the Untersee Traverse. Kinematic GPS measurements and barometric heighting were carried out in parallel. Using this data a geoid profile can be determined which is suitable for comparison with the gravimetric regional geoid model computed by W.Korth in 1997 on the basis of surface gravity data.

Similar measurements were made on the Skidoo ride from the Schirmacheroase to the second camp site (C2) on the ice shelf Nivlisen. A third profile was observed between the camp C2 and the Russian discharge base.

Other work

Height estimation at the camp site C2

During the stay in the camp at the Nivlisen a grid of height points was measured. The grid size was about 3 X 5 km. and the point spacing about 250 m. Ellipsoidal heights by GPS as well as sea level heights by trigonometric heighting were determined.

This height grid can be used for the verification of the digital elevation model which resulted from helicopter aided measurements during the GEOMAUD expedition in 1996, and also as reference data for the geoid model.

Registration of meteorological data

During the whole time of the expedition an automatic meterological station was running in the Tirumala-hut in the summer camp of the Indian base Maitri. The main purpose of this registration was the necessity of weather data for correcting tide gauge measurements in the epishelf lakes. During the first days of the expedition this weather station was not running. It was possible to get a dataset from the Russian station Novolozareskaya which is about 5 km away. Our data include values of temperature, air pressure, wind speed, and wind gust. The Russian data contain the same values and in addition some other data like wind direction, humidity etc.

The following data are available.

01.01.98 - 31.01.98	1 value per minute	Russian registrations.
13.01.98 - 02.02.98	1 value per minute	on-line registration to PC
02.02.98 - 27.02.98	1 value per 5 minutes	on-line registration on data storing unit (DSU).

Special GPS experiments

Special experiments with GPS receivers were carried out in the station area and close to the camp site C2. The purpose was to investigate the influence of multipath and direct ground reflexions on the GPS data. These experiments were performed at the ground on a special tripod as well as from helicopter with a nadir directed GPS antenna.

Water and ice sampling

Some samples of water and ice were collected for colleagues from the Alfred Wegener Institute fur Polar- und Meeresforschung (AWI) in Potsdam.

Water samples from lake Untersee (50 litres) and glacier ice from the inland glacier south of Maitri (100 kg) were collected and transported to Germany.

Co-operation with other expedition members

Coordinates of the convoy route

The locations of the physical waypoints (signposts, markers) of the convoy track between the station Maitri and the Indian discharge base are shifting with time up to 100 m per year because of the movement of the ice. That's why it is necessary to build new markers and signposts after some (3-5) years to keep a safe route.

We have measured a kinematic GPS profile along the convoy route including all important waypoints. The coordinates of the current waypoints of a safe track (free of crevasses and snow bogs) were handed over to the leader of the Indian logistic party. It is possible to use these coordinates for the convoy navigation during the next few years.

GPS data for atmospheric research

Owing to a drop down of a sling load from a helicopter

the computer and GPS receiver of the Indian scientist Dr. Laka Singh were damaged. Therefore, he was unable to fulfill his working program by own measurements. The data of our trimble receivers at the marker MAI1 in the station area were also suitable for some of his planned investigations. He got some data sets for later use in India. Further cooperation between the IPG in Dresden and his institution might be possible.

Publications

Some papers were presented at national and international conferences by the Indian and German expedition members in 1998 and 1999. A general publication about the SCAR Epoch GPS Campaigns in the Jounal of Geodesy is under preperation.

It is planned to publish a joint paper about the local and regional GPS and geodetic work by Mrs. E.C. Malaimani (NGRI, Hyderabad) and the group from TU Dredsen. It is expected to be completed by Dec. 1999.

Acknowledgements

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