COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1953 No. 4

GEOPHYSICAL TEST SURVEY OVER DYKES IN THE NEWCASTLE COALFIELDS, N.S.W.

by

J. HORVATH

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ABSTRACT

Results are given of a geophysical test survey made at three localities on the Newcastle coalfield in August, 1952, to determine whether intrusive doleritic dykes could be located by the magnetic method. Knowledge of the position of the dykes would assist in planning the lay-out of underground workings and of surface roads.

The results showed only slight variations of the magnetic field, but some weak anomalies of less than 100 gammas were recorded. The position of these anomalies coincides with the inferred position of the basic dykes near the surface. The variation in the shape of the anomalies suggests non-uniformity of the magnetic properties and shape of the dykes.

The magnetic method might be helpful in determining the position and extent of the dykes beyond the areas where they are known, but supporting evidence from other geophysical methods such as the gravity or electric resistivity methods may be needed to verify the magnetic results.

1. INTRODUCTION

At the request of the Broken Hill Pty.Co.Ltd., a geophysical test survey was made in the Newcastle area by the Bureau of Mineral Resources between 14th and 18th August, 1952.

The survey was made at three different localities on the Newcastle coalfield to determine whether the intrusive dykes that occur in this field could be located by the magnetic method. With the assistance of Mr. F. Canavan, Chief Geologist of Broken Hill Pty., some suitable areas were selected where the position of the dykes is known approximately from observations made in the mine workings. Altogether,five traverses were surveyed in the course of the test. Two at the Stockton Borehole Colliery were over a dyke which is close to the surface. Two traverses at the Lambton Colliery were over some dykes covered by thick sand, and one near the John Darling Colliery was over the assumed extension of a known dyke. The position of the collieries is shown on Plate 1.

Knowledge of the extent and position of these dykes is required for several reasons. Firstly, it would enable the mine workings to be laid so that coal production is affected as little as possible by the dykes. Secondly, the workings could be planned to avoid zones adjacent to the dykes where the coal quality is poor owing to cindering. Thirdly, it may be possible to plan the laying of roads, railways, etc., so that they would be situated over dykes. This would help to conserve coal reserves, as the necessary safety pillars would then fall within the dykes and not in coal.

It was decided to make a magnetic survey first, as this method, if successful, would provide the easiest, quickest and cheapest way of locating the dykes. The Broken Hill Pty. Co.Ltd. pegged the observation points and the geophysical survey was done by J. Horvath, assisted by the surveyors of the respective collieries. The survey was planned to determine whether or not a more extensive magnetic survey would be warranted to determine the position and extent of the dykes beyond the areas where they are known.

The assistance given by the Ore Department of Broken Hill Pty. in Newcastle (Messrs. McCandy and Looney), by the surveyors of the respective collieries who pegged the traverses, especially by the surveyor of Lambton Colliery who assisted with the geophysical field work in all three areas surveyed, is acknowledged.

2. GEOLOGY

The collieries in the Newcastle district are located in Upper Permian rocks, consisting of shales, cherts, sandstones and conglomerates, with a number of coal seams, of which only the lowest, or "borehole" seam, is large enough for economic mining.

Near the coast, the coal measures are covered by sand dunes. In the area surveyed near Lambton Colliery, the thickness of sand reaches 80 feet. The coal measures have very low dips, and show little evidence of tectonic disturbance, except for some minor faulting. They have been intruded by basic dykes of doleritic composition, up to two hundred feet thick, which have caused coking and cindering in the coal adjacent to them. The general strike of the dykes appears to be westerly and north-westerly, but little information is available about them, for the following reasons:-

(i) They weather to "trap" rock or clay, and are inconspicuous in outcrop. Even where the coal measures are not covered by sand, it is impossible to trace the dykes by surface mapping.

(ii) Information concerning the dykes is derived from underground workings. These are confined mainly to the "borehole" seam, which is worked at a depth of 700 feet. A large extrapolation is necessary to estimate the position of the dykes at surface from observations taken at this level.

(iii) Because of the hardness of the dyke material, and the fact that the coal near the dykes is valueless, workings avoid the neighbourhood of the dykes as much as possible.

3. SELECTION AND APPLICABILITY OF GEOPHYSICAL METHODS

As no samples of the dyke material were available for testing, it was not possible to determine its physical properties. However, it is very generally found that basic rocks have a magnetic susceptibility which is relatively high but varies over a wide range. The susceptibility may be expected to be greater than that of the sediments in the Newcastle coal measures and it was expected that the dykes would give magnetic anomalies due to this contrast. As mentioned in the previous section, the dykes are generally deeply weathered to clay which has a low magnetic susceptibility similar to the sediments. The effect of this weathering is to increase the depth to the top of the magnetic dyke with a corresponding decrease in the magnitude of the expected anomalies. The magnetic method is rapid and economic in operation and was considered suitable for the tests.

Due to the presence of mine buildings and residences which give rise to erratic and usually large magnetic anomalies, it was not possible to select any area in which the position of the dykes was known with any approach to accuracy, and over which a routine magnetic survey could be carried out. All that was possible was to select isolated traverses. The results therefore give only a general indication of the possibilities of the method.

Other geophysical methods such as the electrical resistivity and gravity methods might be suitable, but compared with the magnetic method they are slow in operation and relatively costly. The weathered dykes, comprising mostly clay, might be expected to have a higher electrical conductivity than the enclosing sediments and the contrast in conductivity should be detectable by suitable methods. It is possible that the dykes would give significant gravity anomalies due to their density being substantially higher than that of the sediments.

4. FIELD WORK AND RESULTS

The traverses to be surveyed were pegged by surveyors of Broken Hill Pty.Co.Ltd. with pegs at intervals of 50 feet along each traverse. These were numbered as shown on the enclosed sketch maps (Plates 2, 4, and 6). As the field work revealed only slight variations of the magnetic field, the distance between observation points was reduced to 25 feet. These points were not pegged, but were marked by pacing from the adjacent pegs.

The areas surveyed are fairly flat and presented no topographical difficulties in the survey. Large areas, especially around the mines, are closely settled however, and the presence of garden fences, pipelines and buildings, as well as pieces of iron lying about, made it difficult to select traverse sites which were not affected too greatly by artificial magnetic disturbances.

A Watts vertical magnetic balance with a scale value of 27.6 gammas per scale division was used in the tests and was adjusted for the latitude of the Newcastle coalfield.

Weather conditions were bad and heavy rains hampered the progress of the work, particularly by making it difficult to gain access to the areas being surveyed.

The sketch maps of Plates 2, 4 and 6 show the geophysical traverses, some topographical features and the positions of the dykes. The results of the test survey are shown on Plates 3, 5 and 7 in the form of profiles of the vertical magnetic intensity.

5. DISCUSSION OF RESULTS

(a) Stockton Borehole Colliery (Plates 2 and 3).

At the Stockton Borehole Colliery, two traverses were surveyed, each 1,000 feet long and 100 feet apart. The traverses are about 600 feet from the main shaft. The mine workings do not extend to the surveyed area and the position of the dyke is known only some distance nearer to the main shaft. However, it was not possible to make the survey nearer the shaft because several iron structures and buildings, and large masses of iron lying around made it impracticable. The profiles are drawn on a vertical scale of 50 gammas to the inch. The northern portion of the profiles, between pegs 13 and 21, shows little variation in magnetic intensity, maximum variations being of the order of only 20 gammas. The accuracy of readings is about ± 5 gammas. It is probable that the small variations are caused mainly by some small magnetic inclusions in the overburden and are of little significance. However, they are the limiting factor in the recognition of anomalies caused by the dykes.

The central section of the profiles, between pegs 7 and 13, shows some magnetic anomalies of greater magnitude. Of these, the shape of the anomaly on profile A at peg 12 indicates an almost vertical magnetic body. The position of the anomaly is only 50 feet north of the expected position of the dyke as deduced from the mine plan and it is reasonable to assume that it is due to the dyke. The anomaly corresponds to that calculated for a weakly magnetic, narrow, vertical dyke close to the surface. With such a distinct anomaly, however, it is surprising that on the adjacent profile (B) 100 feet away, only a very minor disturbance was recorded at peg 12. Whether this is due to the dyke pinching out between the two profiles or whether there is some other explanation cannot be determined with only two profiles available for the interpretation.

There is a second magnetic anomaly on both profiles between pegs 8 and 9. The shape of the anomaly on profile B indicates a body at shallow depth, magnetised in a horizontal direction, and no satisfactory explanation can be offered for it. The shape of the anomaly on profile A indicates that it could be produced by a dyke further below the surface than the one at peg 12 on the same profile. A check by another geophysical method, or by additional magnetic traverses, is needed to clarify the interpretation. The disturbance at peg 4 on profile A is of rather doubtful significance as it could have been caused by a long piece of wire rope that was lying nearby.

On the whole, the results at the Stockton Borehole Colliery are promising enough to encourage the belief that it is possible to locate the dykes by the magnetic method.

(b) Lambton Colliery (Plates 4 and 5).

At the Lambton Colliery the position of the dykes in the mine is known more accurately than in the other two areas. However, there are at least 70 to 80 feet of sand covering the coal measures and the strength of any magnetic anomaly would be less than if the dyke were close to the surface. The profiles are somewhat disturbed by dwellings situated near the traverse. Nevertheless, magnetic highs were observed on both traverses approximately where they would be expected from the known position of the dykes. A slight displacement to one side or the other is not surprising, as the position of the dykes is known only at a depth of 700 feet below the surface, whereas the magnetic indications are caused mainly by the part of the dyke nearest the surface. A slight deviation of the dyke from the vertical would account for such a displacement.

Although the location of the anomalies suggests that they originate from the dykes, their irregular shape does not permit any simple calculation or interpretation regarding the thickness or shape of the magnetic body. The complicated form of the anomaly on profile 2 suggests that the dykes may have several branches or may have one or more sills associated with them. Alternatively, the irregularities in the profile could be caused by variations within the coal measures or in the overburden. A more detailed interpretation is not warranted without supplementary geophysical measurements, using a gravity or electrical method, to assist in determining the width of the dykes.

(c) John Darling Colliery (Plates 6 and 7).

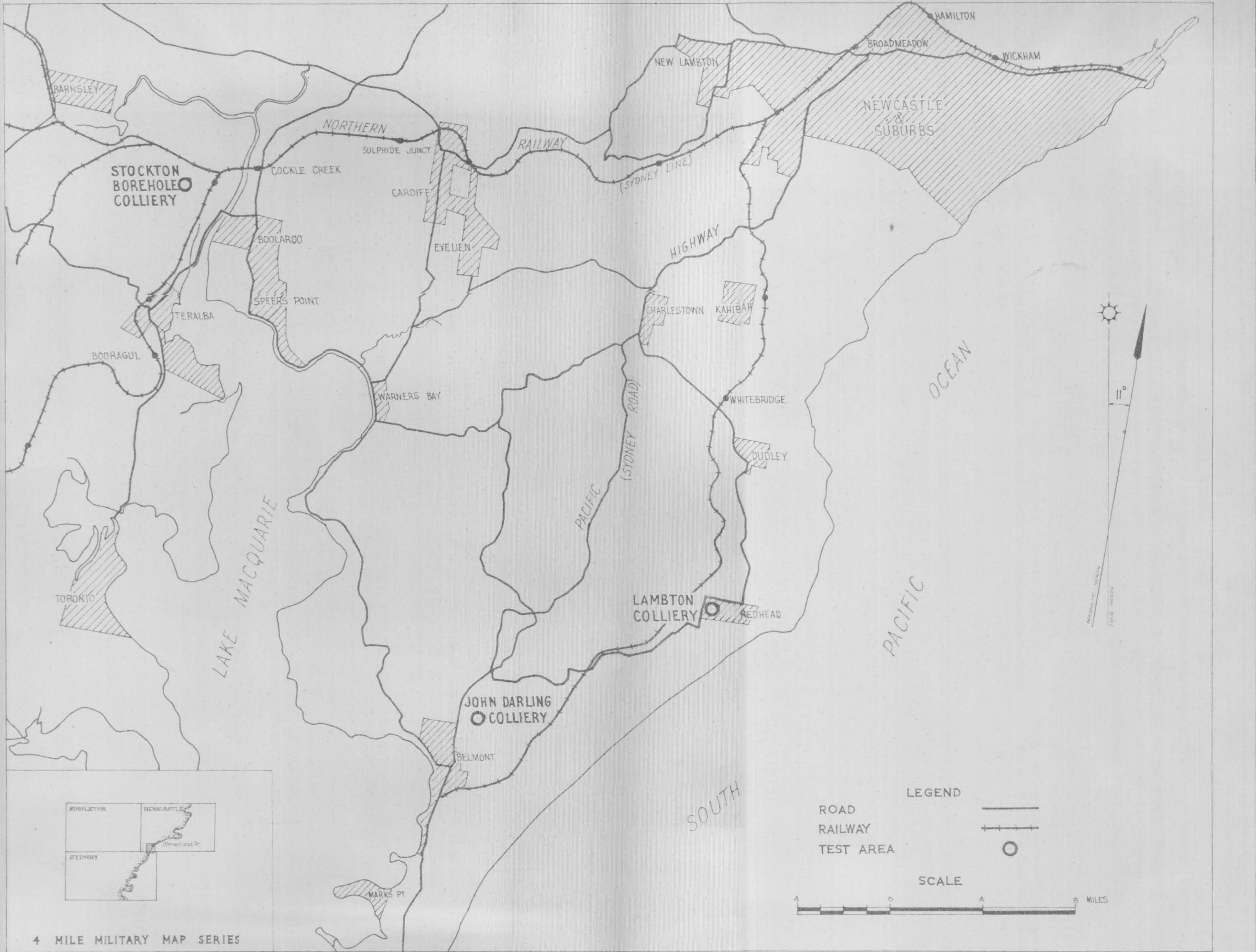
The magnetic survey was made at a time of heavy rainfall, and the area near the known dyke was flooded and inaccessible. A traverse was therefore laid about half-a-mile further west, as requested by the Superintendent of Mines for Broken Hill Pty.Co.Ltd., Mr. Fallons, who was interested in knowing its position in that area. The surveys there can hardly be called a test because too little is known geologically to give a comparison with the geophysical results. It was expected, however, that the dyke would cross the traverse near its midpoint. This traverse was partly under water, and the ground was so soft that it was difficult to keep the instrument level.

The results of the survey show a well-pronounced broad magnetic high, with a maximum of about 100 gammas between pegs 12 and 13. As the anomaly was recorded over a distance of more than 1,000 feet, between points 6 and 16, it is assumed that the dyke is comparatively wide. The shape of the profile also suggests that the main influence comes from considerable depth. The dyke is probably weathered near the surface, with consequent decomposition of the iron minerals and a reduction in the magnetic susceptibility. The maximum of the anomaly is about 200 feet south of the point where the dyke was expected to cross the traverse.

6. CONCLUSIONS AND RECOMMENDATIONS

The tests were successful, insofar as a definite magnetic anomaly occurs close to the extrapolated outcrop position of each of the dykes crossed by the traverses. It seems possible that detailed magnetic surveys would provide a general indication of the presence of the dykes. However, the form of the anomalies varies greatly. For example, the anomalies observed at Stockton Borehole Colliery are similar to those characteristically associated with narrow bodies at shallow depth. This is also true, though not to the same extent, of the anomalies observed at Lambton. However, the single traverse at John Darling Colliery shows an anomaly apparently associated with a deep-seated body.

It is impossible to account for these differences on the geological information available. They indicate, however, that very detailed surveys would be essential, before any reliable conclusions could be drawn with regard to the shape or aspect of the dykes, on the basis of magnetic measurements alone. Such surveys would be quite impossible in built-up areas such as Newcastle. It is possible that other geophysical methods, such as the resistivity and gravity methods, could supply additional information.



LOCALITY MAP

SHOWING

GEOPHYSICAL TEST AREAS ON NEWCASTLE COALFIELD

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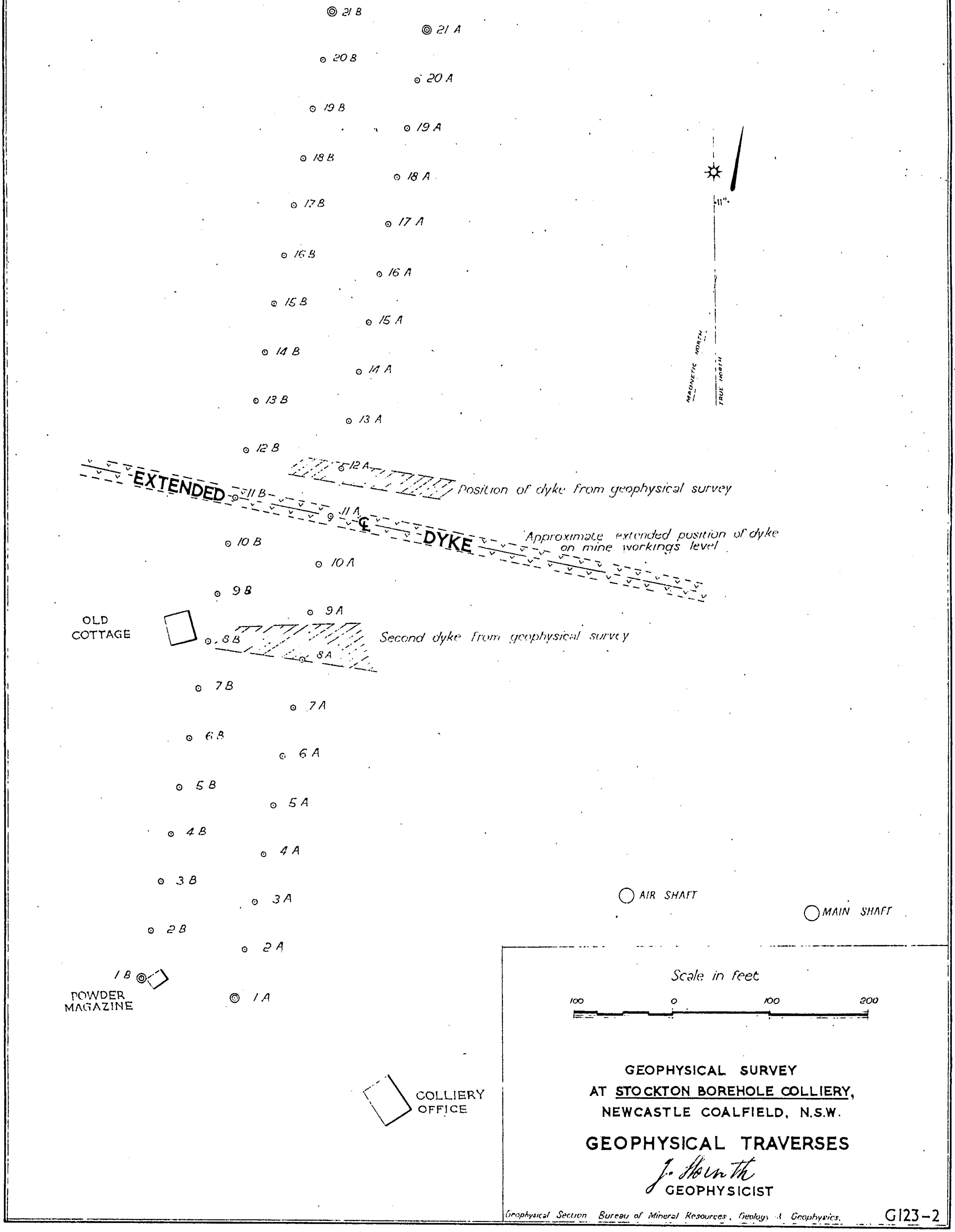
G123-1

PLATE 2


21 B
21 A
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19 B
19 A
18 B
18 A
17 B
17 A
16 B
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15 B
15 A
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14 A
13 B
13 A
12 B
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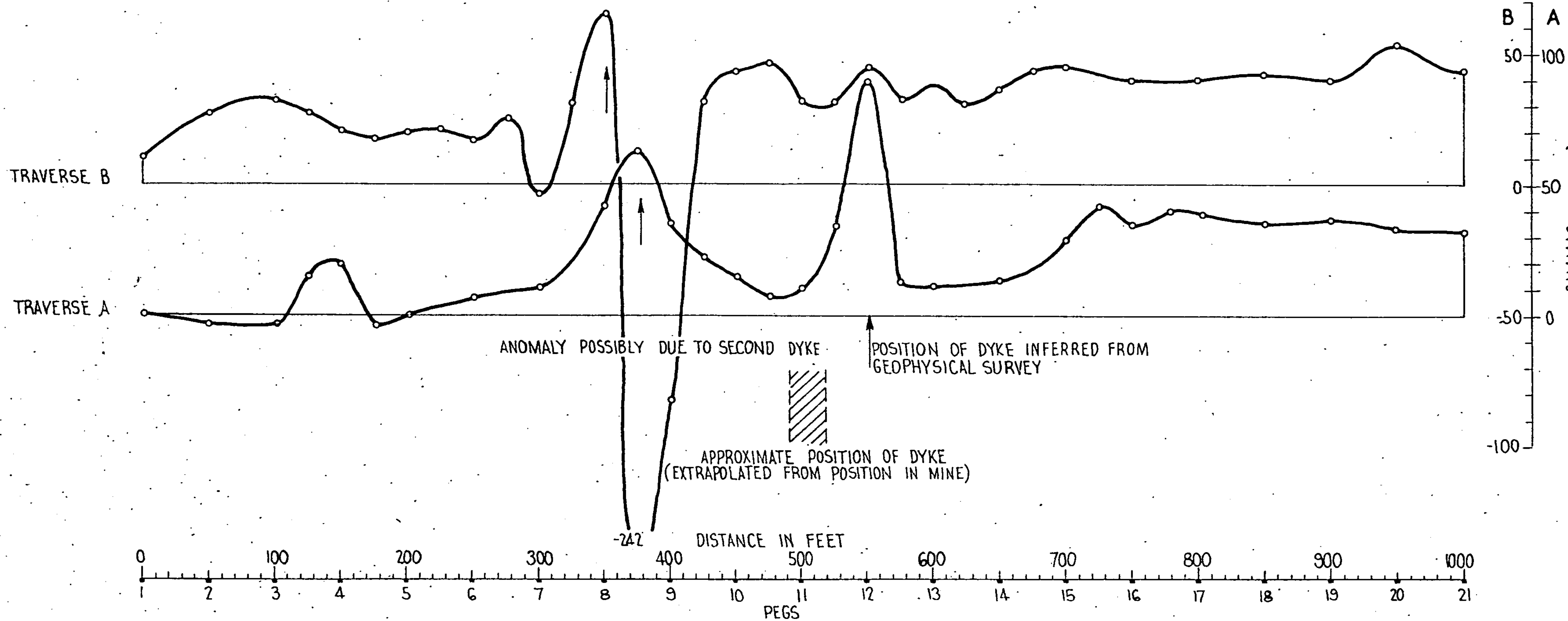
11 B
11 A
10 B
10 A
9 B
9 A
8 B
8 A
7 B
7 A
6 B
6 A
5 B
5 A
4 B
4 A
3 B
3 A
2 B
2 A
1 B
1 A
11°
MAGNETIC NORTH
TRUE NORTH
Position of dyke from geophysical survey
EXTENDED ℄ DYKE
Approximate extended position of dyke on mine workings level
OLD COTTAGE
Second dyke from geophysical survey
AIR SHAFT
MAIN SHAFT
POWDER MAGAZINE
COLLIERY OFFICE
Scale in feet
100 0 100 200
GEOPHYSICAL SURVEY
AT STOCKTON BOREHOLE COLLIERY,
NEWCASTLE COALFIELD, N.S.W.
GEOPHYSICAL TRAVERSES
GEOPHYSICIST
Geophysical Section Bureau of Mineral Resources, Geology & Geophysics.
G123-2

PLATE 3



GEOPHYSICAL SURVEY AT STOCKTON BOREHOLE COLLIERY, NEWCASTLE COALFIELD, N.S.W.

VERTICAL MAGNETIC INTENSITY PROFILES

J. Horvath
GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics

G 123-3

PLATE 4

GEOPHYSICAL SURVEY AT LAMBTON COLLIERY, NEWCASTLE COALFIELD, N.S.W.

PLAN OF GEOPHYSICAL TRAVERSES

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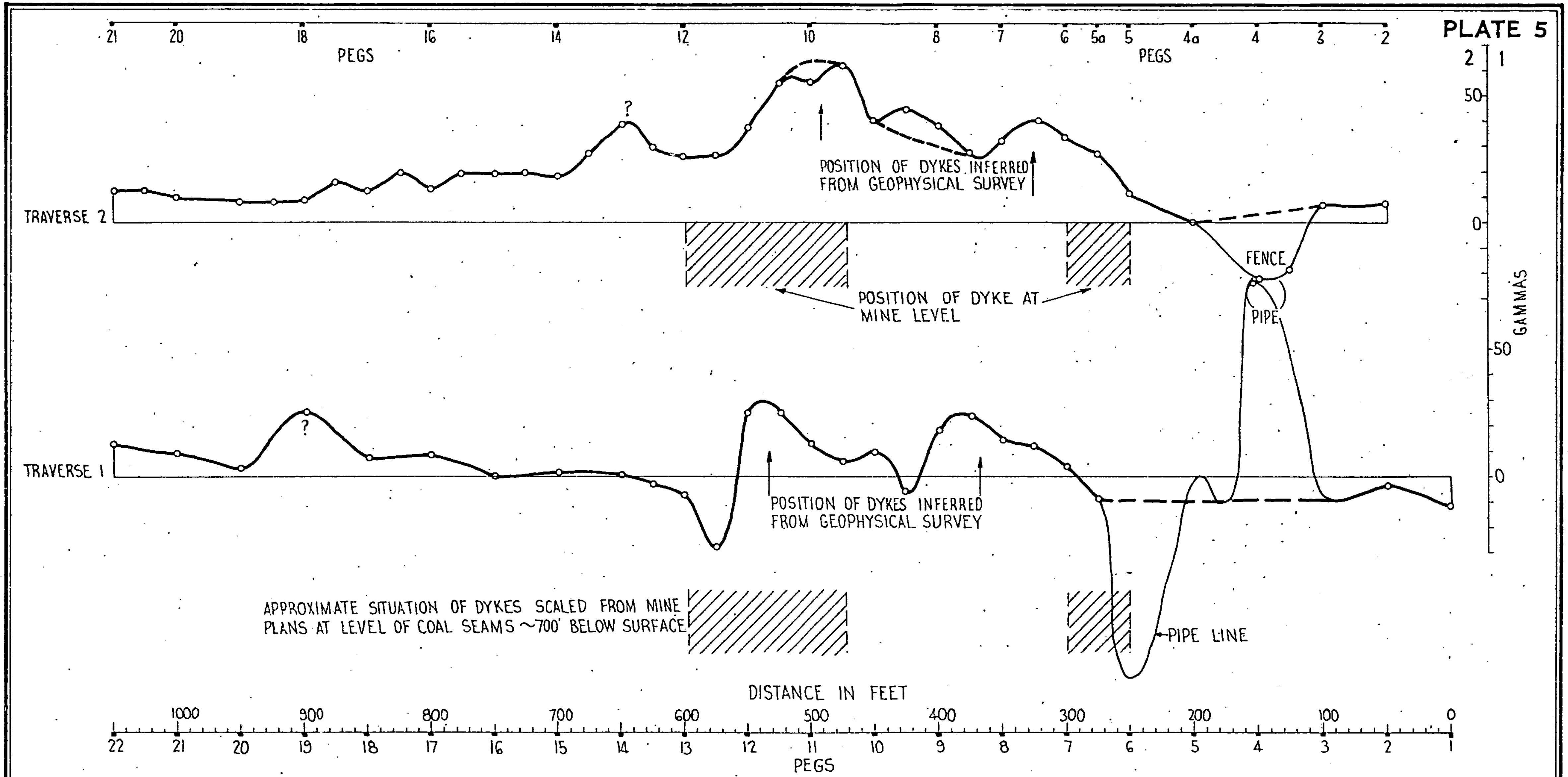
GEOPHYSICIST



GEOPHYSICAL SURVEY AT LAMBTON COLLIERY, NEWCASTLE COALFIELD, N.S.W.

VERTICAL MAGNETIC INTENSITY PROFILES

J. Horvath
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Geophysical Section Bureau of Mineral Resources Geology & Geophysics

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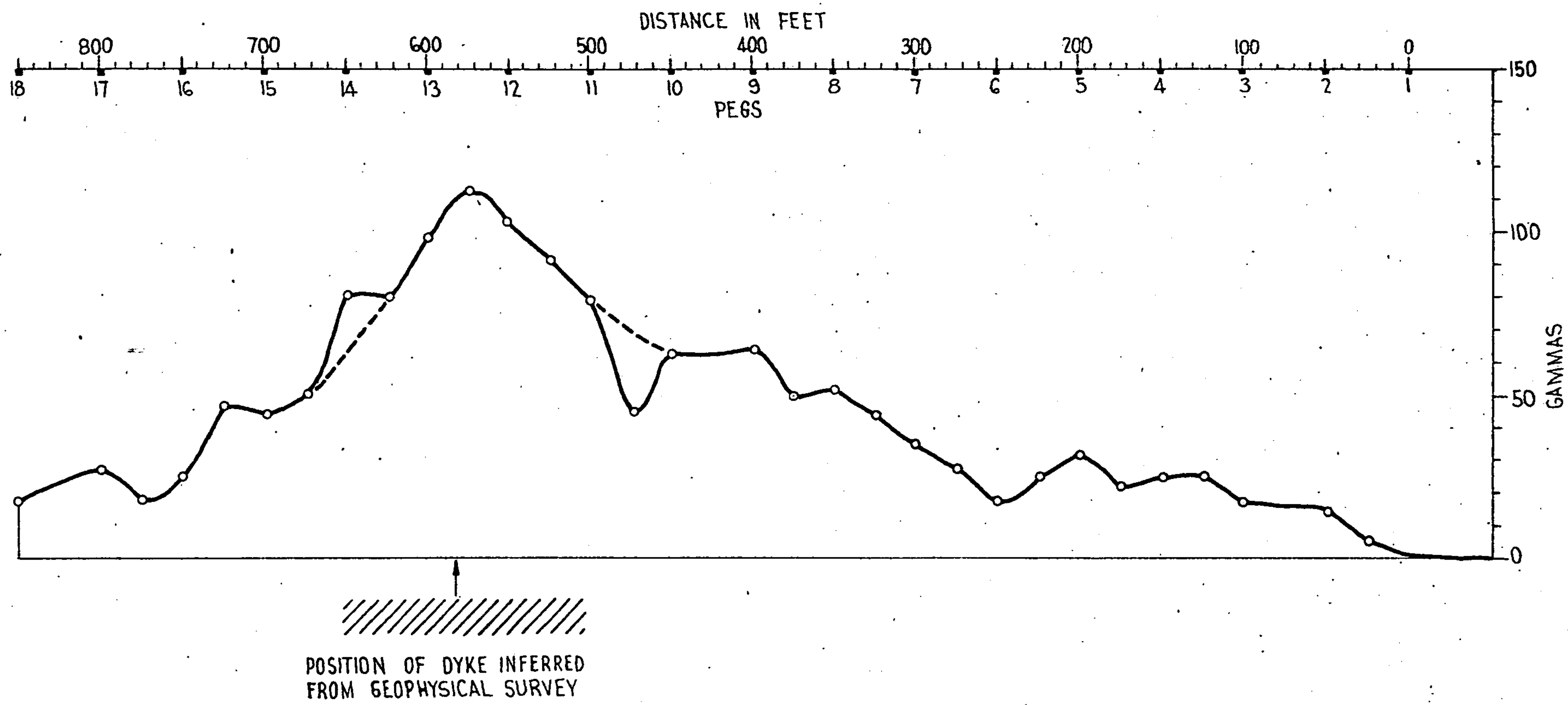
GEOPHYSICAL SURVEY AT JOHN DARLING COLLIERY, NEWCASTLE COALFIELD, N.S.W.

PLAN OF GEOPHYSICAL TRAVERSE

J. Horvath
GEOPHYSICIST



GEOPHYSICAL SURVEY AT JOHN DARLING COLLIERY, BELMONT TOWNSHIP, NEWCASTLE COALFIELD, N.S.W.

VERTICAL MAGNETIC INTENSITY PROFILE

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GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics

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