# GeoArch

Report 2007/03

# Topographic and geophysical survey of two bloomery sites near Highley, Shropshire

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4th July 2007

# Topographic and geophysical survey of two bloomery sites near Highley, Shropshire: Ned's Garden, Chorley Covert [SO 706 840] & Fiddle Bloomery, Old Coppice [SO705 827]

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## Abstract

*Topographic and geophysical surveys were undertaken at two locations for the Four Parishes Heritage Group.*

*One of the two locations, at "Ned's Garden" in Chorley Covert, appears to represent two distinct bloomeries, operating on either side of the small stream marking the former parish boundary between Stottesdon and Billingsley. These two sites each lie in the lower part of the valley below a series of pits cut into the underlying Carboniferous Coal Measures. These are mainly probably early ironstone pits, although some overprinting by later coal-mining is likely. The geophysical surveys produced evidence for extremely high magnitude magnetic anomalies lying on the higher river terraces in the upper parts of both sites, which were strongly suggestive of locations of ore-roasting. Other significant anomalies may be locations of smelting furnaces, but these were not identified with any certainty. The lower parts of both sites include large deposits of smelting slag draped over the terrace edge and, in the case of the eastern site, forming mounds on the stream floodplain. The preservation of such an extensive early (medieval?) industrial landscape makes this a site of regional and probably national importance.*

*The second site, known as the Fiddle bloomery, lies away from the ironstone outcrops (they lie about 800m upstream), within an area of ancient coppice (Old Coppice). The site appears to have been re-used as a water mill in the late 17th century, and it remains unclear whether the bloomery site had also employed water power. The site comprises a slag dump, much of which has been removed by quarrying, on the valley floor, a probable leat, a slag dump to the north of the leat along the foot and lower slopes of the northern valley side, strong geophysical anomalies on the slope (which by analogy with the Ned's Garden sites are interpreted as from ore-roasting) and anomalies suggestive of buildings on a platform within the slope. The possible buildings include features with a strong magnetic signature, likely to be part of the bloomery, but this location also yields a large quantity of post-medieval pottery and is likely to be the site of the mill buildings and associated cottage.*

## Contents

## Background

Geophysical and topographic surveys of two bloomery sites (for locations see Figure 1) were commissioned by the Four Parishes Heritage Group. Basic methodologies for the project were laid out in the initial tender document. Where the final methods differed in detail from the proposal, this was discussed and agreed with members of the FPHG.

The surveys were intended to describe and delimit the sites, as well as to provide evidence to aid their interpretation. In particular, the possibility of water-power having been employed at both sites was to be investigated.

The topographic and geophysical surveys form Stages 1 and 2 respectively of the overall project, with slag analysis and a working bloomery reconstruction forming future Stages 3 and 4.

## Methods

The surveys were undertaken between 15th and 26th January 2007, in order to take advantage of low winter vegetation.

The topographic surveys were undertaken using arbitrary coordinate systems, aligned sufficiently close to N-S to be able to be used as a basis for the geophysical surveys.

At Fiddle Bloomery two grid positions were subsequently tied in to National Grid using a survey-grade GPS system. This comprised a base-station outside the wood, with an RTK rover used to obtain the peg positions. Both base and rover were Trimble 4700 receivers using micro-centred L1/L2 antennae. The results were post processed using Trimble Geomatics Office.

At Ned's Garden the dense tree cover precluded use of the GPS system to locate the survey. However, the presence of sufficient landscape features that would allow the survey to be relocated in the future, should that be necessary, meant that a "floating" survey was here deemed acceptable by the FPHG. This report details a "best-fit" of the survey data with Ordnance Survey mapping; this location is believed to be accurate to an acceptable level.

The main topographic survey was undertaken with a Nikon DTM330 EDM, with data logged to a TDS Recon 200 running TDS Survey Pro software. Data were collated into the Trimble Geomatics Office software. Topographic data were subsequently exported into Golden Software's Surfer package for regridding and 3d-imaging.

The EDM was used both for the collection of the topographic survey and for staking out the grid pegs for the geophysical survey, which was undertaken using a 20m grid. On completion of the survey all pegs were removed apart from those marking the survey stations, which were retained in-situ in case of a need for further investigations.

The magnetic susceptibility survey was undertaken with a Bartington MS2 meter with an MS2D loop probe. Data were collected on a 2m grid placed symmetrically within the 20m grids, such that the SW reading in each grid would be taken at 1,1 with respect to the grid peg. The data were logged to Microsoft Pocket Excel running on a TDS Recon, and transferred to Microsoft Excel on the PC for reworking into the Surfer ASCII grid format in order to be imaged using Golden Software's Surfer.

The magnetic gradiometer surveys were undertaken with a Geoscan FM256 fluxgate gradiometer. The gradiometer was employed with a range of +/-200nT. Peak values within some of the slag dumps proved to be of greater magnitude, so there is some data-slipping in limited areas. The survey grid entailed readings at 0.5m sample interval and 1.0m traverse interval. Because of the difficult terrain and undergrowth, traverses were walked along survey strings, with readings taken using a manual trigger. The grids were conventionally walked in parallel, northwards, commencing with the SW corner, although for some grids for practical considerations this was reversed and the grid walked southwards starting from the NE corner.

Data were downloaded, balanced and collated using Geoscan's Geoplot software. For final image production the data were exported into Golden Software's Surfer package, where they were regridded to a 0.125m node spacing by kriging.

## Results

### Ned's Garden bloomeries (SO 706840)

The Ned's Garden site was referred to by a manuscript of Thomas Crump of c.1799 which states:

*There hath been in very antient times an old Furnace or Bloomery at the bottom of the Common Heath by the side of the Southal Bank Brook at a place called Ned's Garden where large quantities of furnace cinders or slag still remain and large quantities were carried from thence to Charlcot Furnace and iron extracted from them by stamping them and smelting over again, there are large heaps also on Southal Bank side of the Brook. Most of the old pit heads that are along the bank and side of the coppice from Ned's Garden opposite to Southal Bank are supposed to have been ironstone pits worked to supply this furnace or bloomery in Common Heath aforementioned, but this is only conjecture.*

(transcript by D. Poyner, and reproduced at *http://www.discovershropshire.org.uk/html/search/verb/GetRecord/theme:20070219221340*)

The survey commenced with that part of the site on the west (Common Heath) bank of the Southall Bank Brook, the part apparently referred to as Ned's Garden by Crump. The survey then progressed to that part of the site on the eastern (Southall Bank) side.

*Topographic survey*

The topographic survey at Ned's Garden (Figure 2, 3) has not been tied-in to the National Grid in detail. Coordinates presented here are given in terms of site [X,Y] and elevations in terms of site Z. Site zero lies at (approximately) SO 70709 83813. The site Y direction is oriented on a bearing of 305° with respect to National Grid. Site elevations (Z) are based on an arbitrary datum at approximately minus 26m OD. The

following description of the topography of the site employs only the local coordinate system (X,Y,Z)

The site was associated with two terraces above the present floodplain of the brook. The level of the brook during the period of survey lay at approximately Z = 94.5m in the northwest of the survey area and 93.8m in the southeast. The meander in the northwest of the survey contained modern river deposits at Z = 95.0 - 95.7m, below the main Ned's Garden site was modern flood plain at Z = 95.0m and the interior of the southern meander on the Southall Bank side was at Z = 94.2 – 95.0m.

The lower terrace occurs in the north on the east bank at Z= 97.0 – 97.5m over a rather limited area. In the centre of the Ned's Garden West site this terrace is well-marked and at Z = 96.7 – 97.3m and is also seen as a narrow bench above the river on the east bank. The possible dam feature at [120,156] also has a top at a little over Z = 97m, and might be interpreted as an isolated section of the same terrace. It is separated from the main distribution of the terrace to the west by a gully 5m in width which descends from its northern truncation by the active river cliff at Z = 96.5m to the modern floodplain at Z = 95.5m over a distance of about 10m. The river cliff just to the northwest of the gully has yielded probably late medieval pottery, associated with a slag deposit (D. Poyner pers. comm. 2007).

The upper terrace is seen on the west bank at Z = 99.8 – 100.8m and at a similar height on the SE edge of the survey area.

The river meanders are actively eroding on the downstream sides of their west-facing meanders, leading to erosion and slipping in the areas around [120,165] and [105,100].

Towards the northwest of the survey a small tributary valley, normally dry, descends from the west to about the level of the lower terrace and then becomes deeply incised before reaching the brook at a low cliff.

The bloomery activity on the west bank appears to have modified the topography relatively little. The main slag dump appears to have been tipped forward of the upper terrace, burying part of the extent of the lower terrace. In the area around [115,147] the dump probably conceals the lower terrace and dumped material has spilled forward towards the modern floodplain. The topography gave little indication of the location from which the large quantity of slag was removed as recorded by Crump (see above).

On the east bank there is a complex topography, including a linear slag ridge [122,110] and slag dumped to the west of what is probably a bedrock ridge at [130,120]. Erosion on the brook side of the linear ridge revealed a small fragment of medieval pottery associated with the slag deposit (at [120,102]; pers. obs.). The hollow in the slag dump area around [130,110] and the gully to the south are morphologically suggestive of a slag quarry.

The surveyed area contained surface evidence for two stone built structures. One of these, Building A is represented by a small area of stone and some surviving wall fragments, immediately above the landslip at [95,110]. The second structure, Building B, was represented by a roughly rectangular patch of debris (including brick) and stonework close to [100,160].

*Geophysical surveys*

The site was surveyed by magnetic gradiometry (Figure 4) and a small area of the western part was also surveyed using a magnetic susceptibility meter (Figure 5).

The magnetic susceptibility survey shows values of 400-800 (SI dimensionless units) over the main western slag dump, even where slag is exposed at the surface. In contrast to these values, areas where there was soil and humus cover in the wide part of the upper terrace show MS values locally well in excess of 1200. The MS fell to very low values in the area of Building B and also decreased very rapidly away from the slag dump.

Limited magnetic susceptibility investigation was undertaken to the east of the river, but this was not a full survey. Spot readings within the slag dumps were comparable to those of the western dumps, but readings taken on the upper terrace were even higher than those on the west of the site, with values locally in excess of 2700 in the area of [150,95].

The magnetic gradiometer survey to the west of the brook shows an area of variable elevated magnetic signature of about 40m x 35m. Within this area, a quiet zone is clearly visible immediately to the northwest of the surface evidence for Building B, with possible co-axial rectilinear featuring extending to its south. Particularly elevated magnetic anomalies within this area lie at [103,152], [89,140] and [92,145] on the edge of the upper terrace. These anomalies are possibly the result of slag-rich topographic features. Further back onto the terrace anomalies at [89,149] and [90,163] are more likely to be potential locations for furnaces or hearths (both with peak values over 180nT).

At a lower level, a linear zone of elevated magnetic signature is visible extending on the line of the gully from [117,155] towards [125,140].

To the east of the brook the magnetic gradiometer survey showed a variable elevated response over an area of approximately 45x30m, corresponding to the surface evidence for a slag dump. Within this area the complex anomalies appear to be mainly the product of topography. The marked dipolar anomaly at the southern limit of the dump at [133, 83] was produced by a partially-buried recent steel cable.

The largest anomalies are not, however, associated with the visible slag dump, but lie on the upper terrace above the eastern margin of the main slag distribution. These locations ([151,92], [143,120]) correspond to those of the extremely high magnetic susceptibility measurements described above.

## Fiddle bloomery (SO 705827)

*Topographic survey*

The Fiddle Bloomery is not attested by any known documentary evidence, but was located by earlier fieldwork. Some documentary evidence probably links this site to that of a water corn mill and messuage in the late 17$^{th}$ and early 18$^{th}$ century (D. Poyner pers. comm. 2007).

The topographic survey was initiated with an arbitrary coordinate value assigned to survey station STN1 of [100,200] and z = 100m, where the Y direction was approximately north. Subsequent GPS data collection

showed STN1 lay at E = 370503.31, N = 282803.72, although data quality was slightly poor, because of the tree cover. The grid peg at [120,100] was also measured by GPS, and, being in the open, gave a higher quality measurement of E = 370521.44, N = 282794.80, height = 83.99m OD. These measurements indicate that the site grid is aligned with the Y direction lying 26.2° east of grid north and the site origin lying at National Grid reference E = 370325.47, N = 282668.34. The site datum lies 15.80m below OD. The topographic description below uses unconverted site X and Y ([X,Y]), but uses corrected heights OD.

The topographic survey illustrates the location of the bloomery within a curious meander of the stream (Figures 6, 7). The stream entered the west of the survey area with a surface height of 80.5m OD at the time of survey. It leaves the moderately broad floodplain to become incised into the southern valley slope at the western end of the bloomery site, where it passes to the south of a marked bedrock ridge and lies within a shallow gorge (up to 4m deep) incised into bedrock. The surface level of the stream at the eastern end of the survey area was approximately 78.5m OD at the time of survey. The geomorphological interpretation of this topography is uncertain. One possibility is that the river has exploited a line of weakness along a landslip scar and the bedrock ridge within the valley is not in-situ, but slumped from the southern valley edge. Alternatively the present stream course may be exploiting an older meander course incised from a higher level. A third possibility is that the stream course has been diverted by human agency.

The northern side of the valley is very clay-rich and subject to slumping. A marked terrace lies at 82m OD in the eastern part of the site, while a small area of flat ground lies at 85m OD at the north, above the river meander and a small, apparently rock-cut, hollow or quarry.

The valley floor slopes gently down from the bedrock ridge to the south towards a prominent straight linear hollow. The hollow does not continue as far as the stream to the west, but shallows into the stream-side floodplain to the east.

The gentle slope to the south of the hollow appears to have been overlain by an oval, E-W elongated slag dump, approximately 40m x 20m, of which the western end has probably been encroached upon by the stream. The slag dump has apparently been largely removed by four large, intersecting scoops, each 6-10m across. The eastern scoop is shallow, but the three western ones are deeper, with their cut edges approximately 1m deep.

Estimation of the original size of the southern slag dump is difficult, for not only is the original height unknown, but the morphology of the underlying ground surface is also uncertain. The upstanding areas between the slag quarry and the stream suggest that the top of the dump lay at least at 82.6m OD at the western end, and the adjacent quarry has its base at about 81.0m OD. On this basis it is possible to suggest that the central region of the dump, an approximately square area of 20m across, had a thickness of at least 1.5m. The total area of the dump is approximately 650m$^2$. That gives a potential volume of 250x0.75 m$^3$ for the margins, and 400x1.5 m$^3$ for the core. This gives a minimum total volume of 790m$^3$.

The hollow that bounds the slag dump to the north forms a straight feature from x= 127 eastwards and is about 5m wide. As it passes to the east it becomes a slighter feature, before merging with the surface of the floodplain. Its course is occupied farther to the east by a slight gully towards the river, but it is unclear if this is an original part of the feature, or recently cut by surface water flowing out of the hollow. To the west of x = 127 the hollow feature is less well-marked, and it is unclear whether it existed previously here but has become backfilled. A slight hollow on the river bank around x = 103, y = 192 provides the suggestion that the hollow originally extended into this area. This hollow is very important to the interpretation of the site, because if it can be demonstrated to have been a leat, then it is the strongest evidence for water power on the site.

To the north of the hollow feature, the ground rises steeply. To the east of x= 145, there is a flat zone about 6m wide adjacent to the hollow, below the hillslope. At x = 130 this zone appears to be overlain by a terrace-like dump of slag, with an abrupt, rubbly eastern margin. The steepness of this margin suggests that it may have been quarried. The slag “terrace” disappears westwards into a more even hillslope, within which a fox earth has revealed a deposit of slag, ore and charcoal. The westwards extent of this more even gradient to the hillside is approximately the same as the length over which the hollow/leat is not well featured. It is possible the disappearance of the least might be related to slumping and/or dumping down the slope.

The western limit of this slope is formed by a knoll around x = 100, y = 200. The evidence from the river bank below suggests that this knoll is largely a bedrock feature. The hollow immediately to its west may be a small quarry exploiting this harder bedrock. To the north of the knoll and possible quarry there is a small platform sloping from about 84.6m OD on the downslope side to 85.6m on the upslope side. This platform appears to lead eastwards into a narrow path or track terraced into the hillside and leading upslope to the northeast. The platform area yields abundant surface finds of post-medieval pottery and mortar.

To the north of the site the valley floor has a slightly mounded topography ranging from about 81.5 to 82.5m OD. Although a small quantity of slag was retrieved from the roots of a fallen tree in this area (D. Poyner pers. comm. 2007) there is no substantial evidence that this area contains slag dumps or other archaeological features, and indeed this ground may be relatively recent alluvium, behind the migrating meander.

The left river bank shows bedrock below the “knoll” described above, but below the possible hollow of the “leat” the bank appears to be faced with large stones. These disappear downstream, where the bank appears to show slag dump over natural, before the rising bedrock of the prominent ridge.

*Geophysical surveys*

The magnetic gradiometer survey (Figure 8) images the roughly oval shape of the valley floor slag dump. From x = 100 to 133, and from y = 162 to 185. Within this area the magnetic anomalies are dominated not by depositional features but by the rapid thickness changes induced by the slag quarrying. Intense positive anomalies (locally >200nT) are visible on the upstanding spurs between the lobate scoops, as well as along the southern quarry margin. Examination of the quarry faces revealed no evidence to support an interpretation of the large anomaly on the

northern quarry spur as a possible furnace.

A similar topographically-induced anomaly appears to lie along the northern margin of the "leat" where it is abutted by the northern slag dump. There are also less-well developed, but nonetheless similar, anomalies along the northern margin of the main (southern) slag dump, leaving a width of approximately 6m through which the "leat" might pass.

North of the course of the "leat" the hillside shows an elevated magnetic signature, in keeping with the observed surface slag. The northern margin of this area of slag passes to the east of the "knoll" and below (south of) the 85m OD terrace/platform. A single substantial positive anomaly (>200nT), 1.5m in diameter, stands out in this magnetically noisy area. It lies at [108,192], approximately on the line of the possible leat.

This upper slope is marked by a series of strong magnetic anomalies. These anomalies are aligned approximately northwest-southeast. The southeastern anomaly has a marked irregular central positive (>200nT), approximately 7m x 4m. The corresponding negative anomaly is dispersed irregularly and discontinuously around the periphery. A less well-marked circular positive anomaly (100nT), 2m in diameter, lies immediately to the northwest, beyond which, on the platform, lies another rectangular positive anomaly, measuring approximately 9m x 4m. This anomaly has very strong peripheral negative anomalies (locally -160nT) along the SW and NE margins, and has a central positive anomaly which increases in magnitude towards the southeast (where it is >200nT). To the northwest of this, towards the back of the platform and intersected by the edge of the survey, lies another series of complex anomalies, including a strong positive anomaly 5m x 2.5m (also >200nT).

Outside the major anomalies, the magnetic background on the platform and the knoll is very quiet, suggesting that there is little slag in this area.

# Interpretation

## Ned's Garden West

The surveys of this site appear to show activity focused on the upper terrace (Figure 9), with dumping of smelting slags forward of the terrace edge, locally covering the lower terrace. The geophysical survey shows no evidence for a furnace close to the gully around 115,155. If the gully represented a take-off from a dam (itself possibly represented by the mound to the east of gully, centred on 122,150), then it would conventionally be expected to power a wheel close behind the dam. The absence of evidence for such a feature, taken together with the apparent dumping of smelting slags from a higher level on the upper terrace, strongly suggest that any bloomery furnace here was not water powered, but would have been on the upper terrace, well above the possible supply of power. Instead, the mound might be an isolated section of the lower terrace, cut off from the main distribution of the terrace by the gully, which is likely to be a former course of either the main brook, or possibly of the western tributary.

The evidence from the magnetic susceptibility survey shows that the anomalies to the rear of the upper terrace (around 85,160) cannot be due to smelting slag, since the MS anomalies are higher than in areas where smelting slags are exposed. The most likely explanation is that the intense anomalies are due to roasted ore, and indeed small ore fragments have been recovered from the surface in this area. The area was probably used for the roasting of ore (although some anomalies might relate to areas of the storage of ore roasted elsewhere.) The strong anomaly on the magnetic gradiometer survey (90,163) in this area is a strong contender for the site of an ore-roasting kiln (and two anomalies to the south of this might also be). Evidence for pits, possibly for ironstone, occurs immediately to the west of the upper terrace (but outside the geophysical survey area)..

Much of the northern part of the upper terrace is occupied by the magnetically quiet zone, interpreted as representing the site of a building, the remains of the SE end of which correspond to the surface evidence for Building B. The almost complete lack of magnetic featuring in the area of the building may be evidence for the contemporaneity of the building with the iron smelting.

To the SW of Building B further slight evidence for rectilinear anomalies are suggestive of additional structures. Close to these structures are strong magnetic gradiometer anomalies which might be possible bloomery furnace locations, although the strong topography here means a purely topographic origin for the anomalies is also possible.

In summary, it would appear that ore roasting and smelting may have been undertaken on the upper terrace, with waste dumping over the terrace edge. Building B may have been in existence at this time, and may therefore be an integral part of the bloomery.

## Ned's Garden East

The bloomery on the Southall Bank side of the brook appears to some degree to be a mirror image of that to the west (Figure 9). The upper terrace again shows extraordinarily high magnetic susceptibility values, probably associated with ore roasting. Although not surveyed in this project, extensive areas of pitting, probably for ironstone, start immediately to the east of the possible ore roasting area.

The dump of smelting slag has a central hollow and a strong bank on the brook side. These features are probably indicative that the central part of the dump has been quarried. It is not clear whether the bloomery furnace(s) lay within the area of the dump, or on the margin of the upper terrace above. It is also uncertain to what extent the surviving slag mounds are untouched dump remnants or ground disturbed by the slag quarrying.

The linear hollow with the area of the slag dump is probably to be interpreted as a track providing access to the slag quarry; the topography offers no likely explanation of this feature as being associated with water power.

## Fiddle Bloomery

This site comprises several distinct components (Figure 10). These comprise, from south to north, the main slag dump on the valley floor. This is approximately 40m x 20m, and was originally at least

1.5m thick in the centre, although most of the core of the dump has been quarried away. Calculations suggest that the dump would have had an original volume of at least 790m3. Conversion of that volume to a slag weight is an uncertain calculation, with estimates varying from 1 to 2 tonnes of slag per cubic metre on a typical dump.

To the north of this slag dump lies a hollow which probably represents the line of a partially filled leat. It is not clear whether the leat is contemporary with the slag dump, or whether it has been cut through a pre-existing dump leaving the north and south dumps as surviving components of an originally single deposit.

The intensely featured magnetic survey of the platform and adjacent hillside is very difficult to interpret. The rectilinear nature of the anomalies and of the quiet zone on the knoll, suggest that the anomalies may be constrained within buildings, but the outlines on Figure 10 are tentative. The large anomalies are very likely, as at Ned's Garden, to have been produced by ore roasting taking place on the upper part of the site.

The strong anomaly on the line of the leat might be interpreted as being associated with a water-power furnace, but equally it might represent material fallen down slope from above. It is also possible that it might, although not obviously a dipolar anomaly, represent ferrous remains from the mill, perhaps debris from wheel.

## Summary

The two sites surveyed show evidence for having included three separate bloomeries. The two sites at Ned's Garden are remarkable for including probable iron ore pits, ore roasting areas and bloomery iron smelting. The landscape around these sites is a rare survival of a (presumably) medieval industrial landscape. The sites show little conclusive evidence for the use of water power, and most likely comprised manually-blown bloomeries at a level well-above that of the brook.

The Fiddle bloomery site is rather different. It does show evidence suggestive of the use of water power. However, documentary evidence suggests reuse of this site for a corn mill, and it is therefore unclear whether the water management systems are associated with the bloomery or whether they are later.

Both sites show evidence for stone-built buildings. Building B at Ned's Garden lies at the core of Ned's Garden West and appears to exclude slag from its footprint. Although the structure has yielded both brick fragments and post-medieval pottery (D. Poyner pers. comm. 2007), it seems likely that it may be contemporary with the bloomery operation. The age of the bloomery on the west side of the brook is only constrained by scraps of possible 14$^{th}$ century pottery from the river cliff north of the gully. Building A appears to be associated with a higher proportion of brick, and may therefore be younger. A similar medieval age is also suggested by a small pottery fragment from the lowest part of the slag dump on the east bank.

At the Fiddle bloomery there is evidence for buildings on the platform in the northwest corner of the site. This area also yields surface finds of post medieval pottery and mortar. It appears likely that the buildings are, at least in part, associated with the mill and messuage recorded from the late 17$^{th}$ and early 18$^{th}$ centuries.

The location of the sites is interesting. The two bloomeries at Ned's Garden both lie on terraces above the brook and below areas of extensive pitting, probably representing ironstone extraction from the same geological horizon.

The Fiddle bloomery, in contrast is not situated on ironstone outcrop, but within an area of ancient coppice, and arguable at a location suitable for harnessing water power. The site appears to have been reused for a water corn mill by the late 17$^{th}$ century, leading to uncertainty over the earlier use of water power. If the evidence for a leat is accepted, then the most likely mode of operation would have been for a dam/sluice to have been placed across the stream at the western end of the gorge (around 80,170). The pond so created would have relied on the river bank between this point and the knoll (100,195), together with any superimposed artificial dam. There is little evidence for any dam at present, although the bank may be stone-faced immediately south of the knoll. The slag dump does approach the river bank from the east, but the preserved top of the dump lies only at about 82.5m OD. It is, however, possible that erosion associated with eastwards (downstream) migration of the stream meander at this point has removed evidence for a higher barrier. The surface of the flood plain to the north now lies at 81.5-82.5m OD, so unless this level has been appreciably raised since the operation of the mill, the surviving dump would only allow ponding of the stream to little more than bank-full level.

Although at this stage proper investigation of the slag assemblages has yet to be undertaken, it is noticeable that neither site has yet yielded significant evidence for bloomsmithing.

## Evaluation of potential

*Ned's Garden bloomeries*

This site is a widespread and well-preserved early (medieval?) industrial landscape, containing two distinct, but similar bloomery sites within two different medieval land holdings and parishes. Such a well preserved setting and self-contained system is extremely rare, and gives this site certainly a regional and probably a national importance. The site has enormous potential for yielding detailed information on bloomery technology and technique.

*Fiddle Bloomery*

This site is different from the Ned's Garden bloomeries in being sited close to a source of fuel and arguable water-power. The significance of the site lies particularly in the potential evidence for water power, which however, at the present state of knowledge, cannot be differentiated with any certainty from water management features that may be associated with a later water corn mill. This bloomery, therefore, appears to have potential for evidence for a different stage of technological development of the bloomery than those at Ned's Garden. Such an interpretation remains far from certain at the present state of knowledge. This site too is certainly of regional importance, and clarification of the role of water-power might also give it a national level of importance.

## Specific recommendations

Both sites present represent apparently well-preserved bloomeries of great significance and potential. Both are, however, under immediate and direct threat from damage by stream erosion. Both sites might be at risk in the future from woodland management activities. In addition, the Ned's Garden site might also be at risk from plans to replace the former footbridge across the Southall Bank Brook in the centre of the site.

In order to refine understanding of the potential of the site the following actions are recommended:

1. Clarification of the ages of the sites through a programme of 14C dating. Suitable samples of charcoal should be obtainable from the slag dumps, and should be acquired through selective test-pitting of the dumps in a variety of locations. At Ned's Garden these test-pits should be located to sample the dumps on both sides of the stream and in a variety of the present morphological features.

2. Careful cleaning and recording of the presently eroding meander faces at the North end of the Ned's Garden site and the west side if the Fiddle Bloomery. In both cases these meanders are presently incising into features which might be related to the use of water power on the site. This evidence may be lost soon, given the present level of erosion. In both cases the cleaning should be targeted and superficial to avoid accelerating the erosion.

3. At Fiddle Bloomery the early history of the bloomery is potentially complicated by later use of the site as a water mill. The mill site probably lies at an elevated level on the north side of the site, a natural location for the original bloomery structures. This same area is currently being damaged through the excavation of animal (fox?) burrows. This damage should be monitored, and ideally test-pitting in an adjacent area should be employed to establish the current integrity of the underlying archaeology.

4. Both sites are currently partially or entirely within SSSIs for largely botanical reasons. It is important that management of the sites takes into account the great significance of the sites for development of the early iron industry; preservation of the buried archaeology should be an important management aim.

5. Both sites contain evidence for buildings that may or may not be later than the use of the site as a bloomery. In both cases the possibility that these structures may have early origins, contemporary with the bloomery must be considered. These structures (particularly that at Ned's Garden) are vulnerable to damage from plant growth and any future woodland management.

6. The Ned's Garden bloomeries appear to include an entire iron-making landscape, with ironstone pits, possible charcoal hearths, ore roasting sites, bloomery furnaces and slag dumps. The survival of this landscape makes this site regionally if not national important, and the granting of statutory protection for the sites should be considered. Their protection during any future logging/replanting operations must be ensured.

7. The investigation of the archaeometallurgical residues at the three bloomeries (to be undertaken as Stage 3 of this project) will form an important further source of evidence. In particular this should address whether there is any evidence for technological differences between the apparently manually-blown furnaces at the Ned's Garden sites and the operation at the Fiddle bloomery for which there is rather better, though not conclusive, evidence for water power.

## Figure Captions

***Figure 1.*** Location of the studied sites, in relation to a simplified geological map. Mid-grey tone shows extent of Middle Coal Measures strata. The dashed lines show the crop of coal seams; heavy solid lines are faults. Modern villages shown in pale grey tone.

***Figure 2.*** Topographic survey of the Ned's Garden site.

a. Survey details as produced by Trimble Geomatics Office. Dots indicate surveyed points, + indicates surveyed break-of-slope point, concentric circles are geophysical grid-peg locations, small squares mark the extent of building debris and x indicates the centreline of a modern path. Contours shown at 0.5m intervals.

b. Contour survey processed in Surfer. Marginal coordinates are those of the site grid; brown lines with internal labelling are the approximate National Grid coordinates. Contours shown at 0.2m intervals. Heavy dark lines indicate the approximate limit of the spread of archaeometallurgical debris. Spread of building debris shown in khaki.

   Geomorphological features include recent flood plain surfaces (pale green), surface fo the lower terrace (blue) and the surface of the upper terrace (pink).

***Figure 3***. Topographic survey of Ned's Garden site illustrated as 3d surface. Direction of view WNW.

***Figure 4***. Magnetic susceptibility survey of Ned's Garden site. Cour scale key in dimensionless SI units.

***Figure 5***. Magnetic gradiometry survey of Ned's Garden site. Greyscale runs from black at -100nT to white at +100nT.

***Figure 6***. Topographic survey of the Fiddle Bloomery.

a. Survey details as produced by Trimble Geomatics Office. Dots indicate surveyed points, + indicates surveyed break-of-slope point. Contours shown at 0.5m intervals.

b. Contour survey processed in Surfer. Marginal coordinates are those of the site grid; brown lines with internal labelling are the approximate National Grid coordinates. Contours shown at 0.2m intervals. Heavy dark lines indicate the approximate limit of the spread of archaeometallurgical debris. Other topographic features as labelled.

***Figure 7*** . Topographic survey of Fiddle Bloomery illustrated as 3d surface. Direction of view N.

***Figure 8***. Magnetic gradiometry survey of Fiddle Bloomery. Greyscale runs from black at -100nT to white at +100nT.

***Figure 9***. Ned's Garden bloomeries: interpretation. Pale grey tone shows approximate extent of archaeometallurgical residues, with the dark heavy line marking the approximate limit of the major dumps of smelting slags. Areas shown in pink are extremely strong magnetic anomalies. Areas shown in yellow are the extremely strong magnetic susceptibility anomalies of the west site. Green lines indicate evidence for structures. For details see text.

***Figure 10***. The Fiddle bloomery: interpretation. Pale grey tone shows approximate extent of archaeometallurgical residues, with the dark heavy line marking the approximate limit of the major dumps of smelting slags. Areas shown in pink are extremely strong magnetic anomalies. Green lines indicate evidence for structures. For details see text.

Figure 1

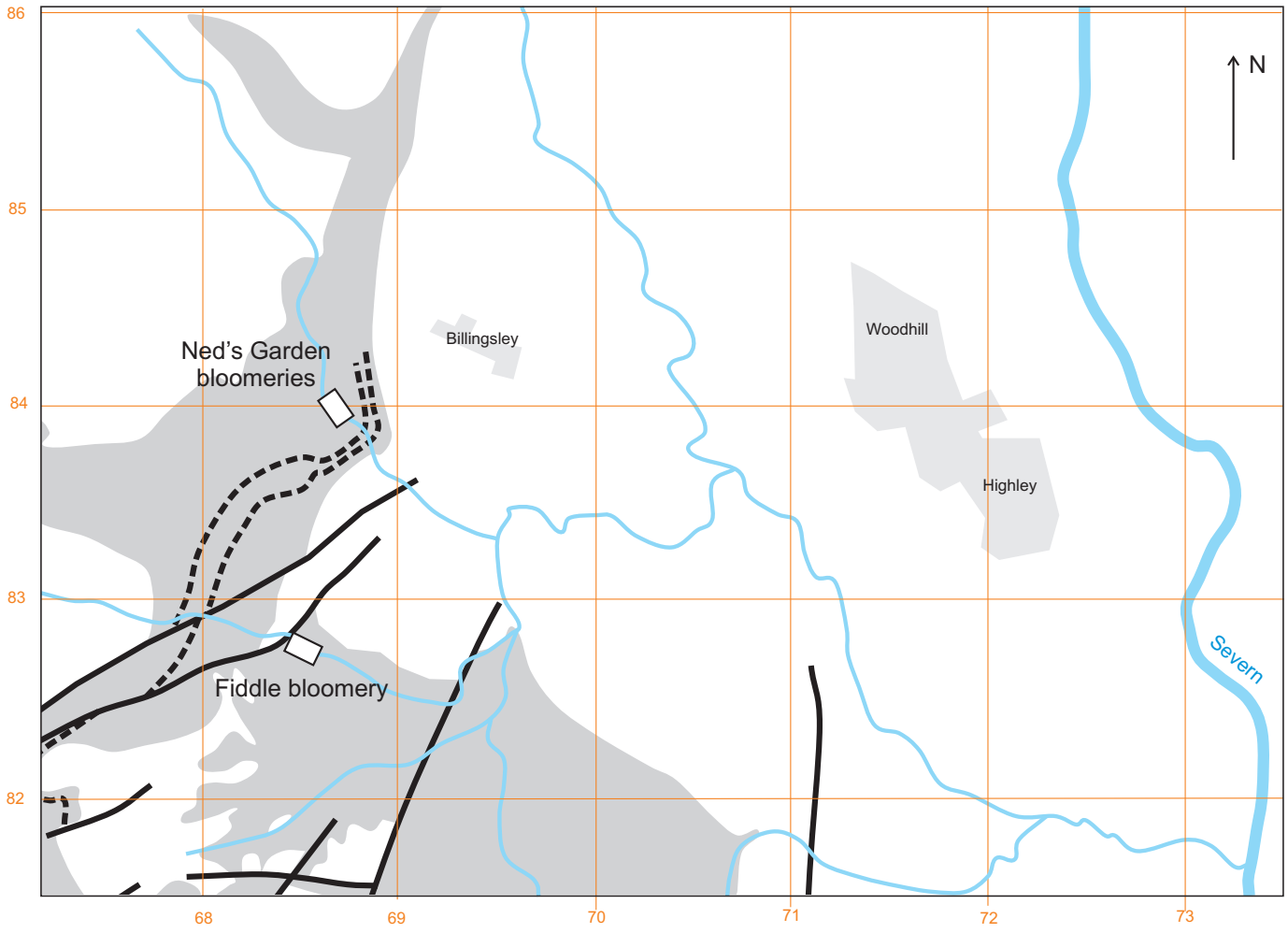
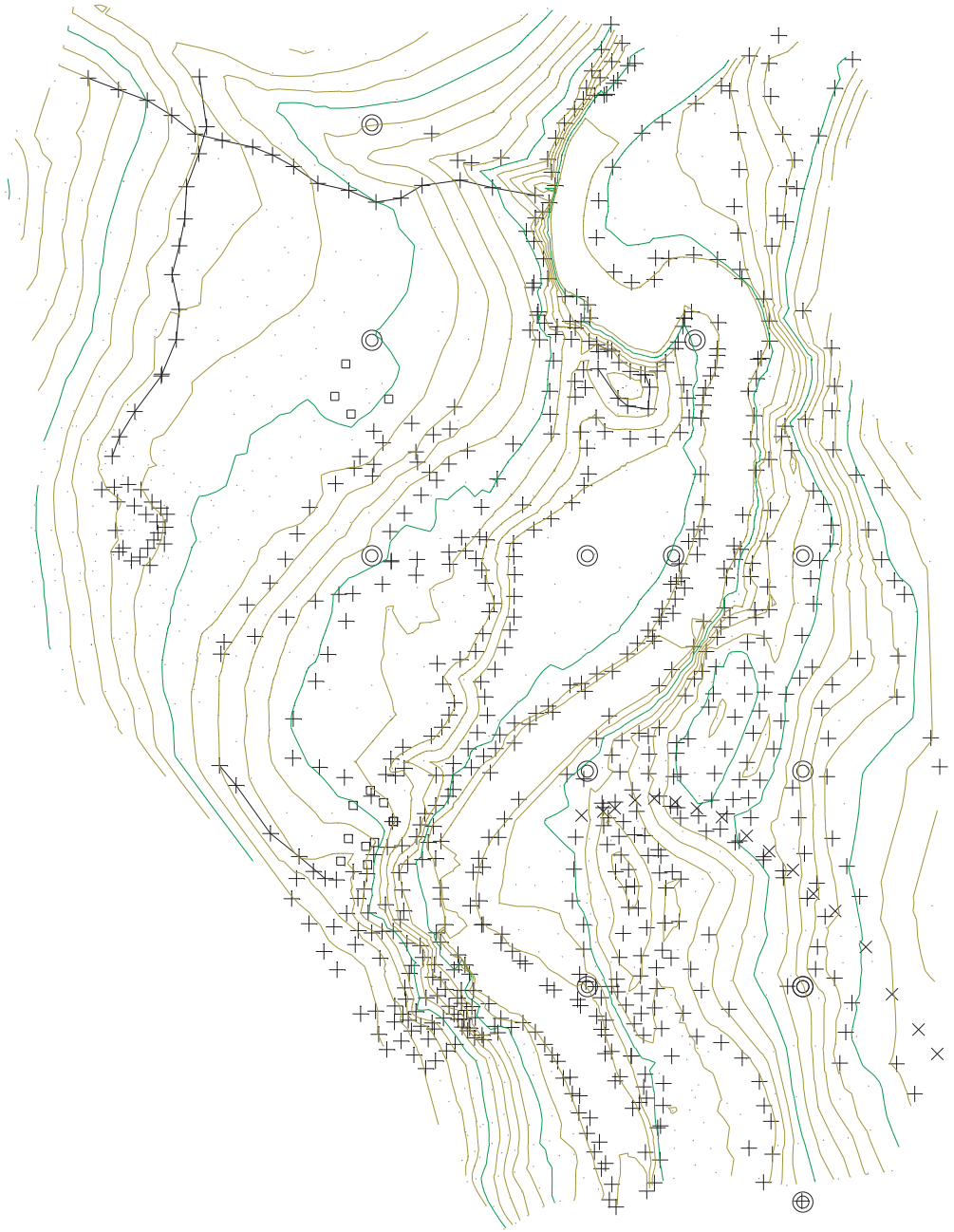
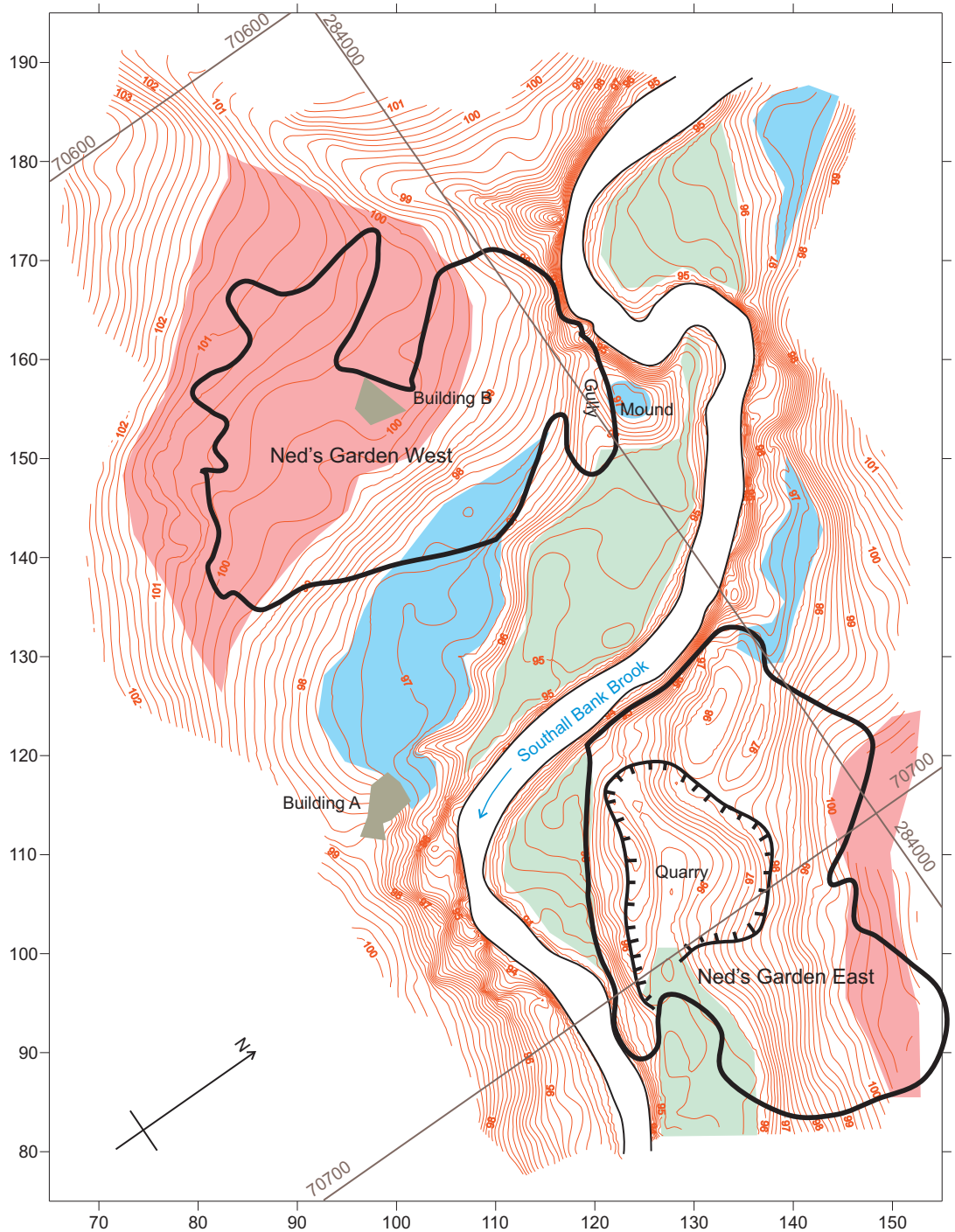

86
85
84
83
82
68
69
70
71
72
73
N
Ned's Garden
bloomeries
Billingsley
Woodhill
Highley
Fiddle bloomery
Severn

Figure 2

a.



b.


70600
284000
70600
70700
284000
70700
Ned's Garden West
Building B
Gully
Mound
Southall Bank Brook
Building A
Quarry
Ned's Garden East
N
190
180
170
160
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140
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100
90
80
70
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90
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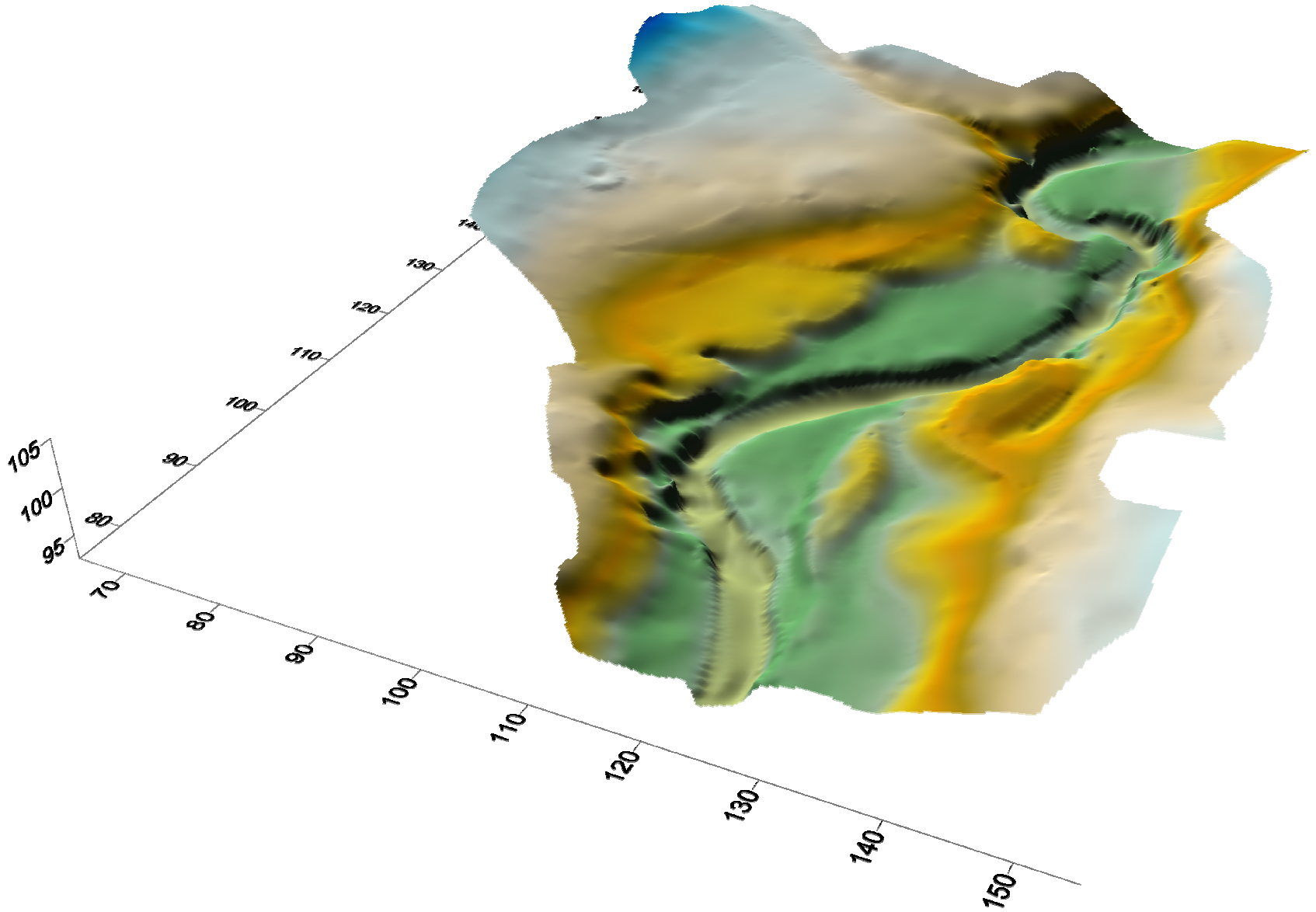
120
130
140
150

Figure 3



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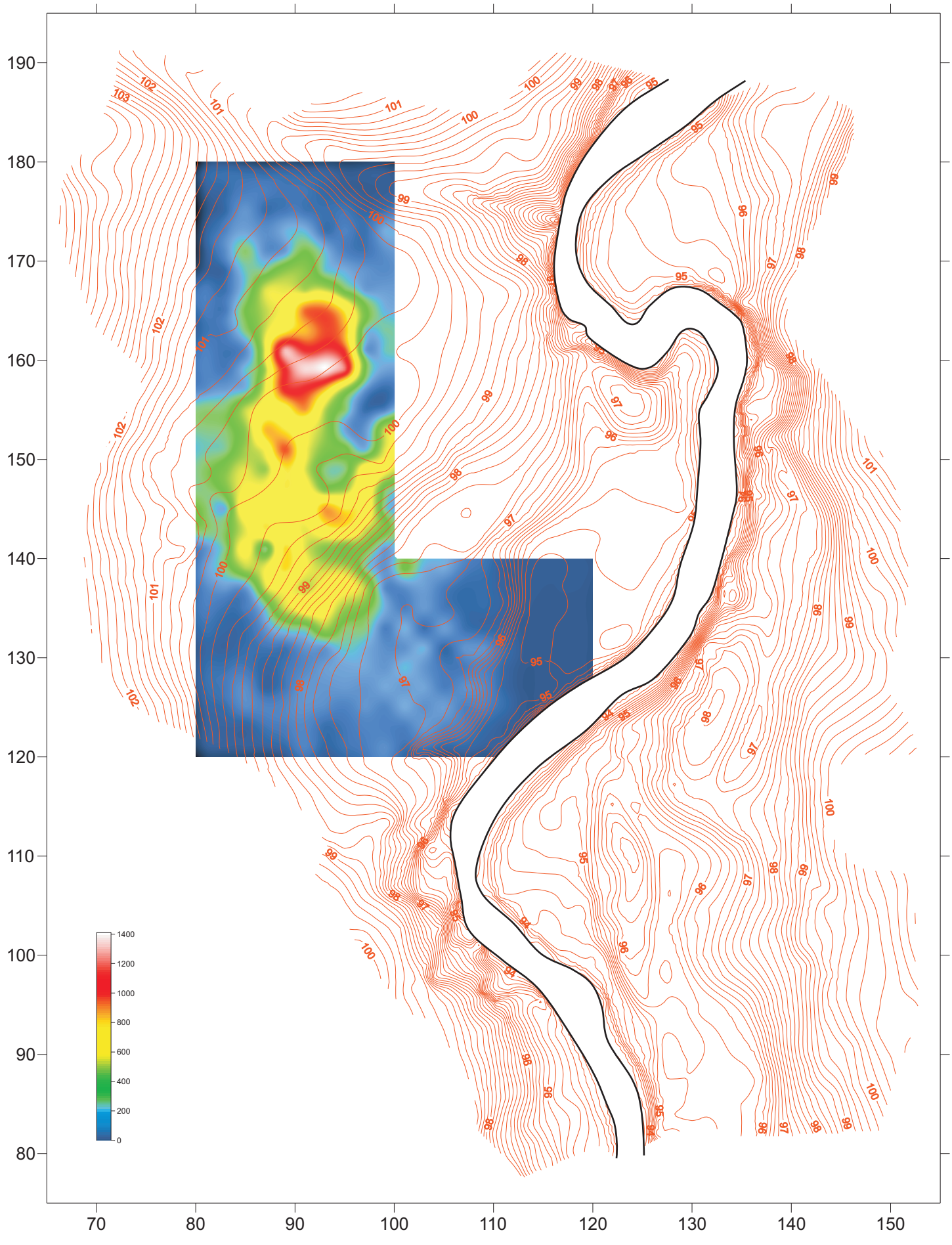
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170
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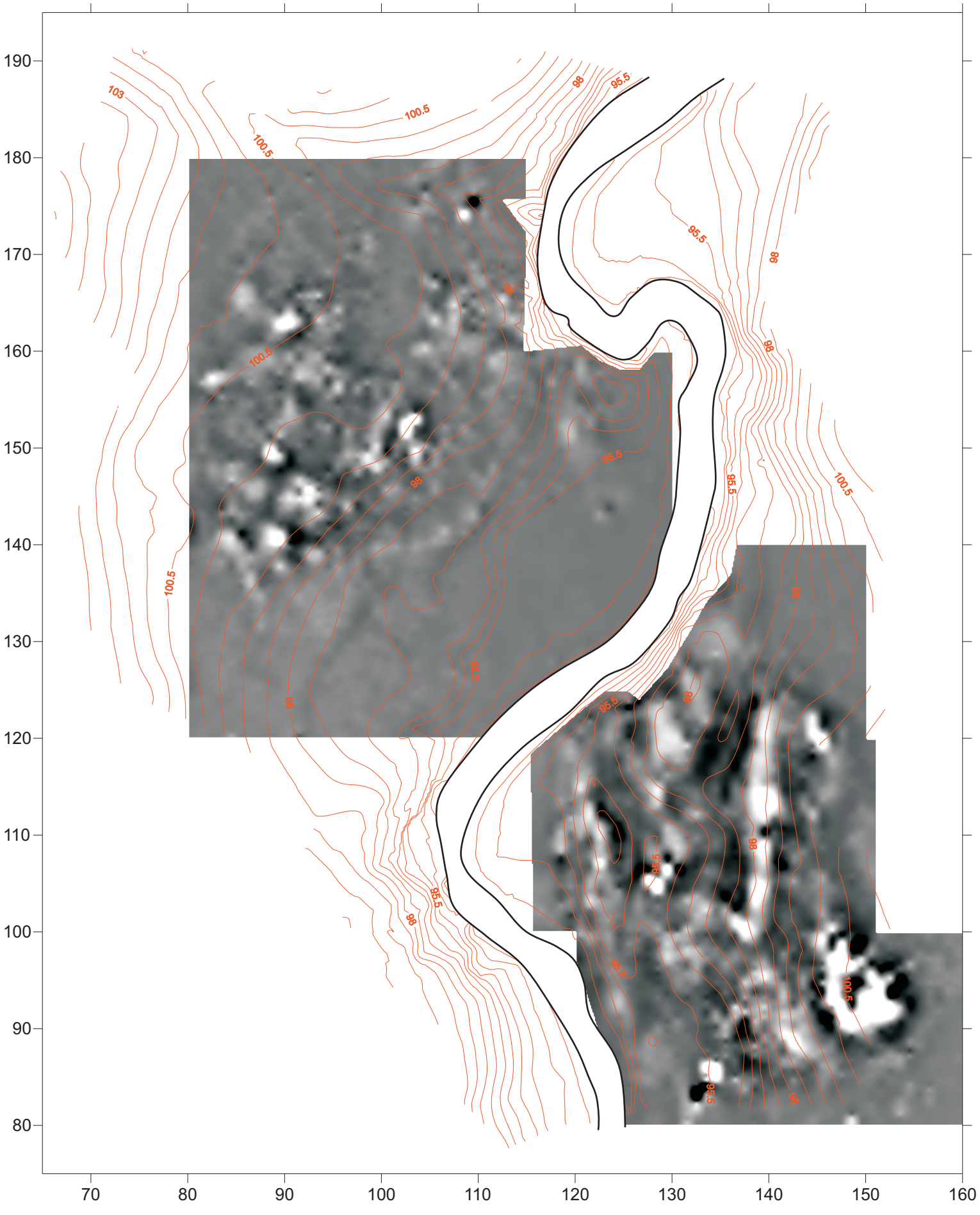
Figure 5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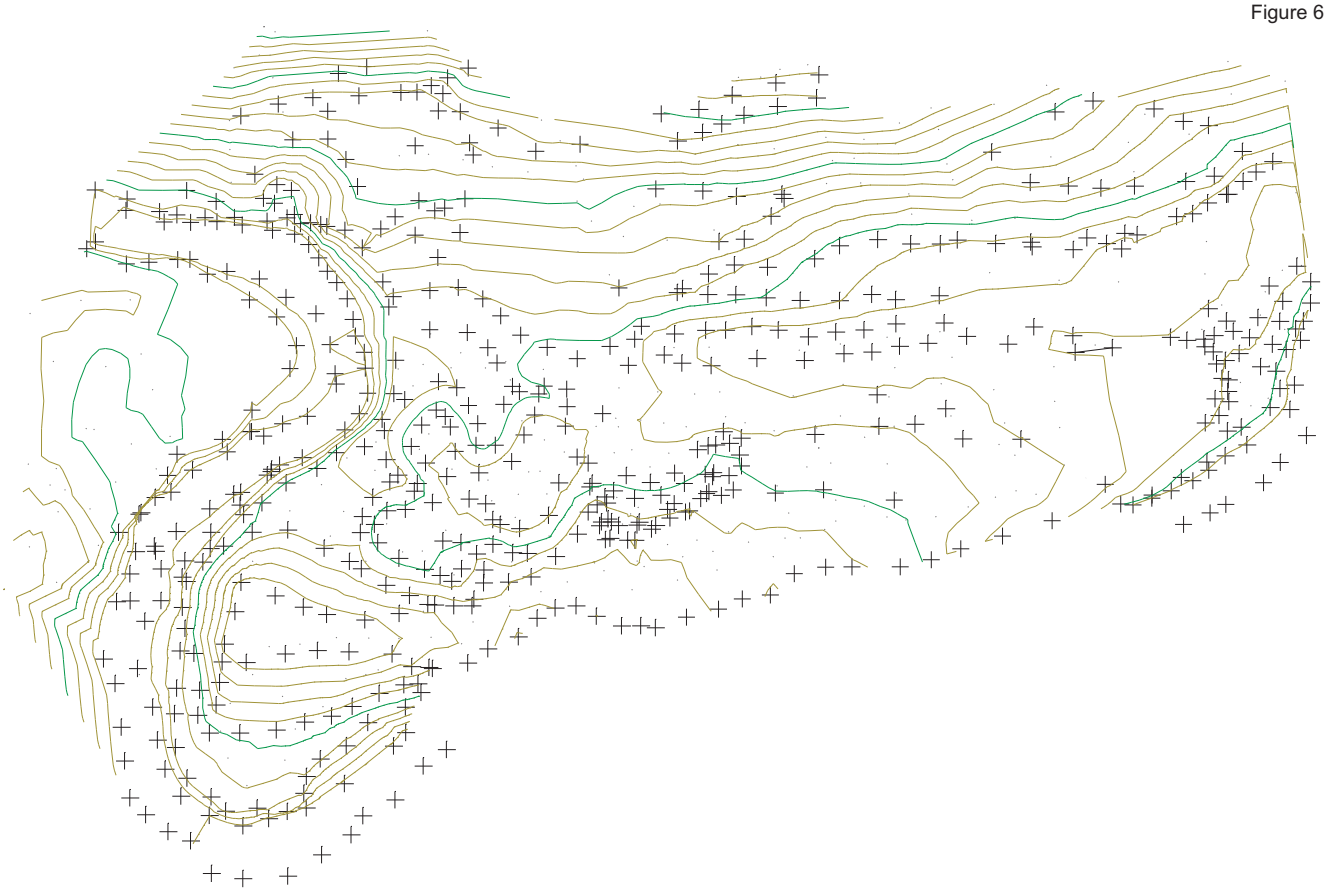
160
103
100.5
98
95.5

a



b

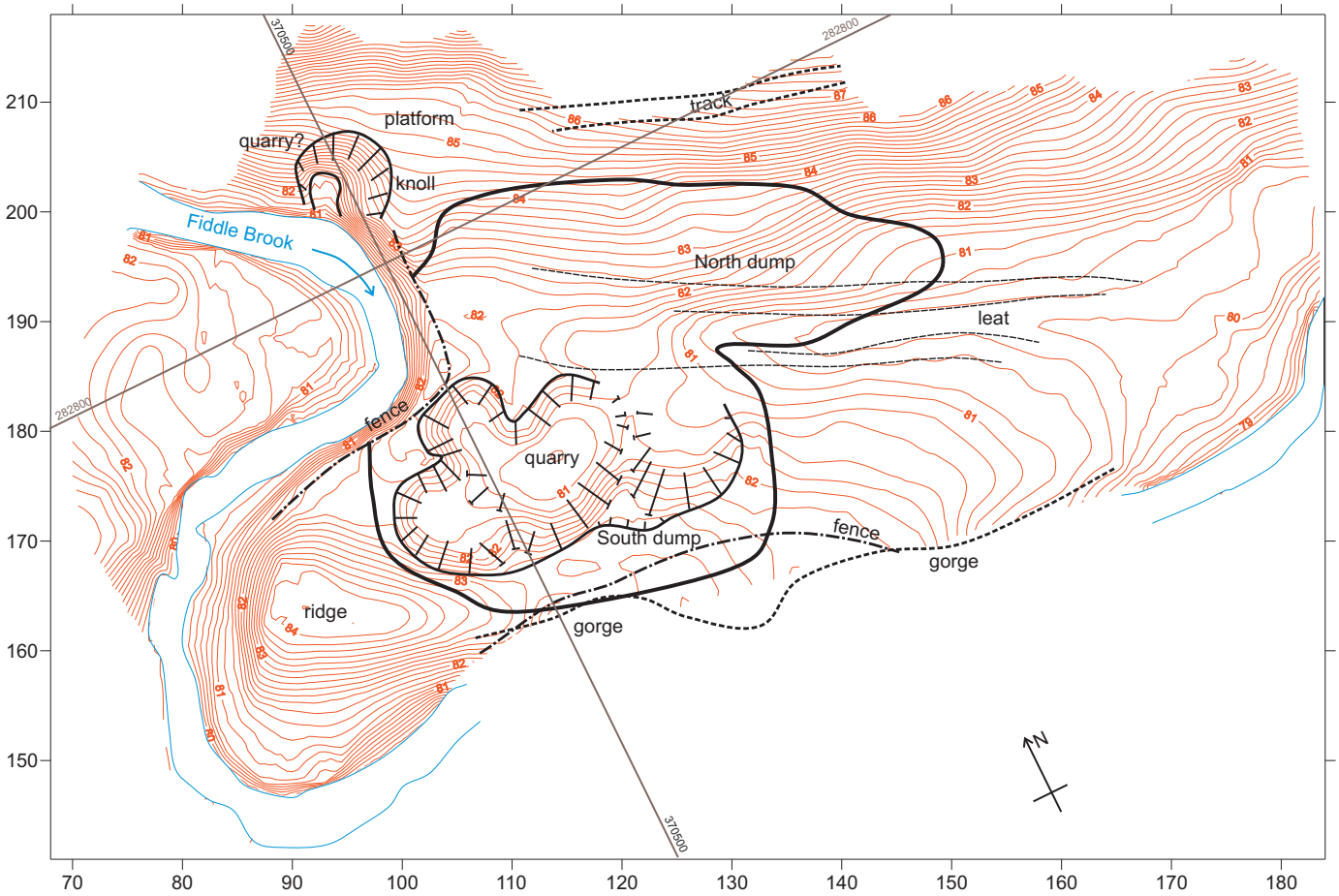

370500
282800
track
platform
quarry?
knoll
Fiddle Brook
North dump
leat
fence
quarry
South dump
fence
gorge
ridge
gorge
N
210
200
190
180
170
160
150
70
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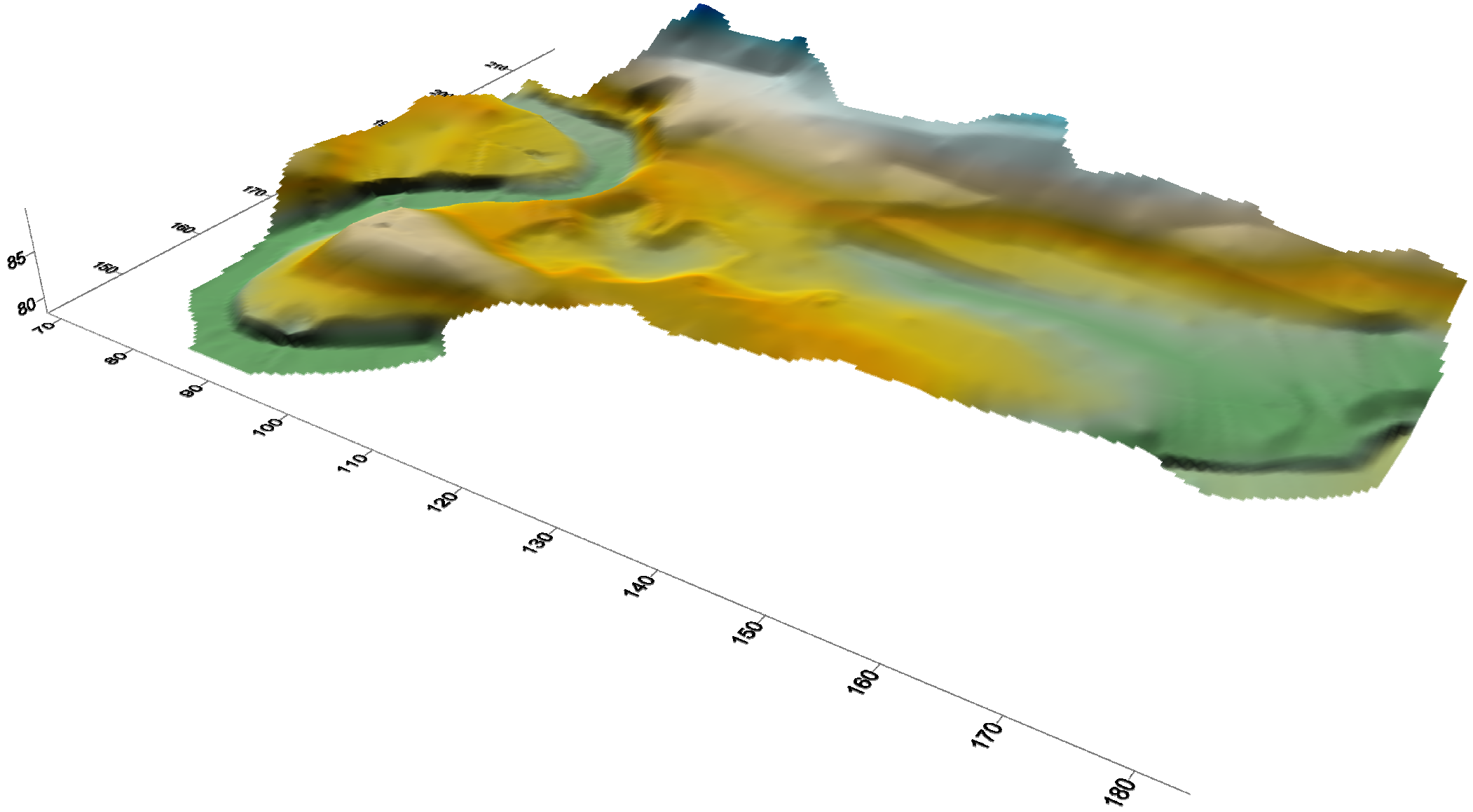
Figure 7



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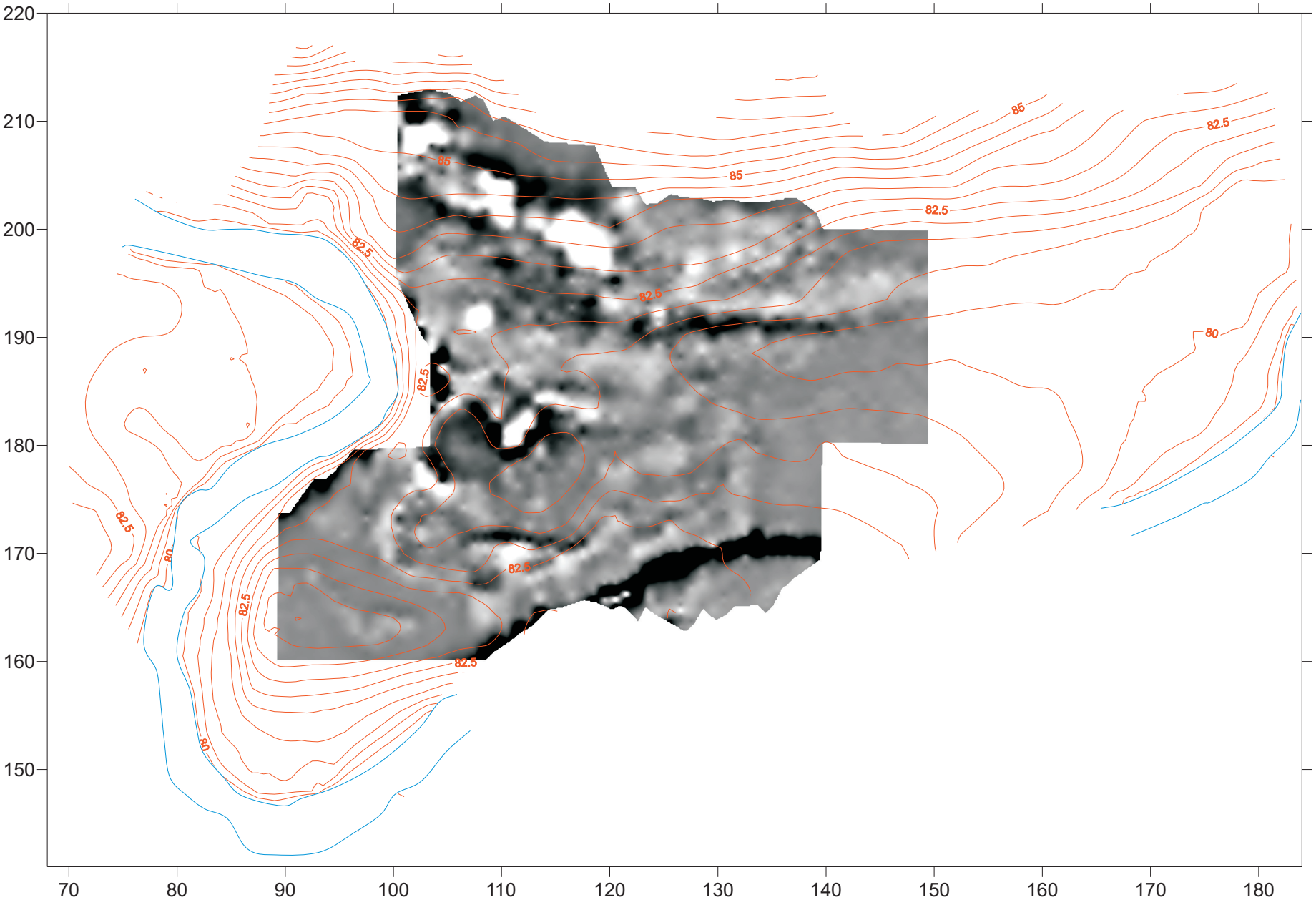
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80

Figure 9

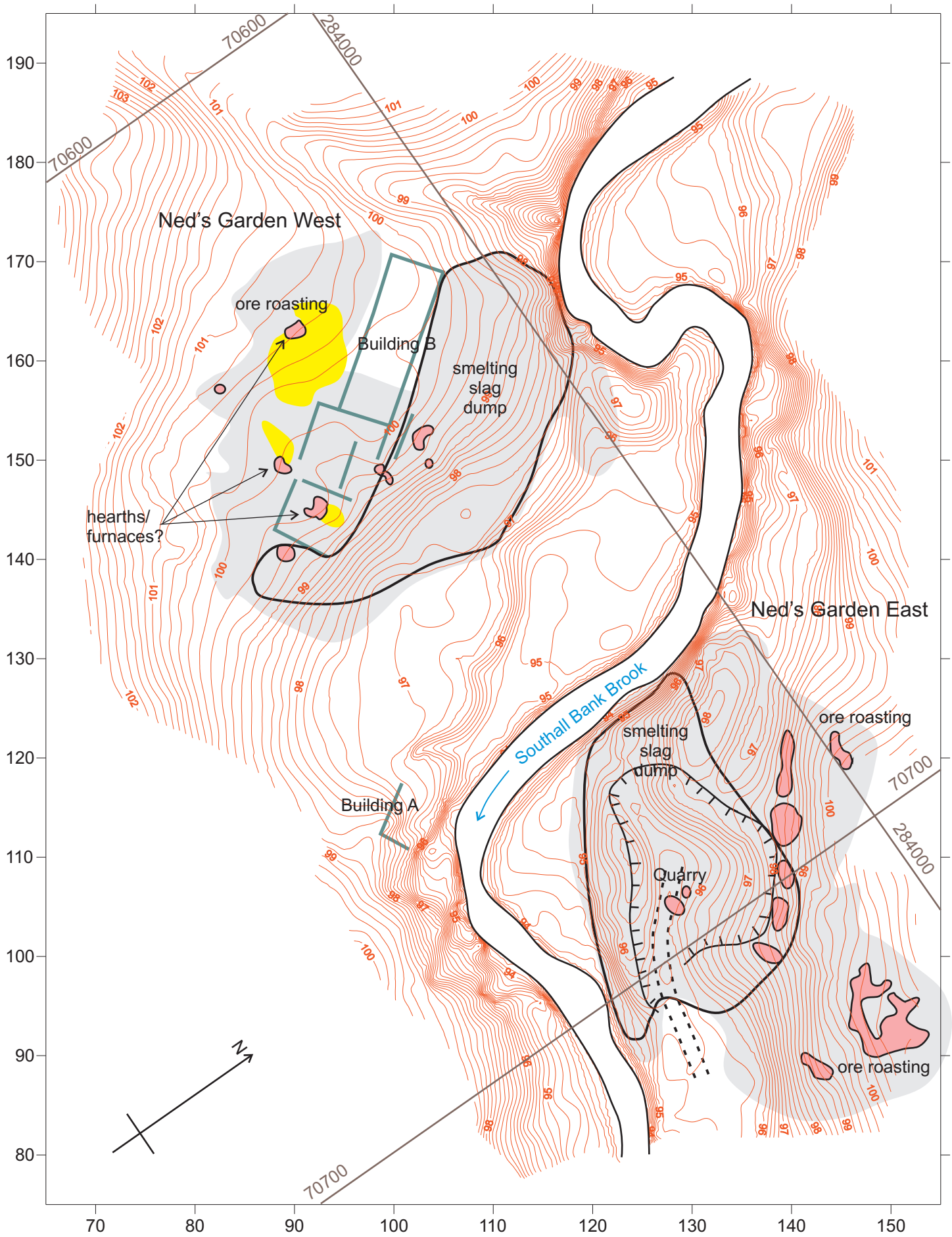
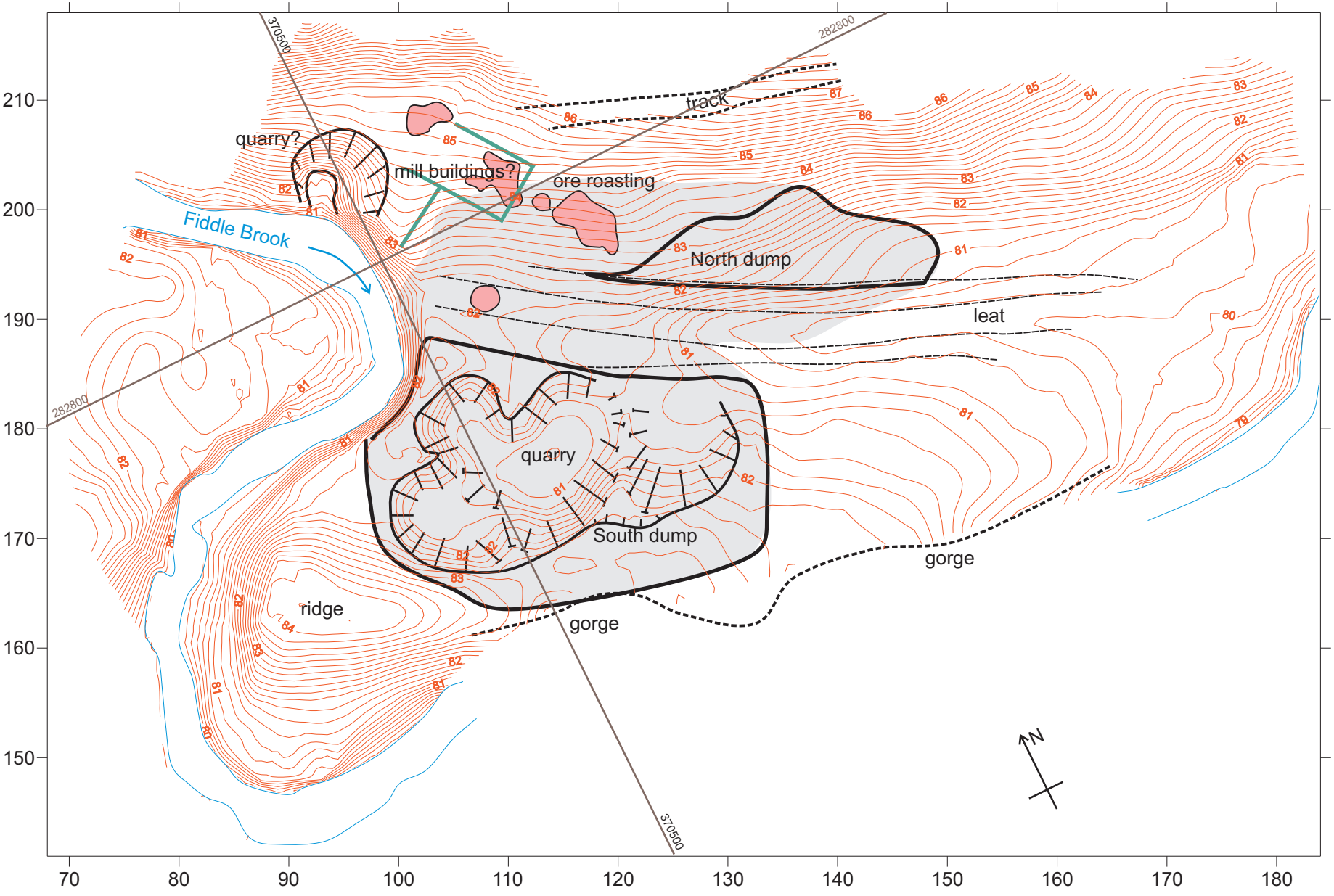

Ned's Garden West
Ned's Garden East
ore roasting
Building B
smelting slag dump
hearths/ furnaces?
Building A
Southall Bank Brook
smelting slag dump
ore roasting
Quarry
ore roasting
70600
284000
70700
N

Figure 10


370500
282800
track
quarry?
mill buildings?
ore roasting
Fiddle Brook
North dump
leat
quarry
South dump
gorge
ridge
gorge
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