U. S. DEPARTMENT OF COMMERCE

COAST AND GEODETIC SURVEY

Washington 25, D.C.

BY

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SUBJECT

GEOMAGNETIC REPORT
SOUTH POLE - QUEEN MAUD LAND TRAVERSE I
1964 - 1965

REPORT ON THE

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The South Pole - Queen Maud Land Traverse I was a multi-discipline scientific expedition into the southern Queen Maud Land region of East Antarctica. The traverse began at the South Pole on December 4, 1964 and ended at the abandoned Soviet station "Pole of Relative Inaccessibility" on January 27, 1965. The route consisted of three zig-zag legs (Figure 1).

The members of the traverse were:

Dr. Charles Bentley, University of Wisconsin, traverse leader
John Beitzel, University of Wisconsin, seismologist
Bruce Redpath, University of Wisconsin, seismologist
Raymond Koski, University of Wisconsin, traverse engineer
Edward Parrish, University of Wisconsin, traverse engineer
Dr. Richard Cameron, Ohio State University, glaciologist
James Gliozzi, Ohio State University, glaciologist
Dr. Edgard Picciotto, University of Brussels, glaciologist
Olav Dybvadskog, Norsk Polarinstitutt (Norway), glaciologist
Norman Peddie, Coast & Geodetic Survey, navigator-geomagnetist

Bentley and Gliozzi left the traverse on the resupply flight of January 6. Scott Kane, who had wintered at South Pole Station, joined us to assist the remainder of the traverse. Cameron assumed leadership at this point.

Our transportation consisted of three diesel-powered Tucker Sno-Cats; two large model 843's, and one smaller model 742 equipped with a drilling rig. Fuel for the engines and space heaters was carried in the special tires of two "Rollie-trailer" transporters. Food, tools, and supplies were carried on the beds of the Rollies and on four 1-ton capacity sleds.

Twenty-nine major stations were established at about 30 mile intervals along the 950 mile route. Studies made at these stations include ice thickness by seismic methods, ice density and temperature, foreign matter in the ice, snow accumulation, sastrugi development, and the geomagnetic field.

Minor stations at 5 mile intervals were set up to measure gravity strength and snow density, take weather observations, and read the altimeters and total-field magnetometers. The two large vehicles traveled 5 miles apart to allow simultaneous readings of altimetry and magnetics at consecutive minor stations; a method traditionally called "leap-frog."

The topography encountered was devoid of major features other than gentle slopes and occasional fields of large sastrugi. The elevation ranged from 9200 feet at the South Pole to over 12,000 feet at the Pole of Inaccessibility. Once in early January the air temperature rose to almost 0° F, but as the summer season waned the temperature dropped continually, reaching -50° F at the end of

January. The wind velocity ranged from 0 to 20 knots; the average near 5 knots. The sky was usually either clear or patched with light cirrus.

For more information on Antarctic traverse operations in general, and geomagnetism-navigation techniques in particular, consult these U. S. Coast and Geodetic Survey reports:

McMurdo to Pole Traverse, Dec 1960 - Feb 1961 by A. X. Meyer

Magnetic Observer's Report on the Ellsworth Highland Traverse by H. Meyers

Geomagnetic Report, Antarctic Peninsula Traverse, 1961-62 by P. J. Wasilewski

Geomagnetic Report, South Pole Traverse, 1962-63 by D. M. Perkins

Geomagnetic Report, Filchner Ice Shelf Traverse, 1963-64 by M. Phelan

Instructions for Navigation and Magnetic Observations on Antarctic Traverses by A. X. Meyer

GEOMAGNETISM

The total intensity of the Earth's magnetic field was measured at 1/3 mile intervals with a Varian M-49A proton free-precession magnetometer. The sensing-head of the magnetometer was towed on a small non-magnetic sled 100 feet behind the last 1-ton sled of the vehicle train.

Troubles with this Varian magnetometer system were almost invariably traced to a break or short in the sensing-head cable.

At least once at each major station, except the second, the declination and inclination angles were observed using a Canadian

Applied Research Ltd. (CARL) portable flux-gate magnetometer. These angles and the value of the total intensity completely describe the magnetic vector at the station (Table 1).

At the second station an open-circuit in one of the wires of the CARL sensing-element cable prevented observations. The break was found to be in the connector at the sensing end of the cable and was repaired in time to resume observations at the third station.

At about mid-traverse it was found that the CARL sensing-element had worked loose on its adjusting screws. It was re-aligned and tightened in accordance with page 2 of A. X. Meyer's "Operating Instructions for CARL Portable Magnetometer."

The observations of the sun for azimuth used in determining the declination were made separate from the observations of the sun for altitude used in navigation. The horizontal angle between the sun and the CARL transit at time t was observed using a Kern theodolite. Then the true azimuth of the sun at time t was found by interpolation of hour angle, sun declination, and latitude in H. O. 214. The back-azimuth from the CARL-transit to the theodolite was then found.

During the early part of the traverse (near the Pole) the CARL-transit and theodolite were always set up north and south of one another in order that the azimuth transfer be unaffected by the polar convergence of the meridians. At the first turning point 180 miles from the Pole the maximum effect of this convergence on the value of the azimuth is less than one minute (assuming an east-west arrangement of instruments 200 feet apart).

NAVIGATION

The position of each major station was determined by the Marcq St. -Hilaire line-of-position (LOP) method, using observations of the sun, with sight reduction via the H. O. 214 tables. The mean of three direct and three reverse telescope sightings with a Kern DKM-2 theodolite constituted one solar observation.

Most often a home-made sun-compass was used to indicate course while driving. When the sky was overcast, or when the sun was at an inconvenient position to allow light to fall on the sun-compass, the less accurate magnetic compass was used.

TRAVERSE COMMENTS

These comments on this year's polar traverse and the suggestions given are intended to aid those involved in similar work, particularly next seasons's continuation of the South Pole - Queen Maud Land Traverse.

1. The cable from the Varian M-49 magnetometer to its sensing head will usually be over 250 feet long. The added resistance of this extra-length cable, along with the everyday condition of the Nicad battery (that is, cold and not fully charged), will reduce the polarizing EMF available at the sensing head, thus reducing also the return signal and its associated reed-meter vibration.

To overcome this an auxiliary six-volt battery can be placed in series with the polarizing circuit, doubling the polarizing EMF. A cable for this purpose was left in the Glac-Cat. Simply attach the leads to the auziliary battery terminals (polarity is marked) and screw the connector end into the shorting plug socket at the side of the magnetometer. Refer to the Varian M-49 magnetometer manual, section 3. 2. 3. 5.

2. The battery charger supplied this year to charge the Nicad batteries off the 24-volt D. C. Sno-Cat power was made at Fredericksburg Magnetic Observatory and worked well. When set at its minimum current of 1 1/2 amperes it would charge a moderately discharged battery in less than two hours. The charger was left mounted on a wall in the Glac-Cat.

3. The shielded, heavy-duty, 2-conductor cable, supplied for the first time this year in place of the stock Varian sensing-head cable, proved to be superior to the lighter Varian cable which continually frayed and broke. However, the plug connectors located at intervals along the cable were unnecessary and sometimes a nuisance. The only times they needed to be disconnected were when a break which occured somewhere in the cable was being isolated using an ohmmeter -- but the breaks always occurred at the connectors, never in the cable.

The cable is stored in the Glac-Cat and should be saved for a spare.

A soldering gun is available on the traverse for repairs.

4. The sensing-head sled is in excellent condition and can be used again next year. It is located on the kitchen table in the Glac-Cat.

5. Tie the tow-rope of the magnetometer sled off to one side of the last 1-ton sled or Rollie-trailer rather than in the center so that the sled will ride smoothly in one of the tire-tracks.

6. The CARL magnetometer control box must be kept relatively warm to maintain sufficient sensitivity. This can be done by storing it in one of the high cupboards and by operating it next to the space-heater.

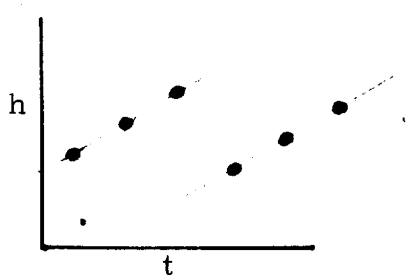
7. Before shipping the CARL transit from Fredericksburg secure the sensing-element orientation adjustment nuts with locknuts or a nut locking compound. In the event that the orientation adjustment nuts do come loose during the traverse the axis of the sensing-element can be re-aligned with the axis of the telescope by following the procedure given on page 2 of A. X. Meyer's "Operating Instructions for CARL Portable Magnetometer."

8. The Kern DKM-2 theodolite supplied by the University of Wisconsin became uncomfortably stiff at temperatures below -40°. It is suggested that a request be made to the university asking them to send a degreased or "winterized" theodolite next season.

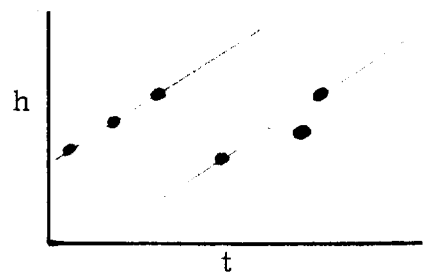
9. Fellow members of the traverse are willing to assist the navigator when he takes sun-shots, by reading the chronometer and recording the observations.

10. A "3 direct - 3 reverse" series of sun-shots allows a check for error that a "2 direct - 2 reverse" series cannot.

The sun's altitude is practically a linear function of time over the short interval of a sun-shot series. This linearity provides a simple way to find bad observations. In the field the series can be plotted on graph paper:



Good Set

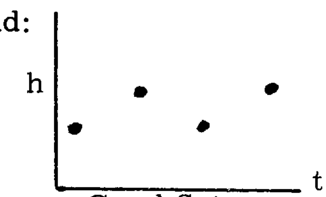


One Bad Observation

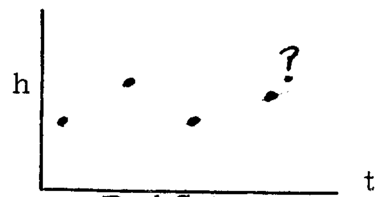
The displacement of the ordinate halfway through the set is due, of course, to shifting the observations to the opposite limb of the sun.

The faulty observations may be either excluded from the mean or adjusted, if possible, and included in the mean. If the cause of a bad observation is obviously some gross mistake in reading the chronometer or theodolite (such as reading the wrong minute of time or the wrong minute of angle on the theodolite micrometer scale) then the observation can be adjusted for the gross mistake and included in the mean. Remember, when discarding observations, that the mean should consist of an equal number of direct sightings on one limb and reverse sightings on the other in order to eliminate the index and collimation errors and to find the altitude of the center of the sun.

Using this test a "2 direct - 2 reverse" series can be shown to be good or bad as a whole, but that observation causing a bad series cannot be found:



Good Set



Bad Set

11. Observers may wish to use a small field-book for recording sun observations and a larger computation notebook for working them up. The forms intended for these purposes are not handy and they are easily misplaced.

12. The wood tripod stakes used on previous traverses are usually unnecessary on the high plateau because hard, stable surfaces can almost always be found upon which to stand the tripods.

Since the major stations were usually established at overnight stops of often ten to twelve hours duration, everyone had to hurry to get his work done. My routine upon arrival at a station was often: LOP observation, CARL observation, dinner, time check, azimuth observation, LOP observation, sleep, breakfast, LOP observation, compute position and course, move on.

SUGGESTED EQUIPMENT FOR 1965-66

2 CARL magnetometers with transit/sensing-head, cables, remote meter

3 Hot-Shot batteries

2 Varian M-49 magnetometers with appropriate tuners

2 Varian sensing-heads filled with normal hexane or heptane

1 Extra Nicad battery

1 Heavy-duty shielded cable 230 feet long attached to one of the Varian sensing-heads

1 Roll Nylon rope 200 feet 2000 lb. test

1 Assortment of small non-magnetic nuts, bolts, and wood screws

1 Multimeter

1 Marine chronometer

1 Weems Mark II plotter

1 6 inch protractor

1 Pair 6 inch dividers, two point

1 Drawing compass

1 Slide rule

2 Rolls friction tape

2 Dozen 2H pencils

4 6H pencils

1 11 inch triangle

1 Bowditch or Dutton navigation manual

1 Vega log tables

2 Nautical Almanacs, 1965 and 1966

2 H. O. 214 tables, 70° - 79° and 80° - 89°

1 Copy "Instructions for Navigation and Magnetic Observations on Antarctic Traverses"

1 Assortment Water Charts covering latitudes expected

100 CARL observation forms

Optional:

1 Stopwatch

1 Headphones for Varian magnetometer

To be supplied by the University of Wisconsin:

2 Varian M-49 magnetometers

1 Marine chronometer

1 Theodolite, Kern DKM-2 or Wild T-2

Glac-Cat Inventory 1 February 1965:

1 FMO Nicad battery charger with two cables, one to connect with shorting socket, other to connect with battery terminals directly

1 Magnetometer sled with cable and rope

1 Adaptor cable for 12-volt polarizing signal

6 Wood tripod stakes with mallet

Table 1. — Summary of Magnetic Observations
(Preliminary)

Station	Latitude	Longitude	Date	UT	D	UT	I	UT	F	H	Z
	° '	°	1964	h m	°	h m	° '	h m	γ	γ	γ
1-24	89 35.7 S	60.0 E	6 Dec.	06 02	87.2 W	06 12	74 12.5 S	06 13	58730	15983	56514
2-48	89 10.5	58.5									
3-72	88 44.9	58.0	9 Dec.	18 08	83.7	18 26	73 53.9	18 26	58405	16198	56114
4-96	88 19.0	58.9	11 Dec.	10 06	83.4	10 22	73 59.5	10 20	58358	16094	56095
5-125	87 48.3	59.2	14 Dec.	02 18	82.8	02 30	73 45.1	02 30	58170	16276	55847
6-155	87 16.8	58.9	15 Dec.	20 15	82.5	20 28	73 34.5	20 26	58020	16406	55652
7-185	86 45.0	58.6	17 Dec.	08 08	80.0	08 22	73 57.2	08 21	58005	16034	55745
8-215	86 47.8	49.2	20 Dec.	20 43	71.0	20 56	73 14.0	20 55	57480	16581	55037
9-245	86 44.5	40.0	24 Dec.	13 17	62.2	13 30	73 00.6	13 30	57100	16685	54608
10-275	86 37.7	30.6	26 Dec.	15 34	53.6	15 50	72 40.6	15 49	56790	16910	54214
11-305	86 30.0	22.2	28 Dec.	10 10	45.0	10 24	72 33.0	10 23	56510	16946	53909
12-338	86 08.9	14.8	30 Dec.	08 25	38.0	08 38	72 08.4	08 38	56038	17186	53338
13-370	85 45.8	08.7	31 Dec.	12 04	31.8	12 18	71 48.6	12 18	55780	17413	52993
			1965								
14-395	85 26.3	04.7	2 Jan.	10 29	28.9	10 44	71 27.6	10 42	55380	17609	52506
15-415	85 10.2	01.6	4 Jan.	14 02	25.2	14 20	71 19.1	14 20	55382	17739	52464
16-445	85 13.3 S	07.7 E	8 Jan.	05 46	30.7 W	06 05	71 21.6 S	06 04	55550	17755	52636

Table 1. — Summary of Magnetic Observations (continued)
(Preliminary)

Station	Latitude	Longitude	Date	UT	D	UT	I	UT	F	H	Z
	° '	°	1965	h m	°	h m	° '	h m	γ	γ	γ
17-470	85 10.8 S	13.2 E	9 Jan.	09 30	35.6 W	09 45	71 31.9 S	09 44	55532	17591	52672
18-496	84 58.1	17.9	10 Jan.	00 22	38.8	00 40	71 20.2	00 39	55510	17764	52591
19-519	84 50.8	21.8	14 Jan.	15 28	42.9	15 44	71 24.8	15 42	55410	17661	52520
20-545	84 41.8	26.0	16 Jan.	02 58	46.4	03 16	71 35.9	03 16	55590	17549	52748
21-570	84 31.7	30.1	17 Jan.	16 06	49.7	16 16	71 40.5	16 15	55795	17543	52966
22-595	84 22.2	33.9	18 Jan.	19 24	53.0	19 36	71 45.5	19 36	55660	17423	52863
23-620	84 10.5	37.6	20 Jan.	00 37	56.1	00 50	71 50.8	00 50	55685	17349	52914
			20 Jan.	08 16	56.3	08 28	71 55.0	08 28	55718	17295	52966
		° '									
24-650	83 52.7	41 18	23 Jan.	04 00	59.1	04 10	71 54.5	04 11	55860	17347	53098
25-680	83 32.0	44 33	23 Jan.	17 11	61.6	17 24	72 02.6	17 24	55955	17251	53229
26-710	83 10.5	47 28	24 Jan.	16 48	63.8	17 01	72 06.6	17 01	55872	17163	53171
27-740	82 50.2	50 31	26 Jan.	06 58	66.2	07 08	72 06.6	07 07	55860	17160	53159
28-770	82 27.2	52 52	26 Jan.	22 47	68.0	23 00	72 06.8	23 01	55930	17178	53227
29-792	82 07.0 S	55 02 E	30 Jan.	13 46	69.4	13 59	72 10.9	13 59	55950	17121	53266
			30 Jan.	21 38	69.5	21 50	72 10.1	21 49	55940	17130	53253
			31 Jan.	0808	69.5 W	08 22	72 14.1 S	08 22	55955	17072	53287