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Report on the Work Done by Survey of India Team During XXIV Indian Scientific Expedition to Antarctica

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INTRODUCTION

It is established now that the data from GPS receivers could provide quicker and more accurate estimates of the earthquake magnitude and it can be effectively used for tectonic movement studies. The Neo-tectonic movement and Glacier movement studies in Antarctica region have always laid a greater emphasis with these objectives. Survey of India has put forth an extensive plan to study these phenomenon to National Centre of Antarctica and Ocean Research, during 23rd Indian expedition to Antarctica by establishing a network of GPS stations in the region. A total Nos. of 40 GPS stations have been planned, to be established in Antarctica region in phased manner. These GPS pillars will duly be connected with Precision Levelling and Gravity mesh. Repeat observations will be carried out on these stations to study the Neo-tectonic movement and Glacial movement in the region.

Survey of India which has been an integral participating organization in Indian Antarctica Research Programme decided to send a two member team during the 24th Expedition to carry out the scientific studies.

Two scientists from Survey of India participated in 24th Antarctica Expedition during an austral summer of 2004-05, to establish GPS stations west of Maitri to carry out first epoch of GPS observations on these stations, along with second epoch of GPS observations on earlier established thirteen stations, which were constructed during 23rd Indian Antarctica expedition. A seven days GPS observation, campaign mode, was also carried out for interplate movement studies between India and Antarctica plates.

OBJECTIVE

The main objective of the participating team from Survey of India was to extend the network of GPS stations in the region and to carry out

GPS observations on existing and newly established stations for the determination of neo-tectonic movement of the region and interplate movement with respect to Indian plate.

VOYAGE

The Russian Ship EMERALD SEA (MONOROIA) was flagged off by Dr. P.C. Pandey, Director NCAOR, Goa, from Cape Town on 12th December 2004. Ship crossed the 40° South latitude (Roaring forties) on 20th December 2004.

Survey of India personnel put their feet on the icy continent of Antarctica in the evening of 26th December 2004.

M/V Emerald Sea

OBSERVATION SCHEME

A tentative scheme for establishing the Geodetic control for seismotectonic studies west of Maitri (Schirmacher Oasis) was conceived in the Geodetic & Research Branch, Survey of India, Dehra Dun. On reaching the icy continent, an extensive reccee was carried out and 14 sites for ground control points were selected on exposed ground, at a spacing of about 900-1000 m cement concrete pillars of dimension 30 cm

GPS Observation

GPS Observation

Observation on S.O.I., GPS pillar

× 30 cm × 20 cm have been constructed at each location. (A brass plug with thread for tri- bratch has been fixed at each station).

INSTRUMENTS USED

1.	Trimble GPS Receiver 5700 series with Zypher Geodetic Antenna (At Antarctica)	1 No.
2.	Trimble GPS Receiver 4600LS (Type I) (At Antarctica)	1 No.
3.	Trimble GPS Receiver 5700 series with Zypher Geodetic Antenna (At Dehra Dun, India)	1 No.
4.	Trimble GPS Receiver 4000 SSI (AT KODAIKANAL, INDIA)	1 No.
5.	Leica GPS Receiver RS 500 (AT SHILLONG, INDIA)	1 No.
6.	Leica GPS Receiver CRS 1000 (AT LUCKNOW, INDIA)	1 No.
7.	Trimble 4000 SSI (AT IISC BANGALORE, INDIA)	1 No.

METHODOLOGY OF WORK

For determination of the coordinates of the selected locations, two GPS receivers were used and observations were taken in static mode. One GPS instrument was kept fixed at Maitri 'S' and another GPS instrument was made Rover. Four hours observations were taken on all the stations with epoch interval of 15 seconds.

Seven days GPS observations, in campaign mode, were also made at Maitri 'S' (Antarctica) with respect to Indian stations viz. Dehra Dun, Kodaikanal, Shillong, Lucknow, and IISC Bangalore for interplate movement studies between India and Antarctica.

The raw data was downloaded in laptop computer from GPS receiver immediately after completion of each day GPS observations. The raw data was converted into Rinex format for further processing and archiving.

DATA PROCESSING

Post processing software Bernese 4.2 was used for Processing the data. Maitri 'S' is fixed with respect to three IGS stations viz. ALIC (AUSTRALIA), IISC (INDIA), and LPGS (LA PLATA) and then all the base lines processed with respect to Maitri 'S'. Maximum Route Mean Square (RMS) of each distance found within ± 3 mm.

For Interplate Movement Studies, three Indian stations are fixed with respect to three IGS stations viz. ANKR (ANKARA, TURKEY), BJFS (BEIJING, CHINA) and POL-2 (BISHKEK, KAZAKHSTAN) and then base lines for Maitri 'S' are processed with three fixed Indian stations.

The GPS coordinates in WGS-84 and heights of all the stations are above sea level (Heights are reduced with respect to Maitri 'S', which was fixed during 10th expedition.). List of coordinates and heights of all the GPS control points have been given in **Table 1**.

RESULTS

We could complete construction of GPS stations and first epoch observations on 14 stations only and second epoch observation on 13 previous stations, which were constructed during 23rd expedition. In addition to this, a seven days GPS observations in campaign mode, are also carried out for interplate movement study between India and Antarctica. We got only 28 normal working days to carry out Geodetic activities in the region. We faced very bad weather with heavy snowfalls and high speedy chill wind. In such a hostile weather, it was very challenging to complete the

Table 1—List of Coordinates & Heights

Sl.No	ID No.	Name of station	Latitude (WGS-84)			Longitude (WGS-84)			Height (Metres)
1.	0001	MAITRI ‘S’	S 70	45	55.550	E 11	44	02.747	117.0000
2.	0002	PRIYADARSHANI LAKE SOUTH ‘S’	S 70	46	07.498	E 11	44	33.533	133.5056
3.	0003	PRIYADARSHANI LAKE NORTH ‘S’	S 70	45	39.843	E 11	44	23.279	127.7066
4.	0004	LOW BUMP ‘S’	S 70	46	02.145	E 11	46	06.024	112.5847
5.	0005	CUTTING HILL TOP	S 70	45	42.160	E 11	46	10.411	138.4037
6.	0006	BROWNISH TOP H.S.	S 70	46	07.238	E 11	47	21.155	142.7308
7.	0007	LOW TOP H.S.	S 70	45	41.018	E 11	47	18.923	111.9238
8.	0008	HUGE BOULDER (IIG)	S 70	45	15.713	E 11	44	30.295	132.9720
9.	0009	BARRAIN SLOPE ‘S’	S 70	45	22.203	E 11	46	06.894	41.7969
10.	0010	BLACK TOP H.S.	S 70	45	17.075	E 11	47	26.182	80.2577
11.	0011	EAST HILL TOP H.S.	S 70	45	45.240	E 11	49	21.700	100.6137
12.	0012	FLAG TOP H.S.	S 70	45	58.052	E 11	48	43.797	151.1456
13.	0013	NE OF NOVA CAMP	S 70	46	10.554	E 11	49	43.336	137.3304
14.	0014	NOVA STATION	S 70	46	39.877	E 11	49	24.819	136.8129
15.	0015	MAITRI WEST ‘S’	S 70	46	06.593	E 11	43	27.043	137.7987
16.	0016	WORK SHOP NORTH ‘S’	S 70	45	47.892	E 11	43	06.991	135.4937
17.	0017	CONTINENT ICE TOP ‘S’	S 70	45	18.768	E 11	42	37.497	147.3114
18.	0018	DOZER POINT ‘S’	S 70	45	59.544	E 11	41	41.698	152.2098
19.	0019	TRISHUL SOUTH ‘S’	S 70	45	36.666	E 11	40	28.780	175.7375
20.	0020	BIG TOP	S 70	44	48.209	E 11	41	45.852	159.7439
21.	0021	TRISHUL WEST H.S.	S 70	45	51.761	E 11	38	21.281	177.6167
22.	0022	TRISHUL NORTH ‘S’	S 70	44	48.236	E 11	40	21.745	153.5105
23.	0023	LANKA H.S.	S 70	44	17.441	E 11	40	12.086	74.4995
24.	0024	NW TRISHUL H.S.	S 70	45	15.158	E 11	37	58.557	154.5879
25.	0025	LOW BUMP	S 70	45	31.496	E 11	36	33.813	147.0430
26.	0026	SCATTERED ROCKY TOP	S 70	45	38.393	E 11	35	26.858	154.5149
27.	0027	ROCKY TOP	S 70	45	10.639	E 11	35	32.227	133.4056
28.	0028	WEST BLACK TOP	S 70	44	45.655	E 11	36	04.141	124.8741

assigned job in the stipulated time frame. But keeping the high traditions of Survey of India, we accepted this challenge and completed the major portion of the allotted task within stipulated time. The results between first and second epoch observations are given below:

Sl. No.	Point I.D.	Name of station	Differences (1st and 2nd epoch)		
			Latitude In sec.	Longitude In sec.	Displacement in metres
1.	0002	PRIYADARSHANI LAKE SOUTH 'S'	0.001	0.005	0.058
2.	0003	PRIYADARSHANI LAKE NORTH 'S'	0.001	0.004	0.050
3.	0004	LOW BUMP 'S'	0.001	0.006	0.067
4.	0005	CUTTING HILL TOP	0.001	0.005	0.058
5.	0006	BROWNISH TOP H.S.	0.001	0.003	0.042
6.	0007	LOW TOP H.S.	0.002	0.000	0.060
7.	0008	HUGE BOULDER (IIG)	0.001	0.004	0.050
8.	0009	BARRAIN SLOPE 'S'	0.001	0.004	0.050
9.	0010	BLACK TOP H.S.	0.001	0.006	0.067
10.	0011	EAST HILL TOP H.S.	0.001	0.005	0.058
11.	0012	FLAG TOP H.S.	0.001	0.002	0.036
12.	0013	NE OF NOVA CAMP	0.001	0.005	0.058
13.	0014	NOVA STATION	0.006	0.004	0.184

** At about 70º 45' Latitude-; 1" in latitude = 30 metre; 1" in longitude = 10 metre*

These results provide very reliable information on the direction and rate of Antarctica plate motion and it may provide driving mechanisms in understanding of Antarctic plate with respect to Indian plate and intraplate seismicity of the region.

SUGGESTIONS

1. Repeat observations at GPS Stations in ensuring expeditions for monitoring the crustal movement of the region.
2. Levelling should be done at all GPS stations for monitoring the vertical movement.
3. To prepare Gravity mesh in the area.

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