

HADRIAN'S WALL
RESISTIVITY SURVEY
SPRING 1981

INTRODUCTION

As part of the Central Excavation Unit's investigations along Hadrian's Wall, a fieldwork programme was initiated during the winter of 1980/81, with the aim of examining the present state of the Wall and its associated features. It was decided that geophysical surveying techniques would be employed as part of the fieldwork, initially concentrating on Milecastles 58 to 63. This report, therefore, is a preliminary statement of the findings, and a general assessment of the potential contribution of geophysics to the fieldwork project.

The geophysical work was carried out with two specific aims:-

1. To try and locate the positions of Milecastles 58-63 (unfortunately access could not be gained to site 60).
2. To check the line and assess the state of preservation of the wall and its associated features, at the above milecastle sites.

SURVEY TECHNIQUE AND EQUIPMENT

Of the two most widely used geophysical techniques, resistivity and magnetometer, the former is usually more suited to locating buried walls and roads. Past work in the area (AM Lab Survey Reports 14/76, 25/76 and 33/76; and British Gas Corporation Survey Report 9/80) has shown that, although the magnetometer does respond to certain archaeological features, its effectiveness is limited because of the magnetically disturbed background provided by the local boulder clay. All the survey work was, therefore, carried out using resistivity equipment.

METER
Bradphys (kindly loaned by the School of
Archaeological Sciences, Bradford University)

CONFIGURATION
Twin-probe, 0.5m spacing. Readings taken at
1.0m intervals.

TREATMENT OF DATA

The standard numerical treatment applied to these surveys was a form of spatial filtering in which the mean of a ring of neighbouring values, of stated radius, is subtracted from each reading in turn. Additional rings may be included in the calculation to give a smoother output. The effect is to emphasise features of radius less than the minimum stated value, relative to others, and the method can therefore be used to strengthen narrow anomalies such as those likely to represent walls, and to suppress broader geological features.

An opposite effect in which narrow features are suppressed can be obtained by adding a similar mean value to each reading. This was done to some of the data using a narrow ring of neighbours to suppress small-scale background noise.

The full range of the data values is seen when the readings are displayed as traces, but for the contour and dot-density plots cut-off levels are set so that only a range of values which appears to be significant for the interpretation of the survey is shown. Both contour and density plots are usually included because they give different visual impressions of the plan and the intensity of the features respectively, and either may be significant in the interpretation. The display range in each case is conveniently stated in terms of standard deviations from the mean of the data.

Each site will be commented on individually before general conclusions are drawn together at the end of the report.

Fig I shows the positions along the Wall of each site surveyed.

SURVEY I
MILECASTLE 58

OS MAP	NY 4862 - 4962
PARCEL NO	8862
GEOLOGY	Drift - Boulder Clay; Glacial sand and gravel Solid - Kirklington Sandstone
ARCHAEOLOGY	Milecastle 58 is marked on the OS Map in the NW corner of the field (NG 49786259).
GROUND COVER	Grass. No visible stonework. The ditch survives as a shallow depression. The field has been ploughed on limited occasions in the recent past, and it is reported that large quantities of stone were removed.

RESULTS

The plots (Fig II) show the ditch and wall crossing diagonally through the area surveyed. Low readings were obtained from the waterlogged ditch which is visible at the NW corner of the survey (plot II.1) The wall and other anomalies are emphasised in the filtered plot (II.2.) but their plan is seen more clearly in the contour and dot-density displays (plots II. 3 and 4).

The area of high readings at "A" corresponds to an outcrop of glacial sands and gravels.

A fairly weak negative linear anomaly is visible running parallel to the NW - SE field boundary: it would appear to cut through the line of the wall, but it is not possible to put an interpretation on the feature.

There is no clear evidence for a milecastle, save the possible rectangular anomaly at "B" but the dimensions appear too small when compared with known structures.

Of particular interest is the apparent line of anomalies "behind" the Wall, which, although broken in places, could represent the line of the turf wall. Only excavation would verify this.

CONCLUSIONS

With the possible exception of the NW corner of the field, the results suggest masonry is still in situ on the marked wall-line. It is further possible that the turf wall is present on a line at an angle to the stone wall.

The milecastle is not visible geophysically where marked on the OS Map, possibly due to robbing and ploughing. It could be that the milecastle lies in Field 7342, to the west: this is an area that would obviously benefit from geophysical investigation when access is possible.

SURVEY II
MILECASTLE 59

OS MAP	NY 4861 - 4961
PARCEL NO	5967 (Field) and 4967 (Track)
GEOLOGY	Drift - Boulder Clay Solid - Kirklington Sandstone
ARCHAEOLOGY	Milecastle 59 is recorded lying in the NW corner of Field 5967.
GROUND COVER	Grass. No visible stone remains. A level platform is visible in the NW corner: the ground falls away to the S and E.

RESULTS

1. TRAVERSES

Three traverses, 1m apart, were surveyed along the track, immediately to the south of the line of Hadrian's Wall. (It was assumed that preservation would be better here, where there was no likelihood of ploughing disturbance).

The graphs show three coincident anomalies of high resistance, suggesting the presence of buried stonework behind the line of the Wall. The general level of readings is higher in the top trace, lying as it does closest to the wall and reflecting the greater amount of collapsed stonework. The long traverse shows the increasing background geological/soil noise in the east, but no other clearly defined anomalies.

2. AREA SURVEY

The results provide an unusually clear demonstration of the effects of spatial filtering, and a series of plots is included to illustrate this. The charts showing graphs of the initial and filtered data (fig III. 1 + 2) appear to be very similar, but the difference is seen in the equivalent contour plots. The contour plot of the initial data (III.3) shows a comparatively broad and weak anomaly representing the milecastle itself, and an area of diffuse high readings of probable geological origin towards the east of the survey. After filtering the walls of the milecastle appear to be narrower, with stronger gradients and more closely spaced contours and the broad anomalies to the east are broken into a few fragments of higher readings. The contour plot of the filtered data is also shown enlarged for clarity in plot 6.

The milecastle is clearly visible: it appears that most of the 'back' wall is in situ; it is even possible (with a liberal interpretation) to envisage the foundation supports for the gate itself. Close to the field boundary, the 'side' walls seem to have been ploughed away, or robbed out. The first anomaly visible on the traverses is also present on the plots to the left of the milecastle. This is clearly a feature of potential archaeological interest.

CONCLUSIONS

The detailed survey located the milecastle to the east of the position marked on the OS Map. This places the milecastle slightly off the level platform visible in the field.

SURVEY III ? TURRET 59A

OS MAP	NY 4861 - 4961
GEOLOGY	Drift - Boulder Clay Solid - Kirklington Sandstone
ARCHAEOLOGY	The wall and ditch are marked crossing this small field and measurements suggest that Turret 59A should lie in the area.
GROUND COVER	Grass. Mounds and depressions are visible, suggestive of former buildings. Much dressed stone, and rubble, is apparent in nearby modern walls.
AIM OF SURVEY	To check for the presence of the Wall below ground. To try and locate the turret.

RESULTS

The plots (Fig IV) show that there is a lot of disturbances in the area, suggestive of rubble scatters, but no clear wall lines - with the possible exception of the anomaly marked on the plots. The readings from the survey were first smoothed to suppress the background (the output from filter radius 1-2 was added to each reading) and then filtered to extract possible significant anomalies. Results are shown on graphs and contours in Fig IV, 1 and 2. It is not possible to isolate the ditch and wall: this suggests that either the wall has been robbed out, or that the rubble is obscuring its presence.

If the turret does lie in this stretch of the wall, it is not possible to identify it geophysically.

SURVEY IV MILITARY WAY

OS MAP	NY 4460 - 4560
PARCEL NO	9200 + 6782
GEOLOGY	Drift - Boulder Clay. Peat in the south of 9200; Glacial Sand and gravel in 6782. Solid - St Bees sandstone.
ARCHAEOLOGY	The Military Way is marked on the OS Map in Field 9200, but is unrecorded to the west. Immediately to the south of field 9200 the Vallum consists of 4 banks due to the waterlogged nature of the ground.
GROUND COVER	Grass and small shrubs. The line of the Military Way is visible in places as a rise in the ground. South of this line the ground is marshland.
AIM OF SURVEY	To confirm the line as shown on the OS map and to see whether the road continues through Field 6782, to the west.

RESULTS

FIELD 9200

The high resistance peaks in traverses A, B, D and E (Fig V) clearly correspond to the road; the curve to the south is shown by the 'displaced' peaks in D and E. Its absences in C suggests robbing, and its disappearance in F a result of the modern road which cuts its line.

The low resistance anomalies visible in A, B, D and E immediately to the north of the road, suggest the presence of a drainage ditch.

The high resistance readings at the start of each run reflect the modern track overlying Hadrian's Wall.

FIELD 6782

The difficulty with traverses a-f (Fig V) is that they lie on the outcrop of sand and gravel, which tends to give rather erratic, high resistance readings. Against this background noise, a clear line of peaks (in some cases double peaks) is visible in b-f. Assuming these peaks represent the road, they suggest that having turned south in 9200, it then straightens out and runs parallel to the line of the vallum. The peak marked in traverse g might then be interpreted as the road on the same line at the western end of the field.

The graphs show no uniform response over the line of the vallum. This could support a view that the vallum consisted of 4 banks in this field as well, though the absence of evidence for a ditch may be due to the sands and gravels, and the high water-table, affecting the resistance readings.

Traverse h shows the background variation throughout the length of the field. The outcrop of sand and gravel is clearly visible in the east. The ground to the west shows a much quieter background. There is one area of high readings, c20m wide. This region is considered below in survey V.

SURVEY V

MILECASTLE 61

OS MAP	NY 4460 - 4560
PARCEL NO	6782
GEOLOGY	Drift - Boulder Clay, Glacial Sand and gravel Solid - St Bees Sandstone
ARCHAEOLOGY	Milecastle 61 is thought to lie in the western half of Field 6782. A minor road divides the field from the line of the wall and at best only the back wall of the milecastle will be surviving.
GROUND COVER	Grass. No visible stones. A low platform is visible in the east, corresponding to the outcrop of glacial sand and gravel.

RESULTS

Traverses j and k were set out 2m distant from h (reproduced as h¹ in Fig VI). There is a definite region of high resistance centred 50m to the east of the stone-barn. The detailed area survey discussed below was, therefore, located here.

The low readings at the start of each traverse correspond to a very water-logged stretch of ground opposite a gateway.

The area survey plots show an area of high resistance close to the fence. This is visible in the initial data, but the plan of the feature is seen more clearly on the contour and density plots alongside. Although it is not possible to form a clear picture of the milecastle, if it is to be found in the western half of the field, then this is its most likely position.

The line of low readings visible in the traces was seen to correspond to a linear depression c1-2m wide, running approximately parallel to fence line.

Other weaker anomalies are visible, the archaeological significance of which is uncertain.

SURVEY VI
CEU SITE 192

OS MAP	NY 4460 - 4560
PARCEL NO	4867 and 7253
GEOLOGY	Drift - Boulder Clay Solid - Kirklington Sandstone
ARCHAEOLOGY	The CEU carried out work prior to the construction of the proposed BGC pipeline on the line of the wall and vallum.
GROUND COVER	Grass. The wall-ditch is visible as a slight depression adjacent to the excavation trench. The wall as such is only visible in places as stones in the field bank.
AIM OF SURVEY	To obtain a correlation between the resistivity results and the results of the excavations. To check the results obtained in the BGC survey carried out the previous summer.
CHARTS/PLOTS ATTACHED	Fig VII site location Fig VIII Traverses

RESULTS

TRAVERSE A

Excavations showed the ditch to be V-shaped, 6 metres wide and 2.5 metres deep. North of the ditch were the remains of a much eroded bank.

The ditch shows as a high resistance anomaly, as does the ploughed out bank. The results are confused by the field drains both in the ditch and to the north.

TRAVERSE B

The graph shows a fairly uniform response throughout the length of the traverse, save for the higher readings near the slumped field bank, and the marked anomaly c90 metres to the south. This is an identical picture to the results obtained in the summer of 1980 (BGC Survey 9/80).

In the BGC survey it was suggested that the anomaly probably corresponded to a road, or perhaps a well-drained ditch (of the vallum). The latter alternative turned out to be correct. Excavations showed the ditch to be flat-bottomed, with steep sides c7.5m wide and 1.60m deep.

With the ground being so waterlogged, the more porous fill of the ditch shows as a high resistance anomaly. Actual resistivity readings are improporionately low for the topsoil: the true level of the readings should be much higher - the ditch would then show as a dip rather than a peak.

SURVEY VII
MILECASTLE 62

OS MAP	NY 4460 - 4560
PARCEL NO	0040
GEOLOGY	Drift - Boulder Clay Solid - Kirklington Sandstone
ARCHAEOLOGY	Milecastle 62 is presumed to lie immediately to the west of where the minor road turns north.
GROUND COVER	Grass. No visible stone remains. The ditch survives as a slight depression. The ground is particularly waterlogged to the north of the ditch.
AIM OF SURVEY	To confirm the line of the ditch, wall and vallum, as marked on the OS map, and to try and locate Milecastle 62.

RESULTS

TRAVERSE

A line of high resistance peaks runs through the length of the field corresponding to the line of the ditch. (The reasons for such results are discussed in survey VI).

An increase in the readings is visible along the supposed line of the Wall, though the anomalies are less distinct in the more wasterly traverses.

A strong linear anomaly is visible to the south of the wall. At points in the field this was seen to correspond to a slight bank visible at ground level.

There is no clear response over the vallum, though the tendency is for the feature to be showing as an area of high resistance.

AREA SURVEY

Plots showing the initial readings and the data after smoothing and filtering are included. The filtered results are shown also as contour and density plots.

An examination of these plots shows the ditch (a), wall (b) and the linear anomaly (c) running in an E-W direction. The high readings on the edge of the survey (d) are due to a field bank, and the apparent narrowing of the ditch (e) is due to a wide area of the ground being underwater.

The most marked anomaly running N-S (f) would seem to correspond to an old field boundary and also a track which is marked on early OS Maps.

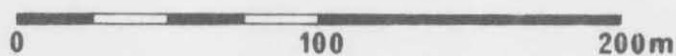
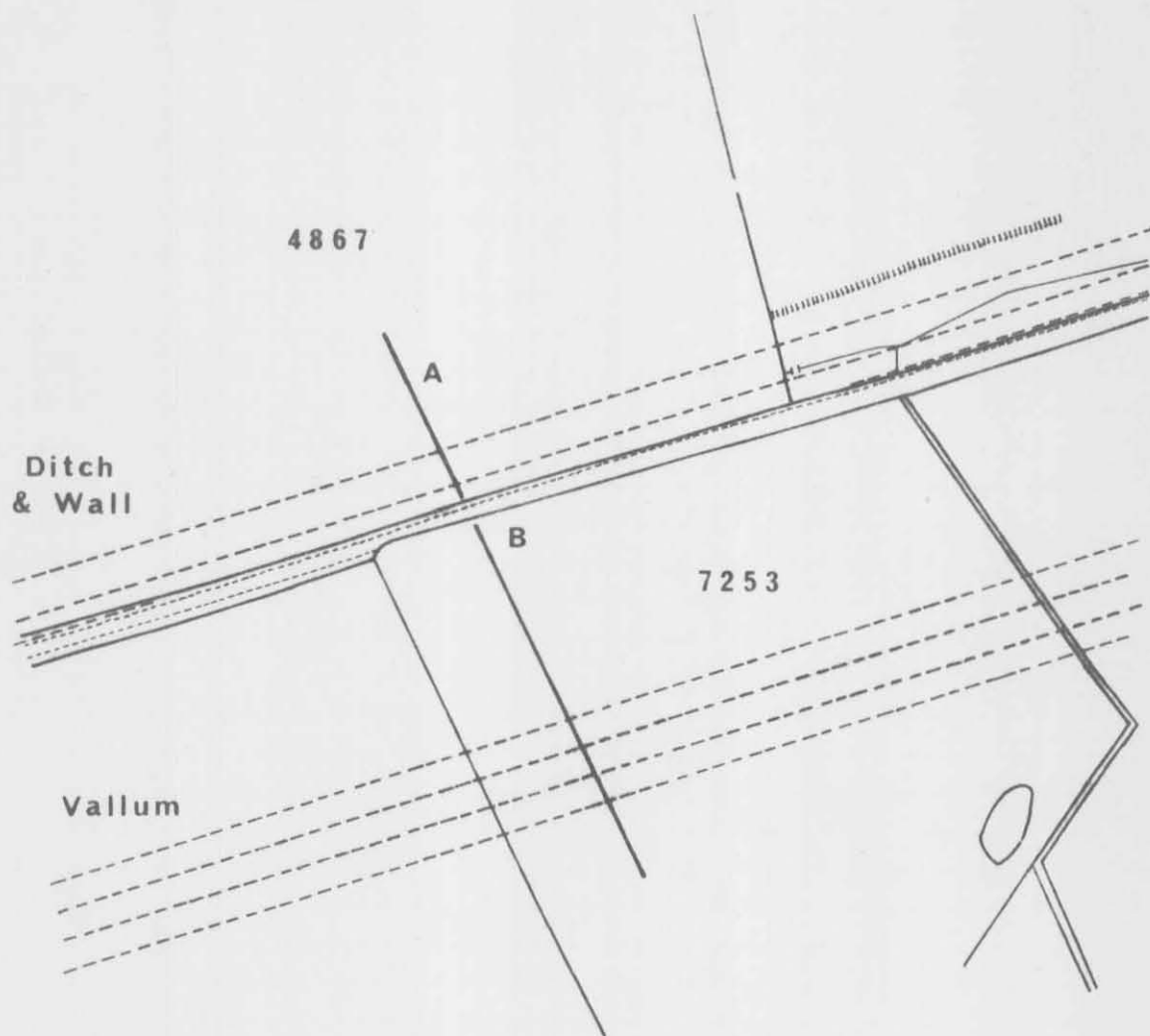
The presence of the milecastle is not immediately ^{apparent}. It is possible that the linear feature (c) corresponds to the 'back' wall and that the eastern wall has been robbed out. Unfortunately the survey did not cover the area to the west: further work would be necessary to try and verify this interpretation.

The alternative for a milecastle is a rather poorly defined anomaly (g), but this is not very convincing.

HADRIAN'S WALL

C.E.U. Site 192

NY 4260 - 4360



It would seem that most of the stonework has been robbed out, or plough^{ed} away: support for this view lies in the fact that only 500m to the east (CEU Site 192) only one course of the wall remained in situ and here the line was protected from ploughing by the field bank.

SURVEY VIII
MILECASTLE 63

OS MAP	NY 4259 - 4359
PARCEL NO	None (Old boundaries removed)
GEOLOGY	Drift - Boulder Clay Solid - Kirklington Sandstone
ARCHAEOLOGY	Milecastle 63 is thought to lie somewhere on the plan in Fig XI
GROUND COVER	Plough-soil. The ditch is visible as a slight depression, and the ground rises to the north. No standing masonry is visible.
AIM OF SURVEY	To check the line of the wall and locate Milecastle 63.

RESULTS

One of the main problems with this survey was trying to establish the positions of old field boundaries and hence the suspected position of the Milecastle. It was decided, therefore, to attempt a total survey of all the field but unfortunately the sowing of crops prevented this. Fortunately it would seem that the position of the milecastle was located within the area covered.

Fig XI shows a range of plots similar to those included for Milecastle 62.

The line of the ditch and wall, (marked on the interpretation) although weak in places, is clearly reflected in the readings.

The most marked anomaly running N-S (a) corresponds to the old field boundary marked on the location plan (Fig XI).

The anomalies at b are of particular interest. Although the plan of the milecastle is not clearly defined, this is the only point on the survey where relatively strong anomalies are at right angles to and south of, the wall. These would seem to reflect the eastern wall of the milecastle.

The anomalies close to the field at d and e lend support to the above positioning of the milecastle. These two points, being protected from ploughing by the bank, suggest the presence of buried stonework. The position of d in the west is 'correct' for the location of the western wall.

The evidence would, therefore, seem strong for locating the remains of the milecastle here.

Other anomalies of equal strength are recorded in the survey: those to the north of the ditch presumably reflect the slight bank visible there.