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DEPARTMENT OF MINES
SOUTH AUSTRALIA

REPORT ON OBSERVATIONS MADE WHILE ACCOMPANYING A RECONNAISSANCE GEOPHYSICAL SURVEY OF THE LAKE FROME EMBAYMENT AREA.

LIST OF ILLUSTRATIONS

DEPARTMENT OF MINES
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REPORT ON RECONNAISSANCE GEOPHYSICAL SURVEY OF LAKE FROME EMBAYMENT AREA IN SEARCH OF NATURAL GAS

SUMMARY:

This report covers the period during which the writer accompanied a reconnaissance geophysical survey of the Lake Frome Embayment area, the object of which is to locate areas, if any, in which Natural Gas may be found.

General details are given of the preliminary work necessary in the way of equipment,and transport of both geophysical instruments used and other transport; the design of the traverse, and the choice of instruments used. Some description follows on the field techniques, both geophysical and optical, reduction of the correcte gravity and magnetic values from the field data is mentioned, as is plotting, contouring and interpretation of the results.

HISTORY:

The techniques and interpretation of geophysical surveying have progressed rapidly since 1900, until it is now a recognised and fairly precise method of prospecting. Most of the initial work appears to have been done in Europe, particularly in Germany, but after World War I, big American Oil interests tried it out and nowadays most of the new developments come from that country.

Australia, due to isolation and lack of knowledge, has lagge badly in both the knowledge and use of geophysical prospecting, a small group of Commonwealth workers being the only men continuously employed on it.

However, in 1946, the Zinc Corporation decided to sponsor a geophysical search for natural gas in the Lake Frome Embayment area. The above-mentioned Commonwealth geophysicists commenced this work. Then early in 1947 a party of American and Dutch experts were brought to Australia by a combination of three companies, including the Zinc Corporation, to continue and enlarge this survey. With these men came the latest gravity and magnetic survey eqiupment, plus a wealth of knowledge and experience. In order that the South Australian Mines Department could establish a geophysical survey section, it was decided that the writer should, with the permission of the Organisers of the survey, accompany the field parties.

PREPARATIONS:

The country over which the survey was to be conducted was in itself rather varied, but entirely in desert land, some distance from regular supply routes. Sand and lack of water combined to make supply and maintenance problems difficult.

After survey flights had been made by several technical men, who were to be closely linked with the survey, it was decided that the only suitable automotive vehicles for continuous work in the area would be Jeeps and Blitz waggons, both fitted with 4-wheel drive. The former made up of the survey fleet, both optical and geophysical, and the latter were used for general heavy haulage of camp gear and so on.

Early in the survey two aeroplanes were used for bringing perishable goods and emergency spares from Broken Hill to the moving field parties, and later, as the parties moved further into the desert, a third plane was to be added.

Arriving in Broken Hill in March, 1947, work on fitting out No.2 field party,-No.1 party consisting of Commonwealth geophysicists, had already been in the field several months - had just begun. The principle items were preparing to supply and maintain the men and vehicles in the field, the actual fitting out of the survey Jeeps and the testing and adjusting of the instruments. The first of these items entailed an enormous amount of work, many hundreds of articles had to be located, brought to a commom supply base, indexed and issued.

The choice of instruments used on this reconnaissance survey was made on experience American Oil Companies have gained in the past. The two factors wieghed against each other are speed and information. On the one hand lies the seismic survey, which gives full and accurate quantitative information, but is relatively slow and costly, and on the other hand a gravimetric survey, which can be much faster but gives largely qualitative and less positive results. A combination of gravimetric and magnetic surveys is nowadays a fairly accepted practice for oil or natural gas exploration over large areas of virgin country.

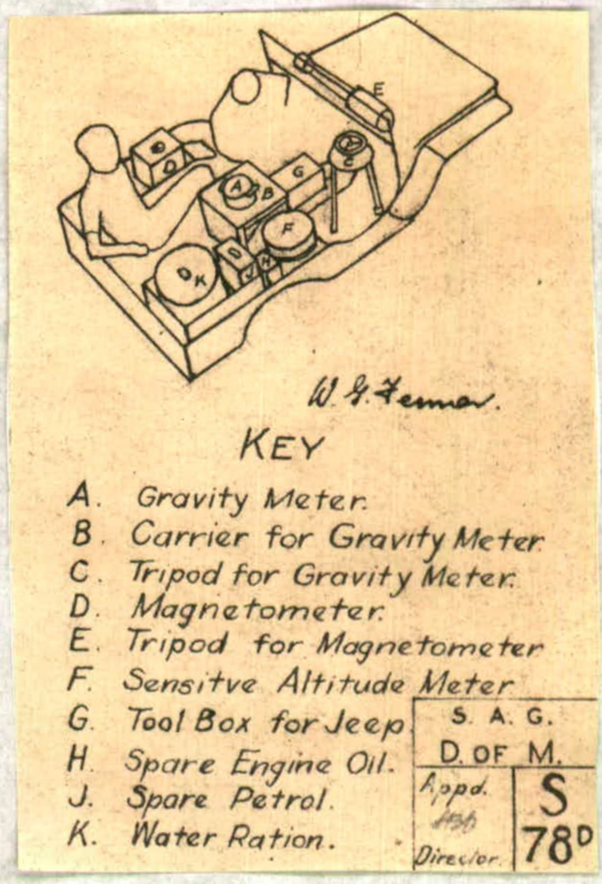


Figure 1 shows an instrument (i.e. geophysical) Jeep fitten out, and the key is supplied. There were initially two such Jeeps, there being two Gravity Meters and only two trained operators free for field work.

Figure II shows a survey (i.e. optical) Jeep fitted out for field work. These numbered three at first. There were also two runabout Jeeps for scouting purposes.

By the end of April all was ready for the field, a party oc cooks, drivers and camp workmen having been sent out ahead to prepare the first camp at Hawker Gate on the New South Wales-South Australia border fence, about 200 miles N.N.W. of Broken Hill. (See Fig. III)

A work about the area to be surveyed. Geological evidence over many years has suggested that on the whole there are few areas in Australia in which oul or natural gas are likely to exist in commercially exploitable quantities. However, one such mildly favourable area is in the Lake Frome Embayment area, and that portion of the Great Artesian Basin lying immediately to the North of the Embayment area. Many of the water bores sunk in these two areas have been giving off inflammable natural gas for many years. Fig.III shows the Oil Exploration Lease covering about 40,000 sq. miles of this portion of Australia, taken out by the interested parties.

It is vital in geophysical surveying to have good geological control. In the area in question the three points were chosen which supplied a fair degree of control, and still covered the major proportion of the lease. These were(a)Tibooburra, a small township in north-eastern New South Wales, where there is an outcrop of the granite basement; (b)Moolawatana, a station homestead and waterbore just west of the lower end of Lake Callabouna, near another basement uotcrop; (c)Patchawarra, a waterbore located midway between Innamincka and Cordillo Downs homesteads, where the borelog locates the geological strata for a depth of over a mile. These were fixed as the corners of the triangular reconnaissance survey.

Further geological control was afforded, in addition to surface geology, by the numerous water bores put down in the area since 1900.

The Embayment area itself showed less hole of success than the northern triangle, and so was covered - apart from the half mile grid worked by the Commonwealth Bureau of Mineral Reslurces before the arrival of the American geophysicists - by only a few traverse lines as shown in Fig. IV.

Figure V shows in more detail the actual course proposed for the northern triangle. Being such a large area, a reconnaissance survey was the logical requirement, the primary object of which was to discover the broad general trends of the Artesian Basin. To accomplish this with the maximum speed and economy, two parallel traverse lines, five miles apart, were laid out. Stations were to be made every two miles along these traverses. In order that better knowledge of the basement gradients could be obtained, at every 16 miles along the main traverse, off shoot stations were to be made perpendicular to the traverse and 2½ miles from each of the two lines, plus one midway between the traverse lines, as shows in Fig. V.

It is worth saying here that an alternative survey which may have been applicable to this area is the use of the wartime development "Shoran". By this means a 10 mile grid (say) could be made fairly rapidly, covering the whole basin, using either surface or air transport for the geophysical instruments.

It was found that there were three old stock routes covering the proposed triangle, and to case the vehicle maintenance and to aid the surveyors, these were to be followed rather than sticking rigidly to the triangle as drawn up in New York on the basis of geological control. In practice it was discovered that these stock ruotes were for a large part wiped out, not having been used for many years.

Prior to leaving for the field work, Gravity Meter, Magnetometer and Altitude Meter ties had been made by plane from Broken Hill to Tibooburra, Pine View, Westward Downs and Whyalla, the object being to tie up these key points with an absolute gravity (pendulum)station established by Mr. Colin Kerr Grant at Whyalla in 1936, for later interpretation of the anomalies found in the Basin.

FIELD OPERATIONS:

On May 2nd 1947, the survey technical party left Broken Hill, and arrived at Hawker Gate via Milparinka on the 3rd May, the geophysical instruments being flown in by plane to avoid unnecessary bumping. The camp was already in running order, the general layout being as shown in Fig. VI.

At this time Party No.1 was still working in the Embayment Area, later to join Party No.2 on the borthern triangle, though still working as a separate Party.

Fig. VI.

The instruments initially taken into the field by party No.2, were as follows:-

1 Gravity Meter
3 Field Magnetometers
3 Sensitive Altitude Meters
1 Transit Theodolite
1 Level
Accessory instrument equipment.

Actually this was not a well-balanced team, as usually one geophysical crew can keep up with 2 or even 3 survey crews. But optical surveying instruments, and surveyors, were difficult to obtain, and it was not until September, 1947, that a balanced set of surveyors and operators were in the field, and this was accomplished only by diverting more men and instruments from Standard Oil's N.E.I. organization.

After making some further instruments tests, a run was commenced with Gravity Meter, Magnetometer and Altitude Meters down the Border Fence for a distance of some 40 miles, to tie to a point to which the No.1 Party has worked. This line has already been surveyed and pegged, and thus gave the surveyors with Party No.2 a chance to get ahead on the first loop.

Due to the relatively irregular time-drift inherent in all gravity meters, and because of lack of roads precluded establishing a network of bases for the Gravity Meter ahead of the survey, the field technique used was the so-called "looping" method. This is illustrated in Fig. VII.

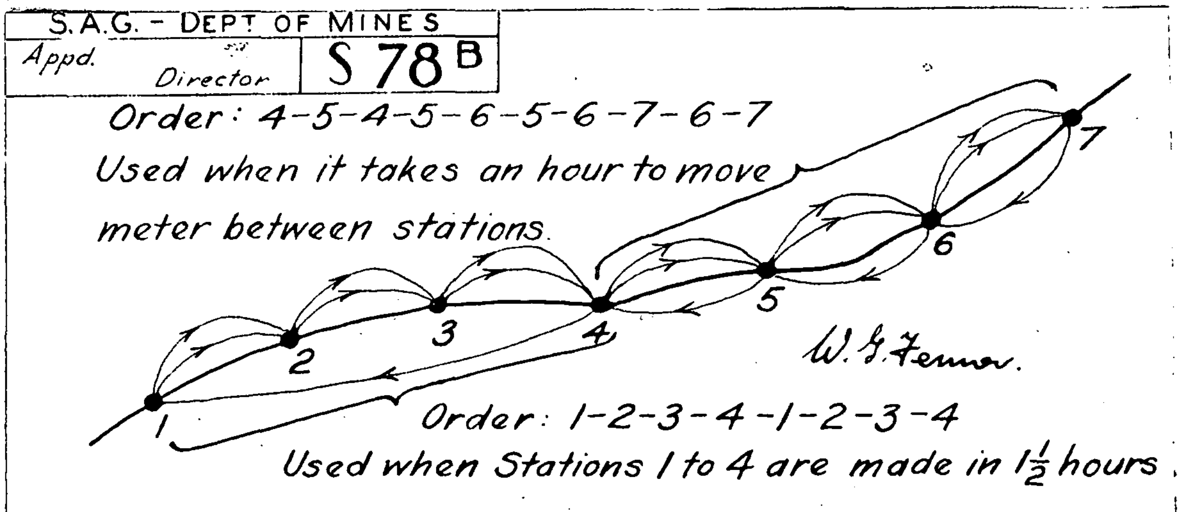


FIGURE VII THE LOOPING TECHNIQUE

For practically no more cost the Magnetometer could be run with the Gravity Meter, i.e. in the same Jeep, and hence this was done. Later this was to be abandoned as more rapid methods were possible when more operators and Jeeps became available.

To account for the irregular diurnal changes of the intensity of the earth's magnetic field, and the even more irregular daily barometric changes, a Magnetometer and an Altitude meter were read at regular intervals all day long at a base station, which was the first station of the Day's run.

Coming in from the field each afternoon, the geophysical operators and surveyors spent part of each evening in drawing Drift Sheets, making gravity and magnetic reductions, plotting, contouring and instrument maintenance.

Sensitivity checks were carried out on the Gravity Meter each day, using a rider of known weight lowered onto the balance arm and producing a known deflection; and on the Magnetometers about once per week.

On completing this tie, work commenced on the first loop of the northern triangle. Fig.VIII shows this loop in some detail, This loop was surveyed in stadia and magnetic bearing, using a following level to check elevation differences, Accuracies of ±2ft on any station were satisfactory. Checks carried out with the Altitude Meters closed remarkably well, even when not using the more accurate two-base method.

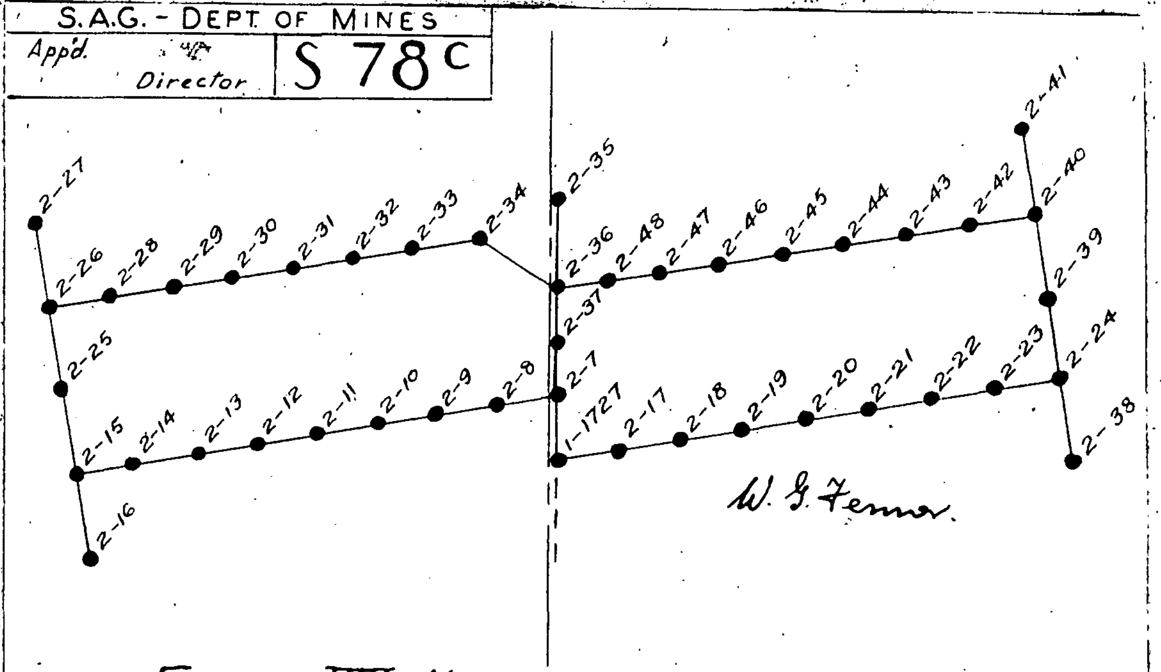


FIGURE VIII HAWKER GATE LOOP (SCHEMATIC)

The meter stations had to be chosen with some care, for whereas the optical surveyors would naturally tend, whenever possible to shoot from the top of one sandhill to the top of the next, the stations themselves need to be on flat firm open ground. Early in the work a number of stations were put on top of sandhills, but the practice of such "meter traps" was quickly and rather humorously overcome.

Survey flags were of two types. Those by the station pegs were red and yellow and about 2ft. square; those used for marking the track taken - "trial flags" - were usually orange in colour, and stood out well in timbered country but had to be changed when in the red sand areas.

Gravity Meter readings were always made right over the pegs as elevation is most important with them; the Magnetometers were read at point 150ft. along the track at 6 o'clock with respect to the order of station numbering. It was found useful to put the stations on the one side of the track whenever possible, as at times it was diffucult enough to see them.

Dingoes and cattle caused some troubel by digging up the pegs and tearing down the flags, and up to the time the writer left the Organization, this difficulty had not been overcome.

Station pegs themselves were 2" square jarrah, 18" long, with the station number stamped in a galvanized iron disk nailed to their upper end.

As there was little accurate survey data available for this part of Australia, to keep any cumulative errors in check, latitude and longitude star and sun observations were to be made every 16 miles round the traverse.

Although some geophysicists believe that a reconnaissance survey should, for reasons of economy, be carried out with the lowest possible useful accuracy, the Americans directing this survey hold the view that it should be made with the highest possible accuracy, so that if, at some later date, one or twenty years hence, it is desired to investigate in detail some interesting anomaly, the new crew can go straight in and use the results of the reconnaissance survey instead of having to establish these stations agian. Hence noth the geophysical and optical surveys were carried out with care, and as many checks and ties as possible in this country were made. As a result, loops were closed to within 2 or 3 gravity units, and 10 to 20 gammas, and in many cases were much better than this.

If, on completing a loop, an appreciable closing error was found in the geophysical work, the location of the part of the loop in which this error had been made was greatly speeded up - when the nature of the country permitted - by using the Auster plane for flying checks. Lines were flown dividing the loop into 3 or 4 sectors, and when the sector containing the error was found, it could be re-run in detail by plane or Jeep.

Any final closing errors in a finished loop were carefully balanced throughout the station to station differences of that loop.

As the field survey results came to hand, checks were made on the Magnetometer results, and it was found possible to simplify the field technique in as much as the base Magnetometer was discarded. The magnetometer accompanied the Gravity meter as before, and readings made just as previously, but the diurnal variations could be effectively accounted for by drawing Magnetometer Drift Sheets in the same way as for the gravity meter, as long as the time interval between the repeat readings at any station did not exceed 2 hrs. This released the base operator for other work, mainly computing results, for the base Altidude Meter can be read by a relatively unskilled man.

With progress in field organization and supply, and as each man became trained for his job, not the least of which was learning to quickly negotiate sandhills and avoud "bull dust" ground, the survey gathered momentum. But time being the essence of the work, more men, instruments, and vehicles were put into the field, until by July the two field parties were using three Gravity Meters, four field Magnetometers, two base recording Magnetometers (automatically photographed), four theodolites and four levels. The introduction of the recording Magnetometers, whoch only need setting up each morning and an occasional check made on the levels, meant that it was now possible to separate the field Magnetometers from the Gravity Meters, and read each station only once, the diurnal variation being found from the recording Magnetometer. Thus if carried in a separate vehicle, the field Magnetometer could cover two to three times as many stations as the Gravity Meter, and so the Magnetometer operator was quickly available for other work.

At first, the Field Data Sheets of all instruments - a carbon copy of which is made in the field - were reduced in the field as far as the corrected station to station values, using the original field base station at Hawker Gate with an arbitrary value as a starting point. These results were then sent to Broken Hill for mapping and contouring, and from there to Head Office, Melbourne accompanied by a monthly Report by the Director of Field Operations, for checking and perhaps the first attempts at interpretation,

With smoothness coming to field work, as well as more operators and instruments, the mapping and contouring waslalso done in the field, on standard sheets prepared by a Draughtsman in Broken Hill. Due to the size of the area under survey, and the necessaril large scale of these maps (1 and 4 moles per inch), some care had to be exercised to get a numbering system allowing easy and logical location and indexing of all maps in a filing system. A modification of the military map endex was finally adopted.

By mid-July the geophysical instruments and operators still overbalanced the rate of progress of the optical surveyors. Steps were taken to overcome this while awaiting the arrival of more men and instruments from America.

Firstly some levelling was done by the Magnetometer operators after they had completed the magnetic survey of the stations in hand from any one camp. Then hydrogen-filled kite balloons, as illustrated in Fig. IX. were tried.

Fig. IX

The idea was to set these up successively at positions inside the loop, and triangulate onto them. Unfortunately in practice the balloons were practically invisible beyond about four miles, and as considerable trouble was experienced in handling them away from the base camps, they were abandoned in favour of a third idea.

This was to use the light aeroplane accompanying the expedition, in the following manner. (Refer to Fig. VIII). The instrument Jeeps go ahead and mark out the station intervals by speedo; sometimes aided in general direction and pathfinding by smoke bombs dropped from the Auster; and instruments read as they establish each station - the Magnetometer operator when separated from the Gravity Meter could accomplish a full half loop in one or two days. The base line containing stations 1-1727 to 2-24 is then optically surveyed and levelled in the normal way. Theodolites are then set up at stations 1-1727 and 2-18. The Auster then flies to station 2-7, 2-37, 2-36, 2-48 and 2-47 in order, as long as it is still visible from stations 1-1727 and 2-18. On reaching a station - marked by special flags - it circles round it for a few minutes to allow the surveyors on stations 1-1727 & 2-18 to pick up the rang

Then the pilot drives towards the flag and executes a predesigned manouvre when directly over it. The surveyors shoot on the plane at this moment, and by reading bearings, are able to locate the station. When stations up to 2-47 are completed, the theodolite from station 1-1727 proceeds to station 2-20, and the plane flies over stations 2-47, 2-46 and 2-45. The theodolites and plane thus progress down the loop locating all stations with respect to the base line 1-1727, 2-24. Levels for these triangulated stations are carried by the Altitude Meters accompanying the instrument Jeeps.

The size and layout of the loops and offshots were designed primarily for giving maximum geophysical information in a reasonabl time. A second consideration may have been the method of progress of the field camps. From the early reconnaissance flights it looke as though a half loop of 16 miles on either side of a central camp could be economically carried, the camp then moving forward 32 miles or thereabout to a suitable spot near the centre of the next loop.

In practice, however, the rough country so lowered the speed of the vehicles - especially the instrument Jeeps - that to get to the furthest stations in any one loop, required up to four hours driving each way. To alleviate this, it was decided to establish "fly" or "lightning" camps for the more distant portions of the loops. The surveyors and operators, accompanied by a cook and driver taking a 4 x 4 Blitz waggon with sufficient food, water, bedding and othe gear for the part, left the main camp and set up a base at the most suitable point as regards the survey work itself and the availability of timber and fires and so on. Thus the technical men had only short distances to travel to and from work, and the survey speeded up considerably. Later this practice, which was normally against the policy of the directors of the survey on account of the lowered living standards it forced on those concerned, was abandoned in favour of the even more rapid methods previously described. When using "fly" camps it became obvious that it would be advantageous t have wireless communication with the main camps, and to this end, walkietalkie sets were tried out, but those tried did not have sufficient transmission range.

On completion of the first full loop based in Hawker Gate, the writer was transferred to Party No.1 in the Lake Frome Embayment area, then based on Yelniff Tank. This party proceeded first to close a large loop containing Glenmanyie and Culberta Bores, Yelniff Tank, Kytoon Swamp and Starvation Lake to the Border Fence as shown in Fig. IV, having also made an offshoot to Arboola Bore from Yelniff Tank.

Several aeroplane ties were made from this camp, both magnetic and gravimetric, and a very memorable Jeep tie was made from the Border Fence near Pine View to Westward Downs, tying in with the grid worked by the Commonwealth.

Party No.1 then moved by a circuitous route - forced by th difficult country between Arboola and Mullawurtina Bores - to a point roughly halfway between these two bores, and by working each way from here, the loop was closed as shown in Fig.IV to the southern leg of the Northern triangle.

The initial fieldwork in the Embayment area was now complete, and Party No.1 moved up to Yandama Station and proceeded to work from the eastern end of the Hawker Gate loop towards Tibooburr then, turning north-north-west, this Party has headed for the top of the northern triangle at Patchawarra Bore, and at the same time Party No.2 is working up the Strzelecki Creek to Patchawarra Bore. At the time of writing, these two parties are well over halfway towards this Bore.

Although mention has been made of the rough country encoun tered, there is no doubt whatever that the survey has been much easier than it normally would have been, due to the best rains for many years in these parts. As a result of these rains the remarkab le growth of the desert flora helped to bind down the sand, thereb making it easier to negotiate with surface transport, and also greatly reducing the dust problem and its many attendant troubles.

PERSONNEL:

The survey, being new to this country, is being directed by American Geophysicists. These highly qualified and experienced men work both in the field parties ~~xxxxx~~ as Party Chief and from Headquarters in Melbourne and Broken Hill.

At first two Dutchmen were the only trained geophysical operators, but two Australian trainees were taught, first the Magnetometers and later the Gravity Meters, and later still more American and Dutch operators wrer brought in. All these men held University degrees or Technical College diplomas.

Commencing with one surveyor and one man operating a level, great trouble was experienced in enlarging this staff, largely because of the surfeit of survey work in the capital cities accompan ing the heavy building programmes. But eventually more Australian Surveyors arrived, and when Party No.1 was taken over, 3 more men with surveying ability were acquired. These were, as mentioned before, supplemented by the American and Dutch surveyors brought out in August-September.

Also attached to each party was at least one geologist. They, apart from having some administrative duties and at times helping with the optical survey, made a condinuous geological stud of the country passed over. The geophysical operators were also expected to keep an eye on the geology of the surface features, noting any significant points such as changes of vegetation which might indicate a near-surface basement. Whenever a basement outcro was seen, samples & descriptions were collected, labled and forwar ed to the geologists. One such notable feature seen by the writer was a limestone outcrop in the form of a hill-range about 200ft. high, east of the northern section of Lake Frome, in the vicinity of Lake Pundalpa. On such outcrops as this, not only was it custo ary to pick out typical rock samples for the geologists and for specific gravity tests,- these latter could be made rapidly in the field with a small portable balance built especially for the job - but when possible a gravity profile was run across the outcrop to determine what might be called the mass specific gravity of the basement, for use in the corrected gravity reductions. Similar gra ity profiles were made over ordimary sandhills to find their mass specific gravity.

A qualified mechanic accompanied each party for the all-important task of transport maintenance. Here the two commonest troubles were broken shock asborbers and, perhaps largely consequently, broken main springs, and replacements wrer for some time obtain bl .

Drivers, drivers' assistants - who acted as rodmen to the optical surveyors - cooks and cooks' assistants, made up the remainder of the personnel. A large percentage of these men were either from stations or had spent some time working on stations, & their knowledge of the country was most useful, especially in one or two outstanding cases.

All vehicle drivers had to carry out daily inspections of their Jeep or Truck, filling out daily, weekly and monthly report sheets/

Each camp was controlled in the field by the Party Chief, General camp duties wrer allocated by the camp forman, responsible to the Party Chief.

No expense was stinted to build up and maintain high working conditions for the field parties, as on the labour turnover of these men, depended to a considerable degree the speed of the survey. The food was excellent, cooking being done in Army-type mobile steam cookers. Two-man tents, camp stretchers, mattresses, mosquito nets and blankets were supplied to everyone. Recreation facilities were provided in the form of footballs, boxing gear, darts and boards, cards, quoits, and reading matter and some sport shooting was allowed covered by safety rules. A portable wireless transceiver accompanied each party, and regular sessions on the Flying Doctor network were maintained, this allowing the sending & receiving of telegrams to any part of the world.

(Paragraph)
Mail was flown to and from Broken Hill on an average of twice per week, as wrer fresh fruit and vegetables. The general level of pa was good, and leave given on the basis of a five day week, i.e. after 40 days in the field 16 days'leave on full pay, with free(air transport to and from Broken Hill. Consequently, the whole camp maintained high spirits and the men were willing and fairly efficient

INSTRUMENTS:

The gravity Meter used on this survey is built by Carter Oil Company, and is a development of the Meter produced previously by the Humble Oil & Refining Company, both being subsidiaries of Standard Oil of New Jersey.

Unfortunately the construction of practically every make of Gravity Meter is somewhat secret, and this particular one is not available to the public for purchase. It is in principle a balance kept at constant temperature, compensated for changes in atmorpheric pressure; which is levelled, unclamped, adjusted to a null point, read, and reclamped, the process being repeated until repeat readings within 0.1 gravity units are made. One of the most remarkable things about these instruments is that depsite extreme sensitivity and consequent delicacy, they can nevertheless be operated so rapidly and reliably under rough conditions. Their maintenance is, of course, a very highly skilled undertaking demanding intimate knowledge of their method of operation, construction and assembly.

Fig.Xa shows a Gravity Meter being read through the floor of a Jeep, and Fig.Xb shows a closeup of a Carter Type Y Gravity Meter.

Fig. Xa

Fig. X b

The Magnetometers used were Ruska Type V instruments, a development of the Schmidt balance. A magnetic element is balanced, or almost balanced, on knife edges, and as the instrument is moved from station to station the various degrees of unbalance are registered in a scale viewed through a telescope. In operation, the tripod is first set up and roughly levelled , orientated, Magnetometer attached and accurately levelled, released several times and the mean reading noted, reclamped, rotated through 180°, unclamped several times and the mean reading noted and reclamped; the mean of these two means is the value at that station. To accommodate big magnetic anomalies, it is possible to alter the sensitivity of the instrument, which is also adjustable for temperature compensation and for alterations to allow for its use in any latitude of either hemisphere. Auxiliary magnets are supplied for several purposes.

The Ruska Vertical Field Magnetometer is illustrated in Fig. XIa, and the Base Recording Magnetometer in Fig. XIb

XIa

XIb

Both instruments will register changer of 1 gamma (10^{-5} gauss) when in their most sensitive state. Of course in operating these instruments, clothing must be worn which contains no magnetic material whatever.

The Wallace and Tierman Sensitive Altitude Meters are merel very sensitive aneroid barometers. Graduated in meters or feet, and having definite ranges, individual readings can be made to about one foot. By using the 2 base method, elevations can be carried to within remarkably small errors. These instruments are clamped whenever being moved from one station to another, or when being flown anywhere.

There were a number of different surveying theodolites and levels in use, both stadia and transits, and Watt's "Quickset" levels. After trying out the Philadelphia telescopic survey rod, the Americans introduced the so-called "E" rod, illustrated in Fig.XII, and this proved preferable, being much easier to read and giving all the required accuracy.

Fig XIII shows schematically the way a gravity anomaly may occur.

Fig. XII

Fig. XIV a magnetic anomaly.

Fig. XV shows a sample **Gravity** Meter Drift Sheet.

Fig. XVI shows a sample Magnetometer Drift Sheet.

INTERPRETATION:

The interpretation of the geophysical survey is in a sense the most difficult and highly skilled part of the whole problem of geophysical prospecting, and certainly requires many years of experience and a good knowledge of geology. A gravity high for example may be due to a rise in the basement rocks, or merely a local increase in the density of those rocks, or even to a local increase in the density of the rocks overlying the basement, or perhaps to a fault as against an anticline. To aid in solving such ambiguities is one of the main reasons for doing a magnetic survey as well as the gravity survey, for even when the two apparently oppose each other - e.g. a magnetic high occurring at at a gravity low - they are giving more positive evidence than either alone.

Quantitative calculations are made, correlating all the known physical properties of the basement and overlying rocks, as found from bore logs, the varying specific gravities and magnetic susceptibilities of the rocks, the ratios of permanent and induced magnetism, and so on, Usually several possible solutions are reached, and these are examined for the one most likely to occur going on the known geology of the area.

Then, if it is considered worth while, a drill hole may be sunk to prove or disprove the suspected formation.

No attempt has been made to give detailed information regarding the geophysical instruments, their adjustments and uses, or field techniques of geophysical surveying in general, for it has no place in a general report of this nature.

ACKNOWLEDGEMENTS:

The writer wishes to express his deep appreciation to Mr. Jack K. Dahlberg, Director of Field Operations, for his help, advice and friendliness, to Willie A. Wiebenga, for willingly passing on his knowledge, and to Monnie Fenner for held in preparing this Report.

(W.G. FENNER)

WGF:TJA
13.11.47

Fig. XVII

Fig. XVIII.

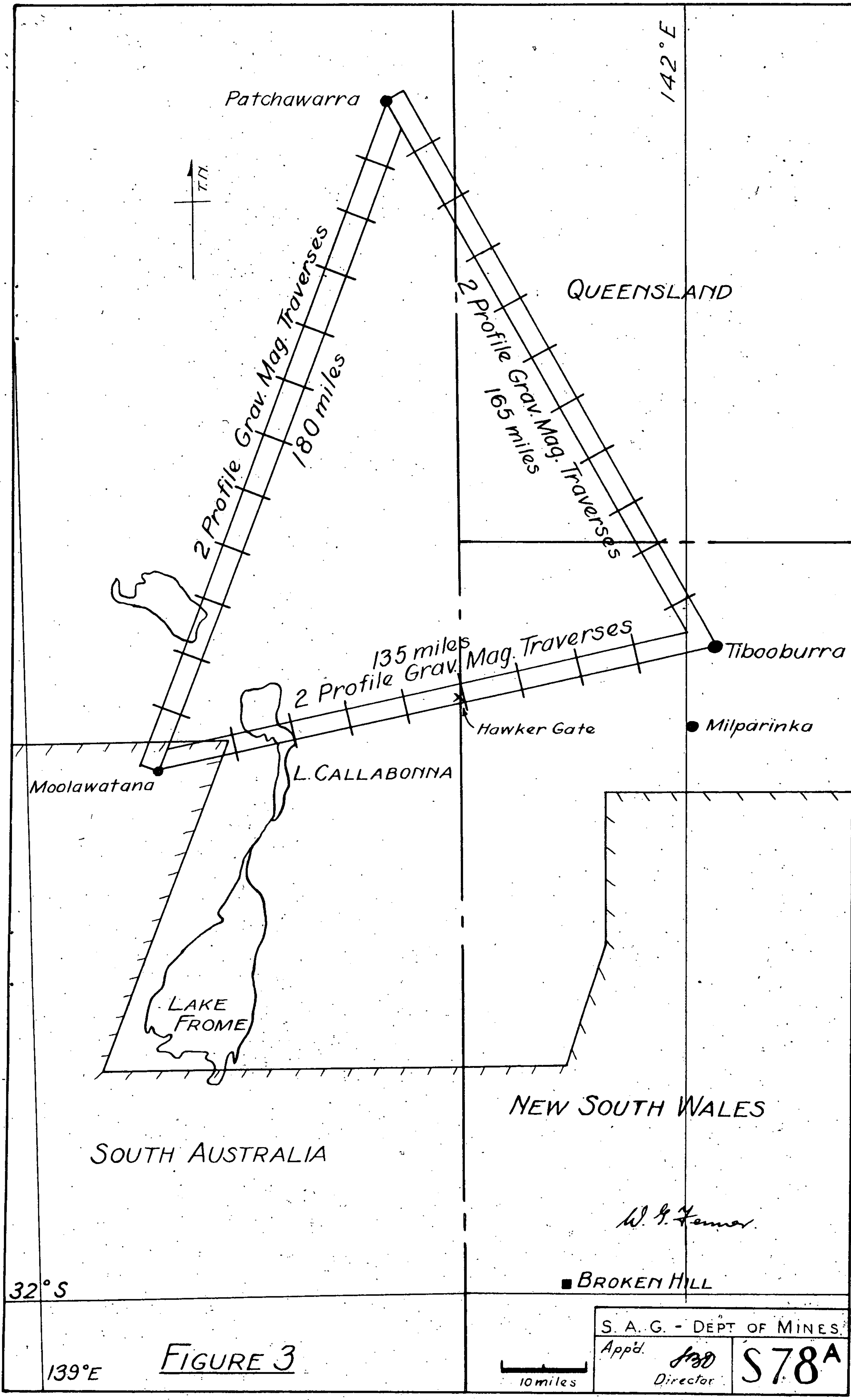
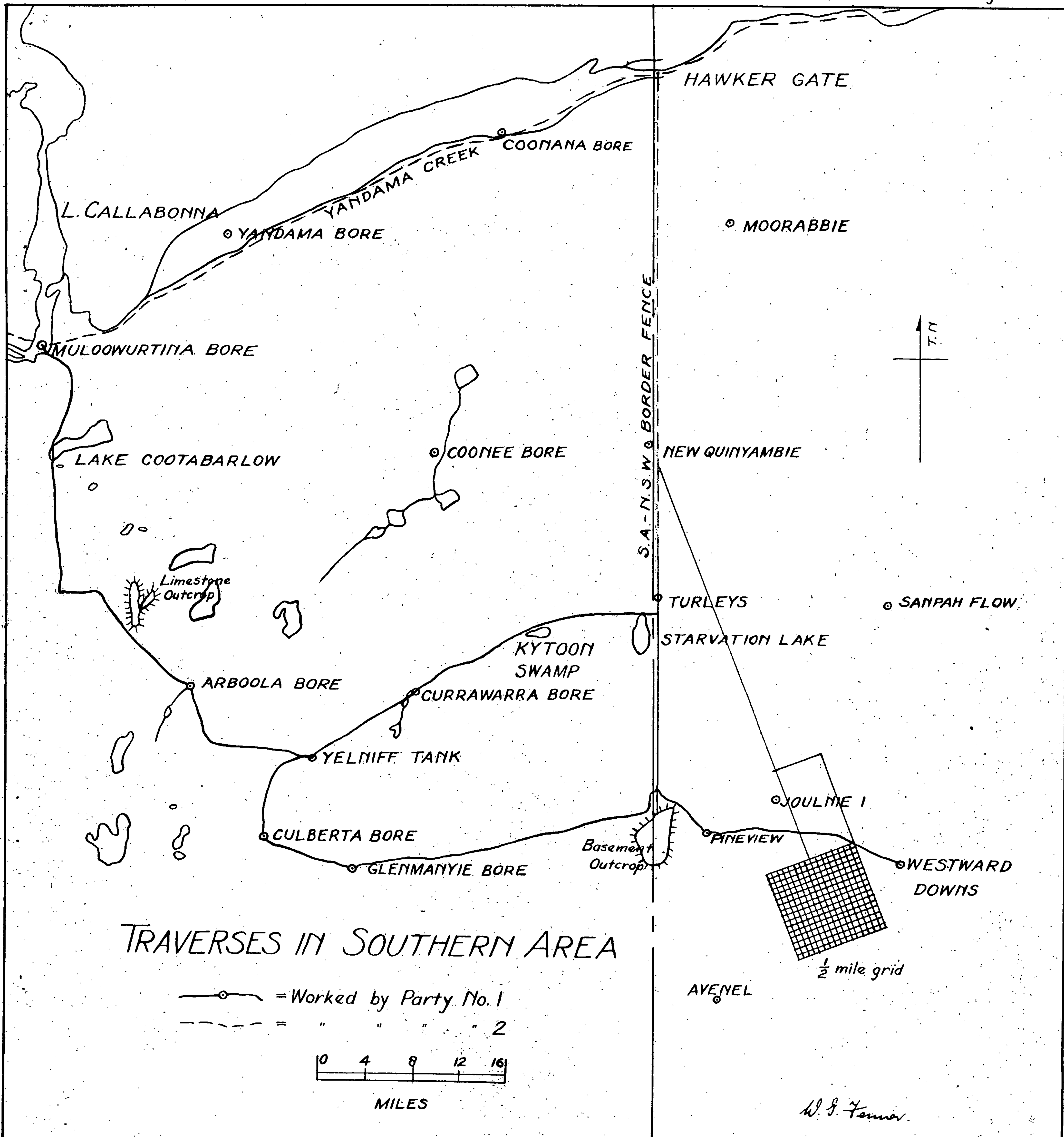

142° E
Patchawarra
T.N.
2 Profile Grav. Mag. Traverses
180 miles
2 Profile Grav. Mag. Traverses
165 miles
QUEENSLAND
135 miles
2 Profile Grav. Mag. Traverses
Tibooburra
Hawker Gate
Milparinka
Moolawatana
L. CALLABONNA
LAKE FROME
NEW SOUTH WALES
SOUTH AUSTRALIA
W. G. Fenner
BROKEN HILL
32° S
139° E
10 miles
S. A. G. - DEPT OF MINES
App'd.
Director
S78A

FIGURE 3



TRAVERSES IN SOUTHERN AREA

W. G. Fenner.

FIGURE IV

S. A. G. - DEPT OF MINES

App'd [signature] Director of Mines.

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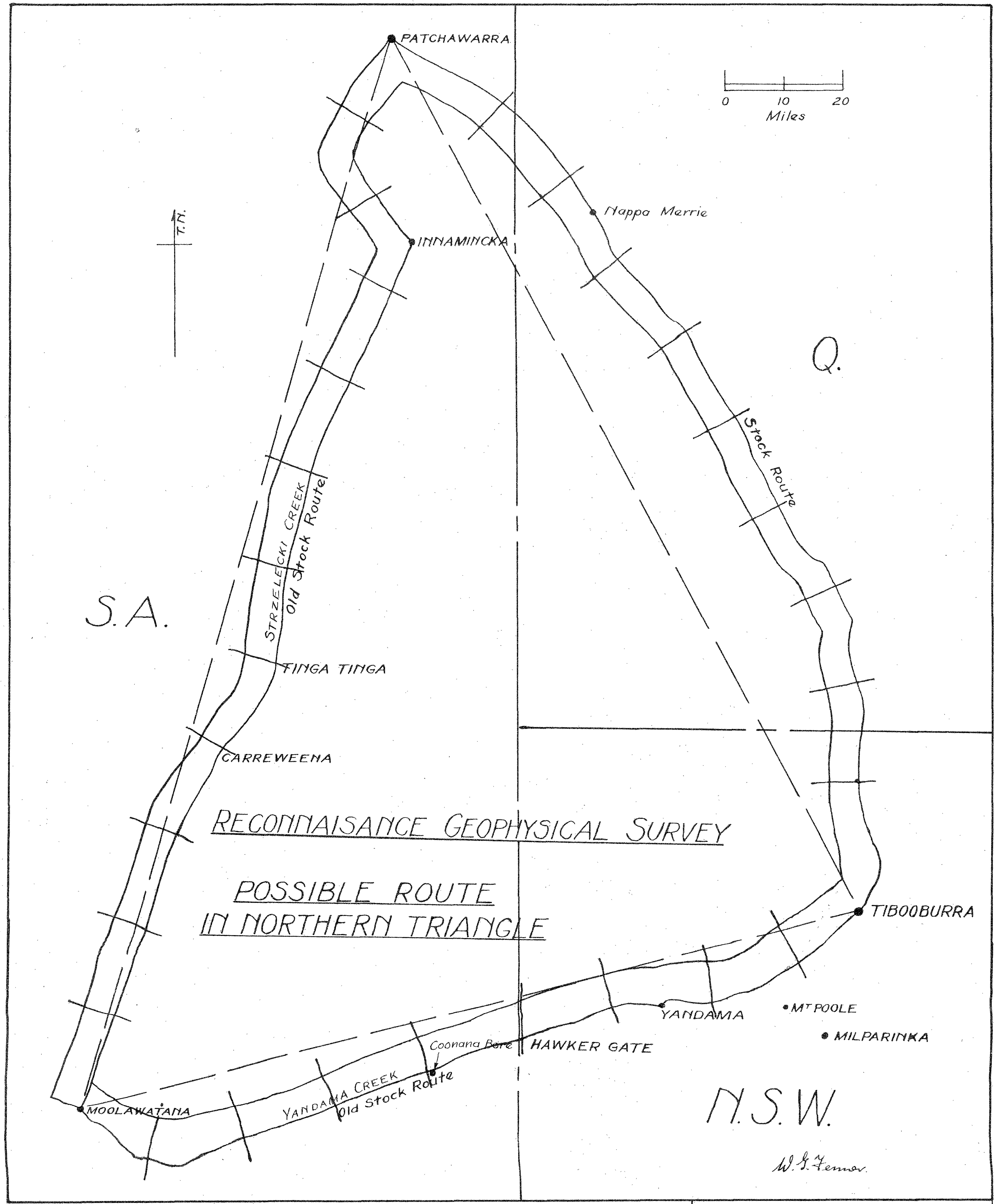
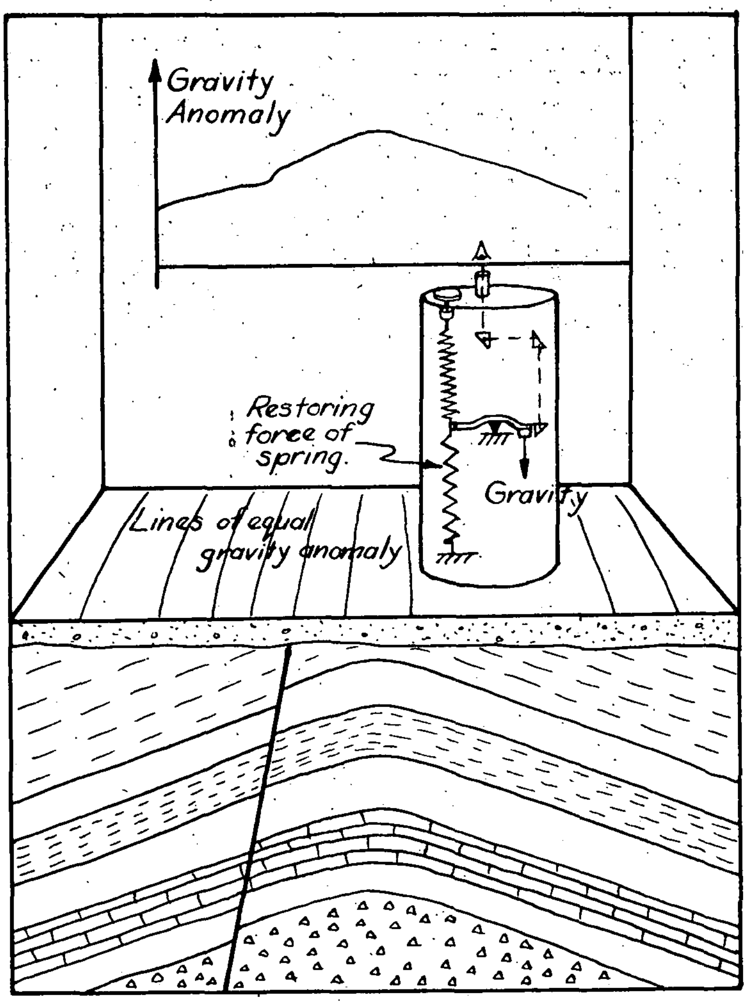


FIGURE V

S. A. G. - DEPT OF MINES	
App'd. SBD Director of Mines	47 - 197

PRINCIPLE OF USE OF GRAVITY METER



W. G. Fenner.

FIGURE XIII

This figure shows schematically the use of the Gravity Meter. As changes occur in densities & depth of formations beneath the meter, small changes in the weight of a given mass also occur, and this change of "g" is measured by the Gravity Meter. Corrections are applied for latitude, elevation, & the rock between stations & sea-level.

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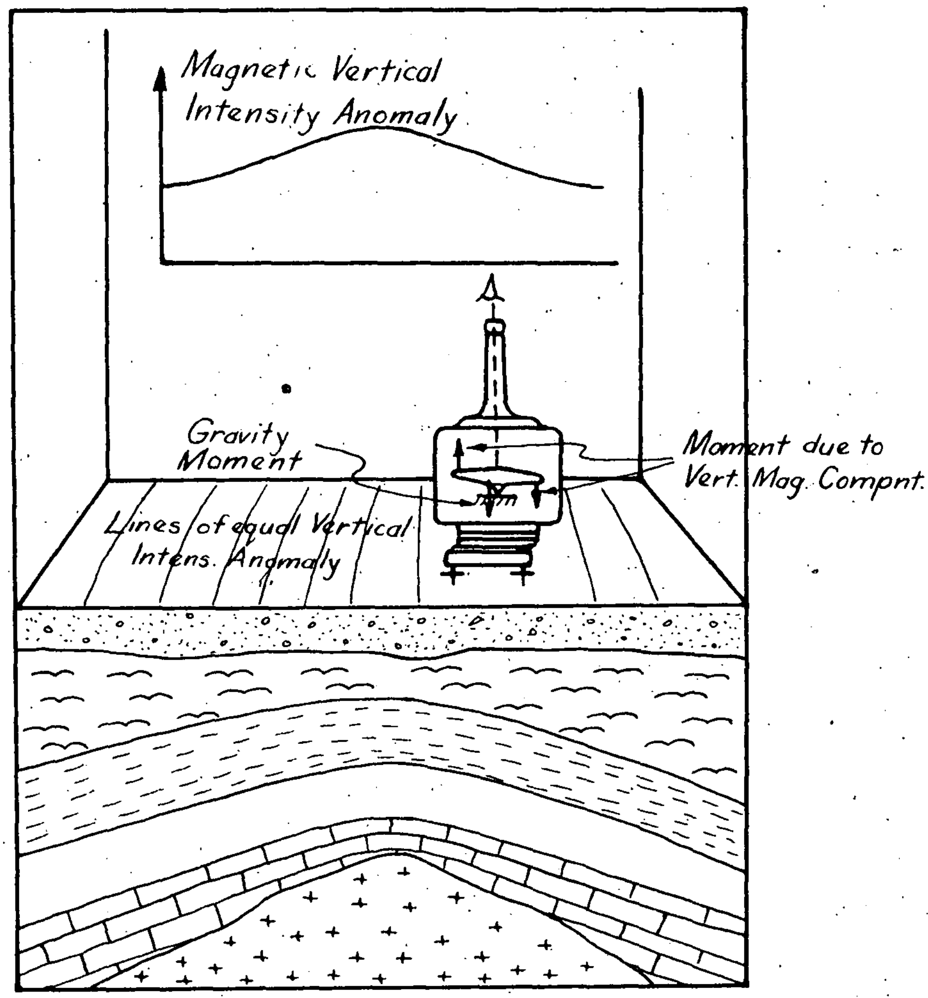
App'd. [illegible] Director	S78E

PRINCIPLE OF USE OF MAGNETOMETER



W. G. Fenner

FIGURE XIV

This figure shows schematically the use of the Magnetometer. Here changes occur from place to place in the intensity of the earth's magnetic field, & this instrument measures the vertical component of this field. Corrections are applied for diurnal variation, temperature effects, & variations with latitude.

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Appd. [signature] Director	S 78 F

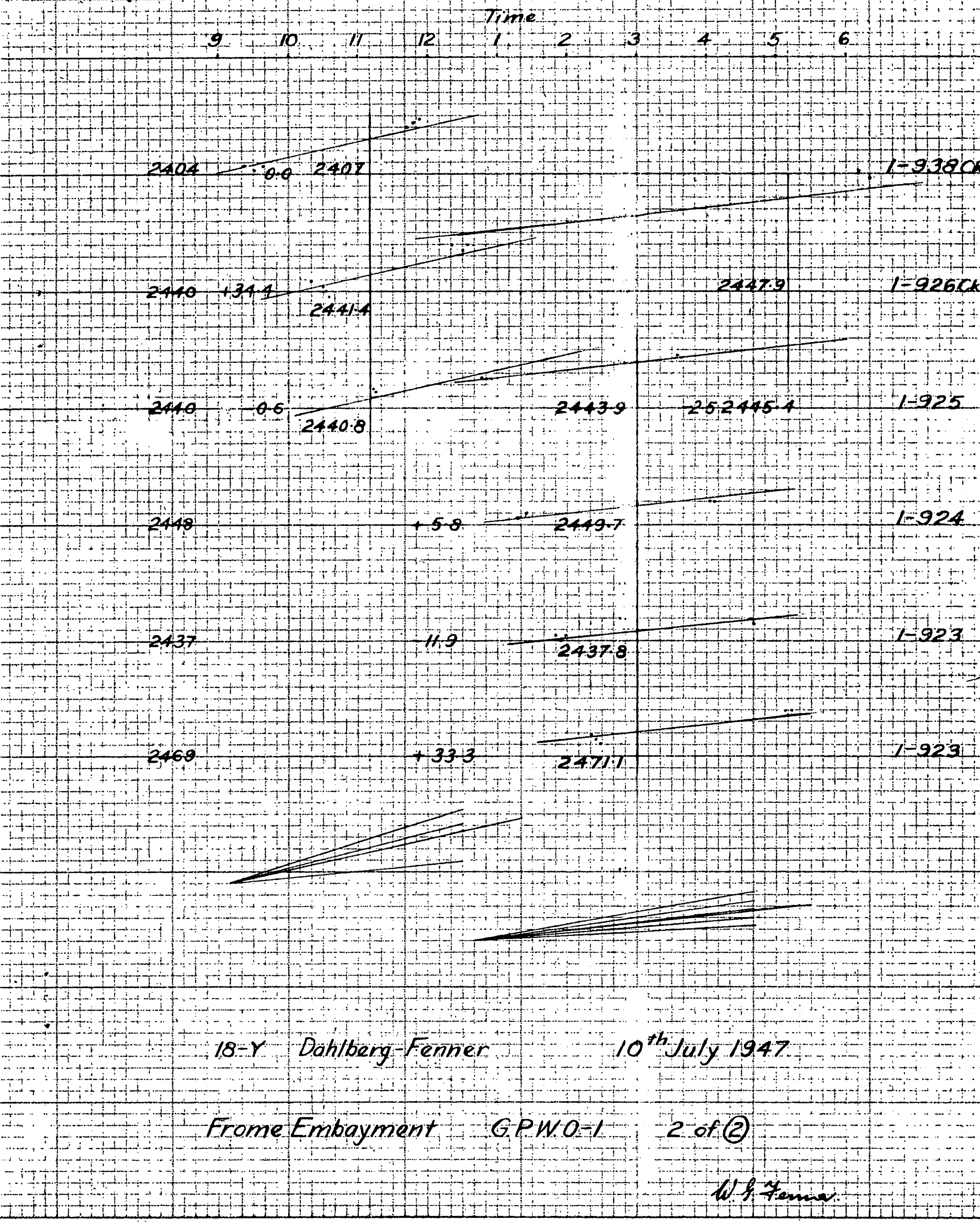

FIGURE 15

Shows Sample Gravity Meter Drift Sheet.

Key: Left hand column represents changing station to station base line.
Next column is the station to station differences read from graph.
The third column is value of intersections with common vertical line.
Right hand column gives station numbers.
All values represent dial divisions of Gravity Meter 18-Y.

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App'd Director	S 78 G

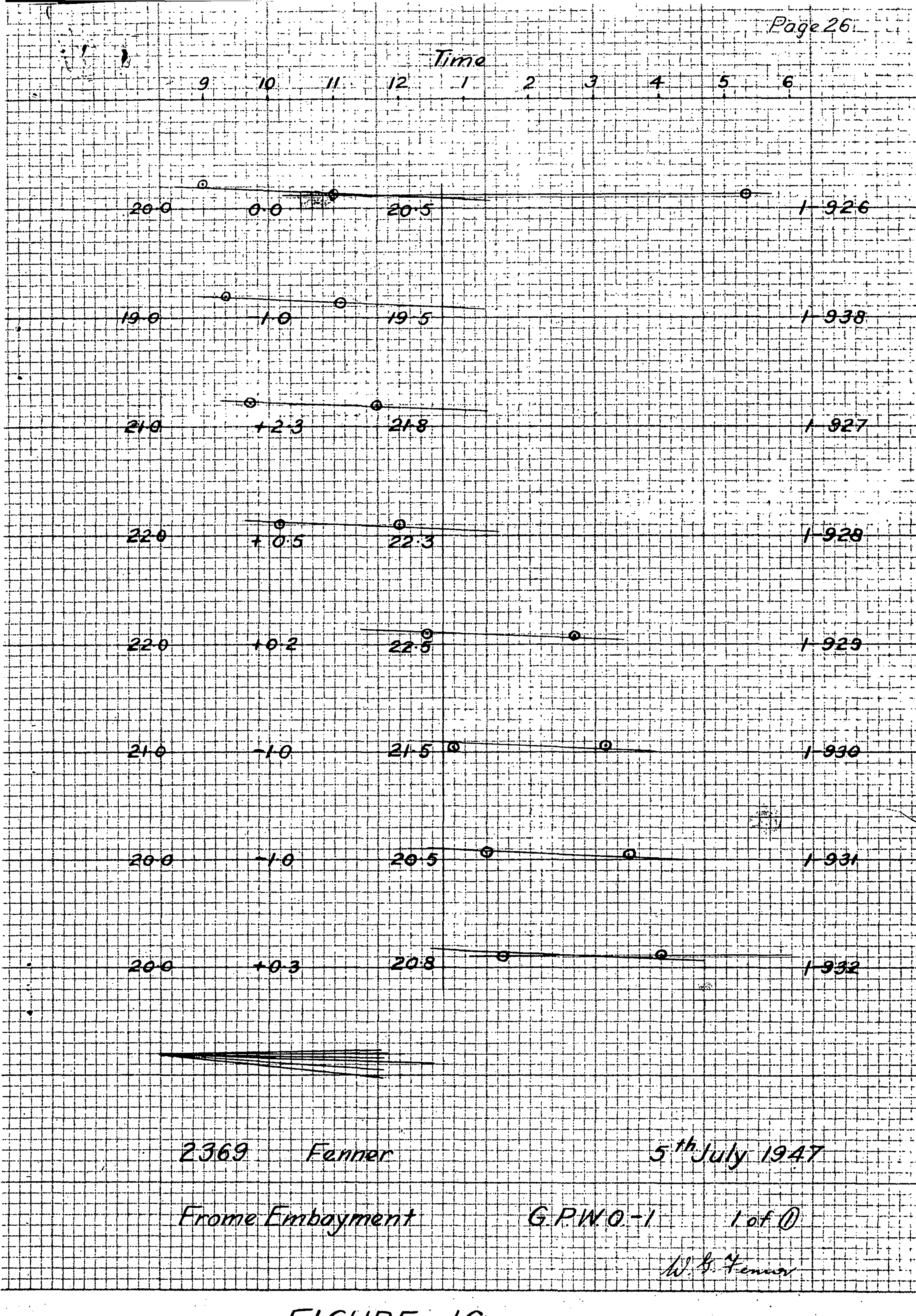

FIGURE 16

Sample Magnetometer Drift Sheet.

Key: Same as in Fig. 15.

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App'd. Director

S 78 H