BATH AND COUNTIES ARCHAEOLOGICAL SOCIETY

The Roman Baths, Bath.
The Archway Project
Deep-looking geophysics
April 2019

John Oswin
Bath and Counties Archaeological Society

Abstract

A number of resistivity profiles were measured within the precincts of the Roman Baths at Bath in April 2019 in order to continue the search for the drain from the Hetling Spring. The requirement was to look deeper than had been done in the survey of January 2018. In order to look down the requested 4 m, lines of at least 25 m, preferably 31 m had to be found, and these had to be north-south profiles in order to intercept an east-west drain. This raised the need to find spaces where such lines could be set up, even if they were diagonal. An extra space, the vaults under Stall Street, was also investigated.

One possible deep location was noted, along with other possible shallow sites, but there was no good corroboration between the profiles to confirm any of these possibilities.

This document has been produced in landscape format as that will better display the results.

The Roman Baths, Bath.
The Archway Project
Deep-looking geophysics
April 2019

John Oswin

Bath and Counties Archaeological Society © 2019

Disclaimer

This report has been complied with all reasonable skill, care and attention to detail within the terms of the project design as specified in the written scheme of investigation and within the general terms and conditions of Bath and Counties Archaeological Society © 2019 (BACAS). No responsibility is accepted whatsoever to third parties to whom these reports or any part thereof is made known. Any such party relies upon these at their own risk.

Table of Contents

Abstract i
Table of Contents iii
List of Figures v
Preface vii
Acknowledgements vii

1 Introduction 1
1.1 Location 1
1.2 Dates and personnel 4
1.3 Background to survey 4
1.4 Scope 4

2 Method 5

3 Results 7
3.1 East Area 7
3.2 West Area 12
3.3 Under Stall Street 14

4 Comment and Conclusions 16

Bibliography 18

Appendix A Profile Data 19
Profile q101 19
Profile q102 20
Profile q103 21
Profile q104 22
Profile q105 23
Profile q106 24
Profile q107 25
Profile q108 26
Profile q111 27
Profile q112 28

List of Figures

Figure 1.1. Location map, courtesy of Cotswold Archaeology ***1***

Figure 1.2. Left. View along York Street, looking east. The distant bollards represent the termination of the east area of the vault. The west area of vault is under the street by the bollards on the right at the end of Swallow Street. ***2***

Figure 1.3. Above. Stall Street, looking north. There is a vault under the line of bollards, and the vault that was surveyed branches south off that, under the van and past the front of the shop. ***2***

Figure 1.4. Left, view along the east area of the vault under York Street. The lower east area and the west area were behind the camera. ***3***

Figure 1.5. Above, the view along the vault under Stall Street, looking north. The steps up to the vault crossing Stall Street under the bollards (see figure 1.3) can be seen at the far end. The cold bath and the extreme of the west area are behind the camera. ***3***

Figure 2.1. Probe supported in tumbler with wet sacking. Contact clip placed low for stability. ***5***

Figure 2.2. Annotated locations of the profiles with respect to the excavated remains of the Baths (based on Cotswold Archaeology). ***6***

Figure 3.1. Profile 101 (top). Profiles line 1 (lower left) and q2 (lower right) from 2018 as comparison. ***7***

Figure 3.2. Profile 102. ***8***

Figure 3.3. Profile 103. ***9***

Figure 3.4. Profiles 106 and 107 concatenated to Profile 167. ***10***

Figure 3.5. Profile 108. Note that the line kinked at 8 m from either end. Topographic data has not been added. ***11***

Figure 3.6. Profile 104, west area. ***12***

Figure 3.7. Profile 105. This repeated profile 104, but the line was kinked beyond 24 m. Note change in resistivity scale from figure 3.6. ***13***

Figure 3.8. Setting up the probes along the rim of the cold bath under Stall Street. ***14***

Figure 3.9. Profile 1122. Box shows approximate position of the cold bath in the Western Baths. ***15***

Preface

The Bath and Counties Archaeological Society investigated the vaulted space under York Street, Bath, next to the Great Bath in January 2018. The results indicated the absence of a drain running from the Hetling Spring which was strongly believed to be there. We were therefore asked if we could look to greater depths to find that drain. This report covers that work done in April 2019 to try again to locate that drain.

It should be noted that the study reported here took the equipment to the limits of its viability, or even beyond, so the results must be regarded as less rigorous than would normally be presented, and in places more qualitative than quantitative. They nonetheless make a useful data set.

Acknowledgements

We would like to thank Stephen Clews for inviting us back again, and Vicky Young for organising the logistics, and particularly the security and reception staff at the Baths for easing away any difficulties of access or setting up.

Some of the figures are based on plans originally provided by Cotswold Archaeology, and we acknowledge their input to these.

Mostly, I would like to thank our volunteers, Janet Pryke, John Knapper, Terri Bell, Les Philips, Lawrie Scott, Fiona Medland and Bob Ford for working under extraordinary conditions. Rick Buettner came along and took photographs for us. Bob Whitaker and Henry Lowe also provided liaison for the project.

1 Introduction

1.1 Location

The Roman Baths site lies in the centre of Bath, grid reference ST 751 647. This is shown in figure 1.1. Two sites within the Baths precinct were investigated during this survey. The first area was the vaults under York St. which had been surveyed in 2018, although work in the western area of this extended out into the public area, touching the circular bath and extending along the corridor to the eastern section.

A line was also taken down under Stall Street, immediately in front of the Roman Baths entrance and shop, and across the western end of York Street. The profile line here started in the vault, in the culvert under the corridor from 'Minerva's Head' to the vaults of Primark. It continued through the vault, past the West Baths and into the western area previously described, but some 20 m further to the west.

The surface views are shown in figures 1.2 and 1.3 respectively, working views of the vault areas are shown in figures 1.4 and 1.5.

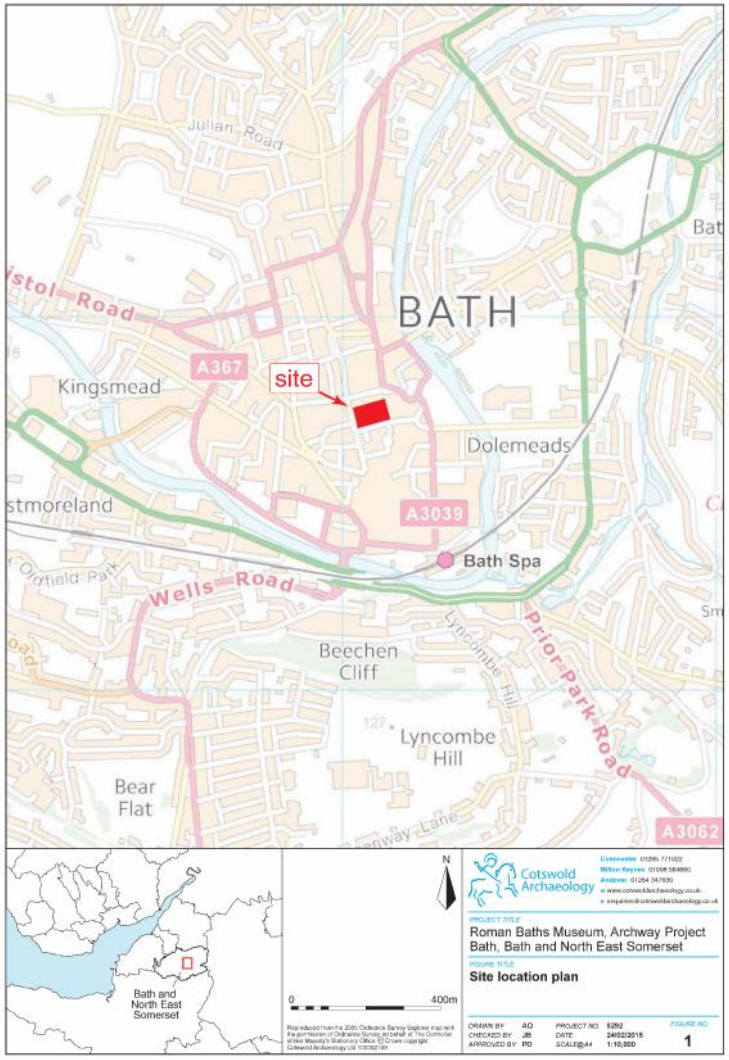


Figure 1.1. Location map, courtesy of Cotswold Archaeology

Figure 1.2. Left. View along York Street, looking east. The distant bollards represent the termination of the east area of the vault. The west area of vault is under the street by the bollards on the right at the end of Swallow Street.

Figure 1.3. Above. Stall Street, looking north. There is a vault under the line of bollards, and the vault that was surveyed branches south off that, under the van and past the front of the shop.

Figure 1.4. Left, view along the east area of the vault under York Street. The lower east area and the west area were behind the camera.

Figure 1.5. Above, the view along the vault under Stall Street, looking north. The steps up to the vault crossing Stall Street under the bollards (see figure 1.3) can be seen at the far end. The cold bath and the extreme west of the west area are behind the camera.

1.2 Dates and personnel

The survey was conducted between Tuesday 2nd April and Friday 5th April, 2019. The survey was hosted by Stephen Clews and Vicky Young of the Roman Baths staff. The survey was led technically by John Oswin MA PhD CSci FGS of the Bath and Counties Archaeological Society (BACAS) with logistic support organised by Janet Pryke and safety supervision by John Knapper, both of BACAS.

1.3 Background to survey

Survey in the vaults to the south of the Great Bath in January 2018 had found no clear trace of the drain from the Hetling Spring, which was believed to run through this area. BACAS was asked if it could revisit the site but look deeper. The ground-penetrating radar tried in 2018 was not in working order in 2019, so only resistivity profiling (otherwise known as 'electrical resistivity tomography', ERT) was the only method. This had been used successfully in 2018, but its depth coverage had been restricted to 2 m nominal by the use of probe spacing of 0.5 m, line length 15.5 m maximum. Full depth coverage is only available over the middle portion of a profile, and obtaining greater depths necessitates a longer profile, which with only 32 probes means increasing the distance between them.

During the 2019 survey, lengths were sought where a full profile of 31 m could be obtained with minimal deviation from straight, and depths down to 4 m nominal (8 m spacing between longest readings) obtained. Indeed, some profiles even tried using longest spacings of 10 m. This took the TR resistance meter beyond its specified use, and results have to be interpreted in light of this.

The survey was undertaken with permission from Historic England, under Section 42 licence S00147125.

1.4 Scope

This report gives the results of the 2019 survey. It may introduce earlier results for comparison with those more recent, but no re-analysis of these is intended. Photographs are used freely of the arrangements as operating conditions were so far from normal that they need to be taken into account while studying the output data. This work was undertaken as an experimental study, stretching the equipment to its limits of performance, and any analysis has to keep this caveat in mind. Excavation evidence is beyond the scope of this report.

2 Method

Only one method was used during this survey, resistivity profiling. This was done using a TR/CIA resistance meter (old model) connected to a set of 32 probes using a cable loom and distribution box devised by BACAS. 1 m spacing was used to maximise profile lengths. In a couple of cases, profiles were concatenated to produce longer lengths, but maximum depth is still controlled by the length of one profile. In a couple of cases, it was not possible to insert the entire 31 m length, so these were reduced to 26 probes (25 m length).

Many of the readings were taken with the probes resting on concrete. Even where not, conditions did not allow us to penetrate the surface. The probes had to be supported upright, and this was done by boring holes in the bottom of plastic one-pint tumblers, inverting them and passing the probe through the bored hole until it reached the surface. The probe end was then wetted thoroughly until good electrical contact was obtained. If needed, the electrical contact could be extended by the use of wet sacking under the probe. The cables were clamped to the probe just above the tumbler to prevent toppling. The arrangement is shown in figure 2.1. Some probes kept good electrical contact, whilst others required frequent wetting in order to secure a satisfactory reading.

The height of the probes could vary along the length of any line, depending on obstructions such as Roman walls or over excavated areas. The change in height from probe to probe was estimated by eye and built into the data, which were all analysed using RES2DINV full version. A couple of heights were taken by dumpy level and related to previous temporary bench marks to gain an idea of height above Ordnance Datum.

Figure 2.1. Probe supported in tumbler with wet sacking. Contact clip placed low for stability.

The locations of the probes with respect to the excavated remains of the Baths is shown in figure 2.2. The various profiles are shown colour coded, and these are annotated.

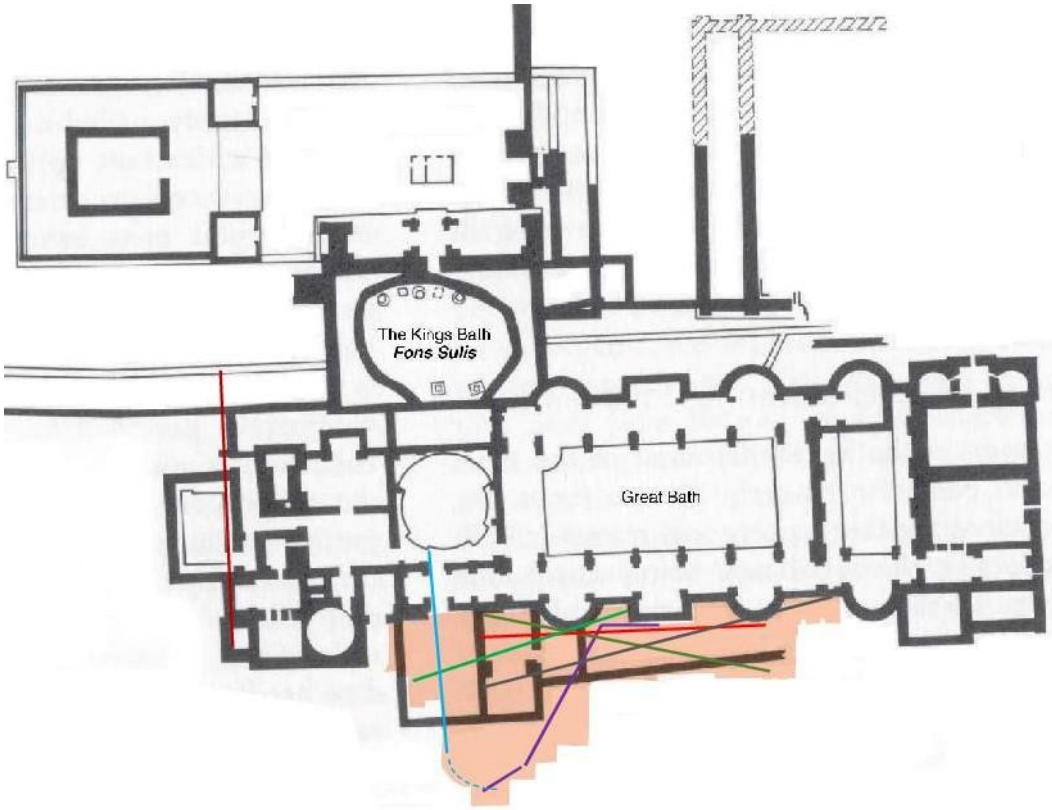


Figure 2.2. Annotated locations of the profiles with respect to the excavated remains of the Baths (based on Cotswold Archaeology).

Profile 101, control profile

Profile 102

Profile 103

Profile 104, extended as profile 105

Profiles 105 and 106 concatenated to 167

Profile 108

Profiles 111 and 112 concatenated to 1122

3 Results

3.1 East Area

The results of the profiles individually will be discussed here, and the overall picture they make will be discussed in Chapter 4. Full details of the profiles will be given in appendix A. The first profile, 101, was east-west, but was done as a control, as it covered familiar territory; profile q2 and line 1 from the 2018 survey. This is shown in figure 3.1.

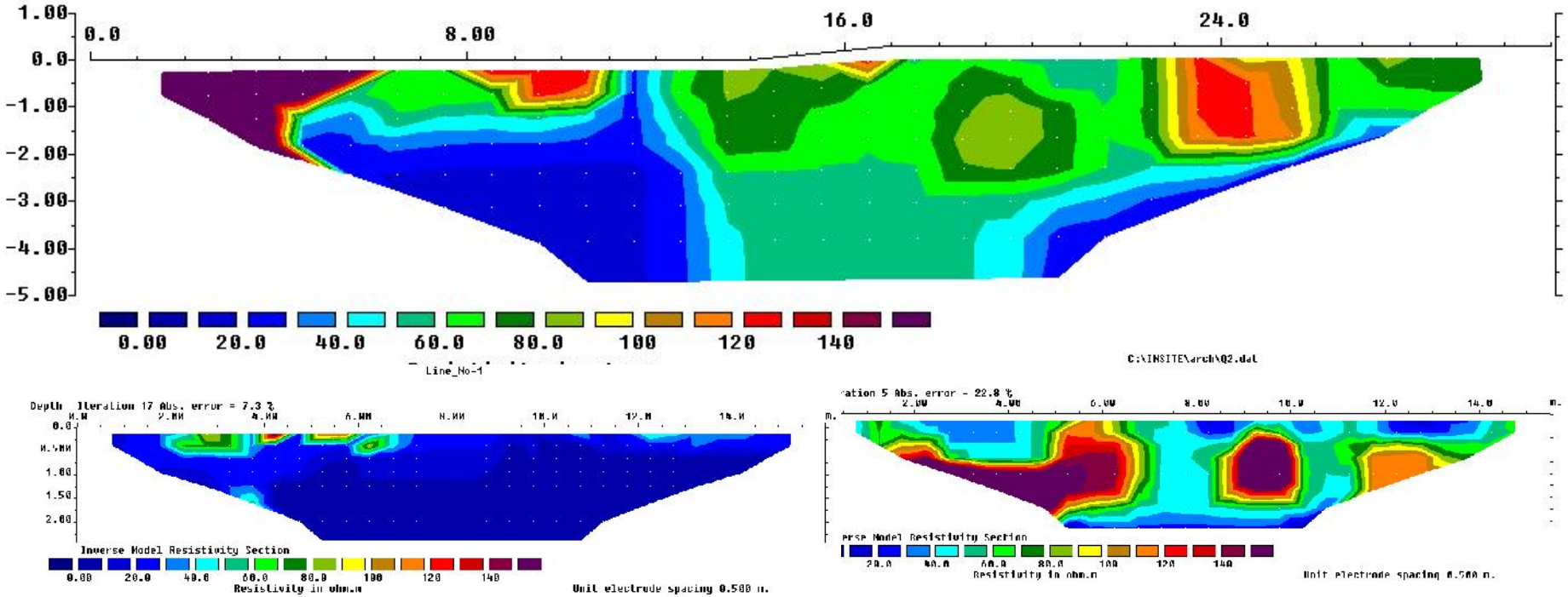


Figure 3.1. Profile 101 (top). Profiles line 1 (lower left) and q2 (lower right) from 2018 as comparison.

Profile q1 (2018) shows good agreement with profile 101, although there are some discrepancies in absolute values of resistivity. The closer spacing used in the earlier plot provides more definition. The patterns in Line 1 (2018) look a little different, with much lower values, but this was conducted with a different device. When the resistivity scale was increased fourfold, a much more similar picture was obtained. The control established a reasonable concordance with the 2018 results. The discrepancy in calculation of resistivity in the other device is an issue beyond this study.

Figure 3.2 shows profile 102. This started in the far north-west corner of the eastern area and crossed it on a diagonal, going through the narrow gap into the space behind the stylobate wall. Probe 32 was just at the edge where the space here was excavated by Cotswold Archaeology following the survey in January 2018. There was a slight kink in the line to fit it through the gap, but this was small and did not degrade the plot significantly. Between 0 m and 6 m, the profile passed through an excavated area. As with Profile 101, the probes passed either side of the stub wall at 8 m - 10 m. The deeper feature at 14 m corresponds with a feature in Profile 101, but is stronger.

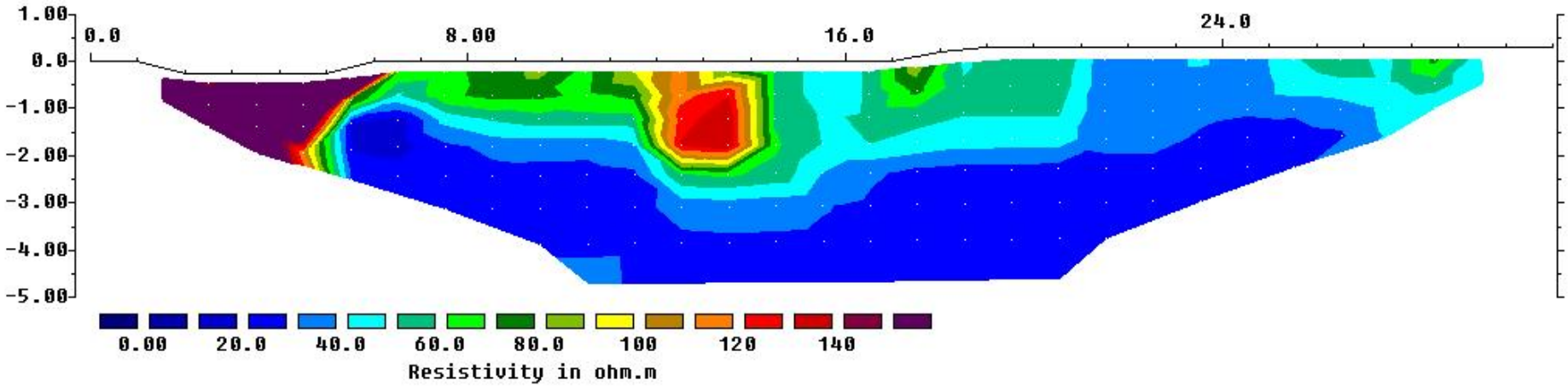


Figure 3.2. Profile 102.

Profile 103 started in the western area and passed through a hole in the wall between the two, between 8 and 9 m. Pushing it into the furthest corner left it aiming directly at the wall of the rectangular alcove by the Great Bath, and this could not be avoided without significant kinking of the line. This restricted the length to 26 probes, so 25 m, so the length available at maximum depth was restricted.

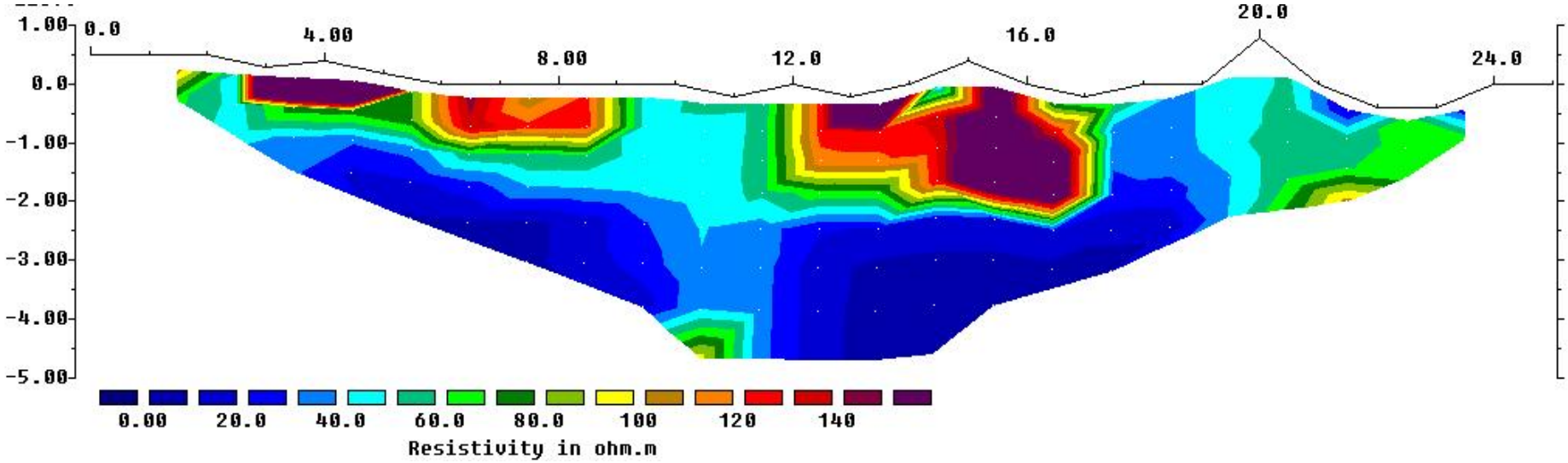


Figure 3.3. Profile 103.

The alignment necessitated having a probe on the stub wall, and this is evident at 20 m. The feature centred on 16 m is seen in Profile 101 at 14 m. The feature between 7 m and 9 m is the footings of the wall between west and east areas. There is a distinct cut through by higher resistance at 10 m - 12 m, terminating with very high resistance at its base. This could be an edge effect at depth, but the cut is consistent at all depths. This may be an indication of the buried drain. Note however, this would put the drain some 5 m below floor level, at about 14 m OD, some 3 m below any features in the baths. Such a deep cutting would be very hazardous by today's standards and may not have been possible in these wet soils. It may also be too low to flow into the great drain from the baths. If this is the drain, it is well south of the line of later pillars.

Profiles 104 and 105 were in the west area and will be discussed later. Profile 106 started in the alcove where the brick support structure had been, and headed for the door into the East Baths. Profile 107 continued the same line until it reached the door, some 8 m further on. Profiles 106 and 107 were therefore concatenated to produce Profile 167. Depth information is trustworthy down to about 4 m but data would be lost in the central section at lower depths.

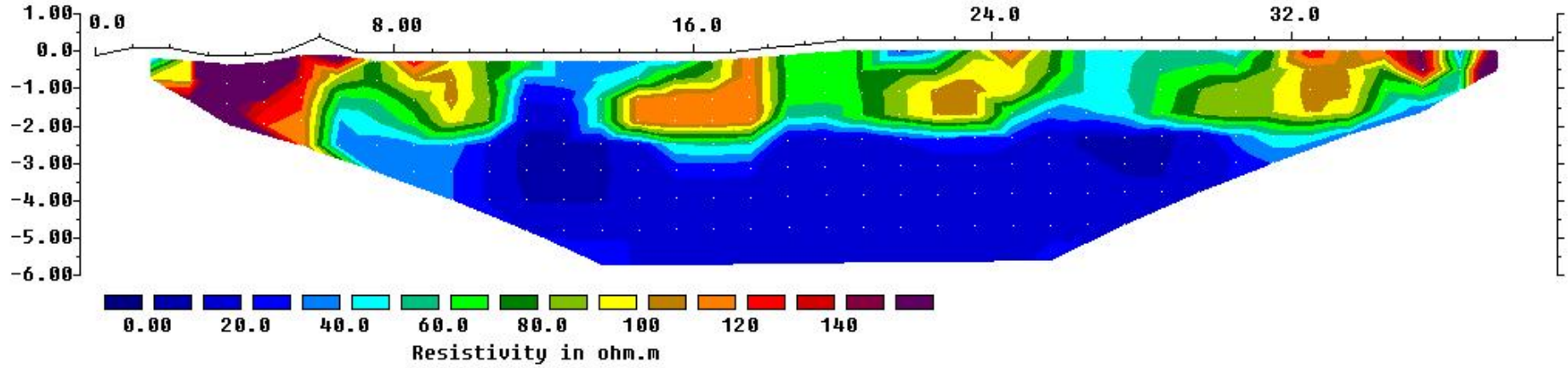


Figure 3.4. Profiles 106 and 107 concatenated to Profile 167.

The part in the alcove shows as high readings and uneven surface up to 7 m. There is just possibly a flooded channel at 12 m, 3.5 m depth and possibly again at 28 m. The high readings from 32 m onwards correspond with high readings seen in profile q3 in the 2018 survey. Features seen at 17 m and 24 m are shallow and correspond approximately with features at 20 m and 24 m in Profile 101.

Profile 108 was a bold move to cross the floor of the eastern area at maximum depth, which involved sharp changes in alignment at 8 m, where the line had been running close to the wall of the Great Bath before heading across the area, through the entrance archway (but over stylobate wall) and through the vaults connecting the area to the main passage before ending in the rectangular alcove. The last 8 m also had to kink significantly to allow the line to continue. This means that electrical conditions of real distance between probes were not met at either end of the line or at depth, but this was considered sufficient to get a qualitative feel as to whether there was any feature crossing the east area at depth.

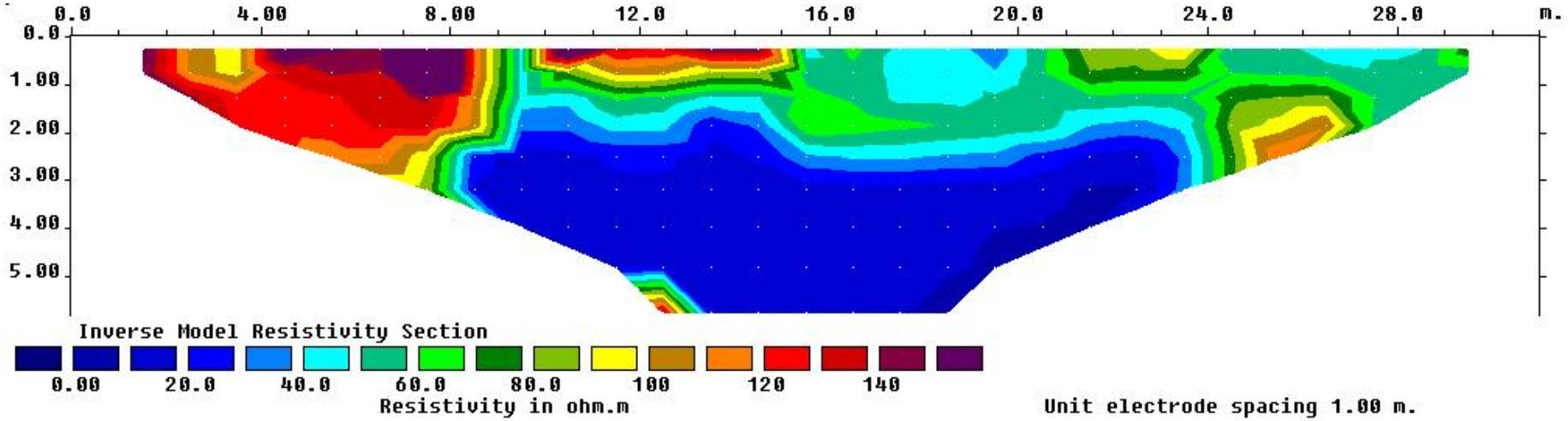


Figure 3.5. Profile 108. Note that the line kinked at 8 m from either end. Topographic data has not been added.

There is an apparent point of high resistivity at maximum depth at 12 m, but this may be an edge effect, especially as there is no effect continuing upwards to the surface as was seen in Profile 103. Low readings from wet soil predominate below 3 m depth.

Overall, there is some slight evidence of a very deep drain, but the plots do not offer much corroboration between them.

3.2 West Area

Profile 104 stretched from the circular pool edge (west of the Great Bath) through the doorway into the vaults and followed a line into the corridor at the southern end of this vault. The last probe in this line was 26 was set off at an angle slightly to maximise the length of the line, but the curvature was small. The restricted length of the profile provided depths down to 4 m over a limited central length.

As an experiment, the profile was repeated as 105 but the probes were continued up to 32 even though that meant taking the end of the line through quite an angle and along the corridor to the bottom of the steps up to the ground floor. This would be sufficient to distort the plot but it was tried to allow readings down to 5 m nominal which might provide a qualitative appreciation of the state at great depth.

Relative heights of probes were estimated by eye, but the central section could be taken from the readings taken for profile q10 in 2018. Note that levels in this area were significantly higher, particularly at the southern end of the vault, than those in the east area.

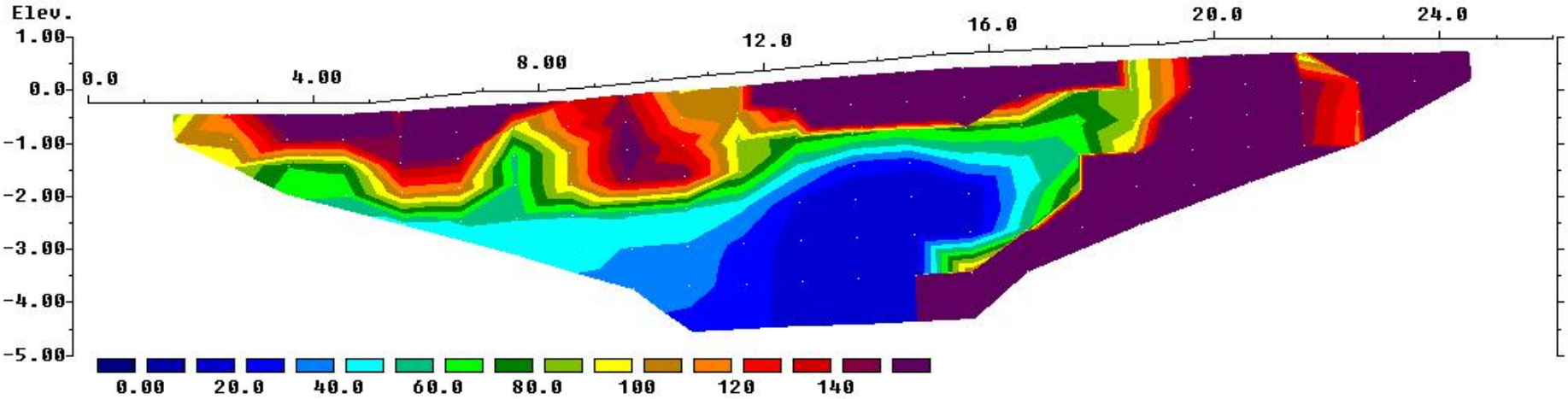


Figure 3.6. Profile 104, west area.

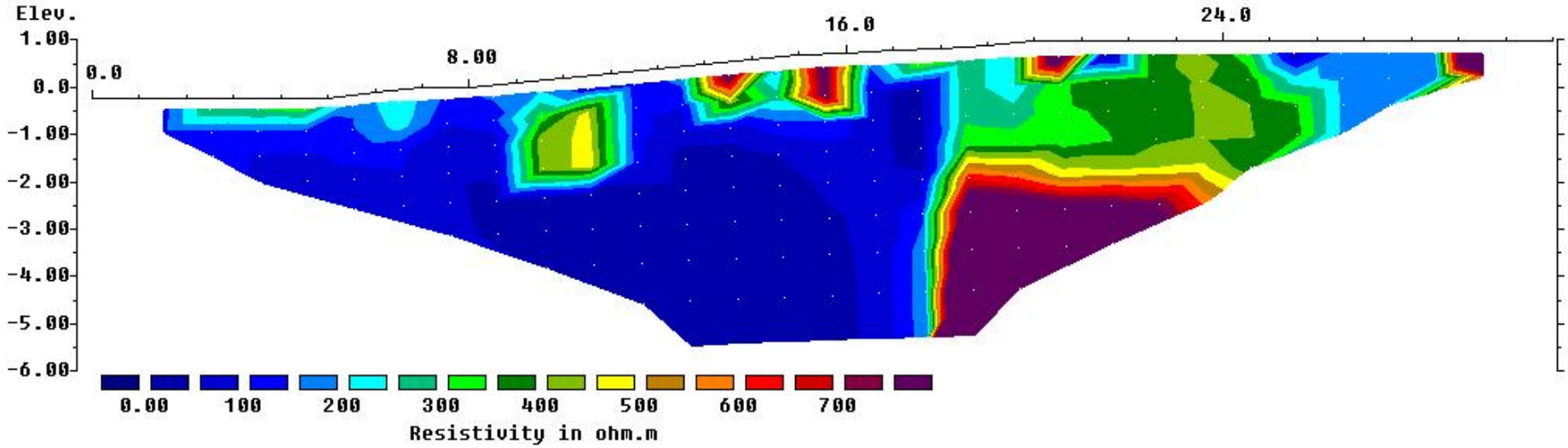


Figure 3.7. Profile 105. This repeated profile 104, but the line was kinked beyond 24 m. Note change in resistivity scale from figure 3.6.

The doorway from the Great Bath to the west area was at 7 m along this line. Profile 104 shows the stonework in the Great Bath precinct to extend down a metre or so, with a possible culvert centred on 6 m, just within the precinct. There also appears to be a culvert within the vaulted area, centred on 10 m, but this does not extend below 2 m depth. Masonry extends at shallow depths from 10 m -18 m, but some of this may be modern drainage, which is very evident on the floor here. There is no sign of any culverts below 2 m. Note that deep feature observed in profile 103 would correspond to about 16 m on these plots. However, the ground surface is about 0.5 m higher here, so a culvert would appear even deeper in these plots. There does, however, appear to be an abrupt change in resistivity at depth here.

Figure 3.7 also appears to show a step change in resistivity at 18 m, but this may be an artefact of the unreal conditions set by the bend in the line. The very high resistivity apparent at depth from 18 m in both plots may also be an artefact of the measurement conditions.

3.3 Under Stall Street

Access to the vaults under Stall Street allowed another cross section to be made electrically some 20 m to 25 m west of the west area line. It was possible to set up a line of 43 m with minimal deviation from straight, although some changes in level were rather abrupt. The end of the line at 43 m was at a similar height OD to 12 m on profiles 104 and 105. Two profiles of 32 probes were done, 111 and 112, and were concatenated to produce profile 1122. The overlap was at 12 m, giving reliable results down to about 4.5 m, with the concatenation interpolating data at maximum depth between the two profiles.

After running down the length of the vault, the line passed along the eastern rim of the cold bath, under the cable trunking, before passing into the furthest part of the west area (as considered in section 3.2). The bath rim started at 25 m and ended at 30 m, so these measurements were constrained by an air space some 1.5 m deep immediately next to the line.

The bath edge is shown in figure 3.8. The line of the profile runs back into the gap on the right of the picture. Some idea of the electrical constraint along these probes can be gained in terms of the depth of the bath and the proximity of the probes to its edge. Note figure 3.9, the profile shows this had a very limited effect in practice.

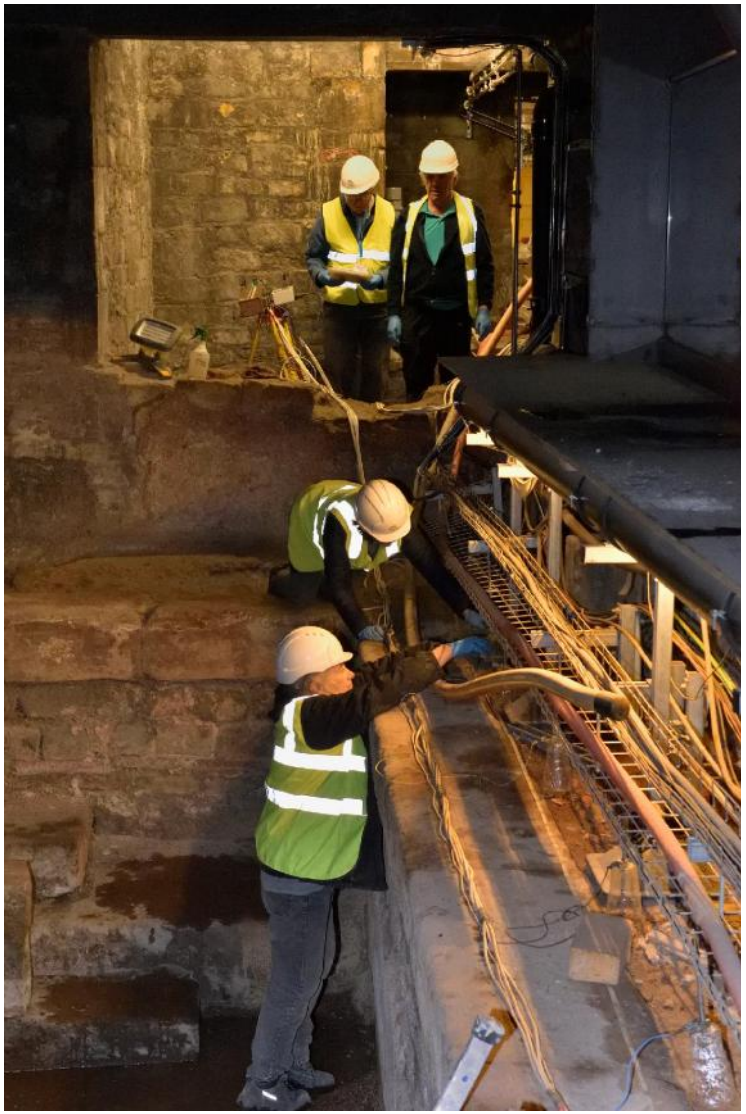


Figure 3.8. Setting up the probes along the rim of the cold bath under Stall Street.

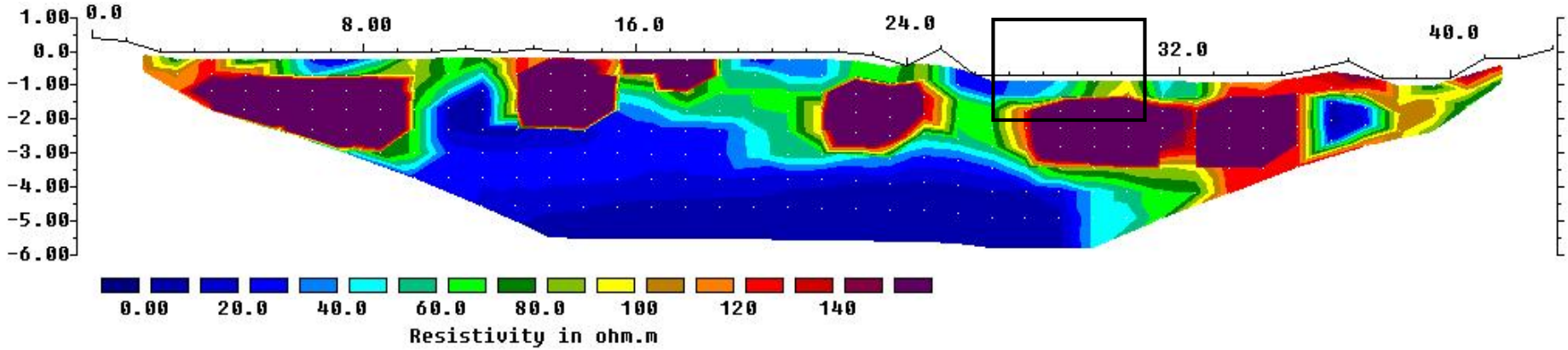


Figure 3.9. Profile 1122. Box shows approximate position of the cold bath in the Western Baths.

The profile again proved very credible, and shows a number of buried features, although none are particularly deep. Shallow high readings at the start indicate the entrance to the culvert to the Mineral Water Hospital. There are then very high readings to 9 m, showing structure to a depth of 3 m. A modern drain at 10 m -11 m does not show, but there is a major feature at 13 m - 15 m and shallow stone footings at 16 m - 18 m. There are signs of a wall at 24 m and a large masonry feature below it, which could again be a modern drain. There also appears to be a large void at 27 m - 31 m stretching under the cold bath, although this may just relate to the structure that supports the bath, or be a feature of the air space inside the bath. The void from 33 m to 35 m can still be seen and was excavated during the 2018 work. A feature of possible interest is the feature at 2 m depth centred on 37 m. This is best interpreted as a water-filled cavity, although its closeness to the end of the profile means it must be treated with a little caution. However, inspection of the data points suggest that it is a real effect.

This plot in particular shows a number of options for a drain and these will be discussed further in the following chapter.

4 Comment and Conclusions

It must be remembered that this was an experimental programme of work, taking the equipment beyond its normal working limits, so the results have to be treated with some reservation. Having said that, the data obtained appeared to be of good quality. Profile 101 was taken purely as a control, so will not be considered in this chapter.

The aim of this exercise has been to intercept the line of a possible east-west drain. That has meant setting up north-south profiles. There has been a secondary requirement to look more than two metres below floor levels, and this has meant that the profiles need to be about 30 m long. It should be noted that reliable data from 4 m depth can only be obtained under the central portion of a profile, with the first and last 10 m providing only progressively shallow data towards the ends. There was some scope for east-west profiles of this length within the areas worked in 2018, but north-south lines have generally been available only as diagonals. Within the west area of the York Street vaults, a continuous line could be obtained by starting at the circular bath in the public area, but it was limited to about 25 m.

The far western area under Stall Street provided new territory for new investigation and this provided a long north-south vault, albeit with many obstructions but with only slight deviations from straight. Conditions of measurement do mean that these results must also be subject to caution.

While one plot may show a promising feature, it really needs at least one more to show the feature along its length to provide corroboration. It should be noted that edge effects can give rise to apparently anomalous readings at the corners of plots at depth. This may just be a limitation of an assumption in setting the boundary conditions for the calculation within the software.

There were few signs of deep features. These will be stated and corroboration sought. There were a number of shallow features, many seen in 2018, and these need to survive elimination by comparison with known features in order to be candidates for the drain.

The most clearly defined deep feature just showed at the deepest portion of Profile 103, just in the eastern area, after the line passed through the wall from the western area of the York Street vaults. This would put it about 5 m south of the wall with the Great Bath, about 1 m west of the wall dividing east and west areas. The deep feature could be an edge effect, but the column of higher resistivity above it suggests something real. Profile 167 would cross this line at about 15 m but shows no deep feature. Profile 108 would cross the line at about 15 m, but shows no deep feature. A slight feature at full depth at 12 m may well just be an edge effect, especially considering the curve of this profile.

Profiles 104 and 105 in the western area would cross the line of any drain at about 14 m, but at this point, these profiles would be raised some half metre above the floor at the point seen in profile 103 so the feature at maximum depth in profile 103 would be too low to see. There are slight signs of an abrupt change of resistivity about that point, though, and this could be a reflection of the column rising in profile 103.

Profile 1122 under Stall Street was but shallow by this point, so cannot offer corroboration.

It should also be noted that floor level at 9 m in profile 103 was about 19 m OD as checked by dumpy level against temporary bench mark, so the drain would be about 14 m OD. This may be too low to join the main drain from the baths, and may also be deeper than was possible to excavate in wet subsoil.

Evidence for a deep drain is therefore finite but very slender. It would run some 5 m south of the wall to the Great Bath precinct.

Many of the shallow-going features have been mentioned in the previous chapter, and have been identified and dismissed. The longer profiles have found some more which need consideration. Two possible targets are at 6 m and 9 m on profile 104. The first of these would be just in the Great Bath precinct by the door through to the western vault, the second would be just within that vault. It may be within the first few metres of profile 102 in the eastern area, but that had very high readings resulting from the excavations in that area, which did not identify the drain. It would however correspond with the high readings at 33 m in profile 167. However, this line is crossed by modern excavations nearly 1 m deep, and with no sign of a drain observed in them. It would also correspond with the flooded feature seen at 37 m in profile 1122. The feature at 6 m on profile 104 would correspond with the large void seen at 34 m in profile 1122, but this was an excavation from 2018 and the drain was not identified then.

The only other feature in need of firm identification is at 14 m in profile 1122 under Stall Street, north of any other profiles, and it would pass along the north side of the Great Bath if it continues.

There is therefore slight evidence for a deep drain 5 m south of the wall between vault and Great Bath, and slight evidence for a shallow drain either just south or just north of that wall. The other possibility is that it runs north of the Great Bath. None of these suggestions are well corroborated. If the drain were any lower, it would not flow into the great drain from the Baths: water would flow the wrong way.

Bibliography

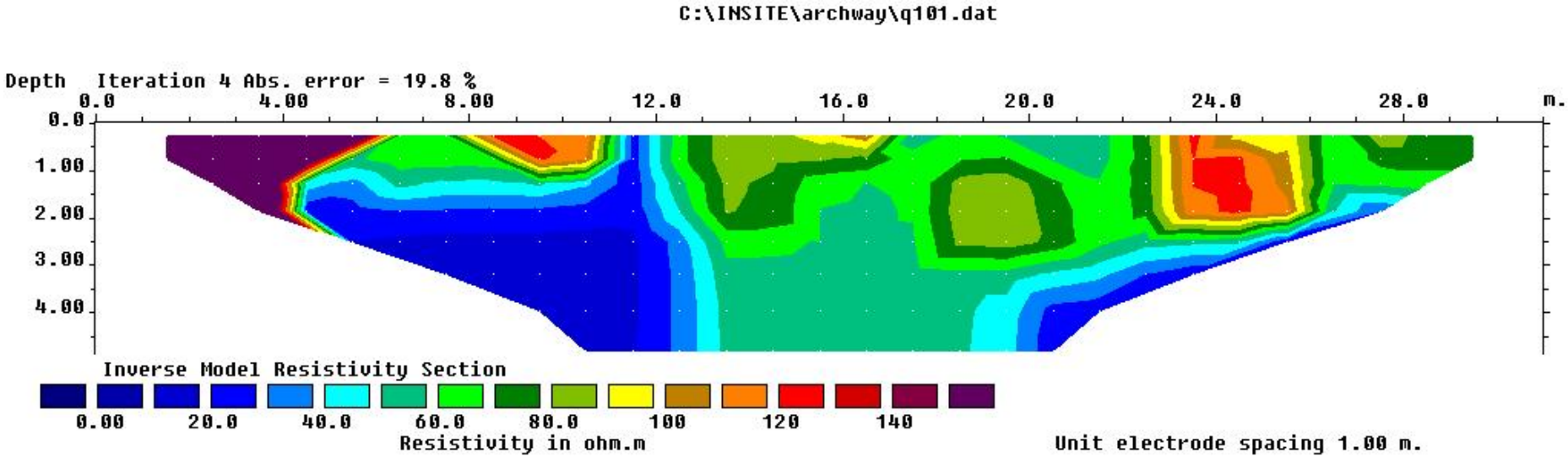
Historic England. Section 42 Licence number S00147125.

Oswin, J., 2018, The Roman Baths, Bath. Archway Project. Geophysical Survey, January 2018. Bath: Bath and Camerton Archaeological Society (now renamed Bath and Couties Archaeological Society).

Appendix A Profile Data

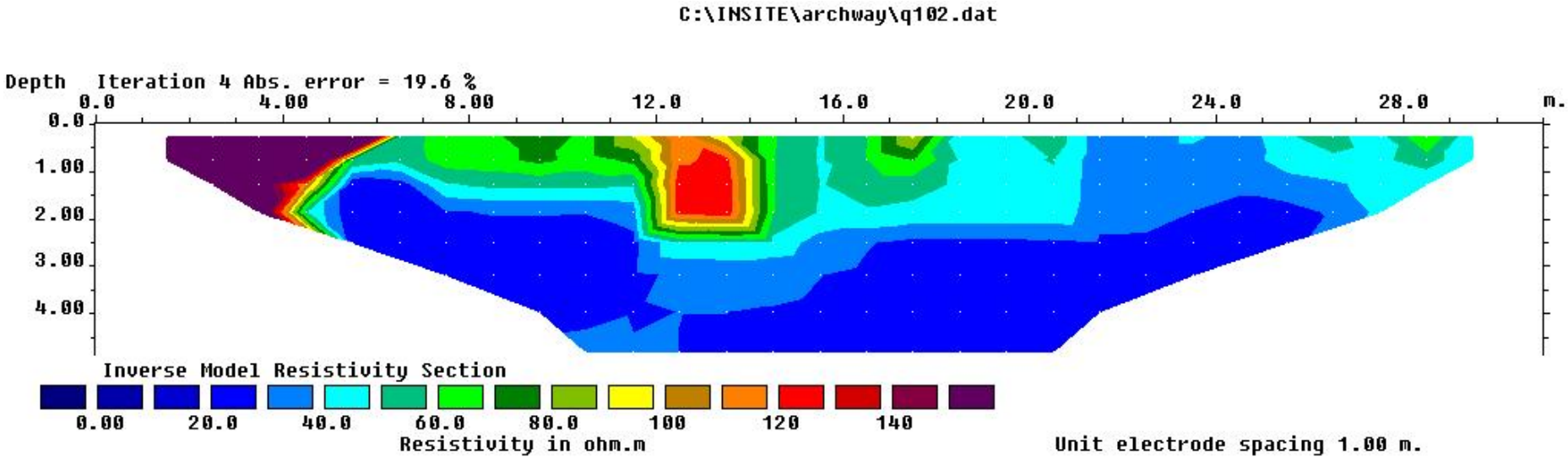
The profiles are all shown below in order in basic form without topography but with any notes attached regarding location or features along their lengths. Linear resistance and height scales are used.

Profile q101



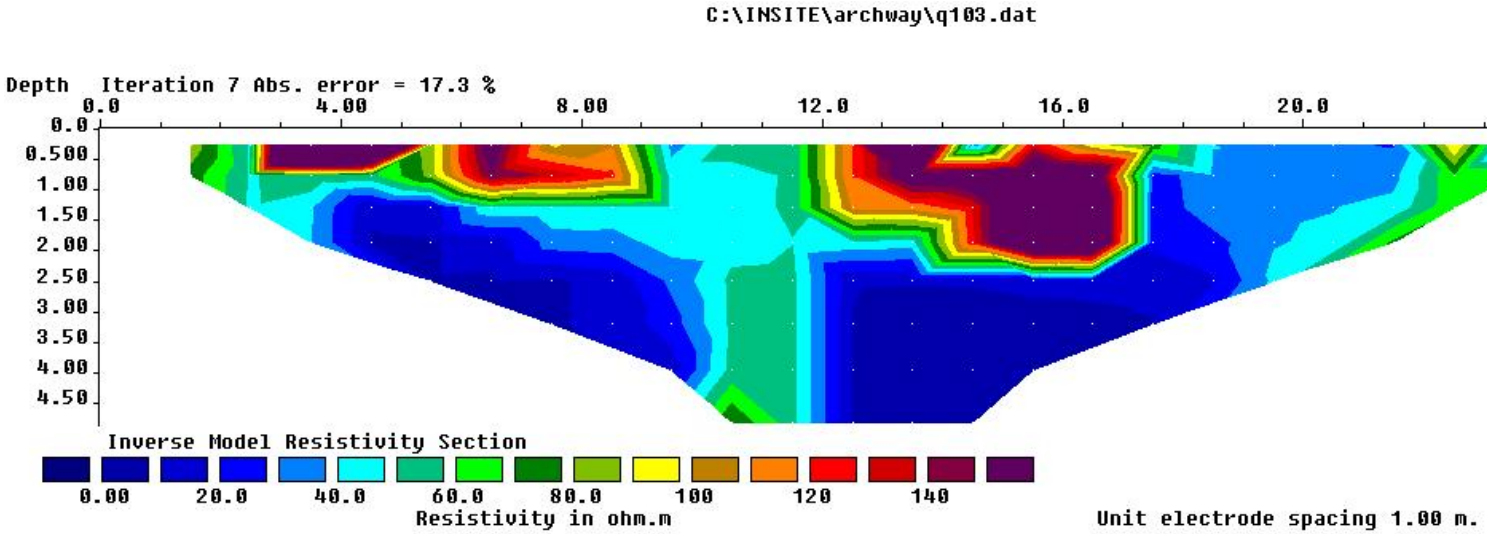
0 was against the west wall of the east area, and the profile ran approximately 1 m south of the wall to the Great Bath. Its line avoided the excavated trenches and probes straddled the stub wall. The final probe was in an alcove on the east wall, just south of the passage way through to the East Baths. This is an east-west line, done for control, and has no north-south component.

Profile q102



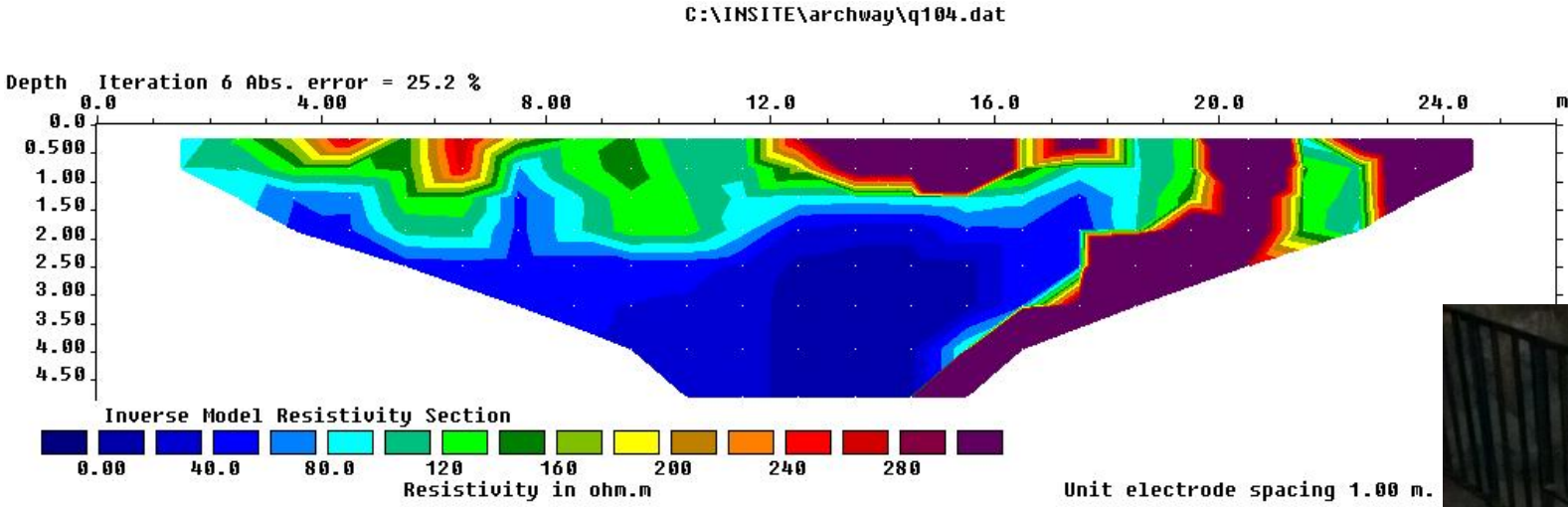
This profile set a diagonal across the east area. It started in the north-west corner, with probe 0 perched on stone before the line plunged into excavations, with some early probes supported on wet sacking to raise their height. The line was curved slightly at 26 m to go behind the stylobate wall, with the last probe perched on the edge of the excavations behind the stylobate, at the east end of where features have been encased for protection. Probes straddled the stub wall.

Profile q103



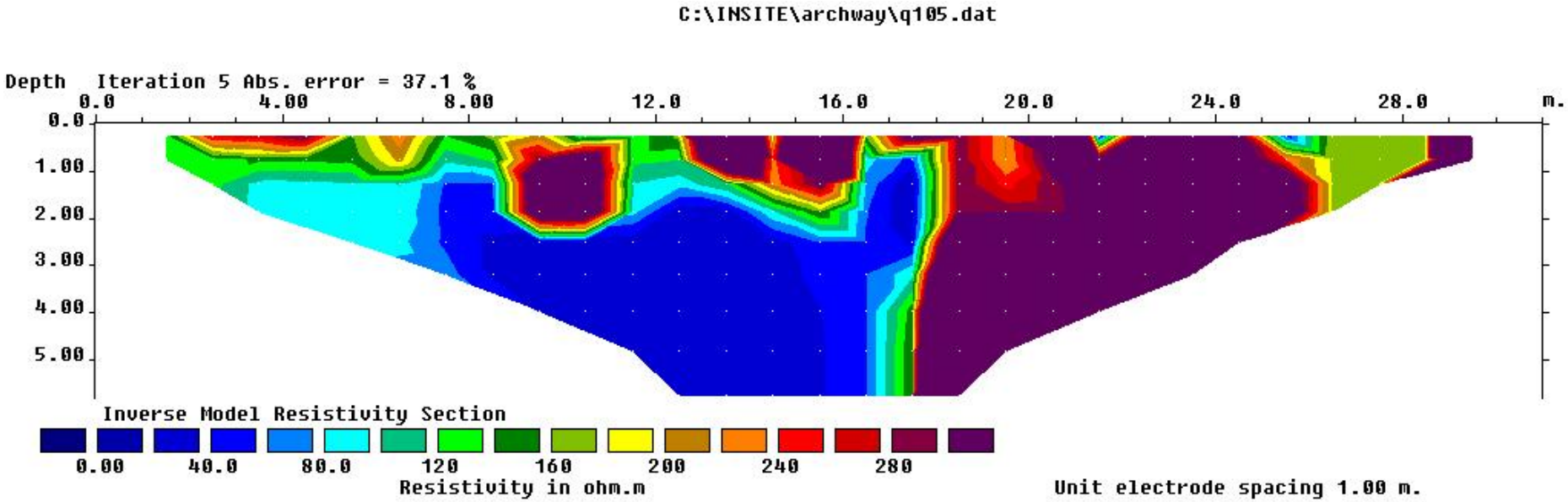
Profile 103 started in the west area and passed through the wall into the east area between 8 and 9 m. It continued through the east area until striking the side wall of the rectangular alcove of the Great Bath, as shown in the figure (with apologies to Bob for the decapitation). Attempts to increase the line length would have involved significant deviation from straight, so it was deemed best to terminate the line at probe 25. The line had pass over a deep excavation at 22 m - 23 m.

Profile q104



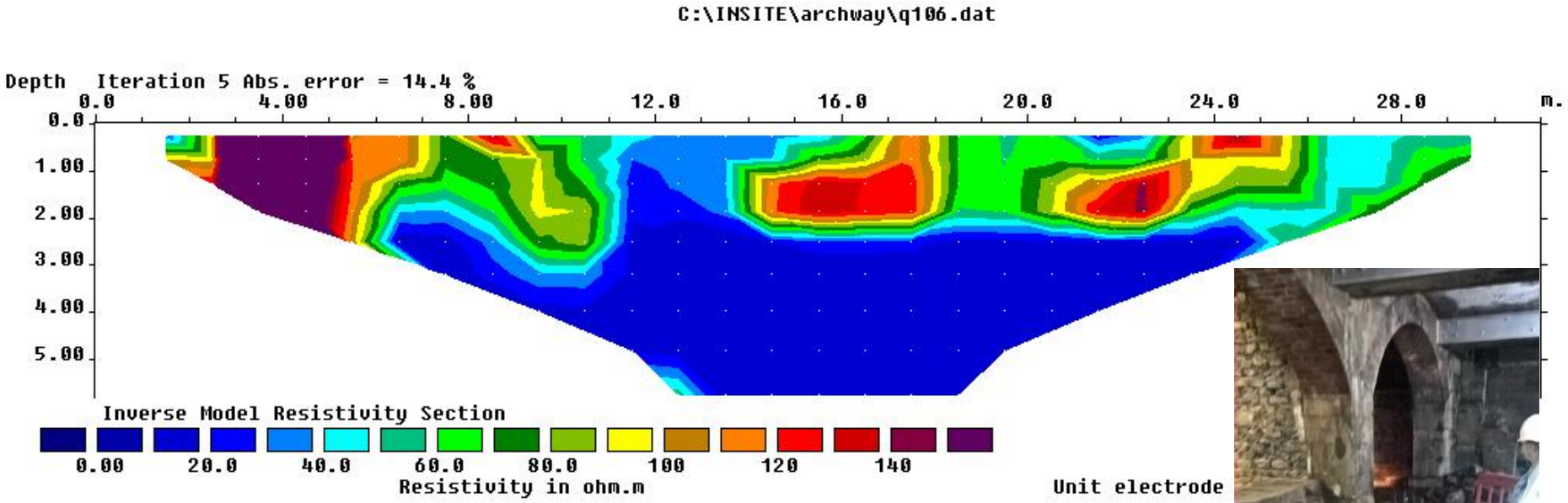
Profile 104 started by the circular bath and passed through the doorway into the west area up into the corridor. The line was terminated at 26 m with the last probe significantly off a straight line as the corridor curved round.

Profile q105



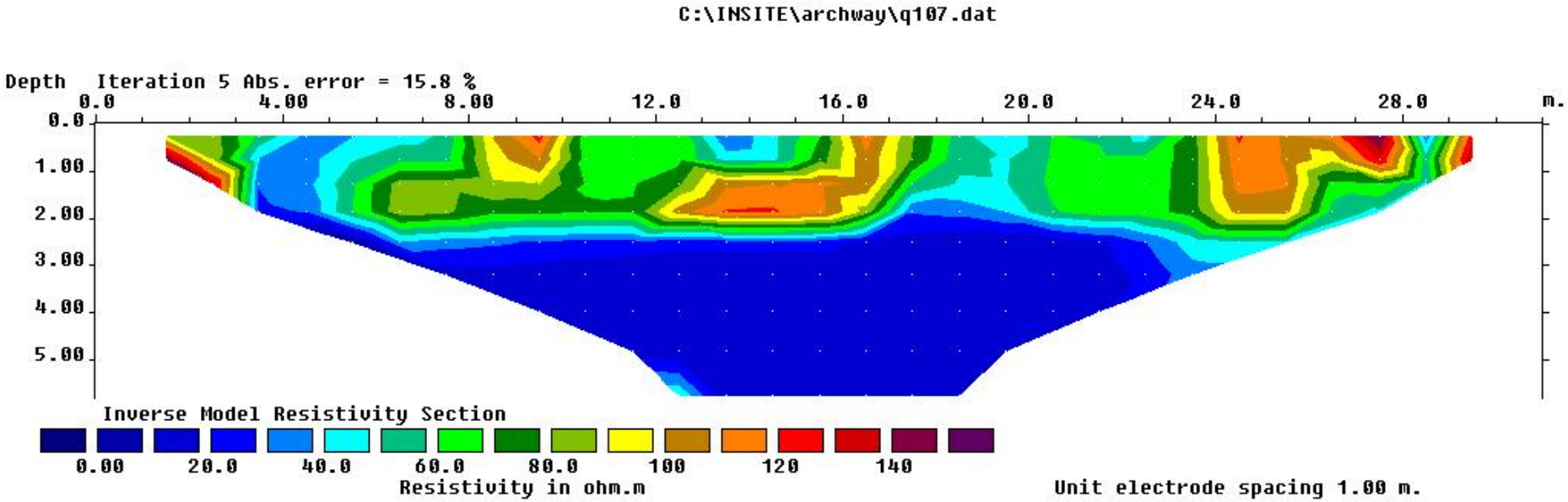
Profile q 105 repeated profile 104 but continued to probe 32 regardless of straightness of line. In the corridor beyond probe 25, the line curved round through nearly a right angle until it finished just under the stairs up to ground floor. This enabled 10 rows of data to be taken to gain data down to 5 m, but the quality of data at depth and beyond 20 m must be considered suspect. Note that the resistivity scale has been doubled on profiles 104 and 105 to improve definition.

Profile q106



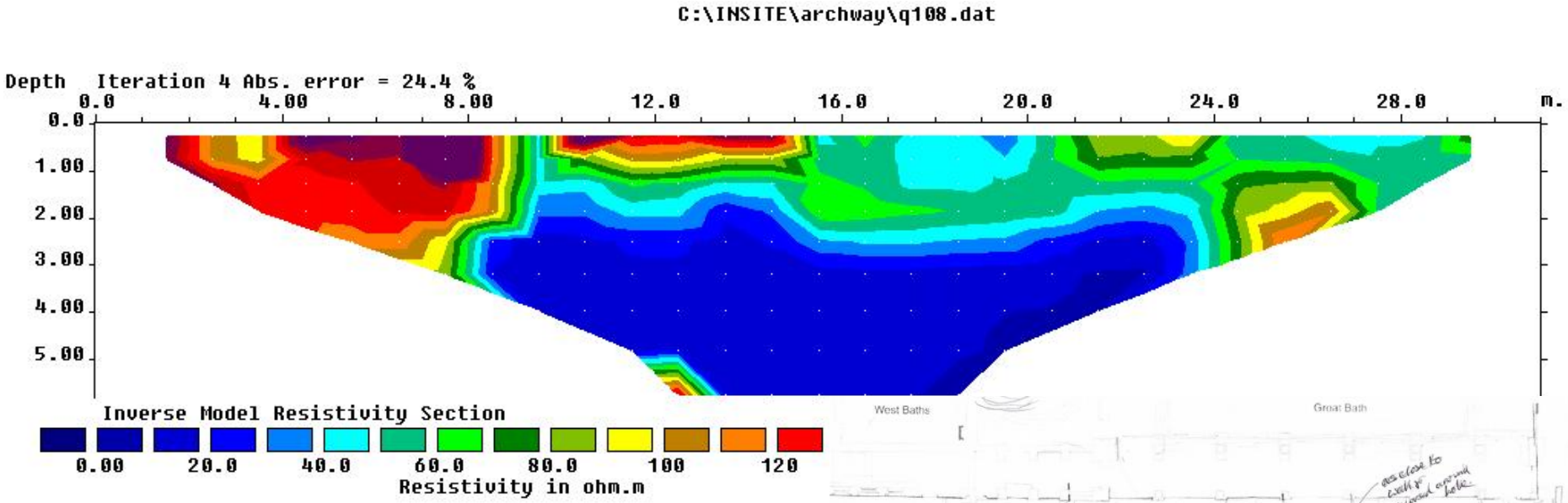
Profile 106 returned to the east area. It had been found possible to obtain a long, straight diagonal line from just inside the alcove where the brick support structure has been removed, in the direction of the door into the East Baths. The picture shows the line to the start, just inside the alcove.

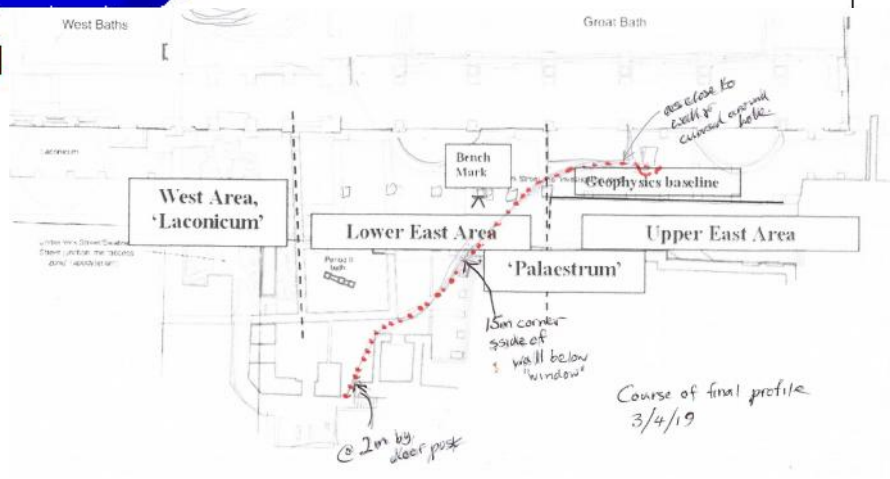
Profile q107



Profile q107 was a continuation of profile q106, starting 8 m along the line and continuing right up to the door which leads to the East Baths. This was concatenated to q106 at 8 m, forming a 39 m line called q167s. The concatenated line is described in the main text, and the two individual lines are given here in the appendix for reference.

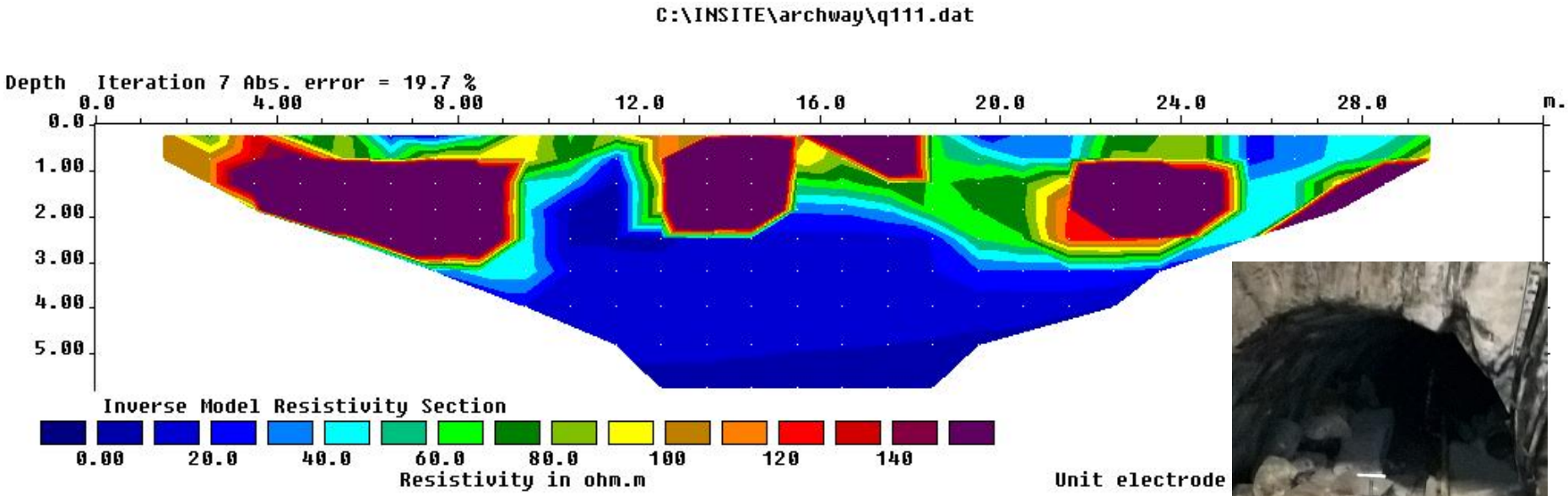
Profile q108





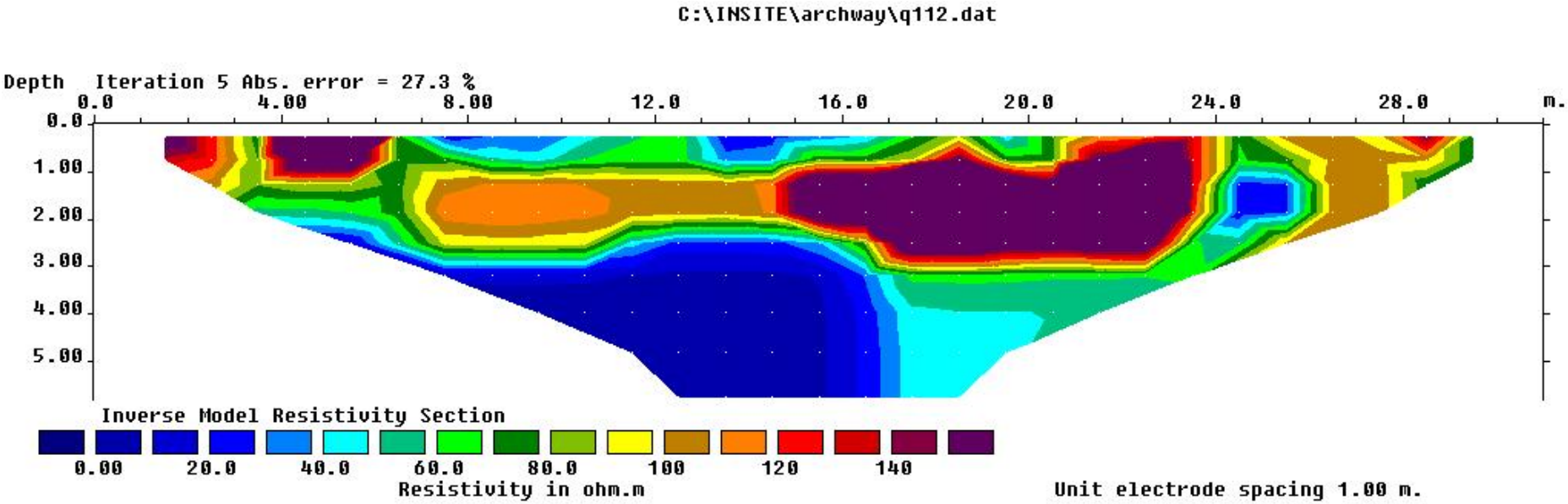
Profile q108 started in the east area then out through the lobby and into the corridor, ending just short of the rectangular recess. The curve had a large curve around 6 m and a lesser bend at about 25 m, so that there was a deep profile available diagonally across the area, as illustrated in the figure. This does mean that the first part of the profile must be treated with some reservation. The sketch attached shows how the profile was laid out.

Profile q111



Profiles 111 and 112 were set up in a western vault under Stall Street, some 20 m west of the west area. The line started 1 m into the culvert heading up to the Mineral Water Hospital, heading southwards along the vault, and then along the eastern rim of the cold bath, with slight deviation just before the bath, but with some change in height. The profile ended just at the opening from the cold bath back into the western end of the west area. The photograph shows probes 1 and 2 near the mouth of the culvert, with probe 0 well inside.

Profile q112



Profile q112 continued the line of q111 up to the wall at the western end of the west area, stopping about 0.5 m short. This profile started at 12 m along the line, so q111 and q112 were concatenated to single profile q1122 of 43 m length.