Bowen's Landing Historic Site, Risdon: Geophysical survey.

D.E. Leaman

Abstract

Magnetic and resistivity surveys at Bowen Park have located anomalous features in the region of the Forge, Governors Residence and Flagstaff. If a moderate proportion of basalt blocks has been included in a foundation in the siltstone areas, magnetic methods offer the easiest means of location whereas resistivity methods are more effective where there is a covering of basaltic soil. Seismic surveys near the landing steps indicate that Risdon Brook may have silted up by more than 1 - 2 m since settlement. Land and declination surveys have also defined errors in Meehan's (1803) survey but only about one quarter of these errors can be accounted for.

INTRODUCTION

A previous report detailing the geology of the site [EN265595], the building materials used and discussing land survey reliability recommended a number of geophysical surveys (Leaman, 1978). Such surveys were to be directed at the following site problems:

1) Mapping of those parts of the area where the siltstone - basalt boundary cannot be definitively identified by normal geological mapping. Areas of soil creep could then be identified.

2) Examination of the properties of the materials around the landing stage and flood plain of Risdon Brook to determine whether a significant change of character could be noted. Such a change might be related to very recent filling in the Brook which today gives the impression of being virtually inaccessible to a loaded longboat.

3) Consideration of some of the landforms in the basaltic area to test if some hollows might represent filled quarries or other excavations. Most, or all, may signify failed slopes.

4) Location of concealed foundations, trenches or stonework. Initial testing was to be directed at the recognised structures so that the expected response could be ascertained. Subsequent testing was then to proceed from the Blacksmiths house, Bowens house and garden to the soldiers cottages after crop harvesting.

5) Consideration of the magnetic gradients associated with the dolerite dyke immediately west of the site in order to evaluate the possibility of compass errors in Meehan's original survey.

All observation points and traverses were to be surveyed and tied to the state grid. In addition, such a land survey should pick up the known building sites within the park. This, in company with the geophysical survey, should allow further discussion of the exact placement of the settlement and problems deriving from the survey by Meehan in 1803.

SEISMIC REFRACTION SURVEYS

A number of refraction spreads were fired in the area of the landing steps and on the flood plain on the southern side of Risdon Brook in an attempt to determine velocity profiles which could be correlated with material types and ages.

Typical profiles found were;

North bank	*South bank*
120 - 480 m/s	140 - 340 m/s
1400 m/s	600 - 700 m/s
>2200 m/s	1000 - 1450 m/s
	>2200 m/s

These values are general and persist over the area sampled (50 m x 60 m). Values up to 700 m/s represent recent poorly compacted and organic rich deposits. The values quoted for the range 600 - 700 m/s are uncertain due to geophone spacing. Values in the range 1000 - 1450 m/s represent better compacted, less organic and partially saturated deposits, while values in excess of 2200 m/s represent weathered bedrock. Some values in excess of 4000 m/s were recorded for the siltstone bedrock, indicating fresh material.

The bedrock surface dips sharply from a position immediately to the rear of the store house to a little south of the present position of Risdon Brook. The base level is then relatively constant at about -10 to 12 m to the pyramids. Similar slopes occur east and west of the landing stage area. The bedrock slope indicated is comparable with the current surface slopes on the surrounding siltstone ridges.

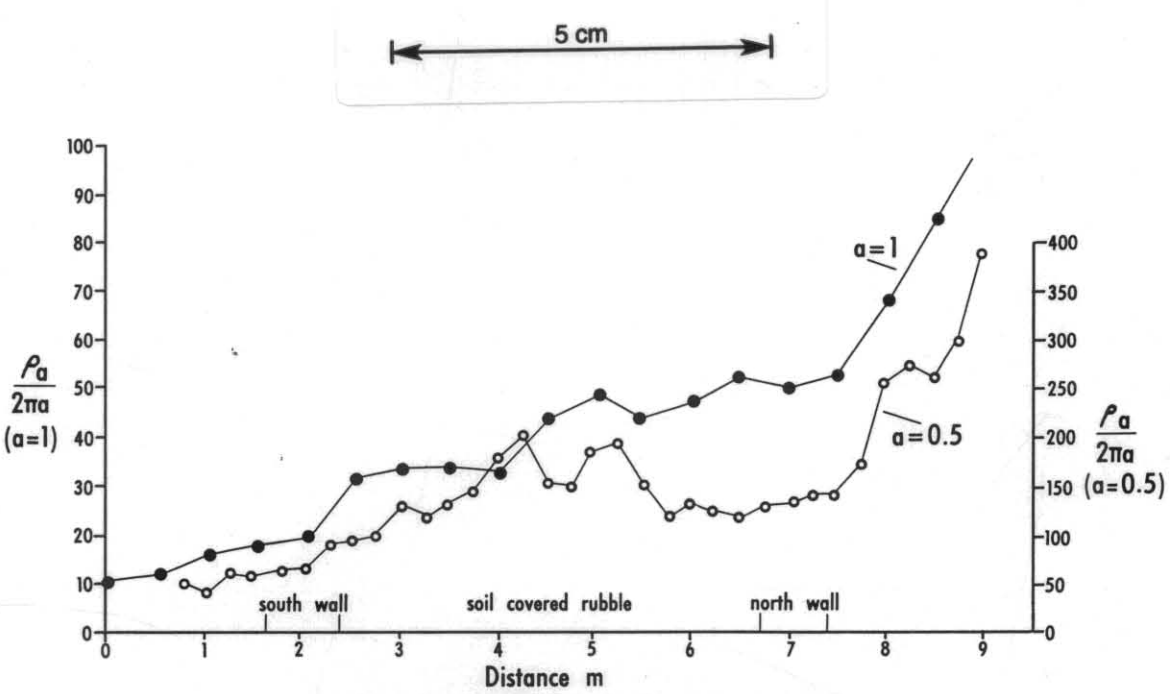
Of greater interest is the fact that the covering alluvium is composed of two discrete materials. The bulk of the section appears to be composed of moderately compacted damp sediments ranging in thickness from 0 - 12 m. Superimposed on these in the region immediately adjacent to Risdon Brook is a further, less compact damp material up to 2 m thick. The average thickness is 0.7 - 1.6 m. The velocity observed (<500 m/s) suggests a high methane content and the material must be very recent. Very little of this material was observed on the north bank west of the steps but a strip varying from 1 to 3 metres in width occurs to the south. It is slightly lower than the surrounding terrace. The time distance plots for the spreads show nick points at the junction and the time delays observed are consistent with a stepped interface as would be the case for a previous stream bank.

No comparable features can be related to other apparent terrace/levee variations which suggests that the more obvious 'levee' about 15 m south of the stream is older and the materials on either side are in an equivalent condition.

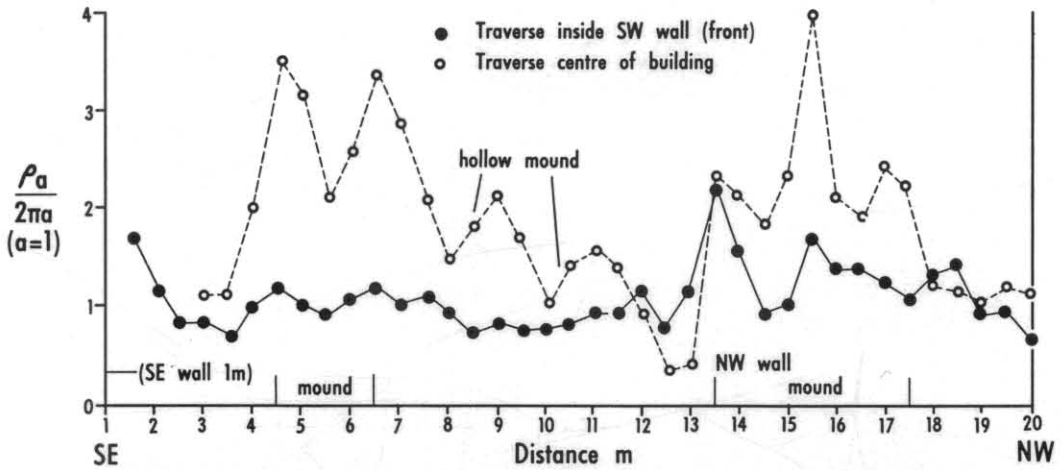
RESISTIVITY SURVEYS

Resistivity traverses were undertaken at the store, the Governors new house, around the Flagstaff and the Governors house, at the Blacksmiths and on some hillside slump or mound positions. Traverses at the store and the new house were used to provide a control for the survey and thus indicate the anomaly patterns to be expected where a substantial wall foundation was covered by soil or fill. The positions of the Flagstaff, the Blacksmiths house and the Governors house have been assumed from an interpretation of Meehan's (1803) survey and an area of about 30 x 30 m was examined in each location. The area covered was considered sufficient to include each object, if present, and allow for any survey deficiencies.

Figure 1 shows two profiles across the store immediately east of the plastic weather protection at the excavation. The perimeter wall alignments may be clearly seen but the enclosed area is quite rubbly. The profiles shown are observed on the same traverse, selected to minimise electrode



RESISTIVITY PROFILES : STORE



RESISTIVITY PROFILES : GOVERNORS NEW HOUSE

Figure 1

contact problems, but with different electrode spacings. An electrode spacing of one metre is effectively examining the material to a depth of 60 - 80 cm. The traverse was selected because the continuous soil cover was known to be much thinner than the penetration depth. The walls could have produced significant anomalies but none have been noted.

The profiles indicate a 'regional' variation across the site and the abrupt increase in values to the north reflects shallow resistive bedrock (*cf* refraction survey). The gently increasing values south of the building reflect the upper extent of the older compacted alluvial materials while the erratic results over the site reflect the disorganised rubble. These profiles suggest that the method may not be effective in the siltstone region.

However two profiles across the Governors new house do offer encouraging results (fig. 1). The profile one metre inside the building crosses two mounds and all walls are soil covered. The main north-west wall is continuous, visible but covered at the point of traverse. This wall shows clearly in both profiles. The central traverse covers a further mound and hollow. The traverse lines are parallel and about 3 m apart.

Consider the anomalies associated with the two mounds common to the profiles. In each case there is a couplet anomaly, consisting of two peaks and an intervening low. This is the classic form of anomaly produced by a wall, dyke or similar tabular irregularity. The peak values relate to the edges of the object if allowance is made for the spread of electrodes. Thus the north-west wall is confirmed and an additional wall is suggested at about 5.5 m. Note that the south-east wall quoted is an internal wall and not the south-east exterior wall. The north-west wall is external to the structure.

The rubble beyond the north-west wall is reflected in the irregular results and the nature of the results between 7 and 13 metres suggests that no additional walls are present and that the central mound is rubble only.

Comparison of the two test sections shown in Figure 1 reveals several orders of magnitude difference between resistivity values at the store and the Governors new house. This difference is due to the siltstone soil being drier and less clayey than the basaltic soil. There is thus a greater resistivity contrast between stonework in basaltic soil than stonework in siltstone soil. The difference in contrast explains the relatively low values associated with walls at the store.

It is likely that siltstone soil has a resistivity of 10 - 200 units compared with 1 - 2 units for basaltic soil. A stonewall appears to offer a resistivity of 60 - 150 units. These observations suggest that the method might not be of value in siltstone regions unless the sought after feature is exceptionally well developed or preserved.

The survey of the area about the presumed position of the Blacksmiths house was not productive. Soil in the area is relatively thin and it is likely that the stonework, if present, is of siltstone. The bedrock is also siltstone. Line spacing was 2 metres. The test survey at the new house indicates that such a spacing is necessary to locate and identify a structural feature given the dimensions of the buildings.

Two traverses were attempted about the presumed location of the Flagstaff (fig. 2). Each terminates over the water pipeline on the south side of the area (high values) and each shows a broad area of depressed values about 15 m across. The regularity of the values and the lack of wide variation suggests either a filled hollow or bedrock weathering. The repeated

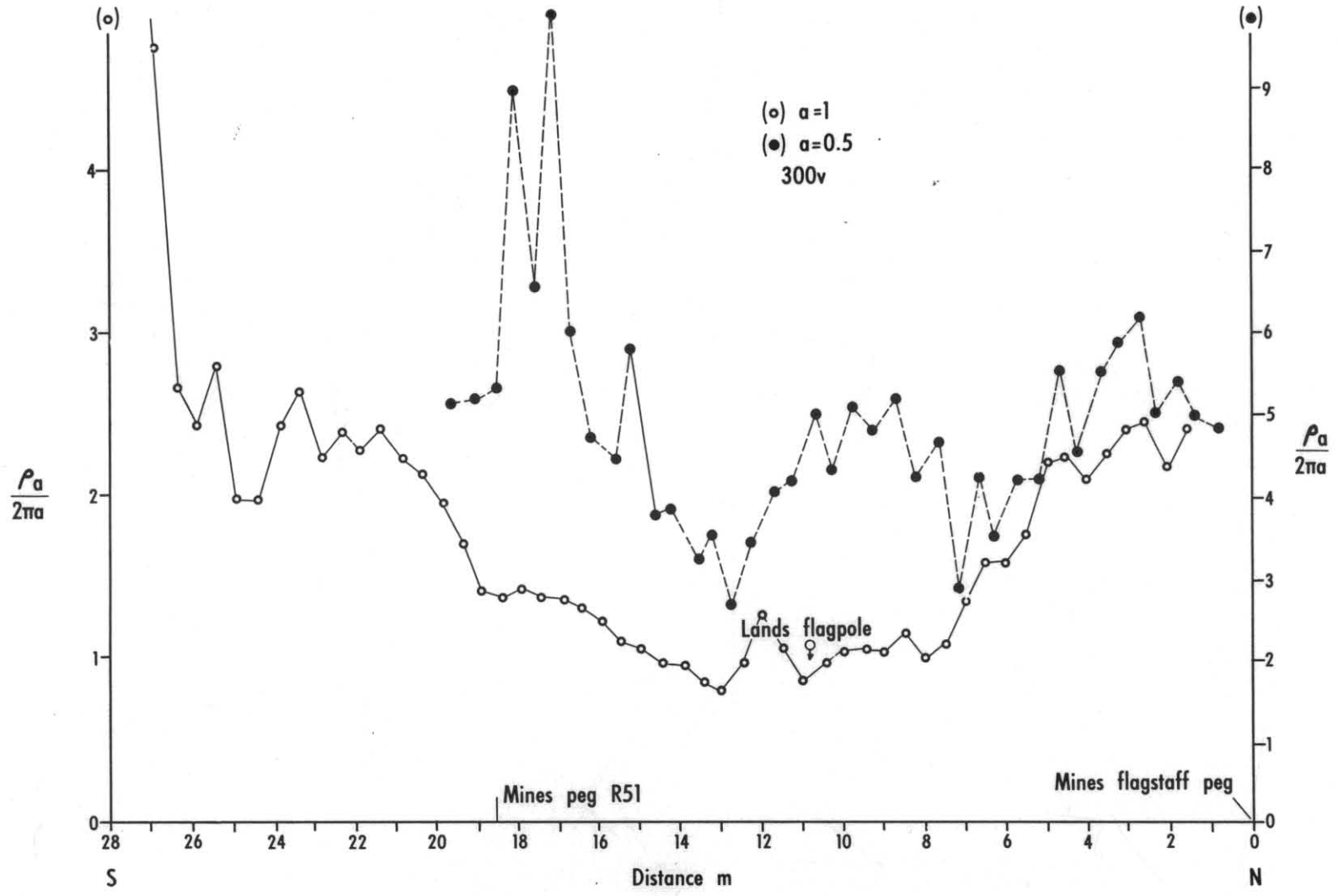


Figure 2a

RESISTIVITY SURVEY, MINES FLAGSTAFF PEG – R51

5 cm

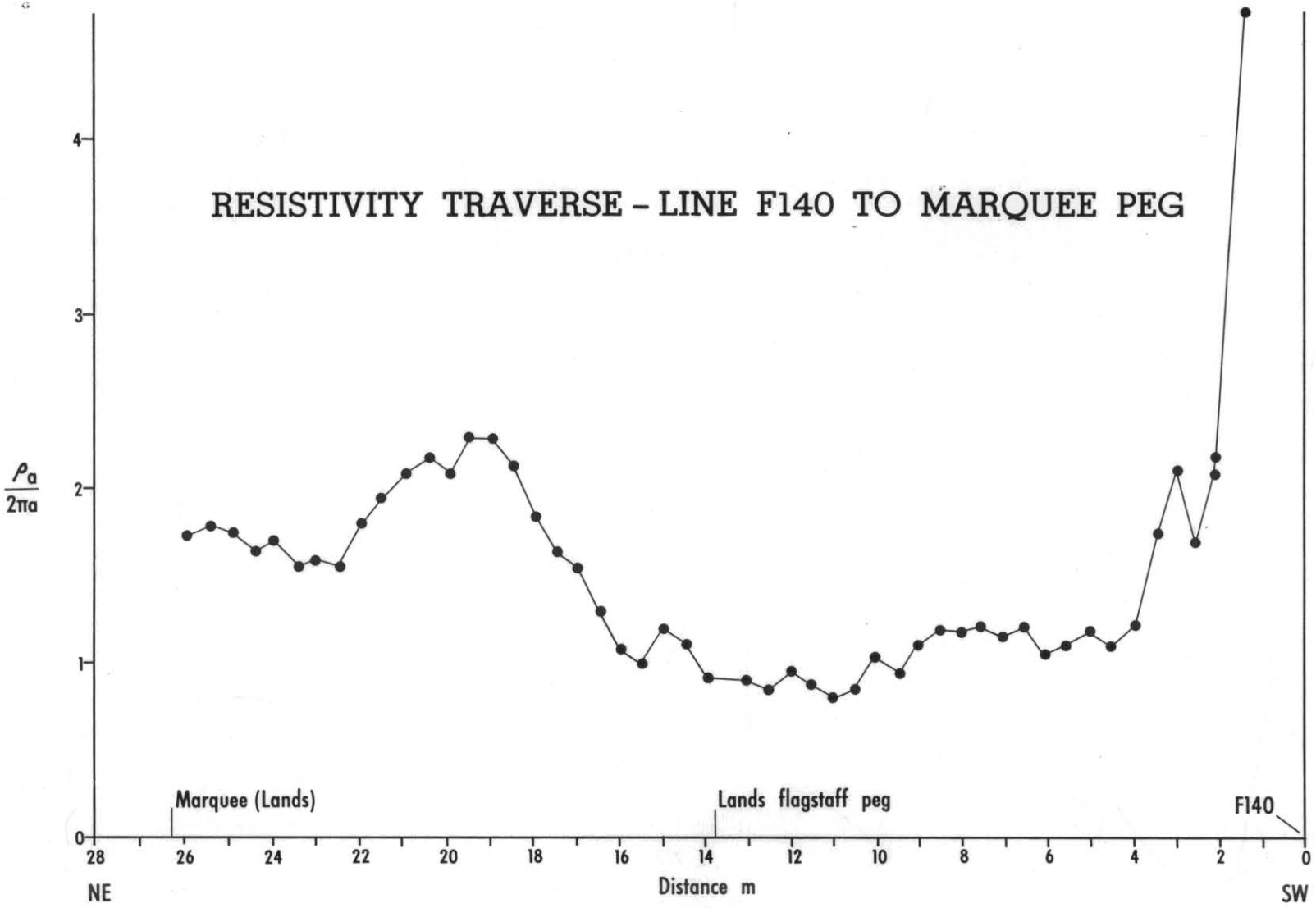

RESISTIVITY TRAVERSE - LINE F140 TO MARQUEE PEG
$\frac{\rho_a}{2\pi a}$
0
1
2
3
4
Marquee (Lands)
Lands flagstaff peg
F140
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
NE
Distance m
SW
5 cm

Figure 2b

profile (fig. 2a), where the electrode spacings used were 0.5 m and one metre confirms the overall shape but does suggest possible edge effects.

A number of traverses around the area of the Governors residence proved more interesting. Most show an exceptionally large and abrupt resistivity gradient (fig. 3) adjacent to the pegged position. The profile shown in Figure 3 is the most extreme. Figure 4 shows the areal distribution of high values. The boundaries shown are approximate only but are surprisingly close to the inference from Meehan's survey for the structure (see Lands Department interpretation, first solution). A magnetic traverse along the same line from peg R43 is also shown in Figure 3. Severe magnetic variations are indicated with an intense negative gradient corresponding to the positive resistivity gradient.

Further resistivity traverses undertaken across mounds in the area of the Governors garden and south of peg A110 were without interest. The large mounds on the north-western part of the area (approx. 326590E, 258265N) are part of a sizeable landslip and are predominantly composed of disturbed soil and clay. No variations suggestive of rock or rubble content were detected in any of the mounds in this area. Most are probably small landslides or soil creep structures.

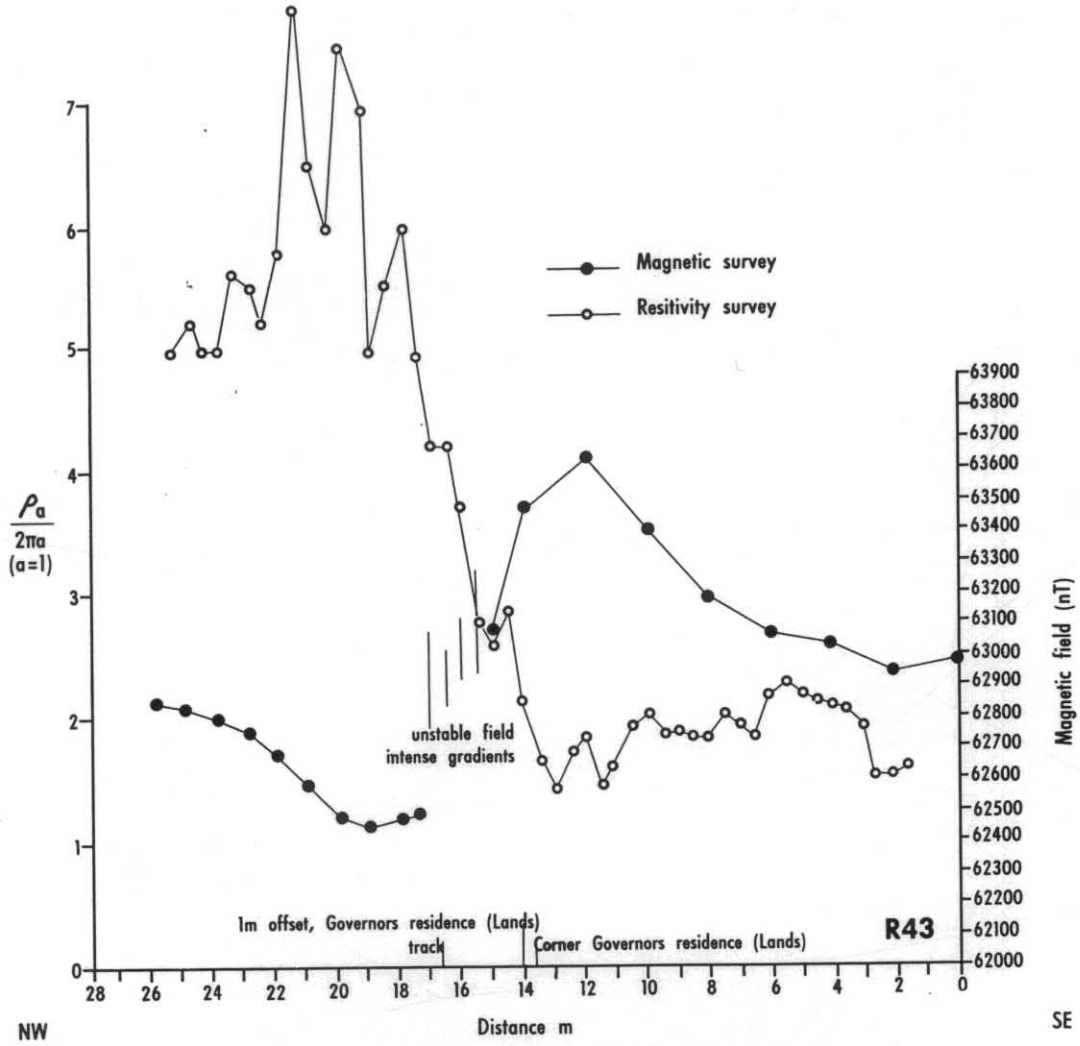
MAGNETIC SURVEYS

Magnetic profiles have been obtained across each of the known structures on the site; the store, Wilsons house and the Governors new house. No variations from background were observed at the store and this is due to the absence of basalt blocks in its construction. Siltstone blocks above a siltstone bedrock could not produce any anomalies. No other magnetic objects appear to be present. A similar situation exists at Wilsons house but some tracing is possible due to the occasional inclusion of basalt pieces in the walls. At the Governors new house, where there is a mix of source materials, the background values are themselves very erratic as is normal in basalt areas. The method cannot be used in such circumstances since the background variations range from 300 - 1500 ηT per 1 - 3 m and the contribution due to walls has been estimated at 50 - 150 ηT maximum.

A similar pattern of extreme variations was found across the entire basalt area and the method has been used for boundary mapping only where basalt is present. A revised version of Figure 1 (Leaman, 1978) is presented as Figure 5. Only in the case of the resistivity anomaly around the Governors house was the method specifically applied as a check procedure.

Use of the method was concentrated in the region of the Blacksmiths house and forge. In this area, the background field is very regular (siltstone bedrock) and any reasonable deviations could be mapped. Further, it was considered likely that any metal objects present might be found nearby. No anomalies were detected in excess of 10 ηT above background in the entire area with the exception of a small area north-west of the pegged position of the forge. Deviations of up to 30 ηT were measured at 1.5 m above ground and more than 60 - 80 ηT at ground level. The position of the anomalous area is shown in Figure 6.

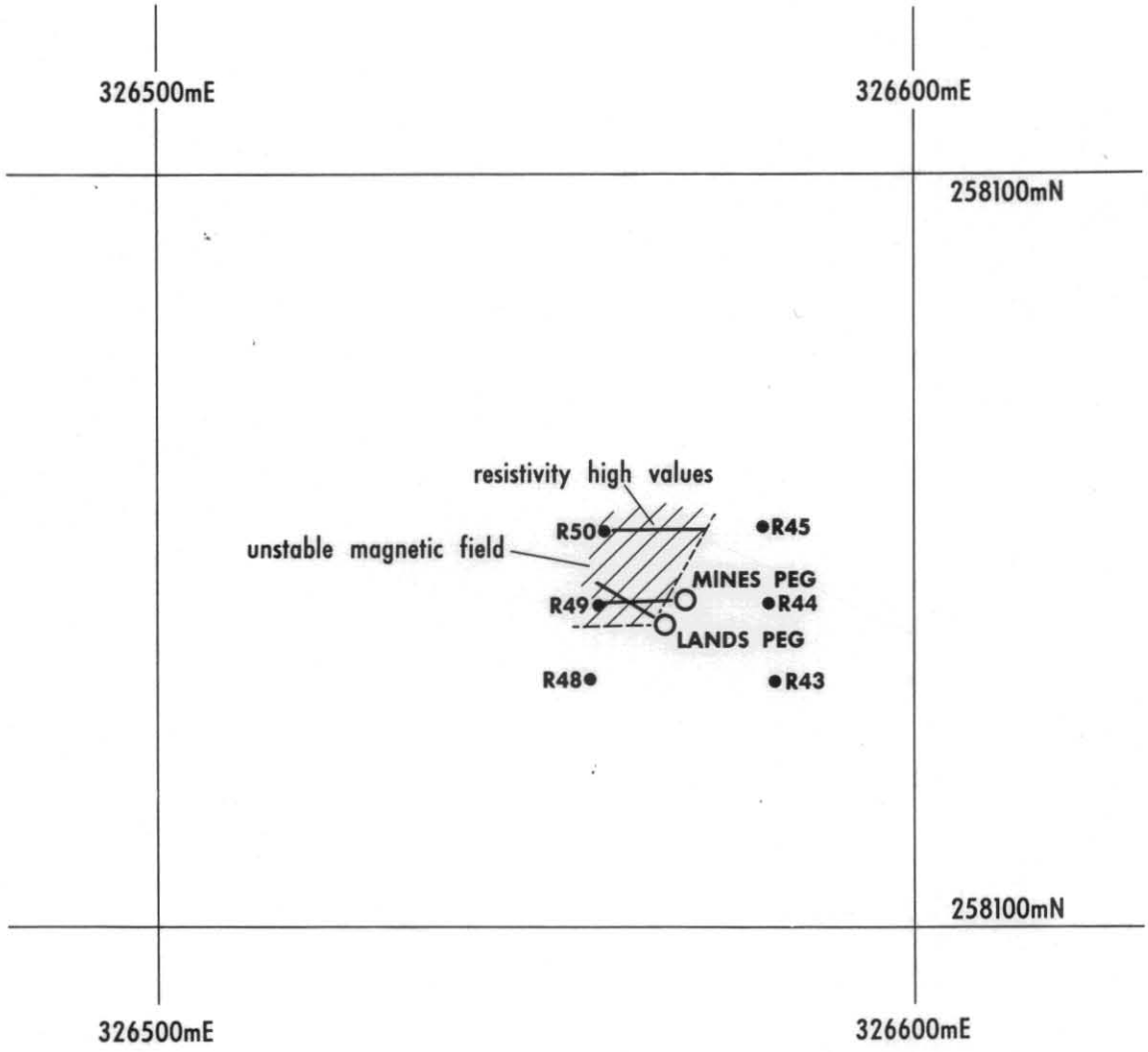
When examined at ground level, the anomalous area is found to be very small and to include three discrete sources. Comparison of the anomalies recorded with that induced by modern nails shows the source material to be very magnetic and not deeply buried. Possible sources include metal objects, iron filings affected by heat or basalt fragments. A magnetic separation of soil materials may be necessary to resolve the source of these anomalies if no large (>2 cm) objects are found.



MAGNETIC AND RESISTIVITY SURVEY, LINE R43 - GOVERNORS HOUSE

Figure 3

5 cm



RESISTIVITY ANOMALY GOVERNORS RESIDENCE

Figure 4

5 cm

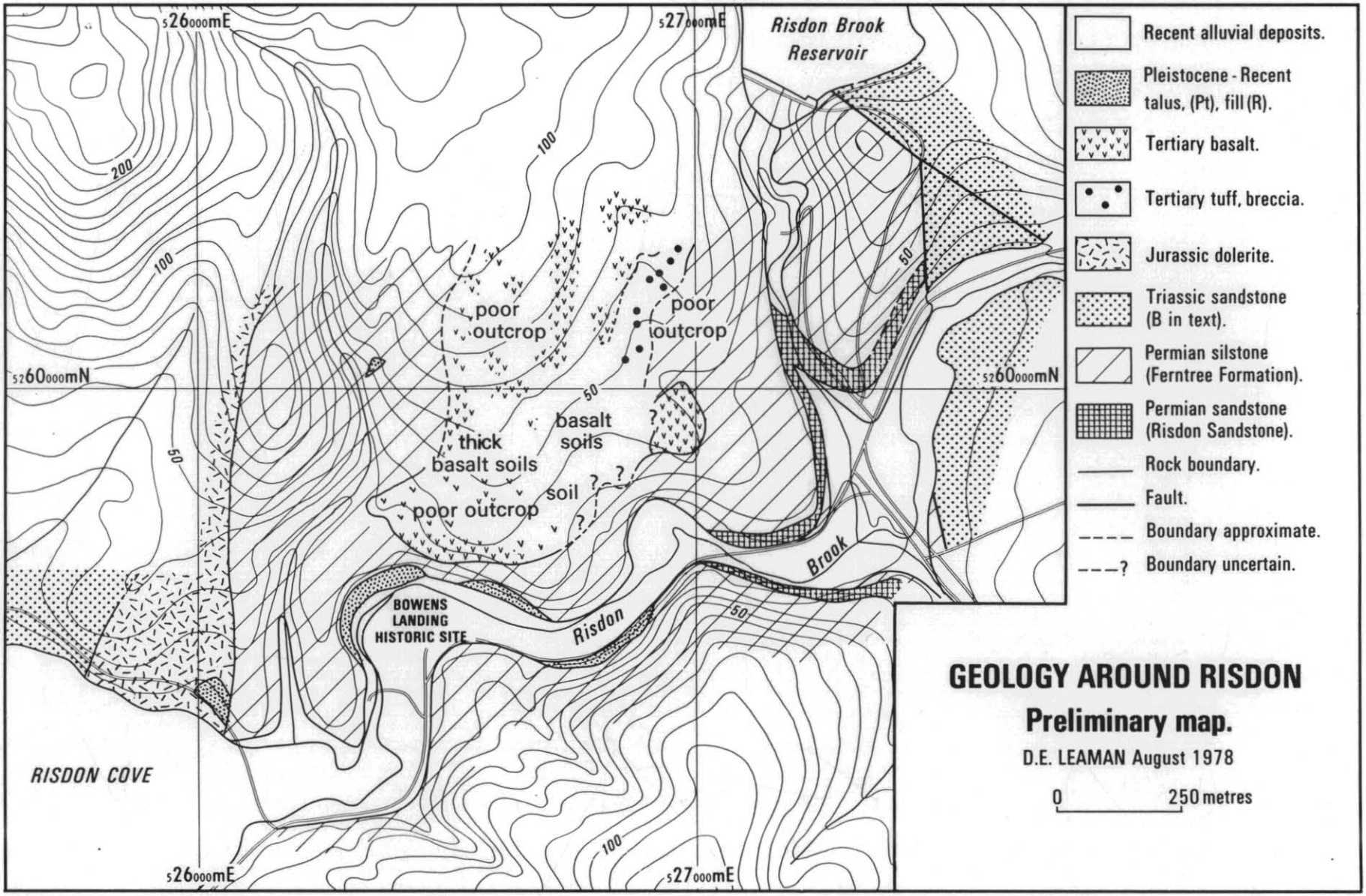


Figure 5

4400

5 cm

MAGNETIC ANOMALIES ; FORGE AREA

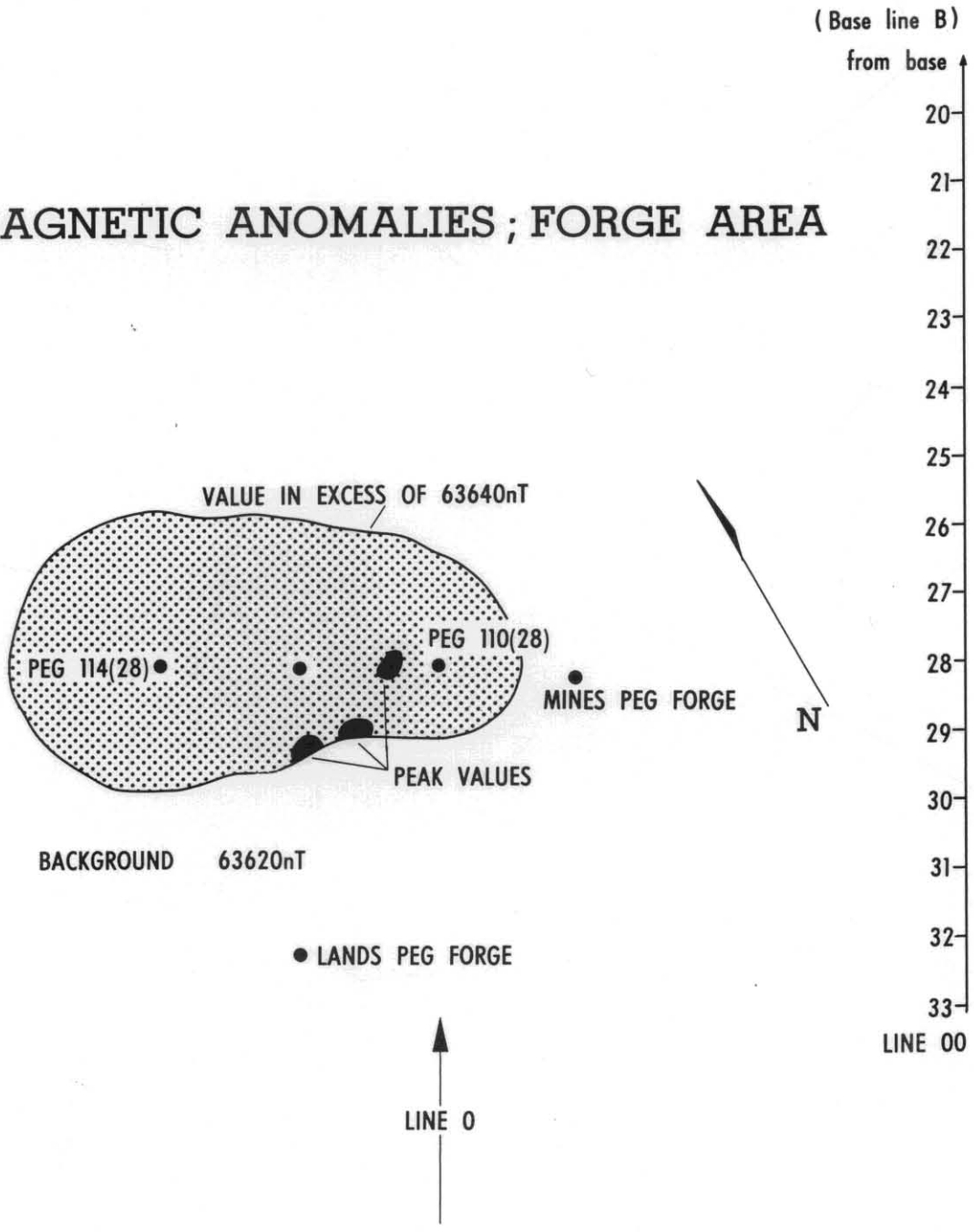


Figure 6

The previous report on the landing site (Leaman, 1978) discussed the possibility of magnetic deviation errors in the measurements of either (or both) Flinders and Meehan around Risdon Cove. A dolerite dyke about 200 m wide trends north-south across Ridson Cove. The eastern margin of this dyke is exposed on both sides of the Cove whereas most of the western margin is concealed in the bay. It is possible that Flinders could have anchored above this structure. Magnetic profiles along the eastern side of Risdon Cove reveal strong magnetic gradients and a single traverse across the dyke at the north side of the Cove suggests stronger gradients are associated with the western margin. The anomaly associated with the dyke exceeds 2000 ηT and there are some strong localised horizontal and vertical gradients. A compass variation of two degrees is readily obtained depending upon the exact site of observation. It is not possible to quote the maximum variation likely at such a locality but it probably does not exceed three degrees. The observations recorded are in accord with Flinders' notes and account for the discrepancy between his and Meehan's observations. But as a corollary, such results also mean that the quoted figure for the declination of the magnetic field in Hobart in 1803 is at best a rough estimate.

LAND SURVEY

A land survey was undertaken as part of the geophysical work in order to locate traverse lines and numerous control and anomaly pegs which now dot the site. All known structures were tied to this survey. Several observations may be made based on the survey results presented in Figure 7 and the interpretation of Meehan's survey as prepared by the Lands Department and commented upon by Leaman (1978).

(1) The overall displacement between the store and the Governors new house is accurate to about 6 m when compared with the interpretation of Meehan's survey for the western part of the site.

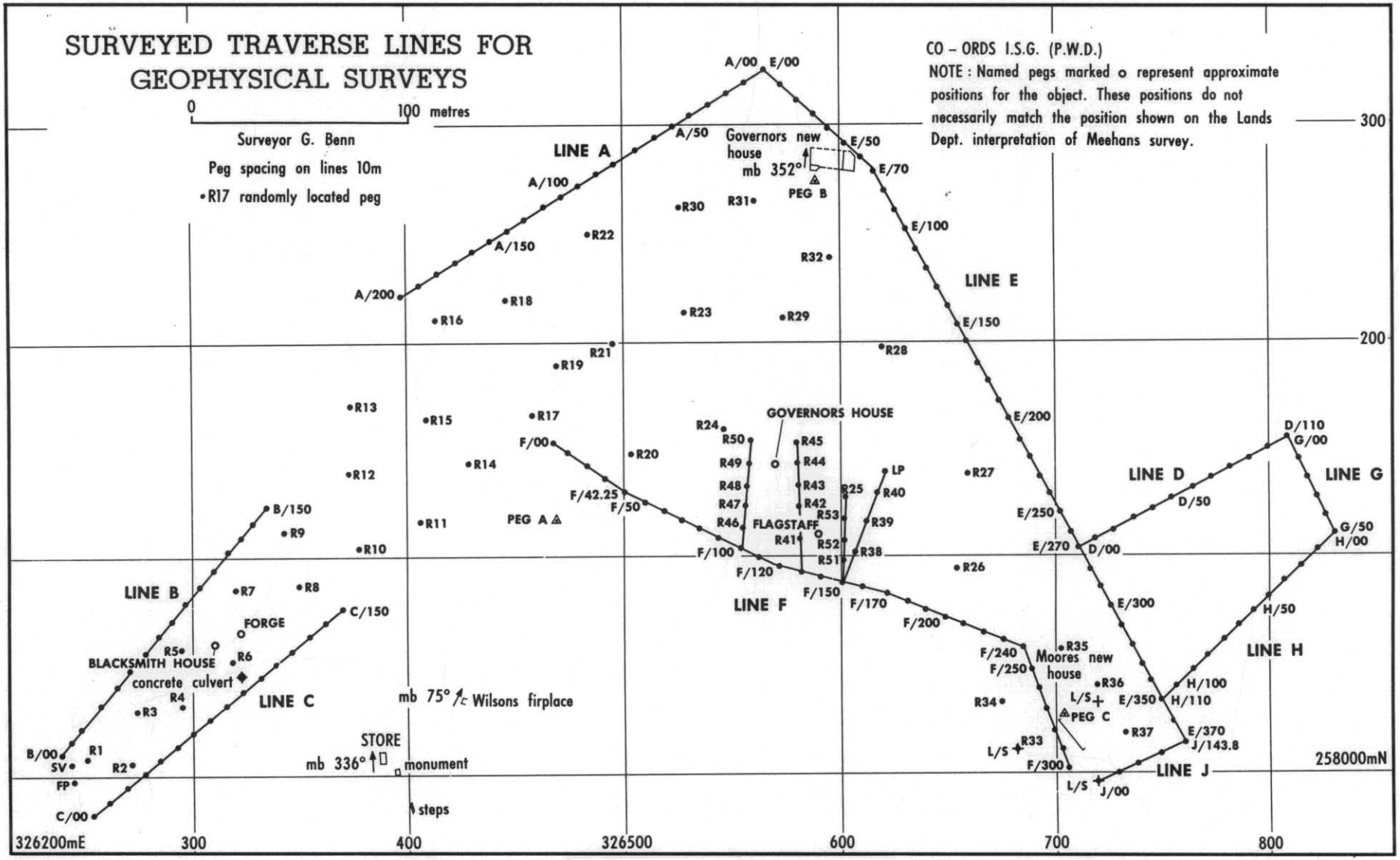
(2) The orientations of both the store and the Governors new house differs from Meehan's measurements by 10 - 15°, depending on the particular alignments chosen, but in a contrary fashion. In the case of the store the error is counter clockwise and for the new house clockwise.

(3) Wilsons fireplace does not readily tie and the orientation of Wilsons house seems incompatible with notes 1.5, 1.6 in Meehan's notebook. The error is clockwise.

(4) The dimensions of the Governors new house do not agree with those quoted by Meehan.

These observations cast much doubt on either the reliability of Meehan's surveying (suggested by his unease with latitude and declination measurements also) or of the recognition of tie points when interpreting his survey. For example, was the Governors new house an idea or under construction while Meehan was at work and is the structure termed the store really the store? An extra point offset from the line store-Wilson-new house must be found to establish the reliability of site survey or interpretation.

Confirmation of any one of the anomalies recorded in the general location of the forge, Governors residence or Flagstaff could resolve this question.


SURVEYED TRAVERSE LINES FOR GEOPHYSICAL SURVEYS
0
100 metres
Surveyor G. Benn
Peg spacing on lines 10m
•R17 randomly located peg
CO – ORDS I.S.G. (P.W.D.)
NOTE : Named pegs marked o represent approximate positions for the object. These positions do not necessarily match the position shown on the Lands Dept. interpretation of Meehans survey.
LINE A
LINE B
LINE C
LINE D
LINE E
LINE F
LINE G
LINE H
LINE J
Governors new house
mb 352°
PEG B
PEG A
PEG C
GOVERNORS HOUSE
FLAGSTAFF
FORGE
BLACKSMITH HOUSE
concrete culvert
Moores new house
mb 75° Wilsons firplace
STORE
mb 336°
monument
steps
L/S
LP
A/00
A/50
A/100
A/150
A/200
B/00
B/150
C/00
C/150
D/00
D/50
D/110
E/00
E/50
E/70
E/100
E/150
E/200
E/250
E/270
E/300
E/350
E/370
F/00
F/42.25
F/50
F/100
F/120
F/150
F/170
F/200
F/240
F/250
F/300
G/00
G/50
H/00
H/50
H/100
H/110
J/00
J/143.8
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
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R36
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
R47
R48
R49
R50
R51
R52
R53
SV
FP
326200mE
300
400
326500
600
700
800
300
200
258000mN
5 cm

Figure 7

CONCLUSIONS

Basalt forms the bedrock for most of the property north and west of the Flagstaff. The basaltic soil is conductive and variable in thickness. Most, if not all, mounds present in this area have resulted from minor landsliding or soil creep. The major mound about 100 m west and downslope of the Governors new house is a land failure.

Consideration of the alluvial materials around the landing stage suggest that the stream channel may have been about one to three metres wider at the time of settlement. It is not possible to accurately date the very recent material and it may be older than 180 years. The writer believes this to be unlikely when the volume of material recently deposited in the tidal zone is also considered. There is little variation from the present bank on the north side and most of the recent fill is on the south bank. The average narrowing is 1 - 2 metres. The refraction survey also suggests a shallowing of 0.6 - 1.2 m.

Magnetic surveys have located an anomalous area in the region of the Forge. The anomaly recorded covers a moderate area which is consistent with a dispersed source (*e.g.* filings) but has three abrupt peaks which might relate to small discrete objects.

The presence of basalt on the site has greatly retarded the use of magnetic methods for foundation location since the background pattern of the field is able to prevent recognition of small localised variations. Unfortunately basalt blocks were not utilised in the siltstone area where a content of 10% would enable complete delineation of a foundation.

The resistivity method, by contrast with the magnetic method, is proven able to locate concealed walls, foundations in areas of basaltic soil but is less effective in siltstone areas due to reduction of the resistivity contrast.

The lack of anomalies in the region of the Blacksmiths house suggests that no substantial foundation was ever laid and this conclusion may be general to the site.

Examination of the magnetic characteristics of the dolerite dyke in Risdon Cove supports the suggestion that orientation errors of 2 - 3 degrees are possible in Meehan's survey. Flinders was quite correct in noting the presence of such deviations "due to the land". Not accounted for as yet are the substantial orientation discrepancies noted between site determinations and Meehan's values.

RECOMMENDATIONS

The portion of the magnetic anomaly near the Forge comprising the peak values should be excavated. This would amount to a block about 1.5 x 1.5 m and the soil should be sieved and sorted in a magnetic separator since a fine magnetic background content is presumably present.

The anomalies located in the region of the Flagstaff and the Governors Residence should be trenched using the alignments;

Mines Flagstaff peg - Mines peg R51
Mines Peg R43 - Lands peg Governors Residence.

Further resistivity work along the "street" east of the area examined in this report may prove productive if solid foundations have been employed

for the lesser structures. The thick basalt soil of the eastern area should permit ready location of any stonework or bedrock irregularities. It is suggested that this work be done in autumn after harvesting and after the first heavy rains to ensure trouble free electrode contact.

REFERENCE

LEAMAN, D.E. 1978. Bowen's Landing Historic Site, Risdon. Geology, building materials, survey factors and recommendations for geophysical work. *Unpubl.Rep.Dep.Mines Tasm.* 1978/27

[24 November 1978]