The South Pole-Queen Maud Land Traverse II, 1965-1966

(Photo: E. E. Picciotto)

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On November 22, 1965, a U.S. Navy LC-130F aircraft took off from the South Pole Station with the 11-man party of the South Pole-Queen Maud Land Traverse II (SP-QMLT II) and 22,000 lbs. of equipment and fuel. Its mission was to unload the men and cargo at the Soviet station at the Pole of Inaccessibility, 82°07′S. 55°06′E., a small, unoccupied station, 800 kilometers (500 miles) from the South Pole.

At the end of the 1964-1965 season, a party of nine scientists and technicians in three Sno-Cats had arrived at this station after completing a 1,340 kilometer (725 n. mile) traverse from the South Pole. This event marked the end of the South Pole-Queen Maud Land Traverse I. The three vehicles were left at the Pole of Inaccessibility for use on the 1965-1966 traverse.

The South Pole-Queen Maud Land Traverse is a major project of the U.S. Antarctic Research Program. Its objective is the scientific exploration of the area between the Greenwich meridian and the 40° East longitude. This zone of Queen Maud Land is the last, large, unknown area in Antarctica, and probably on the Earth's surface. It was first crossed during the summer of 1963-1964 by the Soviet traverse, Vostok-Pole of Inaccessibility-Molodezhnaya, led by A. P. Kapitsa.

The plan is to investigate this area in four summer traverses along a zigzag route extending from the South Pole to the Princess Ragnhild Coast. The scientific objectives include the determination of the surface and subglacial rock topography, observations of the geomagnetic field, and studies of the physical properties of the ice sheet. Weather observations and collection of snow samples for various geochemical studies are also included in the program.

The group of the SP-QMLT II included eight scientists and three traverse engineers representing the Free University of Brussels, Ohio State University, University of Wisconsin, and U.S. Coast and Geodetic Survey, and an exchange scientist from the Norwegian Polar Institute. Four of the party were also on last year's traverse (SP-QMLT I). During the three weeks spent at the Pole of Inaccessibility, an additional traverse engineer assisted in the preparation of the vehicles, a Tucker Sno-Cat, model 743, which was equipped with a drill for boring 40-meter (130-foot) holes, and two Tucker Sno-Cats, model 843, which were used as living quarters by most of the members (three men slept in tents).

An expansion of the scientific program raised serious problems in installing equipment in the limited space still available in the vehicles. The two 843 Sno-Cats were turned into moving physics laboratories. In addition to the usual equipment—seismograph, altimeters, magnetometers, Tellurometers, radio transmitters and receivers, etc.—three new instruments were used for the first time on a major antarctic traverse: a radio sounding device, an electronic quartz thermometer, and a neutron density probe designed to record continuous density and profiles in 40-meter (130-foot) boreholes.

After a 10-day period of acclimatization at the South Pole Station, the traverse team proceeded by air to the Pole of Inaccessibility. The landing was brilliantly carried out in good weather, with no wind, and temperature around −40°C. (−40°F.). The 22,000 pounds of cargo were unloaded in less than 40 minutes, but owing to the soft snow conditions, the takeoff required several hours of effort. No appreciable changes had taken place at the site since the previous summer. The cached equipment was quickly excavated from a slight drift, and the vehicles were easily started. The initial plan was to spend 10 to 15 days fixing the vehicles and to start the traverse on December 1. In fact, 23 days, from November 22 to December 15, were required to put the vehicles in working order and to install the scientific instruments. In spite of strenuous efforts, the efficiency of the work was not too high,

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owing to the high elevation, intense cold, and relatively strong wind.

An interesting attempt to improve working conditions was carried out. The whole vehicle park was covered with a 25- by 30-meter (80- by 100-foot) translucent plastic sheet. This "greenhouse" provided an excellent shelter against the wind, with an inside temperature 15° to 20°C. higher than on the outside. Unfortunately, this comfortable shelter lasted only three days before it was destroyed by high winds.

From the previous year's experience, unfavorably soft snow was to be expected at least during the first 185 kilometers (100 n. miles) from the Pole of Inaccessibility; ergo, it was essential to keep the weight of the vehicles at a minimum. With this in

Fig. 1.

mind, one of the Rolli-trailers was disassembled, the heavy steel bed was discarded, and the four tires, used as fuel containers, were put together in a light assembly. The weight of food, fuel, and explosives was also kept at a minimum. About one ton of food and 300 gallons of fuel were left near the station.

During the three-week stay at the station, the SP-QMLT II achieved the following scientific objectives: an astronomical determination of the position and a detailed map of the station; tellurometric measurement of the strain-rate network established by the Soviet expedition in 1964; studies of the magnetic field; measurements of the accumulation stake network established in February 1965 by the SP-QMLT I; the establishment of a new five-kilometer (three-mile) accumulation stake line; studies by seismic and by radio soundings of the thickness and the physical properties of the ice sheet; surface weather observations; and glaciological pit studies.

On December 15, everything was finally ready, and the leading Sno-Cat started west. The three Sno-Cats were hauling, in all, three one-ton sleds, three two-ton Maudheim sleds, one Rolli-trailer, and the four-wheel assembly. The total load was approximately 40,000 pounds including about 12,000 pounds of fuel, 2,000 pounds of food, and 2,000 pounds of explosives. This equipment had been airlifted from McMurdo Station by LC-130F on the initial flight of November 22 and a second flight on December 3, 1965.

The proposed plan was to reach the Greenwich meridian and then turn on an approximately northeast course to the site of Plateau Station, which was to be established in January 1966. There the Sno-Cats were to be taken apart and flown back to McMurdo Station. The traverse was expected to arrive at Plateau Station not later than February 1, after which date weather conditions were expected to be too severe for air operations and traverse activities.

Owing to its late departure, the traverse had to turn northeast at 82°00'S. 09°35'E. on January 8, and reached Plateau Station at 79°15'S. 40°30'E., on January 29, 1966 (fig. 1). A total distance of 1,340 kilometers (725 n. miles) was covered in 45 days at an average speed of 30 kilometers (16.1 nautical miles) per day. Several days were spent at Plateau Station making additional observations and preparing the vehicles for backloading. Six LC-130F flights were needed for this operation. The last flight left Plateau Station on February 10, 1966.

Several delays were encountered en route. Mechanical failures were exceptionally few. The only important one, which delayed the traverse for two and one-half days, was a broken front axle. On December 30, at the end of a drilling operation, 28 five-foot drill sections fell back into the borehole. The retrieval of the sections, an absolute necessity for the continuation of the seismic program, was successfully accomplished at the cost of excavating a 15-meter (50-foot) trench, which took five days of unceasing digging. In compensation, this trench allowed the measurement of the snow density profile down to 15 meters (50 feet), affording an opportunity to calibrate the neutron density probe.

tered in other parts of the world. These new data from SP-QMLT II will be used in the compilation of the next version of the charts and will greatly strengthen the chart values for Antarctica.

Geodetic positions were determined every 40 nautical miles at the 17 major stations using a Kern DKM-2 theodolite. Severe weather conditions and extreme refraction of the sun sometimes hampered position determinations. Between these principal points, navigation was performed by use of a simple sun compass and a tank magnetic compass mounted near the driver of the lead Sno-Cat. Trail azimuth and slope shots were taken with a transit at more frequent, nine-kilometer intervals to check the track further. These slope shots also recorded as surface highs the three suspected crevassed areas, and a fourth area was also sighted as a possible crevassed zone.

Glaciological Studies on the South Pole-Queen Maud Land Traverse II

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During the 1965-1966 antarctic field season, an intensive glaciological program was conducted on the South Pole-Queen Maud Land Traverse II from the Pole of Inaccessibility to Plateau Station. Twenty-seven glaciological stations were established along the route of the traverse. At each station a 2- to 3-meter (7- to 10-foot) pit was excavated, and stratigraphy and density were measured. Samples were also taken for laboratory analysis of Sr^{90} and Pb^{210}, to determine the rate of snow accumulation. Measurement of stable oxygen and hydrogen isotopes and analysis of chemical elements and particulates will also be made on these samples. Additionally, 8- to 10-meter (25- to 30-foot) core sections were taken for subsequent analysis of the microparticle profile.

Temperature measurements were taken in twenty 40-meter (130-foot) deep boreholes, the emphasis being placed on the temperature gradient between 20 and 40 meters (65 and 130 feet). The temperatures were measured to ± 0.002°C. with the new Dymec Quartz Crystal Thermometer in order to determine, to a meaningful accuracy, the small geothermal/climatic temperature gradient at the surface of the ice sheet. This new electronic device records temperatures by measuring the variation of frequency with temperature of a quartz crystal sensor.

Forty-meter (130-foot) boreholes were logged at 16 sites with an automatic neutron density probe. This piece of equipment, designed at the Institute of Polar Studies, proved to be a useful tool for rapid measurement of depth-density profiles.

In addition to these studies, continuous meteorological, surface hardness, and surface relief records were kept by Mr. Olav Orheim, the Norwegian exchange scientist. Surface snow samples were collected at 27 stations to begin studies on the distribution of particulate deposition across this portion of Antarctica. Additional studies will be initiated to determine the mechanism of particulate deposition as well as the migration of such particles during metamorphism of the firn.

Geophysical Studies on the South Pole-Queen Maud Land Traverse II

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Ice surface elevations along the traverse route were determined with 12 aneroid altimeters, which were read at intervals of approximately nine kilometers (five n. miles). In addition, two altimeters were monitored almost continuously. The elevations ranged from 3,718 meters (12,198 feet) above sea level at Pole of Inaccessibility, to 2,512 meters (8,241 feet) at the turning point. The ice surface sloped upward from the traverse turning point (82°00'S. 09°35'E.) eastward with regional gradients of 2 to 5 meters (7 to 16 feet) per nautical mile (see fig. 1). Smaller topographic features of the order of tens of meters in height and of kilometers in horizontal extent were ubiquitous.

The ice thickness, which averaged nearly 2,800 meters (9,200 feet), was measured seismically at 18 vertical reflection stations, generally spaced about 75 kilometers (40 n. miles) apart. Gravity field measurements at nine-kilometer (five-mile) intervals provided additional ice thickness information. The tentative results of these measurements

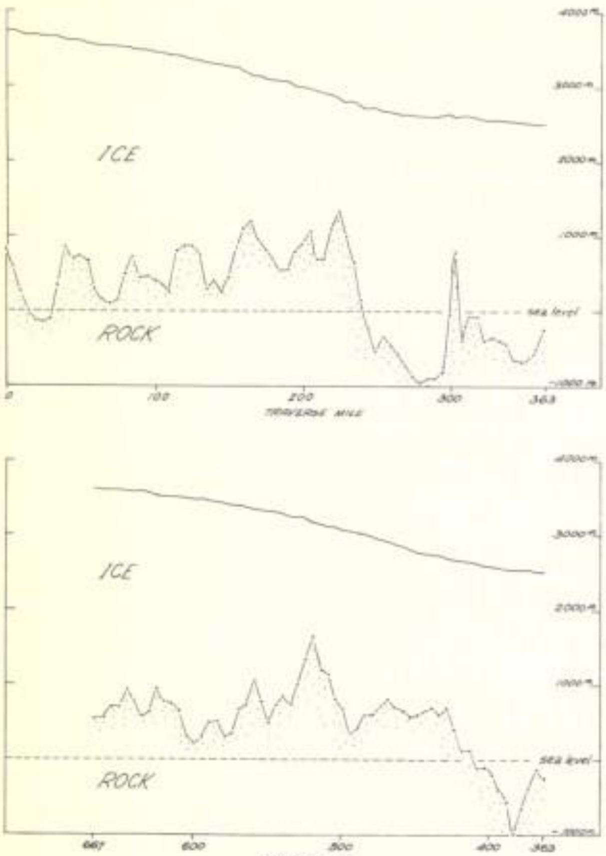

Fig. 1.

are shown in the ice and rock surface profile, (fig. 1). Three short seismic refraction profiles and three wide-angle reflection profiles were established to help determine more accurately the velocity of seismic waves in the ice cap. Four long refraction profiles were attempted, but yielded poor results.

Radio-frequency depth measurements were made on a major antarctic traverse for the first time. The equipment, which was developed for the U.S. Army Electronics Command, consists of a 30 mc./s. pulsed radar transmitter and receiver. The pulse travel-time is measured on an oscilloscope. The travel time was recorded every 0.37 kilometers (0.2 n. miles) and photographs were obtained at one-mile intervals. Echoes were received from depths as great as 3,500 meters (11,500 feet) and were received over 90 percent of the radio sounding profile. This profile extended over 1,000 kilometers (530 n. miles) of the traverse.

Velocity determinations by the wide-angle reflection technique were attempted. The horizontal ranges, limited by usable echo strength, were less than adequate for a reliable velocity result. Therefore, the radio sounding travel-time was instead tied to the seismic depth at 15 stations, and the velocity thus obtained was used to provide a detailed profile of ice thickness. The character of this profile agrees very well with that provided by gravity measurements on the rock surface profile (fig. 2).

The strain network which was established by U.S.S.R. personnel at the Pole of Inaccessibility in February 1964 was remeasured in December 1965 with Tellurometers. Another strain network, in the form of a quadrilateral 19 kilometers (10 n. miles) in circumference, was established at Plateau Station at the conclusion of the traverse.

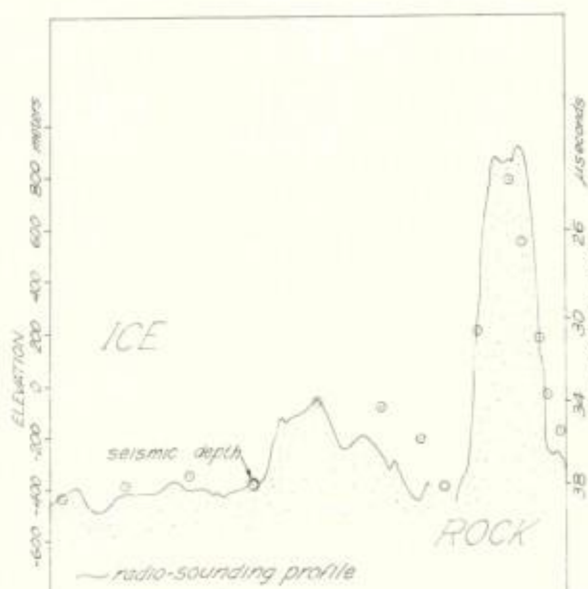

Fig. 2.

On January 4, the traverse unexpectedly encountered a heavily crevassed zone at 82°45'S. 15°02'E., and a day was spent retrieving one of the Sno-Cats, the front pontoons of which broke through a snowbridge. The main crevasses, several tens of meters in width and 5 to 7 kilometers (3 to 4.5 n. miles) in length, were oriented in an approximate east-west direction. The crevassed zone is above a major anomaly in the bedrock topography, an abrupt rise of over 1,200 meters (3,900 feet) over a horizontal distance of less than 9 kilometers (5 n. miles). Two similar crevassed zones were identified by aerial reconnaissance at approximately 82°30'S. 08°E. and 82°S. 22°E.

Two scheduled airdrops, on December 26, 1965, and on January 17, 1966, resupplied the traverse with fuel. An additional airdrop on January 6 supplied spare parts. The rapidity and efficiency of these aerial resupply missions contributed in a major way to the success of the traverse.

Geomagnetism and Navigation on the South Pole-Queen Maud Land Traverse II

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Responsibilities of the U.S. Coast and Geodetic Survey on the South Pole-Queen Maud Land Traverse II were to perform a magnetic survey over the entire traverse route for determining the distribution of intensity and direction of the Earth's magnetic field, and navigation duties in guiding the party over its previously determined course. Magnetic measurements of total intensity were taken with a portable Varian M-49 proton magnetometer every nine kilometers (five n. miles). At major stations every 40 n. miles, in addition to the total intensity measurements with the proton magnetometer, magnetic measurements of declination and inclination were taken with a saturable-core, inductor (fluxgate) magnetometer mounted on a Gurley transit. Fig. 1 shows the total intensity (F) measurements along the track. Several magnetic anomalies are evident. The largest one, MA3, is over 500 gammas below the smoothed F line. The curves of MA3 and MA7 are shapes typical of plotted total intensity values taken on a crossing at right angles to the strike of a magnetic body. Fig. 2 shows declination values determined at the major stations. The data showed good self-consistency along the straight-line portions of the track, with expected departures where the track line jogged.

Magnetic data, ranging from recordings of rapid and secular change to accurately observed values of the vector field at many points throughout this previously unexplored region, are vital for adequate knowledge of the geomagnetic processes in Antarctica, as well as throughout the world. A preliminary comparison of SP-QMLT II data with the latest version of the World Magnetic Charts shows differences in excess of those usually encoun-

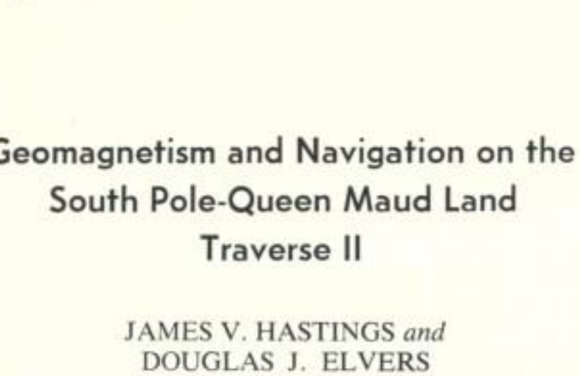

Fig. 1.

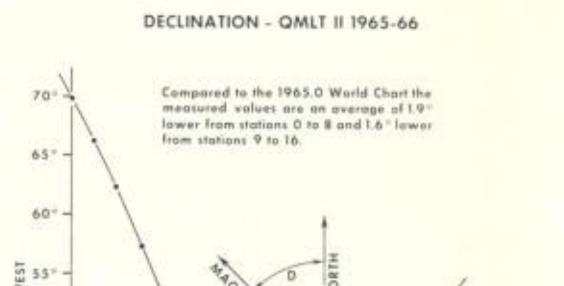

Fig. 2.