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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1959/74

PRELIMINARY REPORT ON ICE THICKNESS MEASUREMENTS ON THE ANTARCTIC ICE CAP BY SEISMIC AND GRAVIMETRIC METHODS, 1958-1959

by

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CONTENTS

LIST OF PLATES

ABSTRACT

During the International Geophysical Year 1957-8, ice thickness measurements on the Antarctic ice cap were undertaken by several nations. This preliminary report describes the work of the Australian team during the summer of 1958-59, when seismic and gravimetric methods were used.

The results indicate that in the region between Mawson and 250 miles south of Mawson 8,000 feet of ice overlies a rugged sub-glacial rock surface of which 50 per cent is below sea level.

A north-east trend of the mountain ranges, 10 miles south of Mawson, together with the seismic and gravity results obtained in this region, indicates that two of the mountain ranges (Henderson and Masson) are part of the same sub-glacial ridge.

1. INTRODUCTION

This report covers ice thickness measurements carried out by the Bureau of Mineral Resources, Geology and Geophysics, in conjunction with the Australian National Antarctic Research Expedition based at Mawson Station in the Australian sector of Antarctica (Plate 1) during 1958-59.

The object of the work was to extend the programme of ice thickness measurements by seismic and gravimetric methods commenced in the previous year, 1957-58, as part of the scientific programme for the International Geophysical Year.

The equipment, techniques and objectives, with the exception of a few variations, have been fully described by M.J. Goodspeed in preliminary reports "Records 1958 No.27" and "Records 1958 No.40" of the Bureau of Mineral Resources. These reports cover the first year of the programme.

The work covered by this report falls into two sections namely:-

A. A detailed east-west traverse, with two short gravity cross traverses, along a line of glaciological flow stakes situated in the region 10 miles south of Mawson (Plate 2). This is referred to as the Henderson-Casey traverse after the mountain ranges of the same names which form a base line for the ice flow measurements. The survey covered a period of 56 days from 22nd March, 1958, to 16th May, 1958.

B. The addition of two loops to the 1957-58 Southern traverse, one loop 30 miles wide to the west and lying between points 88 and 237 miles south of Mawson on the Southern traverse, and the other loop to the east, being triangular in shape, 15 miles across at the apex, and lying between 25 and 70 miles south of Mawson on the Southern traverse (Plate 3). These are referred to as the Southern loops. The survey covered a period of 110 days from 30th September, 1958, to 17th January, 1959.

2. EQUIPMENT

A. Changes in equipment were:-

(i) replacement of three 1,500 feet plastic covered seismic cables by similar rubber covered cables, which,unlike the plastic ones, retain their flexibility and do not crack in the cold.

(ii) replacement of two Askania microbarometers by two of the same model barometers lubricated with special fine oil to prevent sticking of the movement in the cold.

(iii) the addition of two Fuess Aneroid barometers on the Southern loops work only.

B. Functioning of equipment:-

(i) Ice drill. This was a source of trouble throughout the year. On the Henderson-Casey traverse stresses exerted on the drill pipe before the drilling technique was changed, together with stresses caused by the cutting bit catching in very fine cracks in the brittle blue ice (as a result of stresses in the ice due to being in a mountainous region), resulted in many "twist offs" where the unions between lengths of drill pipe sheared. This was later found to be due partly to faulty drill unions. Before the completion of the Henderson-Casey traverse the hydraulic system failed and drilling was abandoned. During the winter months the drill was overhauled, but no suitable replacement oil seals were available for the hydraulic system, and the old worn ones had to be replaced. At the commencement of the southern journey, the drill sled tipped over on a "melt water stream" and fractured the feet on the hydraulic pump and control unit. It was returned to Mawson for welding, but vibration, due to rough surface conditions, and cold caused the welds to fracture after only two holes had been drilled, resulting in it being completely unserviceable. On the two holes which were drilled, the hydraulic oil was leaking badly with air entering the system causing loss of power which prevented drilling to a depth greater than 60 feet.

(ii) 32 volt D.C. Generator Set. After running continuously for about 100 days on the previous year's Southern traverse, this engine and generator were taken on the Henderson-Casey traverse without time for servicing, apart from oil change. There were consequently many stoppages mainly due to broken wires on the control panel, which was eventually simplified and rewired. The commutator was badly distorted causing it to spark and get very dirty and icy, again causing stoppages. The whole unit was also subject to intense vibration because the sledge was not in good repair, and also because it could not settle down firmly on hard blue ice.

On the Southern loops, due probably to cold running, a fault in the fuel injector on the Lister diesel engine driving the generator caused the engine to stop frequently. Injector replacement, followed by many attempts at pressure adjustment by trial and error, proved to be wasted effort after finding that a main bearing was unserviceable, thus putting the unit completely out of action. Following this failure, batteries were charged on the Caterpillar D4 tractor 6 volt generator supply.

(iii) Seismic Equipment. This operated satisfactorily subject to:-

(a) Slight mechanical modification to reduce amplifier noise.

(b) Amplifier noise due to operating in the cold after the D.C. generator, and therefore cab heating, had failed. This was probably due to components undergoing physical change as they warmed up after switching on the equipment.

(c) Electrical noise due to low power supply voltages brought about by voltage drop across the batteries as a result of the cold reducing their capacity. Series - parallel combinations of all available batteries failed to rectify this source of noise completely.

(d) Recording oscillograph camera having a few intermittent and/or dirty joints, and use of all spares for two items, making it necessary to operate for a period without timing lines.

(e) The system was altered to allow the camera H.T. supply to be available from batteries. This enabled work to be carried out on the camera for testing and starting the timing motor without putting a heavy drain on the main batteries by running all the equipment.

(iv) Shot boxes. Connections were made so that the smaller T.I.C. shot box could be used to fire the shot from inside the cab rather than from outside in the cold and wind. It was later necessary to use the larger SIE shot box to cope with the increased load when firing multiple air shots.

(v) Seismic Cab. On the Henderson-Casey traverse the ventilators iced up resulting in high humidity which was probably the cause of some cross feed on the seismic equipment. A careful check was kept on this on the Southern loops.

During the winter the lay out of the equipment in the cab was modified to make it more accessible and to make more economic use of available space.

(vi) Barometers. It was found on the Henderson-Casey traverse that the microbarometers still tended to stick, in spite of the special thin lubricating oil. This is the reason for the addition of two Fuess Aneroid barometers on the Southern loops. This proved worthwhile since:-

(a) With one microbarometer the calibrated range was exceeded.

(b) The same microbarometer later suffered a broken suspension.

(c) The microbarometers were subject to rapid temperature variations in excess of 3° centigrade per hour, as specified by the manufacturer for reliable usage. The Aneroid barometers, being temperature compensated, should be less susceptible to these temperature variations.

(vii) Gravity Meter. A slight modification was made to provide power for the light source from an external battery. The normal batteries, being small, are very susceptible to cold and often become too weak to complete a reading even when carried in a pocket or in the hand between readings. The total gravity meter drift from Mawson back to Mawson over a period of 110 days on the summer Southern loops was only 3.0 milligals.

(viii) Explosives. Of the two types of explosives used, RDX/TNT with CE primer and Nobel 704, the former was more convenient and easier to use. The Nobel 704 was difficult to use from the point of view of inserting an electric detonator. The charge was extremely hard but crumbly once broken. In consequence it was very difficult to spike for insertion of the detonator, and often the paper split and the charge fell apart.

3. PROGRAMME AND SELECTION OF ROUTE

A. Henderson-Casey Traverse.

The purpose of this traverse was to investigate the ice thickness and configuration of the underlying rock in an attempt to correlate these factors with the rate and direction of ice flow being examined by the line of glaciological flow-stakes.

Progress was very slow due to:-

(i) bad weather, 21½ days being lost out of the total of 56 through blizzards and severe ground drift.

(ii) days rapidly becoming short with the approach of winter.

(iii) trouble experienced with the drill, starting its Deutz diesel motor, digging out lost drill pipe and repairs to other mechanical equipment.

The programme started with the intention of shooting at ⅛ mile intervals, but it soon became obvious that this was impracticable, and the interval was increased to 1 mile intervals for 3 miles. This was then increased to 4 miles for 3 more intervals making a total of 8 shot points over a traverse length of 15 miles. Over the three four mile intervals, gravity stations were established every ½ mile. Two short gravity cross traverses, 3½ and 6½ miles long were put in (Plate 2).

B. Southern Loops.

The original purpose of the summer southern journey was to reach a fuel depot at the 237 mile point (SP25) with all speed, and to establish approximately a 100 mile square loop to the east of the previous years Southern traverse, extending between the 237 mile depot and the southern extremity of the Southern traverse. This was to examine the possibility of a submerged north-south mountain range blocking the easterly ice flow into the Lambert Glacier.

Once again progress was very slow due to:-

(i) bad weather, 44½ days being lost out of the total of 110 days, through blizzards, ground drift, whiteout and a period of extreme cold when for 6 days it was not possible to start the engines, apart from the "Lister" 32 volt D.C. generator.

(ii) Surface conditions were very bad following the worst winter in the history of Mawson, making progress slow. The worst example of this was on Sunday December 14th when it took 3 hours to travel 1.6 miles, the tractors becoming bogged 14 times in soft snow.

(iii) poor surface and light conditions (partial whiteout) prevented the detection of a crevasse into which one tractor fell 30 miles out from Mawson. The other tractor returning to Mawson for extra lifting equipment also broke into a crevasse. This delayed the party for 16 working days while the tractors were recovered, sledges repaired and the tractor trains dug out of the huge snow drifts which had accumulated.

This loss of time together with the heavy fuel consumption, brought about by the soft snow, put the original programme out of reach, it being shortened and reviewed at each stage of progress. The final route is shown on Plate 3. The first attempt at heading west from SP25 was stopped by soft snow and a second attempt was made at a point 27 miles further north where conditions had improved slightly. The northerly small triangular-shaped loop is the result of a new route through the Masson, David and Casey Mountain Ranges, the nunataks just south of the ranges and many large ice domes which, being badly crevassed, make the area very unsafe for travel with heavy equipment.

4. TECHNIQUES

A. Levelling

(i) On the Henderson-Casey traverse the shot points were levelled by theodolite, taking shots on mountain peaks of known position and height. Gravity stations were levelled by differential barometric levelling using the shot points as control.

(ii) On the Southern loops the standard method of differential barometric levelling was again used. The station interval was reduced from 5 miles (Goodspeed 1958) to three miles. To reduce the time taken to reach the starting point, SP25 at the 237 mile depot, a value of height was taken from the previous year's work in preference to levelling along the route from Mawson.

B. Gravity.

(i) Henderson-Casey Traverse. On the sections where the stations were at ½ mile intervals, the normal "leapfrog" method was used, in which a drift tie is made back to a base station over a period of several hours. Travel was slow, however, and this restricted the frequency of return to a base station, the normal return period of 2 hours being extended to 3 or 4 hours when necessary. Over other sections, where the gravity stations were more widely spaced, the leapfrog method was impracticable, and it was necessary to rely on drift rate readings taken while preparing to travel and after arrival at a new camp.

(ii) Southern loops. Once again the drift rate reading method was adopted.

C. Drilling.

Drilling in blue ice on the Henderson-Casey traverse required modification of the techniques used for drilling in snow. In snow, 3-wing drag bits $\frac{1}{4}$" larger in diameter than the diameter of the auger flights produced a clean hole, but a slightly larger bit tended to jam in the hole or a large part of the hole was lost by cuttings falling in as the drill pipe was pulled out.

In blue ice, however, the bit of $\frac{1}{4}$ inch larger diameter than the flights resulted in cuttings packing tightly around the auger flights and bit, causing the bit to jam and the drill pipe to shear. By increasing the diameter of the bit to $\frac{3}{8}$ inch greater than the auger flight diameter a clean hole was produced.

At approximately 20 feet intervals in depth it is necessary in both cases to leave the drill to rotate freely for about 5 minutes without downward motion to clear the hole of cuttings.

D. Seismic Shooting.

(i) For the Henderson-Casey traverse, which was mainly on blue ice, but with a thin snow cover in some parts, single deep shot holes were used, as they were also required for glaciological work. At two points shallow (20 ft. maximum) 4- or 5-hole pattern shots were tried, but due to drilling difficulties it was not possible to compare them with deep holes.

The charge size was generally $\frac{1}{4}$ lb. T.N.T.

Two types of spread were used starting with an X spread (Goodspeed 1958) with 3 geophone stations in each arm, the nearest being 400 feet from the hole at the centre of the cross with others at 55 feet intervals. This appeared to give good results at first, but subsequent shot points indicated that a split spread (Goodspeed 1958) was preferable in order to have 6 geophone stations on each arm rather than 3. In the split spread the nearest geophones to the holes were at 200 feet with the others at 55 feet intervals.

(ii) For the Southern loops the surface was always snow or in two cases hard névé. Two holes only were drilled and in each case an offset L spread (Goodspeed 1958) was used with 200 feet to the nearest geophone in each arm and the others at 100 feet intervals.

Following the breakdown of the drill standard air shooting procedure (Poulter 1957) was used with 9 one pound charges in a square pattern with 30 feet separation between charges. These charges were suspended on bamboo poles 5 or 6 feet above the surface of the snow. With air shooting the standard split spread was used with 200 feet to the nearest geophone on either side of a centre point, and the other geophones at 100 feet intervals. The shot point was offset from this centre point at right angles to the geophone spread at a distance of 2,000 feet, although this was reduced as the ice thinned towards the edge of the continent.

Owing to inability to drill shot holes, low battery capacity, cold-created electronic noise, difficult processing and shortage of time, no refraction work or low velocity surface layer work was carried out on the Southern loops.

E. Photographic processing.

On the Southern loops photographic processing became rather difficult. After the stoppage of the 32 volt D.C. generator, there was no cab heating and photographic solutions rapidly cooled in the cab where the ambient temperature was of the order of -10^{o} Fahrenheit. This also resulted in an ice layer forming over the equipment from condensation of vapour from the hot solutions. It was thus necessary to shoot all shots at each point and rapidly process all the records together afterwards. This resulted in lack of control over the shooting and consequently some loss of quality. At the start of air shooting, which had failed to produce results when tried in this area during the previous year (Goodspeed 1958), processing was essential between shots and reheating the chemical solutions became very tedious, making shooting very slow.

5. DISCUSSION OF RESULTS

A. Levelling.

(i) On the Henderson-Casey traverse, the microbarometer readings were converted to heights, were corrected for instrument temperature, air temperature, barometer comparisons and then adjusted to control heights at the shot points. The topography is shown on Plate 6.

(ii) As indicated previously (Section 2B(vi)) the aneroids were used exclusively for height computations on the Southern loops. Differences in height between stations were computed using tables of pressure against height (Royal Geographical Society, 1935). The results have been corrected for air temperature and comparison readings of the barometers.

The 1957-58 and 1958-59 work forms the two loops:-

Loop I. Mawson-SP5-Mawson, distance 148 miles, misclosure 255 ft.

Loop II. SP5-SP25-SP5, distance 386 miles, misclosure 753 ft.

Further consideration of results and corrections is required in an attempt to explain and reduce the misclosures. For the purpose of this report the errors due to misclosures have been distributed around the loops. The topography is shown on Plate 7.

B. Seismic.

(i) Preliminary work only has been carried out on the records which are of variable quality, but generally poor, due, on the Henderson-Casey traverse, to high surface noise on hard blue ice, and on the Southern loops to electrical noise as described and due to cold. The seismic shots have been used to give depth points which act as control on the gravity work.

(ii) On the Henderson-Casey traverse, some surface shots were fired to record near surface low velocities. The following velocities were recorded:-

3,000 to 4,000 feet per second
7,000 to 8,000 feet per second
11,000 to 13,000 feet per second

Some deep refraction work was also carried out and showed a maximum velocity of 12,500 feet per second.

Picking second events on these records showed velocities of 15,950 feet per second over 14 geophone stations, shooting to the west, and 15,850 feet per second over 7 geophone stations shooting to the east.

This is of the order of velocity expected for the Granitic type rocks in the region of Mawson and the mountain ranges just south of Mawson.

C. Gravity.

Although the gravity meter drift from Mawson to Mawson over a period of 110 days on the Southern loops was only 3.0 milligals, the short period drift rates vary greatly from this and a detailed analysis of drifts is required.

Preliminary field drift curves have been used to get intervals between gravity stations, and, by successive addition over the complete traverses, values relative to Mawson have been obtained. Over the loops formed, any misclosure has been distributed around the loops for the purpose of this report. On the Southern loops, the misclosure from Mawson back to Mawson was 28 milligals. Some of this may be explained by the fact that the meter drift rate becomes erratic at temperatures below -15°F. It is not practicable however to keep the instrument in a warm compartment unless it can also be read in that compartment, since when the meter is subjected to a large temperature change, there is a sudden jump in the drift curve within a few minutes. This presumably is due to physical change in the dials and optical system. The temperature change effects the working parts of the meter after about 8 hours.

Gravity values have been adjusted for latitude corrections and elevation corrections (Nettleton 1940). The elevation correction is in two parts. The "free air" correction adjusts the measured value to one which would be measured if the station were at the sea level datum, and assumes air to be the medium between the datum and the station. The "Bouguer" correction allows for the gravitational attraction of the ice between the datum and the station, and assumes the ice to be a slab of infinite horizontal extent with a density of 0.9 grammes per cubic centimetre.

The resulting "Bouguer Anomaly" is a combined "regional" and "ice thickness" effect. For computational purposes the anomaly is measured relative to an arbitrary value of zero at Mawson for the Southern loops traverse, and a value of zero at a point 1500 feet above Mawson for the Henderson-Casey traverse.

A regional effect has been removed from the Bouguer Anomaly in the following way.

(i) the seismic information has been interpreted to give the height of the ice-rock interface above sea level.

(ii) using an ice density of 0.9 grammes per cubic centimetre, and a rock density of 2.8 grammes per cubic centimetre, then a change of one milligal in the gravity anomaly is brought about by a change in height of 41 feet of the ice-rock interface.

(iii) using this figure of 41 feet per milligal the theoretical gravity anomaly, resulting from the ice-rock interface being above sea level, is found.

(iv) subtracting this theoretical anomaly from the actual anomaly gives a correction to be applied to the actual anomaly to remove the effect of its having an arbitrary datum value and a regional effect.

(v) the correction thus found is plotted against the position of the station for each seismic shot point. A mileage scale is used for the Henderson-Casey traverse, and a latitude scale for the Southern loops traverse, the latter being equivalent to the distance inland from the edge of the continent. The resulting curves are shown on plates 4 and 5. The curve for the Southern loops traverse is as would be expected (Heiskanen 1953), as a result of isostatic compensation between a land mass and surrounding ocean, where the anomaly becomes increasingly negative as the land mass is approached.

(vi) using these curves to interpolate between the known regional anomaly values, at the seismic shot points, a regional gravity correction has been applied to the values at all gravity stations.

On the basis of the regional anomaly curve (Plate 5), since the correction for shot point 39 disagreed with the correction suggested by the curve, then the record was examined and repicked on a later event. This record showed the arrival of several events, the earliest one being doubtful, as it is a double event, which, when half the seismic geophone spread was swung round from east-west to north-south, the first half of the event underwent a strong change in shape and the second part remained similar. This is probably reflected energy from a crevasse or crevasses which are known to be in the vicinity on ice domes.

After the removal of the regional gravity effects from the computed anomaly the residual anomaly was converted to an equivalent height (using 41 feet/milligal). This height was then adjusted to give the best fit to the seismic points.

The resulting gravity sections with seismic points are shown on Plates 6 and 7. The gravity and seismic points are shown separately on the section. The disagreement between these points is probably that a true plot of the regional gravity anomaly correction is not a smooth curve. Variations in sub-glacial rock density and altitude would affect this curve, and until a combined one for the 1957-58 and 1958-59 work is constructed, no better correction is available.

D. Sections.

(i) Henderson-Casey:-

Traverse A (Plate 6). This traverse indicates two valleys in the rock surface, 250-300 feet below sea level, lying between SP29 and G2 where it is 4 miles wide, and between G12 and G17 where it is 3 miles wide. The section between these two valleys and the section on the extreme west lie between 150 and 200 feet above sea level. The easterly end rises 500 feet from SP29 towards SP27.

Traverse B (Plate 6). This traverse, at the westerly end of Traverse A indicates the rock surface dipping towards the north a total of 400 feet over 3½ miles. At G26, ½ mile north of Traverse A, a 300 feet trough is indicated, but since this is based on one gravity station only it must be considered unreliable, although the ice surface sloping towards the north shows a corresponding flattening which corresponds to the trough.

Traverse C. On the north end of this traverse the rock surface is indicated as dipping towards the north by 500 feet over two miles. The next two miles is indicated as being flat at 200 feet above sea level with a 100 feet shallow trough about 2 miles wide at the southern end.

A study of the section for Traverse A in conjunction with the location map (Plate 2) shows that northerly extensions of the Masson and David Ranges cut the traverse at points in the two valleys and that the raised section between the two valleys lies in an extension of the gap between the Masson and David Ranges. Also the rising section on the east of the traverse lies in the gap between the Henderson and Masson Ranges.

The orientation of the Casey Range together with the nunataks south of it, and also of the David Range, suggests that these large ridges have an easterly component, i.e. run approximately north-north-east. This is not so obvious for the Henderson and Masson Ranges. In this case the raised section of the traverse between G1 and G12 may well be an extension of the David Range, and the rising section on the east of the traverse an extension of the Masson Range, in which case the Masson Range, the Henderson Range and the rise on the east of the traverse are probably all part of the same ridge. The proposed ridge running north-east through Henderson and Masson Ranges, if extended towards the north-east, would project out to sea and would explain the orientation in a north-east direction of the coastline east of Mawson as shown on Plate 2. The ice surface contours also run north-east parallel to the coast and this supposed mountain ridge suggests that the ice is flowing over the ridge and down to the sea in a north-westerly direction.

(ii) Southern Loops:-

This work is shown in section on Plate 7 as one long traverse.

Considering the ice-rock interface, the results show that from the 237 mile depot (SP25) to G48, a distance of 13½ miles to the west, is a west dip falling from 500 feet above to 1200 feet below sea level.

From G48 to G58, a distance of 27½ miles to the north, an 18 mile wide ridge is crossed. This ridge is 1200 ft. high and has its highest point 50 feet below sea level.

From G58 to SP36, a distance of 17 miles to the west, is a rise of 400 feet towards the west, from 600 feet to 200 feet below sea level.

From SP36 to SP39, a distance of 100 miles to the north, the first 20 miles is mainly flat and about 500 feet below sea level. The remaining 80 miles crosses a mountain system having six ridges rising to between 1400 feet and 1700 feet above sea level. The bottom of the troughs between the ridges lie between sea level and 700 feet above sea level.

From SP39 to G111, a distance of 42 miles to the north-east, a north-east dip is shown from sea level to 2200 ft. below sea level.

From G111 to SP5, a distance of 20 miles to the north, a 3000 feet high ridge is crossed with its peak at G116, 600 feet above sea level. This ridge is just north of a surface ice dome which is steep and badly crevassed.

From SP5 to G123, a distance of 20 miles to the north-east, there is a sharp rise of 1300 feet between G118 and G119 from 200 feet below to 1100 feet above sea level. This sharp rise is followed by a gentle rise of 300 feet with a 600 feet trough in the middle at G121. This trough is based on one gravity station only, but does correspond to the flat area between two ice domes seen to the north-west of this part of the traverse.

From G123 to G133 a distance of 31 miles to the north-north-west, a broad ridge is crossed with its highest point 1700 feet above sea level, and is about 1 mile east of Mount "Twin Top" (formerly Tvittoppen) which rises 880 feet above the ice surface.

From G133 to Mawson, a distance of 27 miles to the north-east, the ice-rock interface falls from 800 feet above sea level to 600 feet below sea level. For the 7 miles just south of Mawson it is mainly flat at 600 feet below sea level and finally rises steeply into Mawson at sea level.

Of the total traverse length of 297 miles, 148 miles or 50 per cent of the ice-rock interface is below sea level.

At some points along the traverse there is evidence of correlation between the topography and the ice rock interface. The southern edge of the mountain system between SP36 and SP39 would have a damming effect on the northerly ice flow. This is shown by the highest point on the surface being about 6 miles south of the edge of the ridges. At stations G119, G116, G90, G87 where small peaks are indicated by the cross section, there is a distinct flattening of the ice surface, generally 2 or 3 miles up-slope from the peak. A much more obvious example is the trough, 12 miles wide and 1500 feet deep, between SP38 and G94. Corresponding to this trough is a flattened surface which is 9 miles long and displaced 3 miles up-slope from the down-slope side of the trough which would dam the ice flow.

6. REFERENCES

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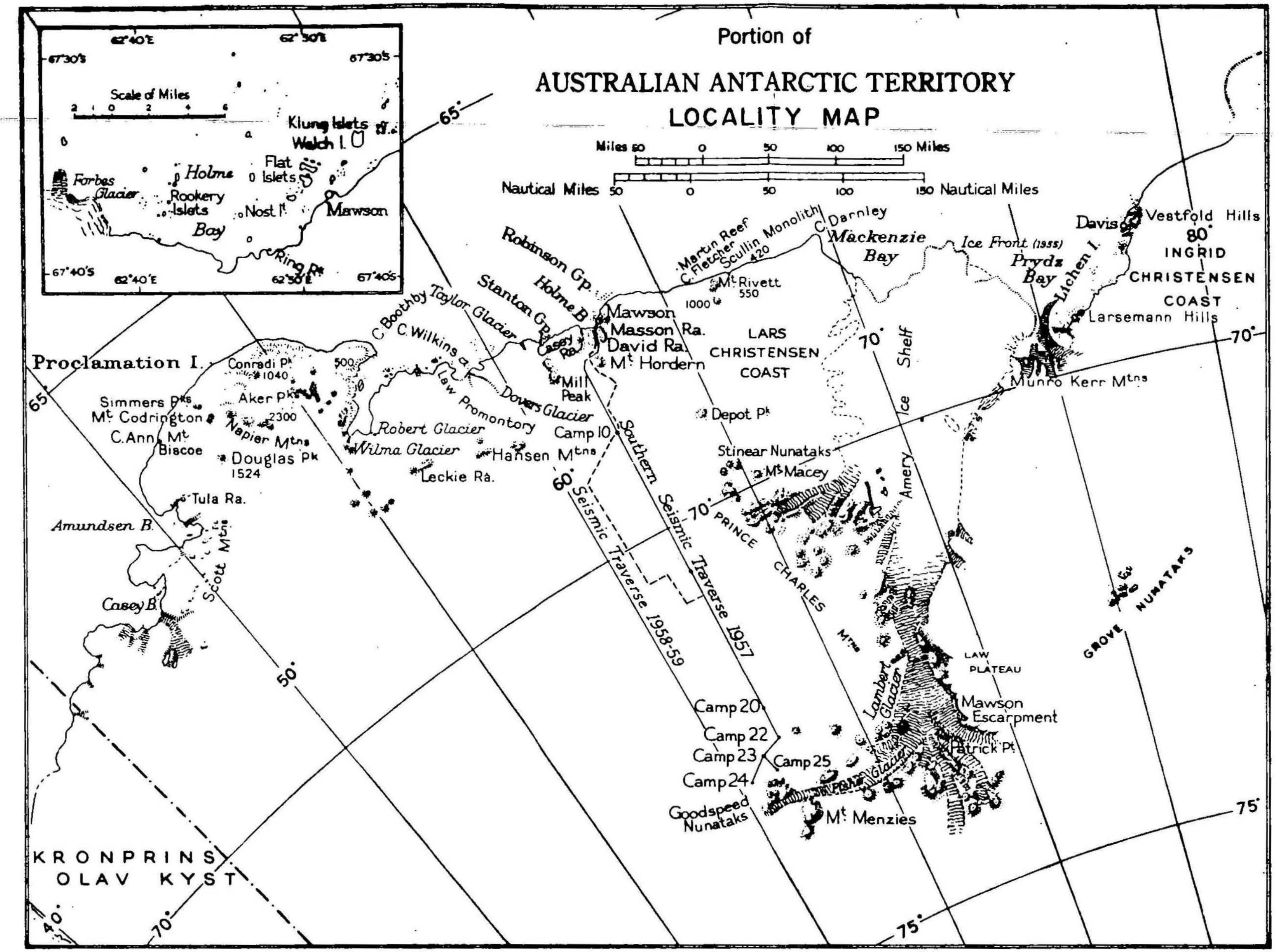
Leave 1.5" binding margin

PLATE I



G 158-26

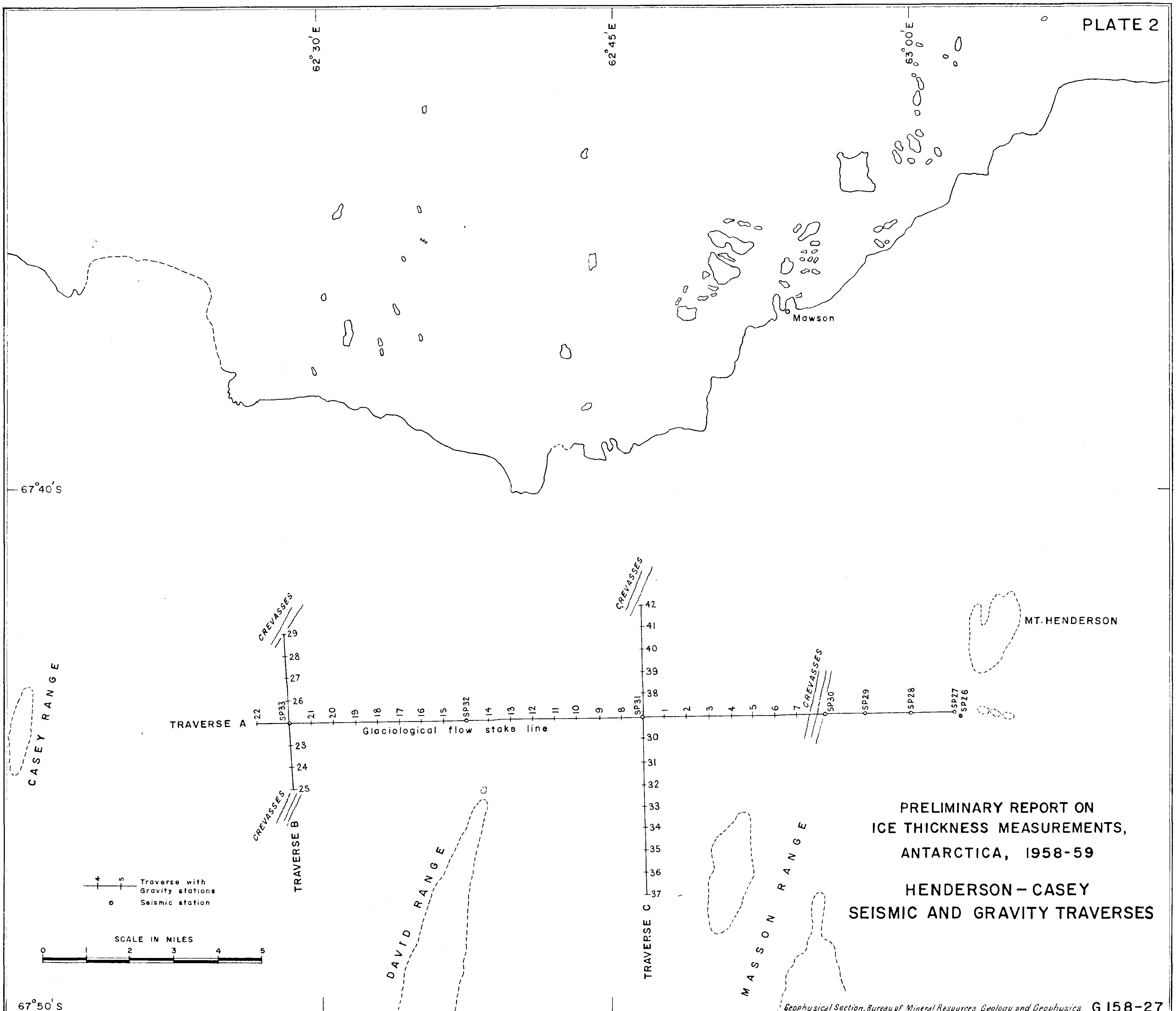


PLATE 2
62°30'E
62°45'E
63°00'E
67°40'S
67°50'S
Mawson
MT. HENDERSON
CASEY RANGE
DAVID RANGE
MASSON RANGE
CREVASSES
CREVASSES
CREVASSES
CREVASSES
TRAVERSE A
TRAVERSE B
TRAVERSE C
Glaciological flow stake line
22 SP33 21 20 19 18 17 16 15 SP32 14 13 12 11 10 9 8 SP31 1 2 3 4 5 6 7 SP30 SP29 SP28 SP27 SP26
29 28 27 26 23 24 25
42 41 40 39 38 30 31 32 33 34 35 36 37
Traverse with Gravity stations
Seismic station
SCALE IN MILES
0 1 2 3 4 5
PRELIMINARY REPORT ON
ICE THICKNESS MEASUREMENTS,
ANTARCTICA, 1958-59
HENDERSON – CASEY
SEISMIC AND GRAVITY TRAVERSES
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics
G 158-27

PLATE 3

PRELIMINARY REPORT ON
ICE THICKNESS MEASUREMENTS,
ANTARCTICA, 1958-59

SEISMIC AND GRAVITY TRAVERSES

Geophysical Section Bureau of Mineral Resources Geology and Geophysics

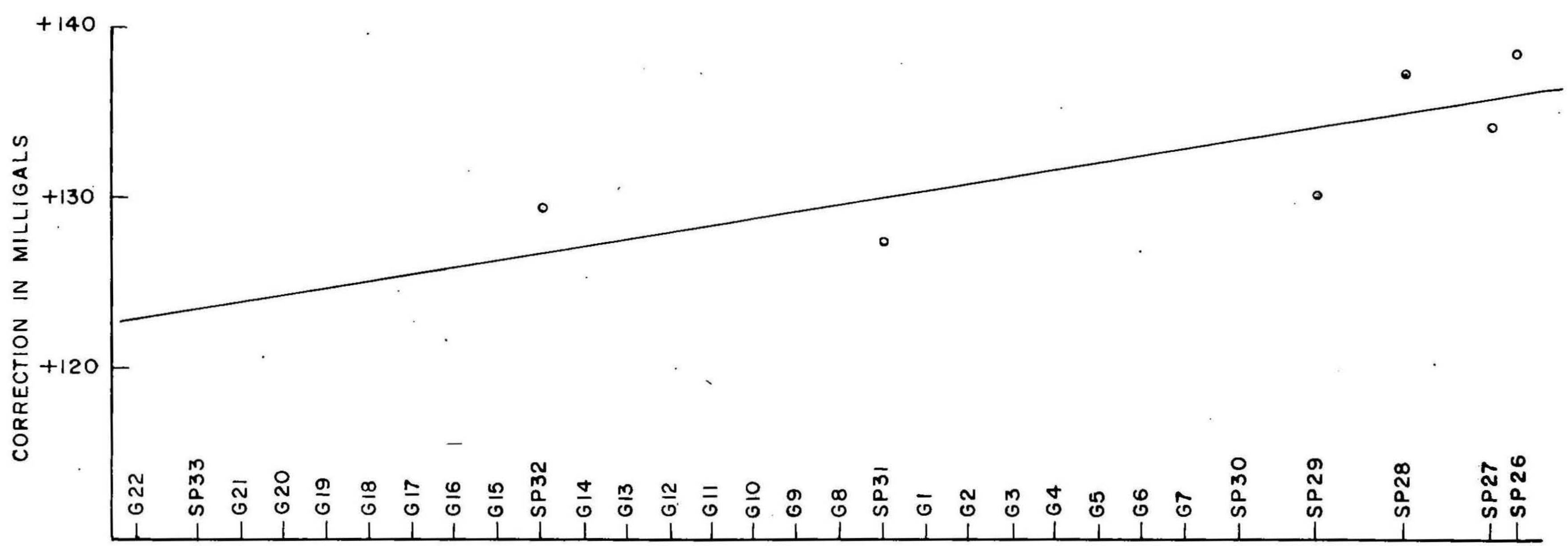
G 158-28

PRELIMINARY REPORT ON ICE THICKNESS MEASUREMENTS, ANTARCTICA, 1958-59

HENDERSON-CASEY TRAVERSE

REGIONAL GRAVITY CORRECTION CURVE

(BASED ON VALUES COMPUTED FROM SEISMIC DEPTH POINTS SHOWN THUS o)



E.E. Jesson.
GEOPHYSICIST

HORIZONTAL SCALE IN MILES
1 0 1 2 3 4 5

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G158-29

To Accompany Records 1959, No74

PLATE 4

PRELIMINARY REPORT ON ICE THICKNESS MEASUREMENTS, ANTARCTICA, 1958-59

SOUTHERN LOOPS TRAVERSE

REGIONAL GRAVITY CORRECTION CURVE

(BASED ON VALUES COMPUTED FROM SEISMIC DEPTH POINTS SHOWN THUS o)

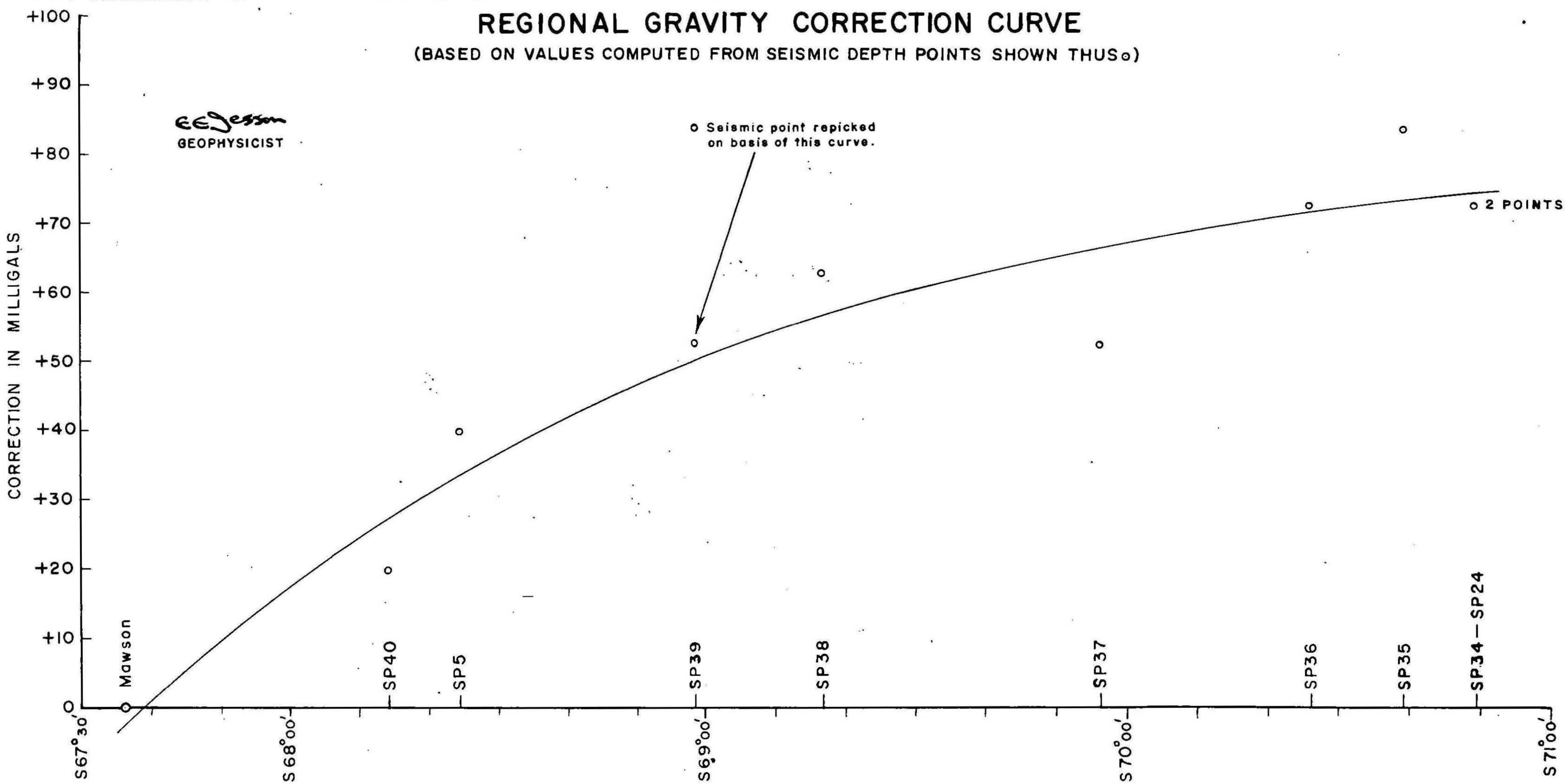


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PLATE 5

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PLATE 7

LEGEND

VERTICAL MAGNIFICATION 21·1:1

TOPOGRAPHY

ROCK-ICE INTERFACE (GRAVITY)

SEISMIC CONTROL POINT

HORIZONTAL SCALE IN MILES

0 5 10 15 20 25

E E Jesson

GEOPHYSICIST

PRELIMINARY REPORT ON ICE THICKNESS MEASUREMENTS, ANTARCTICA, 1958-59

SOUTHERN LOOPS PROFILES

Geophysical Section, Bureau of Mineral Resources, Geology and Geophsics.

G 158-32

To Accompany Records 1959, N°74