

BLACK HEAD PROMONTORY FORT

ST AUSTELL BAY

CORNWALL

Results of a Geophysical Survey



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BLACK HEAD PROMONTORY FORT,
ST AUSTELL BAY, CORNWALL
RESULTS OF A GEOPHYSICAL SURVEY

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Work undertaken by SWARCH for the Cornwall AONB

SUMMARY

This report presents the results of a magnetometry survey and resistivity survey carried out by South West Archaeology Ltd. (SWARCH) on land at Black Head promontory fort, St Austell Bay, Cornwall. Black Head Iron Age promontory fort (DCO1403; 1004391; MCO6530; HER no. 24062), which protrudes into the sea to dividing St Austell Bay from Mevagissey Bay. A firing range established in the late 19th to early 20th century (MCO29688; HER no. 50644) incorporated part of the monument, extending across the proposed survey area. This phase of geophysical survey was requested as part of the AONBs Monumental Improvement project.

The geophysical survey identified 13 groups of anomalies, comprised of c.22-28 anomalies across the survey area. These represented: probable geological variation on the site; extant features on the site such as ramparts to the fort and trenches and spoil heaps associated with the modern rifle range; possible pits, tree-throws or geological anomalies; a possible ring-ditch; and spreads associated with probable ground disturbance that could be associated with modern activity and earthworks represented on historical mapping, as well as probable metallic/ferrous deposits presumably associated with 19th and 20th century activity.

The surveys have ostensibly worked in producing identifiable anomalies and possible archaeological deposits/features. Intrusive archaeological works would test the efficacy and validity of the results of the geophysical survey and aid to confirm the presence or absence of any archaeology resource on the site.

The current use and maintained condition of the site seems appropriate for its continued preservation and future understanding and enjoyment



June 2023

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1.0 INTRODUCTION

LOCATION:	BLACK HEAD PROMONTORY FORT
PARISH:	ST AUSTELL BAY
COUNTY:	CORNWALL
NGR:	SX 03933 48001
SWARCH REF.	CANB22 (BLACK HEAD)

1.1 PROJECT BACKGROUND

South West Archaeology Ltd. (SWARCH) was commissioned by the Cornwall Area of Outstanding Natural Beauty (AONB) to undertake a geophysical survey on land at Black Head promontory fort, St Austell Bay, Cornwall. This work was requested as part of the Cornwall AONB's Monumental Improvement project which is seeking to ensure that 40 scheduled monuments in the protected landscape, currently on the Heritage at Risk Register or vulnerable to loss, are better identified, supported and enjoyed by a wider range of people by 2024. The geophysical surveys are part of the projects archaeological programme to help understand more about the sites and the risks they face, and will help to inform future management with the aim of improving their condition. This work was undertaken in accordance with best practice and ClfA guidance.

1.2 TOPOGRAPHICAL AND GEOLOGICAL BACKGROUND

Black Head promontory fort occupies a headland dividing St Austell Bay and Mevagissey Bay, on the south-west side of St Austell Bay and c.4.50km south of St Austell. The promontory fort is defined by large ditch and bank ramparts at the neck of the headland, a steep hill towards the end of the headland and a relatively level area between. The headland has steep cliffs down to the sea. The monument is at a height of between c.30m and c.48m AOD; with the survey area across a relative plateau at c.30m AOD.

The soils on the site are the shallow well-drained loamy soils over rock of the Powys Association (SSEW 1983), which overlie mudstone of the Hallane Formation and an unnamed sill of Devonian Microgabbro/igneous formation (BGS 2023).

1.3 HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

The site is in the parish of St Austell Bay and the historically in the parish of St Austell. At the time of the c.1839 tithe apportionment for St Austell, Black Head promontory equated to plot 1505, which was part of *Blackhead Farm* (MCO60161). This farm and a small number of associated plots were located just north-west of the promontory, but absent from subsequent mapping. The farm was owned by Sir Joseph Sawle Graves Bart. And occupied by a James Bray. Plot 1505 was named *Blackhead Point* and listed as *rough pasture*. James Bray was also one of a number of occupants of *Trenarron*, which incorporated the majority of fields nearby to the site, including the adjacent plot, 1506 (named *Chinoam*, under *pasture*). The *Trenarron* estate/farm was owned by Thomas Hext Esq. in c.1839 and Lysons states that the former manor of *Trenarren/Trenarren* was given to the priory and convent of Tywardreath in the 12th century by a Robert de Cardinan (Lysons 1814). *Trenarren* was first recorded in 1302 as *Tyngharan* (MCO17568). By 1814 it had been in the Hext family for some time and its mansion had been taken down. It was held by Thomas Hext Esq. of Lostwithiel, who had built a new house there (Lysons 1814). The extant 18th-19th century *Trenarren House* is Grade II Listed (DCO13711; 1212097). A post-medieval rifle range (MCO29688; HER no.50644) is established on the headland and site between 1882 and 1905 (Ordnance Survey mapping).

Black Head is ostensibly named for it being a headland and the colour of rock at its shore line. Local anecdotal knowledge of the site claims people at sea could take refuge on the rocks at the end of the 'point' and that these exposed black rocks are the 'black head' (pers. comms.).

Apart from management recommendations for Black Head having been made (ECO2085), the site has not been subject to archaeological works.

Cornwall's Historic Landscape Characterisation (HLC) describes the site as an area of *Coastal Rough Ground* (HCO8), with the adjacent inland area predominately identified as *Farmland: Medieval* (HCO4), and *Modern enclosed Land* (HCO11).

Cornwall's Historic Environment Record (HER) includes a modern commemorative monolith to A.L.Rowse (MCO58823) immediately north of the site, and a World War II military installation further north of the site near Ledrah (MCO29686).

HER events that cover the area of the site include various broad assessments and appraisals of the 'coastal zone', china clay area and an assessment of the Dodman and St Austell Bay (ECO1578, Parkes 2008; ECO4575, Kirkham 2014; ECO49, Ratcliffe 1997; ECO5328; ECO5358).

1.4 CARTOGRAPHIC DEVELOPMENT

The 1811 Surveyor's draft map depicts Black Head, showing the ramparts as slopes defining a hill on the headland and segregating it from the mainland. Although unclear some structures may be depicted in the approximate location of Blackhead Farm, as shown on the c.1839 tithe mapping. The c.1839 tithe map shows the headland as *Blackhead Point*, divided from the mainland by a boundary across its neck and with Blackhead Farm to its north-west. The apportionment details described the site (plot 1505) as *Blackhead Point* and as under *rough pasture*. The Ordnance Survey (OS) 1st edition, published 1882 shows the headland in detail as 'camp', including; ramparts across the neck at the north-west end of the site, internal banks and/or ridges and areas of more scrub/rough ground. The internal banks roughly separate the higher rough ground at the south-east end of the headland from the slope and more level central ground across the north-west half of the headland. This more level ground and the south-west facing slope of the hill on the end of the headland is defined by earthworks along its north-east and south-west sides. The OS 2nd edition, published 1907, labels Black Head as 'Cliff Castle (camp)' and is similar to the 1st edition map. The most significant change to the site appears to be the establishment of a Rifle Range that includes a trench labelled 'Target' on the headland. On 21st century LiDAR and satellite imagery of the site one can see an approximate change of topography/slope that corresponds to the south-west internal earthwork. The north-west internal earthworks defining an approximately recti-linear enclosure are also visible. Trenches associated with the rifle range are visible. These include the previously depicted trench on the headland, a possible trench beyond the ramparts and near the north-west end of the neck of the headland that is included in the HER entry for the rifle range, and two other smaller possible trenches located between the 'Target' trench and ramparts and one on the ramparts. The HER entry for the rifle range includes another trench/butt 300m north-west from the 'Target' trench. This is not clear discernible on the mapping imagery, but corresponds to a boundary at the north-west end of the rifle range. Some aspects of these visible earthworks have been mapped by the National Mapping Programme (NMP) and are depicted on the HER's aerial investigation mapping polygons. Supporting cartographic sources and LiDAR imagery for this section can be seen in Appendices 1 and 2.

1.5 SITE DESIGNATION AND HER DESCRIPTIONS

Black Head promontory fort is a Scheduled Monument (DCO1403; 1004391; MCO6530; HER no. 24062). Its Scheduling text reads as follows -

'Reasons for Designation

Promontory forts are a type of hillfort in which conspicuous naturally defended sites are adapted as enclosures by the construction of one or more earth or stone ramparts placed across the neck of a spur in order to divide it from the surrounding land. Coastal situations, using headlands defined by steep natural cliffs, are common while inland similar topographic settings defined by natural cliffs are also used. The ramparts and accompanying ditches formed the main artificial defence, but timber palisades may have been erected along the cliff edges. Access to the interior was generally provided by an entrance through the ramparts. The interior of the fort was used intensively for settlement and related activities, and evidence for timber- and stone-walled round houses can be expected, together with the remains of buildings used for storage and enclosures for animals. Promontory forts are generally Iron Age in date, most having been constructed and used between the sixth century BC and the mid-first century AD. They are broadly contemporary with other types of hillfort. They are regarded as settlements of high status, probably occupied on a permanent basis, and recent interpretations suggest that their construction and choice of location had as much to do with display as defence. Promontory forts are rare nationally with less than 100 recorded examples. They are important for understanding the nature of social organisation in the later prehistoric period. Despite its later re-use as a rifle range, the promontory fort at Black Head survives well and will contain archaeological and environmental evidence relating to its construction, development, longevity, social organisation, strategic and territorial significance, trade, agricultural practices, domestic arrangements and overall landscape context.

Details

The monument includes a promontory fort, situated on the dramatic headland dividing St Austell and Mevagissey Bays. The promontory fort survives as irregularly-shaped area, defined by at least three parallel rampart banks, with partially buried outer ditches to the north across the narrowest part of the headland and with the other defences provided by steep natural cliffs. The outermost rampart is slight and the ditch almost totally buried. The central and inner ramparts are up to 5.2m high with 2.1m deep ditches. In the interior is at least one stone hut circle to the NNW of the more recent rifle butts. The rifle range was built in the 1880's and modified during 1907 and the 1970's and many of the surviving features are associated with this subsequent re-use.'

The Cornwall Historic Environment Record (HER) for Black Head promontory fort (MCO6530; HER no. 24062) describes the site as -

Black Head cliff castle is situated on a rocky headland connected to the mainland by a narrow neck of land across which run several lines of entrenchments, and is practically inaccessible from the sea. It is a bivallate promontory fort, having an outer ditch 1.5m deep and bank approx 2.5m high. The total width of rampart is 34.7m with banks cutting through a causeway created through the centre. The original entrance was probably on the west side. There are traces of low banks in the interior. Surveyed at 1:2500 by Palmer in 1968 and recorded as having extant remains by Sheppard in 1972, who also reports damage caused to the site by its having been in use as a rifle range (50644).

The site is also the location of a firing range (MCO29688; HER no. 50644). This firing range is first depicted on the OS 2nd edition, published in 1907. The HER description of this asset is as follows -

'A shooting range on the cliff top at Black Head, consisting of three butts which are visible on aerial photographs. The range covers a length of 300m, the most northerly of the butts being 120m from the central one and the most southerly being 180m distant from it.'

1.6 ARCHAEOLOGICAL POTENTIAL AND GEOPHYSICAL RELEVANCE

The site has an obviously high archaeological potential. Assets with a potentially direct impact on the sites geophysical record include: the Iron Age promontory fort (MCO6530) that constitutes the site itself, earthworks present on mapping and other imagery of the site and recorded by the NMP, and features or remnants of military activity associated with the rifle range on the site (MCO29688). Debris or features from these prehistoric or modern phases could be account for potential geophysical anomalies on the site.

1.7 METHODOLOGY

This work was undertaken in accordance with current best practice and ClfA guidance.

Any desk-based assessment aspect of this report follows the guidance as outlined in: Standard and Guidance for Archaeological Desk-Based Assessment (ClfA 2014a) and Understanding Place: historic area assessments in a planning and development context (English Heritage 2012).

The geophysical survey follows the general guidance as outlined in: EAC Guidelines for the use of geophysics in Archaeology: Questions to Ask and Points to Consider (Europae Archaeologiae Consilium/European Archaeological Council 2016) and Standard and Guidance for Archaeological Geophysical Survey (ClfA 2014b).



FIGURE 1: SITE LOCATION (THE SITE IS INDICATED).

2.0 GEOPHYSICAL SURVEY

2.1 INTRODUCTION

An area c.0.17ha comprising the relatively level ground immediately inside the promontory forts ramparts, between the ramparts and steep rough ground at the south end of the promontory, was subject to a magnetometry- and resistivity survey. This equated to approximately half an initially targeted area of c.0.37ha, but was subject to appropriate ground clearance. The purpose of the magnetometry survey was to identify and record magnetic anomalies within the survey; and the purpose of the resistivity survey was to identify and record anomalies of relative resistance within the proposed site. While identified anomalies may relate to archaeological deposits and structures the dimensions of recorded anomalies may not correspond directly with any associated features. The following discussion attempts to clarify and characterise the identified anomalies. The survey was undertaken on the 21st and 22nd of March 2023 by J. Bampton, P. Bonvoisin of SWARCH, local volunteers, and members of the AONB and NDMDC; the survey data was processed by J. Bampton.

2.2 SITE INSPECTION

The site was across the north end of a promontory fort. The area immediately south of the ramparts across the neck of the headland had had gorse and hawthorn scrub cut back prior to the survey. Approximately half the relatively level part of the fort between its ramparts and an extant rifle range target trench (butt) was cleared to an adequate level to be surveyed. In the space between the target trench and ramparts were two trenches, c.5m long and c.1m wide, with the soil dumped to form a low long mound on the east side of the trenches. These trenches and mounds were aligned approximately north-east by south-west, parallel to the target trench, and spaced at regular distances from the ramparts towards the target trench. A rough circular divot, a few meters across, was located east of these trenches. This divot was ostensibly a similar ground disturbance to the trenches and may have been contemporary to them; possibly associated with military training activity, including ammunition storage during exercises or foxhole practice, or cover examples for shooting positions. A footpath ran across the survey area; the majority of the survey area was in its north-east side with a smaller survey area of more woody gorse scrub that had been cleared on its south-west side. Supporting photographs for the site inspection can be seen in Appendix 3.



FIGURE 2: SITE SHOT FROM THE NORTH-EAST END OF THE RAMPARTS; VIEWED FROM THE NORTH (NO SCALE).

2.3 METHODOLOGY

The magnetometry and resistivity survey follow the general guidance as outlined in: *EAC Guidelines for the use of geophysics in Archaeology: Questions to Ask and Points to Consider* (Europae Archaeologiae Consilium/European Archaeological Council 2016) and *Standard and Guidance for Archaeological Geophysical Survey* (CIfA 2014b).

2.3.1 MAGNETOMETRY METHODOLOGY

The magnetometry survey was carried out using a twin-sensor fluxgate gradiometer (Bartington Grad601). These machines are sensitive to depths of up to c.1.50m. The survey parameters were: sample intervals of 0.25m, traverse intervals of 1m, a zigzag traverse pattern, traverse orientation was circumstantial, grid squares of 30×30m. The gradiometer was adjusted ('zeroed') every 0.5-1ha. The survey grid was tied into the Ordnance Survey National Grid- and set out using a Leica CS15 GNSS Rover GPS. The data was downloaded onto Grad601 Version 3.16 and processed using TerraSurveyor Version 3.0.36.0. The primary data plots and analytical tools used in this analysis were Shade and Metadata. A technical summary of the survey method, and data details and processing can be seen in Appendix 4.

2.3.2 RESISTIVITY METHODOLOGY

The resistivity survey was carried out using a RM15-D Resistivity Meter with an MPX15 Multiplexer module allowing for four terminal sensing using a PA20 multiprobe array with parallel twin log mode 2. These machines are sensitive to depths of up to c.1m. The survey parameters were: sample intervals of 1m, traverse intervals of 1m, a zigzag traverse pattern, traverse orientation was circumstantial, grid squares of 30×30m. . The survey grid was tied into the Ordnance Survey National Grid- and set out using a Leica CS15 GNSS Rover GPS. The data was downloaded onto- and processed using TerraSurveyor Version 3.0.36.0. The primary data plots and analytical tools used in this analysis were Shade and Metadata. A technical summary of the survey method, and data details and processing can be seen in Appendix 4.

2.3.3 ASSESSMENT OF METHODOLOGY

Both types of geophysical survey produced a usable range of results, demonstrating the potential for them to work and provide meaningful results. The magnetometry survey provided data that corresponded to discernible topographic features on the site as well as potential archaeological features and/or deposits. The resistivity survey provided data that corresponded to probable geological variation across the site and possible modern features. Archaeological evaluation/excavation would test the efficacy and validity of the results of the geophysical survey and aid to confirm the presence or absence of any buried archaeology resource on the site. The magnetometry survey identified probable metallic anomalies presumed to be associated with activity associated with the relict rifle range on the site.

As part of a community engagement and volunteer element to this project metal detectorists from the North Cornwall Metal Detecting Club were asked to identify locations of responses to cross-reference with the results of the geophysical survey. However, the detectorist's responses were so frequent and sporadic that no corresponding pattern would have been feasible. The locating of these responses by GPS was abandoned due to the imposition of people and response markers with ferrous content across the geophysical survey area at the time of the survey. Their responses including ferrous and copper alloy responses and were presumably associated with small arms fire. The detectorists are not allowed to excavate on the Scheduled Monument and were only granted access with their machines as part of this survey and research.

2.4 RESULTS

Tables 1 and 2 with the accompanying Figures 3-6 show the analyses and interpretation of the geophysical survey data. Additional graphic images of the survey data and numbered grid locations can be found in Appendix 1.

*note on 'Class' when interpreting the resistivity survey data:

- High responses refer to readings of higher relative resistance and represent built/compact stony features or relatively hard deposits. Simplistically, these are comparable to negative responses in the magnetometry data and both are represent in the interpretive Figures 4 and 6 in shades of blue.
- Low responses refer to readings of lower relative resistance and represent in-filled cut features or relatively soft deposits. Simplistically, these are comparable to positive responses in the magnetometry data and both are represent in the interpretive Figures 4 and 6 in shades of red.

In this instance readings of above 200 Ohm are considered high responses and readings below 200 Ohm are considered low responses. Readings above c.260 ohm are considered strong high; and readings below c.150 Ohm are considered strong low. Responses ranging between, but not exclusively limit to- between c.180 Ohm and 220 Ohm could be considered as probable natural variation.

TABLE 1: INTERPRETATION OF MAGNETOMETRY SURVEY DATA.

Anomaly Group	Class and Certainty	Form	Archaeological Characterisation	Comments
1	Very strong mixed, probable	Linear	Open trench	Located near the middle of the survey area. Aligned approximately north-east by south-west. Equates to an extant open trench. Associated with the rifle range recorded at the site. Response strengths of <-100nT and <+70nT.
2	Moderate-strong negative and positive, probable	Oval	Made-ground and depression, pit	Located near the middle of the survey area. Possible partially associated with the deposited material excavated from the trench (Group 1) that was visible during the survey on the north-east side of the Group 1 trench. Possible also associated with a cut and in-filled feature such as a pit or hollow. Examples of hollows, presumably associated with military practice activity was noticeable in the north-east half of the survey area. Response strengths of c.-35nT and c.+72nT.
3	Strong mixed, possible	Amorphous / semi-circular spread	Disturbed ground, edge of historical demolished earthwork	Located on the eastern edge of the survey area. Spread of possible discrete anomalies or disturbed ground in the location of a possible bank or slope depicted on historic mapping. Associated with Groups A and B. Response strengths of c.-51nT and c.+63nT, but with a dipolar response strength of <+/-100nT.
4	Moderate positive, possible	Linear spread	Extant rampart bank	Located along the northern edge of the survey area. Indicative of earthy bank material at the bottom of the extant rampart bank. Response strength of c.+15nT to +30nT.
5	Weak-moderate negative, possible	Curving spread	Disturbed ground	Located at the south end of the survey area. Indicative of compacted or stony ground associated with probable disturbed ground, shallow soil over rocky natural and equating to an area of woody scrub cleared prior to the survey. Associated with Group A. Response strength of <c.-20nT.
6	Strong-very strong positive, probable	Oval	Pit or tree-throw	Located in the south end of the survey area. Indicative of a cut and in-filled feature such as a pit or tree-throw. Response strength of <c.+76nT.
7	Moderate positive, possible	Oval	Pit, tree-throw or geology	Approximately eleven examples across the survey area. Indicative of possible cut and in-filled features such as pits or tree-throws; or representative of geological variation given the broad spikes in natural variation within the survey data. Associated with Group B. Response strength of <c.+35nT.
8	Weak-moderate, positive, possible	Curvi-linear / semi-circular	Ditch, ring-ditch, disturbed ground	Two lengths of a possible single curvi-linear anomaly. Located in the south end of the site. Indicative of a cut and in-filled feature such as a pit or tree-throw, but also within an area of probable bioturbation. Possibly indicative of a ring-ditch

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				associated with a structure. Associated with Group A. Response strength of <c.+23nT.
9	Very weak negative, possible	linear	Paths, geology	Nine depicted examples associated with five approximate paths across the site, including the main footpath bisecting the fort. Indicative of slightly compacted or stony deposits. These responses have extremely weak responses and are probably indicative of shallow and/or ephemeral features. Probably associated with a small amount of footpath maintenance or made-ground and compacted topsoil. Associated with Groups C and D. Response strength of <c.-5nT.
10	Magnetic disturbance, probable	amorphous spread	Magnetic disturbance, debris or object	Typically these types of response are near the edges of sites and fields due to the magnetic disturbance from fence lines as well as areas of debris and metallic equipment. In this instance the response that would normally be associated with modern metallic debris/interference could be associated with modern activity or a deposit associated with military activity associated with the extant remains of the rifle range at the site. Associated with Groups B and C. Responses of <+/-100nT.
Other Anomalies				
-	Moderate-strong dipolar, probable	Point/ovoid	Geology/Ferrous objects/debris	The site has a handful of dipolar responses. Black crosses in Figure 4. The strongest examples are indicative of ferrous objects that are typically presumed to be modern, such as machinery fragments. Similar and weaker responses can be indicative of geological features/anomalies. In this case these may include igneous deposits/boulders and mudstones and associated differential weathering of the underlying natural. These are highly probable to be non-archaeological in nature. Responses of <c. +/-100nT.

TABLE 2: INTERPRETATION OF RESISTIVITY SURVEY DATA.

Anomaly Group	Class and Certainty	Form	Archaeological Characterisation	Comments
A	High, possible	Amorphous spreads	Geology	Located across three broad areas: along the south-west side of the survey area; across the eastern part of the survey area; and the northern edge of the survey area. Indicative of compact or stony material and probably the underlying geology. The examples on the northern limit of the survey area and the south-western examples had less high resistance than the eastern examples. The northern examples may indicate stony or compacted material associated with extant rampart banks on the site. The eastern and south-western examples are probably indicative of underlying rocky natural geology, particularly in the eastern spreads. Groups A and B both probably represent natural geological variation of some kind and may be reflective of the geology or overlying soils. Associated with Groups 3, 4 and 5. Response strengths of between c.240 to 256 Ohm, and c.205 to 220 Ohm.
B	Low, possible	Amorphous spreads	Geology	Located predominantly between the Group A anomalies, across the middle of the survey area. Indicative of lower relative resistant geology and presumably softer geology. Groups A and B both probably represent natural geological variation of some kind and may be reflective of the geology or overlying soils. Examples on the east side of the site may allude to a feature such as a path potentially cutting through or overlaying eastern Group A spreads. Associated with Group 3 and 7. Response strengths of c.180 to 195 Ohm, and c.160 Ohm.
C	Strong high and low, possible	Linear	Geology, debris	Linear anomaly in the south part of the survey area that equates to the approximate line of the footpath bisecting the site, aligned north-west by south-east. Associated with Group 9. Response strengths of <c.300 Ohm and >c.150 Ohm.
D	Strong high and low, possible	Amorphous spreads	Extant footpath	An irregular area/spread of erratic, strong high and strong low responses that may indicate some geological anomaly/feature or a spread of debris or material that could be comparable to the extant path. Located near the middle of the survey area. Associated with Group 9. Response strengths of <c.300 Ohm and >c.150 Ohm.

2.5 DISCUSSION

The geophysical survey identified 13 groups of anomalies (1-9 on the magnetometry survey; and A-D on the resistivity survey) comprised of c.18-23 magnetometry anomalies, and 4 or 5 resistivity anomalies, depending on where one chooses to define discrete anomalies, across the survey area. These included: a linear trench and spread associated with an extant trench on the former rifle range (Groups 1, 2); a spread of possible geological variation but associated with a possible weathered or levelled bank/slope type boundary (Groups 3, A); linear spreads along the northern edge of the survey area associated with the extant rampart bank (Groups 4, A); a spread of probable natural variation or disturbed ground (Groups 5 and A); possible pit or tree-throw type features (Groups 6, 7); a possible ring-ditch (Group 8); mixed resistivity anomalies and faint linear anomalies associated with shallow ground disturbance, footpaths or geological variation (Groups 9, C and D); a possible metallic deposit probably associated with 19th or 20th century activity (Group 10); and broad geological variation with possible approximate north-north-east by south-south-west and perpendicular striations/alignment (Groups A, B and possibly 3, 5).

Instances of magnetic debris associated with ferrous debris or weak geological variation were also evident in the survey data. Other than metallic debris/objects, some of these examples on this site may correspond to igneous boulders or intrusions, or differentially weathered mudstone that approximately correspond to resistivity anomalies (Group A). Additional visual interpretations of the data and cartographic sources supporting the discussion and comments can be seen in Appendices 1 and 2.

Regarding the magnetometry survey, the general 'noise' (inherent geological variation) of the site was low-moderate across the site, $<c. \pm 2nT$, with occasionally higher fluctuations/spikes into the low teens. Anomalies of a comparable strength are probably/possibly natural and geological in nature. The recorded presence of two geology types on the site will probably account for some broad variation in responses and ostensible dipolar anomalies. The targeted area of the survey ostensibly contains sedimentary geology with igneous incursions (Possibly Groups B and parts of Group 7), bounded by igneous geology (possibly Group A) (BGS 2023). In terms of the resistivity survey, responses of between c.180 Ohm and 220 Ohm are of possible natural/geological origins or variation; although similarly to the magnetometry survey, the range of responses may be indicative of varying geologies on site (igneous and sedimentary), or made-grounds.

One cannot identify definitive Iron Age features from the geophysical anomalies on the site. A possible partial ring-ditch (Group 8) could be associated with a prehistoric structure on the site and various discrete anomalies (Groups 6 and 7), that could represent pits, tree-throws or geological variation could be of any date and man-made or natural origin.

The extant ramparts were discernible as anomalies indicative of both possibly earthy and stony or compact deposits (Groups 4 and part of Group A). An area of ostensibly disturbed ground in the north-east part of the survey area (Groups 3 and possibly parts of Groups A and B) approximately corresponded to the edge of a ridge type earthwork or boundary depicted on historical mapping and the edge of NMP aerial mapping lines/polygons. This/these evident features may have been levelled or eroded down and or been lost to collapse at the edge of the monument. An approximately circular hollow/dip on the ground, visible during the survey, was on the approximate edge of the Group 3 anomaly and was presumed by comparison to the condition of topographic features associated with the former rifle range to be of a possible comparable date.

Another area of ostensibly disturbed ground in the south part of the survey area (Group 5 and parts of Group A) corresponded to an area of recent scrub clearance and ostensibly shallow ground over

rocky natural. However, within this area were possible features associated with a possible pit (Group 6) and the possible ring-ditch (Group 8).

The trench within the survey area and its associated spoil heap essentially account for Groups 1 and 2 and probably account for other topographic features in the survey area and across the wider site. various forms of cover and terrain would allow for the practice of shooting from various positions and the presence for observers and ammunition areas set away-from, but near live firing positions could all have been considerations from the time of the ranges construction, between 1881 and 1905 and a use up to at least during the Second World War.

During the survey of the site, community involvement in the project included allowing metal detectorist to survey the survey area and provide comparative locations for the geophysical survey of magnetic anomalies/readings. The detectorists were not permitted to excavated identified responses. However, the frequent responses of the detectorists were wide spread and sporadic and included ferrous and non-ferrous responses, presumably associated with spent rifle shells and ammunition. A possible non-ferrous spread or cable may have run approximately along the main footpath up the slope on the south side of the survey area and beyond. This may account for the resistivity response (Group C) in this area and could be associated with communication wires(?), a copper cable or service, and may be associated with the (Group D) response also. There may have been some automation associated with the main rifle range butt south of the survey area for which a cable was required. Group 10, at the south-west end of the Group C anomaly was indicative of a metallic/ferrous spread or buried object and is probably associated with an object or debris from the time of the rifle range construction onwards (late 19th- to early 20th century onwards).

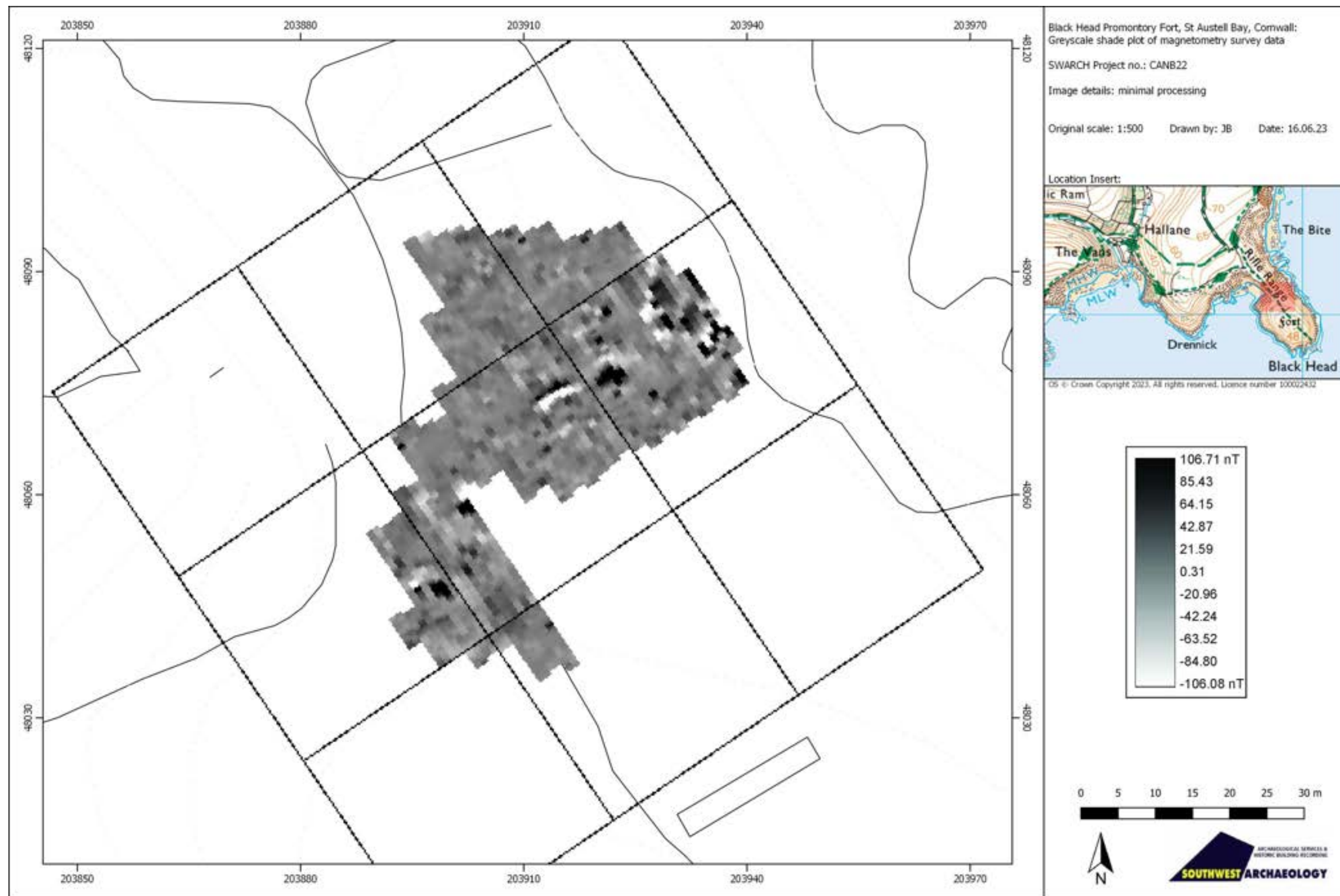


FIGURE 3: GREYSCALE SHADE PLOT OF MAGNETOMETRY SURVEY DATA; MINIMAL PROCESSING.

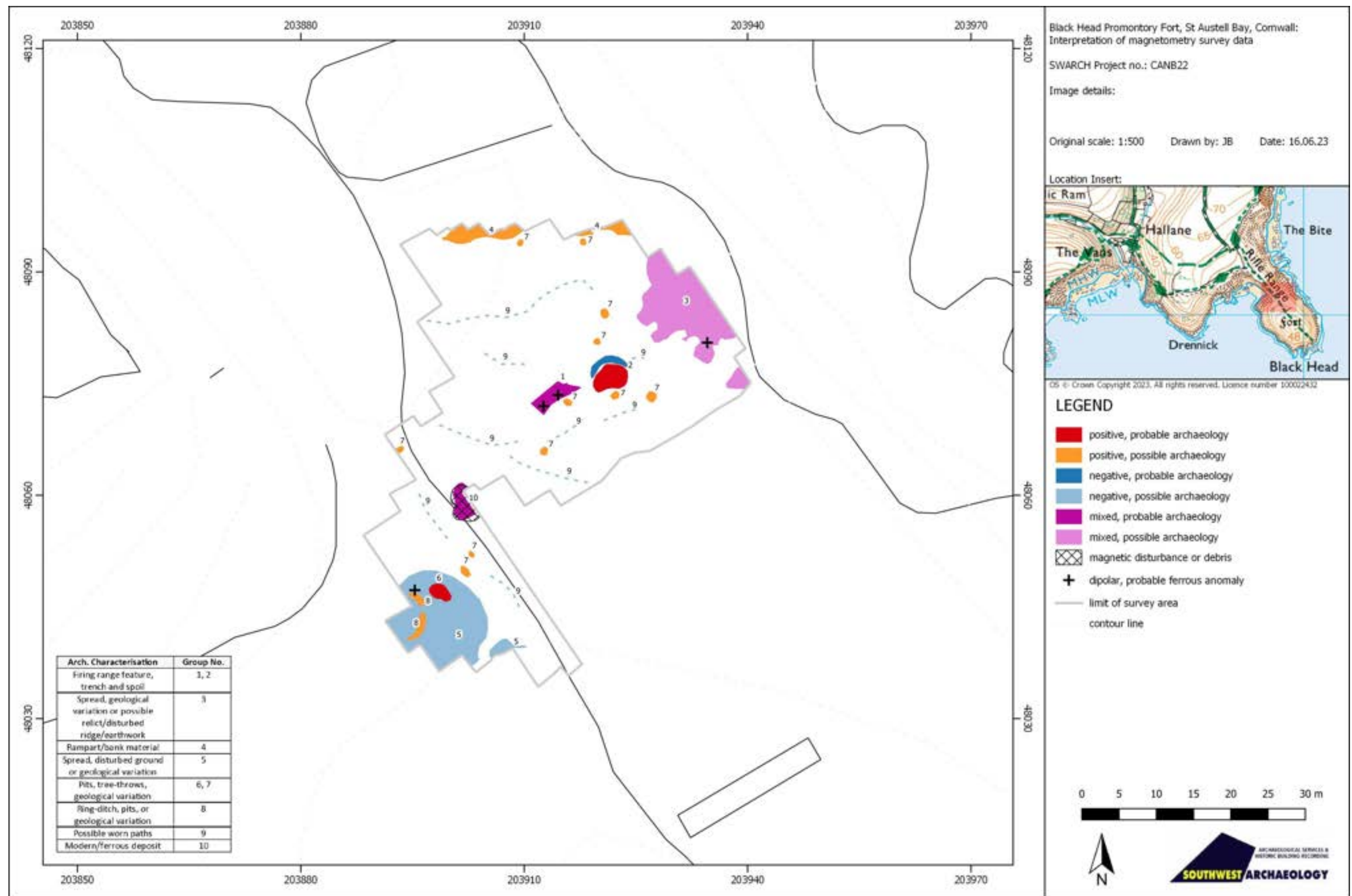


FIGURE 4: INTERPRETATION OF MAGNETOMETRY SURVEY DATA.

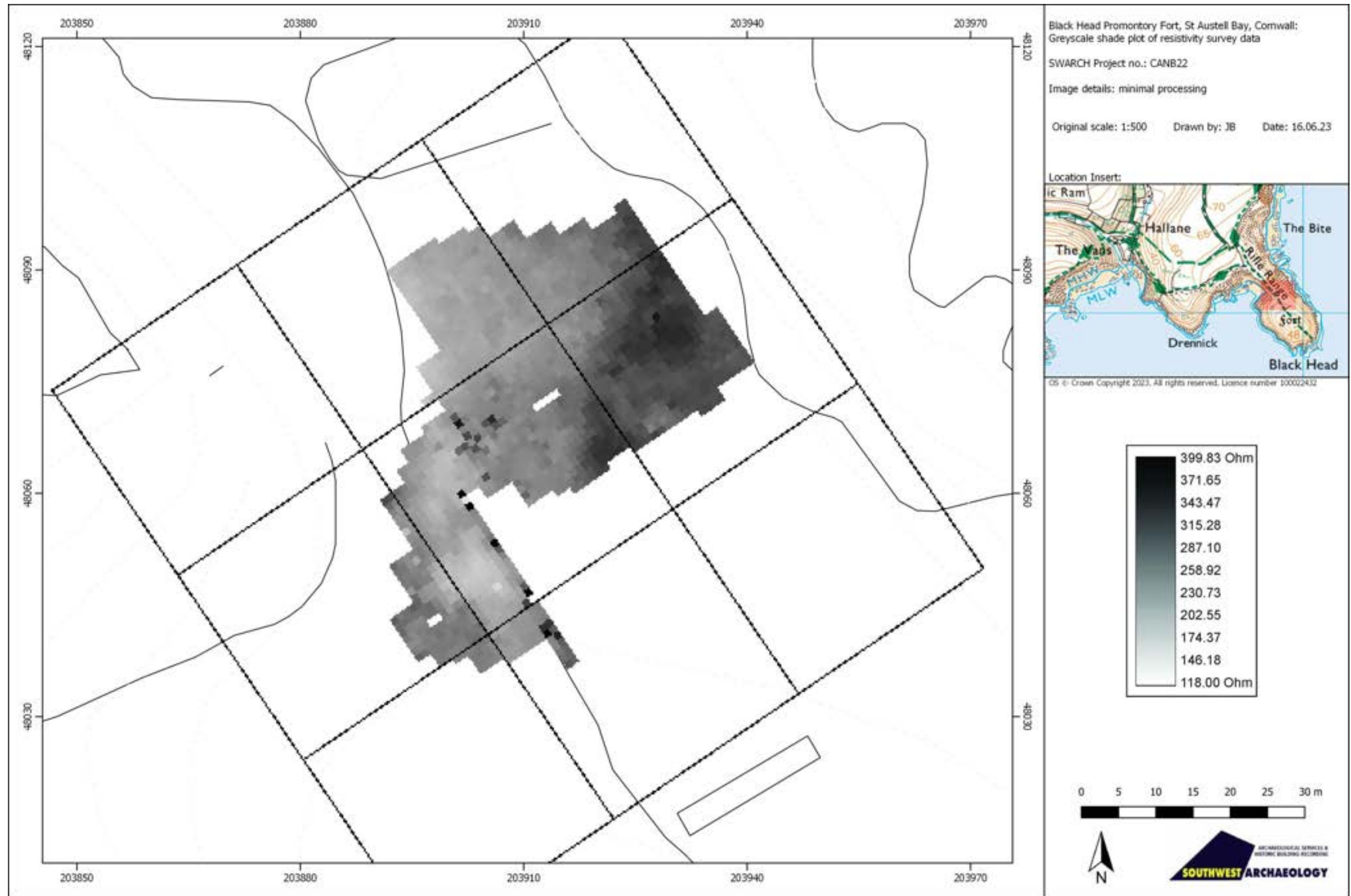


FIGURE 5: GREYSCALE SHADE PLOT OF RESISTIVITY SURVEY DATA; MINIMAL PROCESSING.

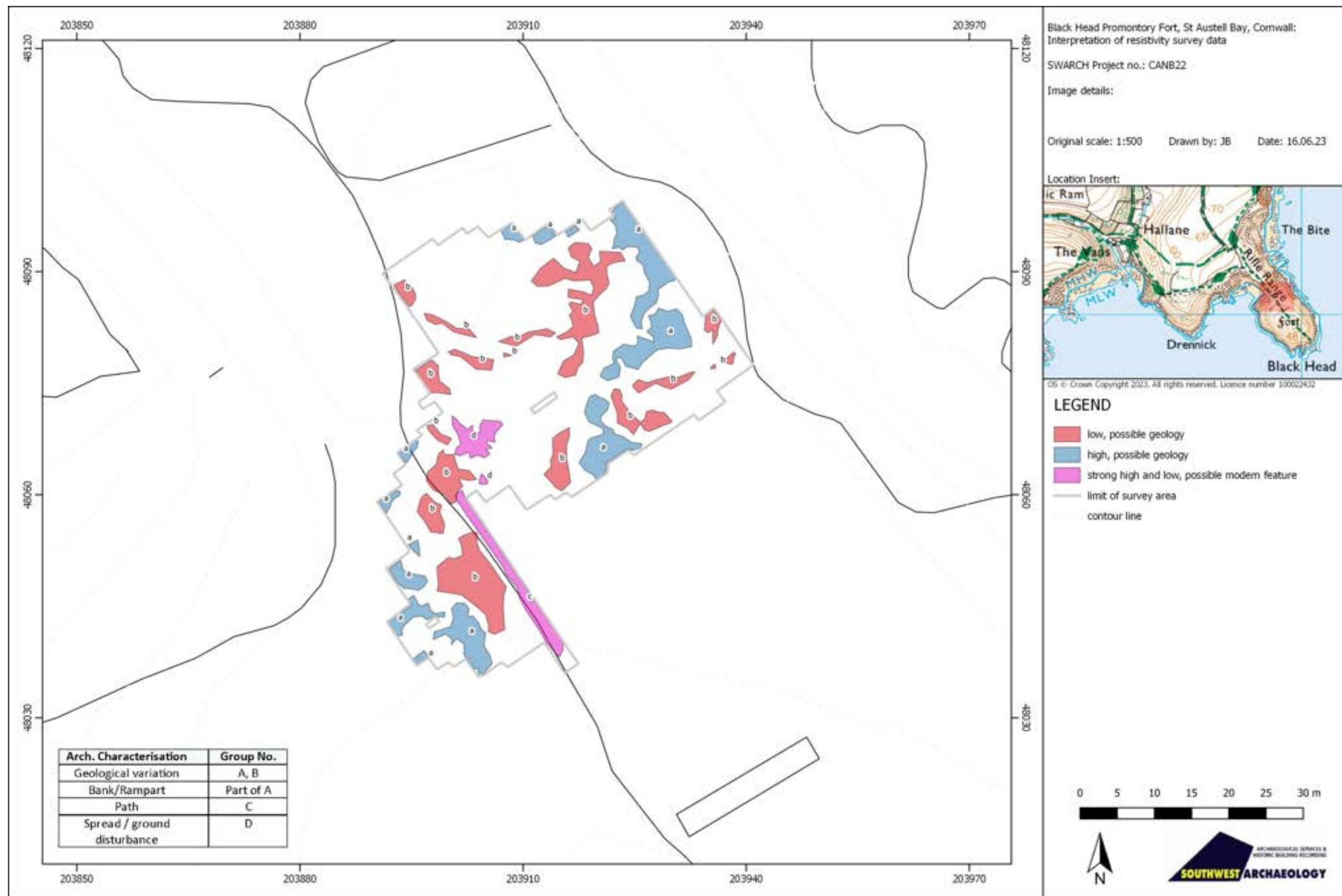


FIGURE 6: INTERPRETATION OF RESISTIVITY SURVEY DATA.

3.0 CONCLUSION

The site is located at the Scheduled Black Head Iron Age promontory fort (DCO1403; 1004391; MCO6530; HER no. 24062), which protrudes into the sea to dividing St Austell Bay from Mevagissey Bay. A firing range established in the late 19th to early 20th century (MCO29688; HER no. 50644) incorporated part of the monument, extending across the proposed survey area. Black Head is within a Cornwall area of the AONB. The site can be accessed via footpath along the South West Coast Path. This phase of geophysical survey was requested as part of the AONBs Monumental Improvement project.

The geophysical survey identified 13 groups of anomalies (1-9 on the magnetometry survey; and A-D on the resistivity survey) comprised of c.22-28 anomalies, depending on where one chooses to define discrete anomalies, across the survey area. These represented: probable geological variation on the site; extant features on the site such as ramparts to the fort and trenches and spoil heaps associated with the modern rifle range; possible pits, tree-throws or geological anomalies; a possible ring-ditch; and spreads associated with probable ground disturbance that could be associated with modern activity and earthworks represented on historical mapping, as well as probable metallic/ferrous deposits presumably associated with 19th and 20th century activity.

The survey does not disprove the presence of structural features or archaeological evidence internal to the promontory fort; however, it does not provide clear proof of any significant surviving internal features or deposits. Although this survey predominantly demonstrates modern activity and surface evidence in the survey area, possible geological anomalies include discrete features that could represent pits or a partial ring-ditch.

Intrusive archaeological works would test the efficacy and validity of the results of the geophysical survey and aid to confirm the presence or absence of any archaeology resource on the site.

3.1 RECOMMENDATIONS ON MONUMENT MANAGEMENT AND FURTHER WORKS

Maintenance of the monument in its current condition and use seems like the most reasonable and effective management of the monument. Grass and scrub/flora retains a relative equilibrium preventing/slowing surface erosion of the site and aiding to keep access from the public to the established paths.

The surveys used in this work may indicate that any further geophysical investigation would probably not yield further significant results in identifying potential structures on the site.

A very small amount of community excavation within the survey area would clarify the stratigraphy and geology of the site to better aid interpretation of the geophysical surveys from this phase of work.

4.0 BIBLIOGRAPHY & REFERENCES

Published Sources:

- Chartered Institute of Field Archaeologists** 2014a (revised 2017): *Standard and Guidance for Historic Environment Desk-based Assessment*.
- Chartered Institute for Archaeologists** 2014b (revised 2017): *Standard and Guidance for Archaeological Geophysical Survey*.
- DW Consulting** 2016: *TerraSurveyor User Manual*.
- Europae Archaeologiae Consilium** 2016: *EAC Guidelines for the use of geophysics in Archaeology: Questions to Ask and Points to Consider, EAC guidelines 2*.
- English Heritage** 2008: *Geophysical Survey in Archaeological Field Evaluation*.
- Lysons, D. & Lysons, S.** 1814: *Magna Britannia, volume 3: Cornwall*. London.
- Schmidt, A.** 2002: *Geophysical Data in Archaeology: A Guide to Good Practice*. ADS series of Guides to Good Practice. Oxbow Books, Oxford.
- Soil Survey of England and Wales** 1983: *Legend for the 1:250,000 Soil Map of England and Wales (a brief explanation of the constituent soil associations)*.

Unpublished Sources:

- Kirkham, G.** 2014: *United Kingdom china-clay bearing grounds: mineral resource archaeological assessment*. CAU Report No. 2014R028.
- Parkes, C.** 2008: *The Dodman and St Austell Bay: Archaeological survey for the National Trust of The Dodman and Penare, Lamsowden, Lamledra and Bodrugan*. HES Report No. 2008R078.
- Ratcliffe, J.** 1997: *China Clay Leader II Programme Area: Promoting the Historic Heritage*. CAU Report No. 1997R019.

Websites:

- British Geological Survey** 2023: *Geology of Britain Viewer*.
<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>
- Cornwall Council Historic Environment Record (HER) and HLC** 2023: *Cornwall Council Interactive Map*
<https://map.cornwall.gov.uk/website/ccmap/> and <http://www.heritagegateway.org.uk>
- Environment Agency** 2019 & 2020: *LiDAR, Digital Surface Model and Digital Terrain Model data*
<https://environment.data.gov.uk/DefraDataDownload/?Mode=survey>

Kresen Kernow (KK):

- Surveyors draft map for the Grampound area, c.1811
- St Austell Tithe Apportionment, c.1839
- St Austell Tithe Map, c.1839

National Library of Scotland (NLS):

- Ordnance Survey 1st edition, 25 inch map, Sheet: Cornwall LX.I, surveyed 1881, published 1882
- Ordnance Survey 2nd edition, 25 inch map, Sheet: Cornwall LX.I, revised 1905, published 1907

APPENDIX 1: ADDITIONAL GRAPHICAL IMAGES OF THE GRADIOMETER SURVEY

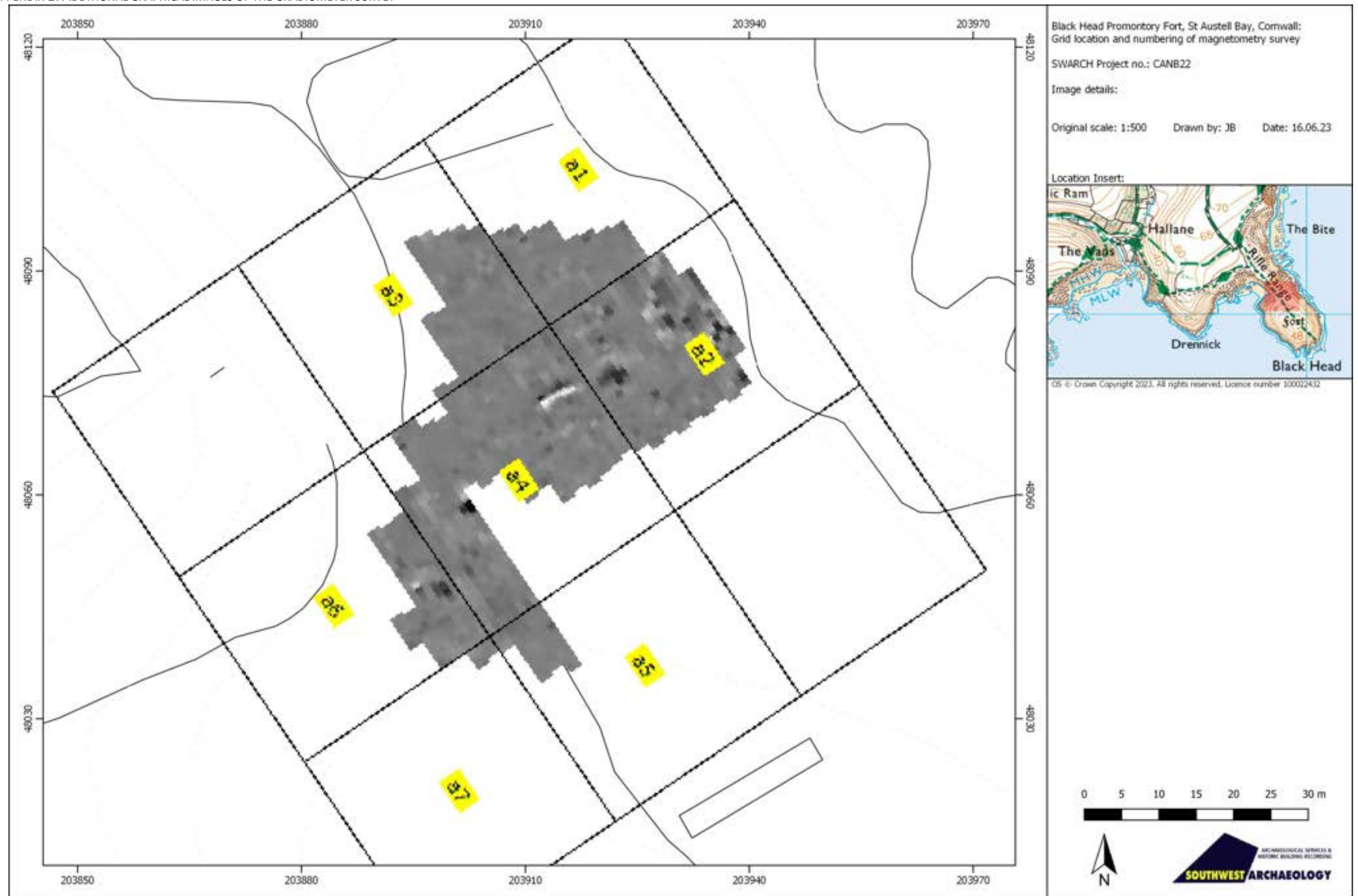


FIGURE 7: MAGNETOMETRY SURVEY GRID LOCATION AND NUMBERING.

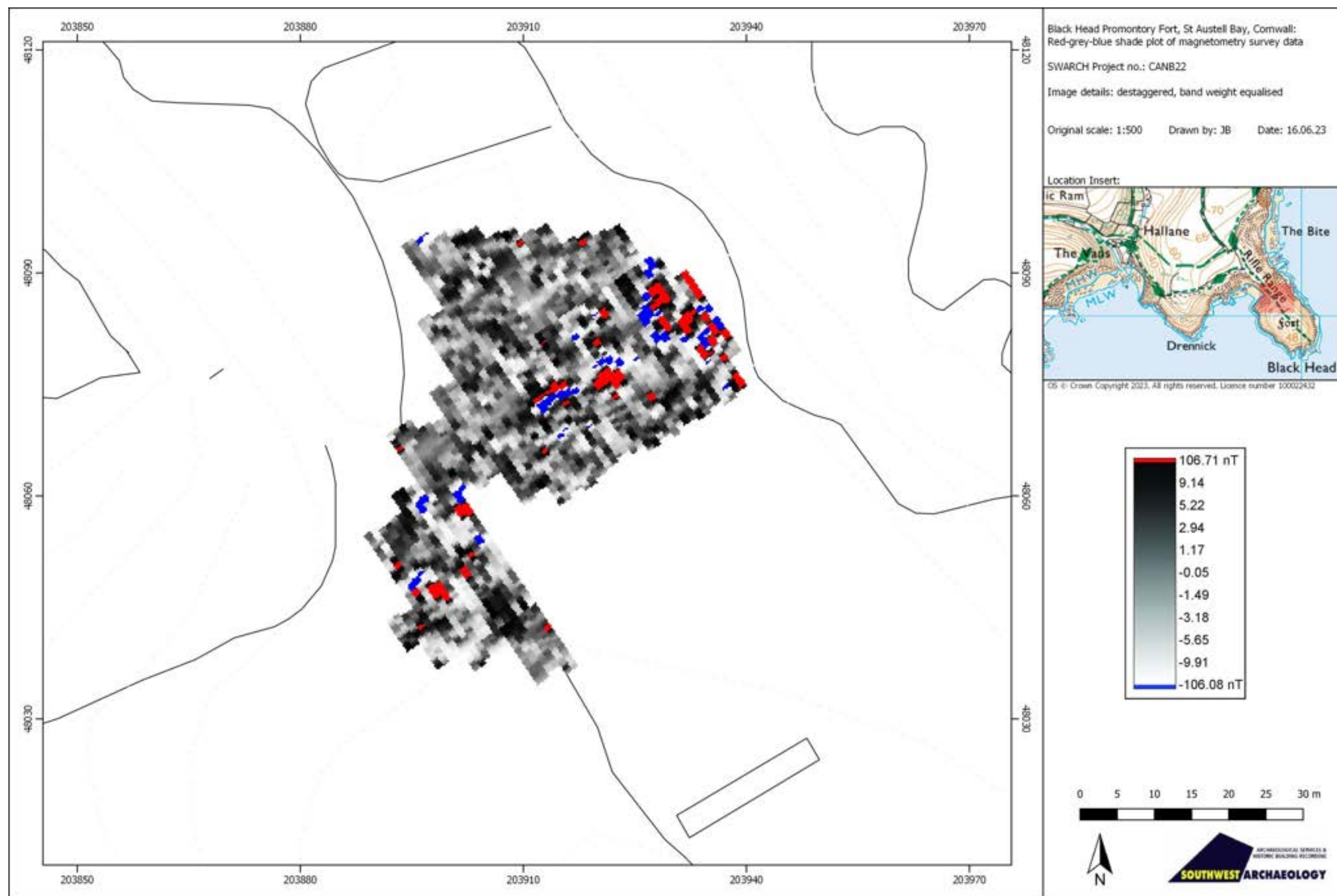


FIGURE 8: RED-GREY-BLUE SHADE PLOT OF MAGNETOMETRY SURVEY DATA; BAND WEIGHT EQUALISED.

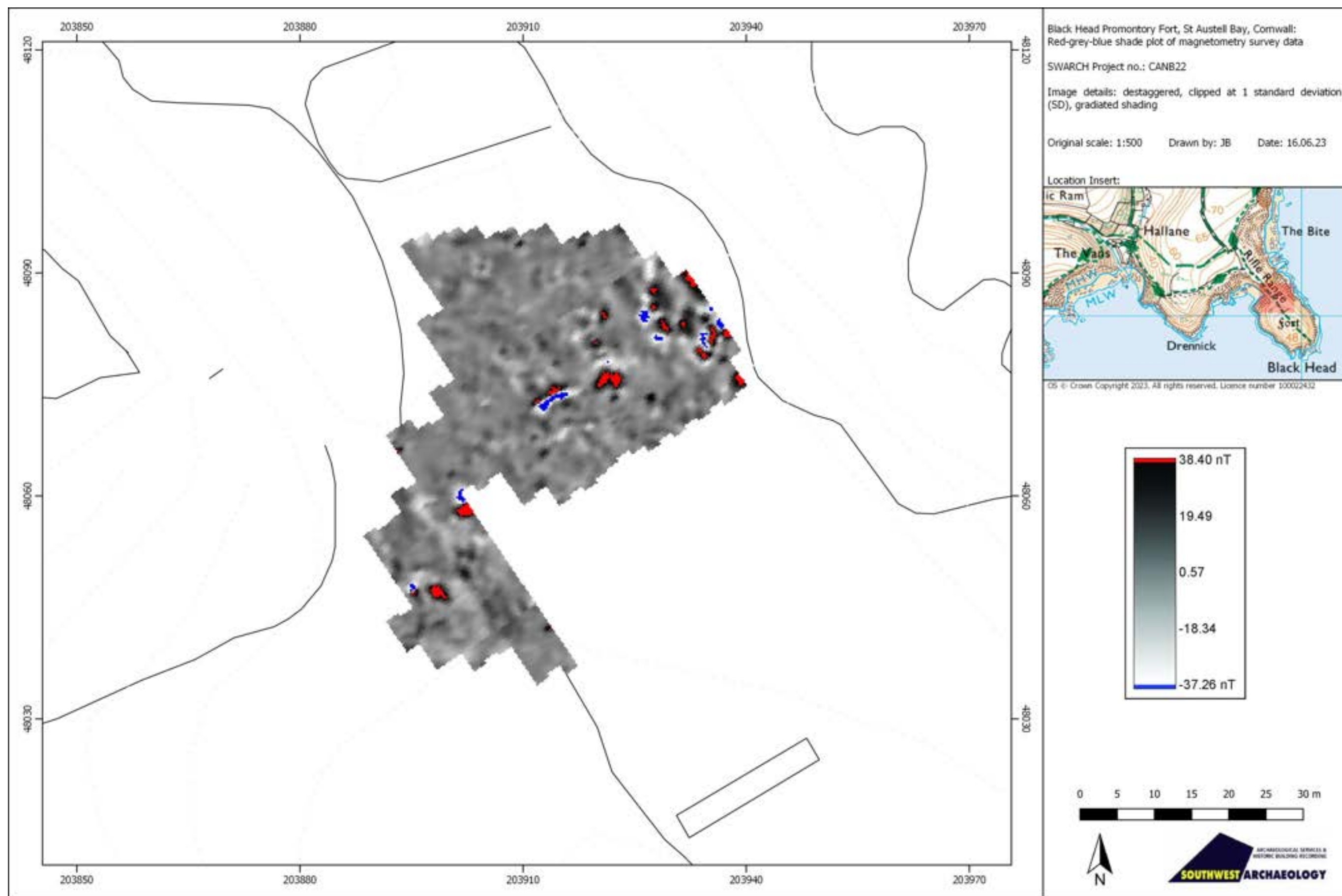


FIGURE 9: RED-GREY-BLUE SHADE PLOT OF MAGNETOMETRY SURVEY DATA; CLIPPED AT 1 STANDARD DEVIATION (SD); GRADIATED SHADING.

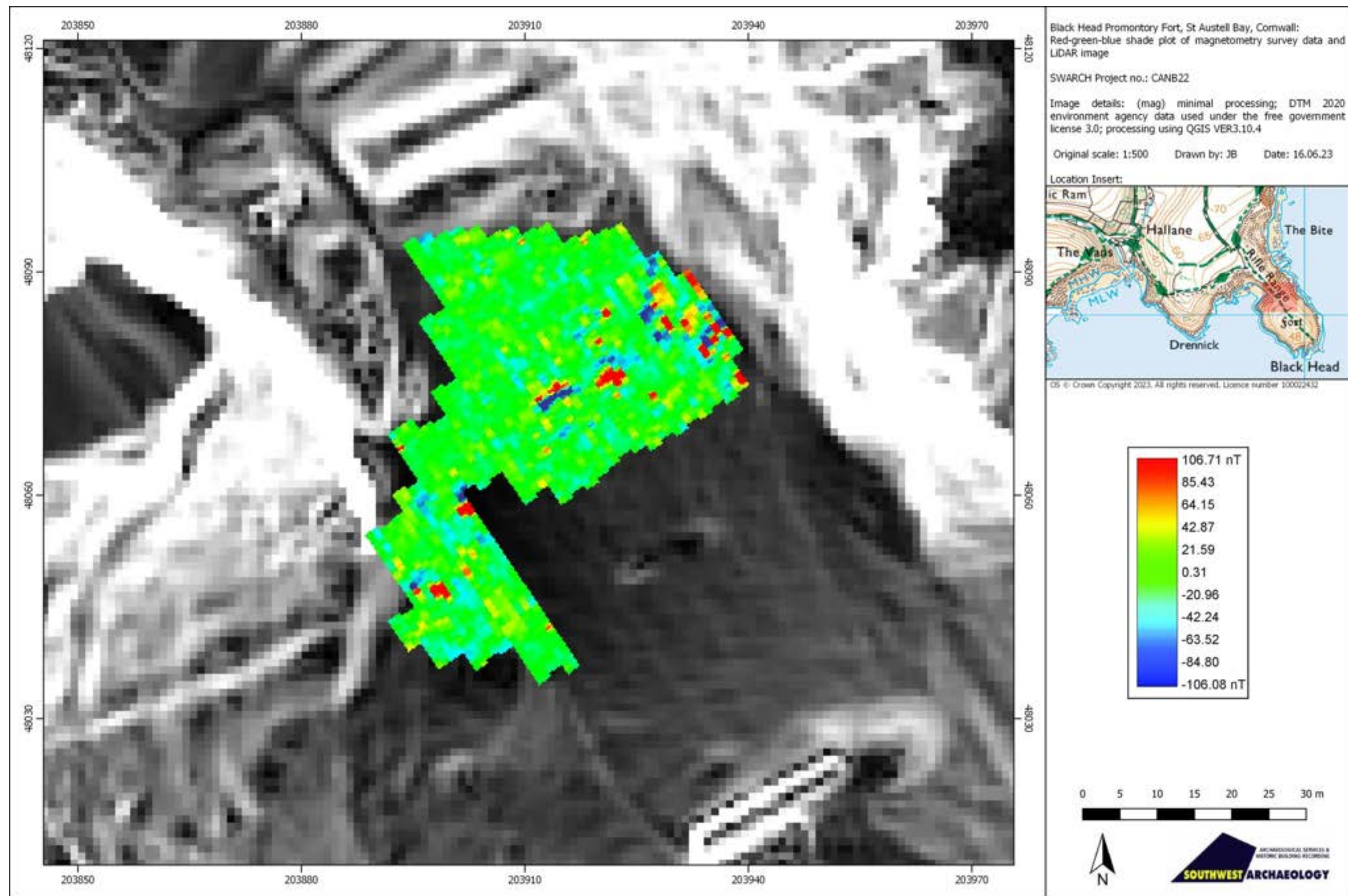


FIGURE 10: RED-GREEN-BLUE SHADE PLOT OF MAGNETOMETRY SURVEY DATA OVERLYING LIDAR IMAGE (DTM DATA SURVEYED 2020).

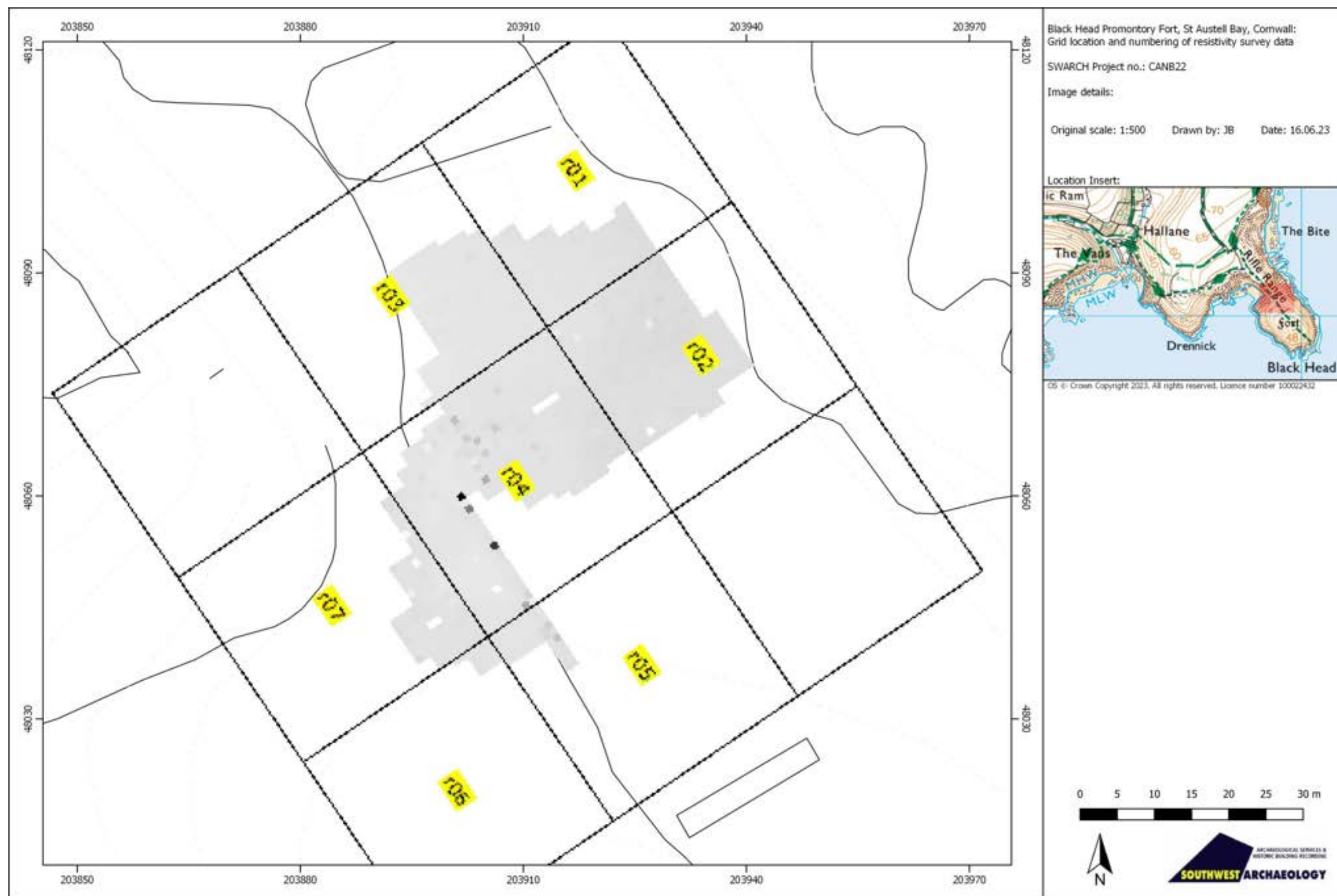


FIGURE 11: RESISTIVITY SURVEY GRID LOCATION AND NUMBERING.

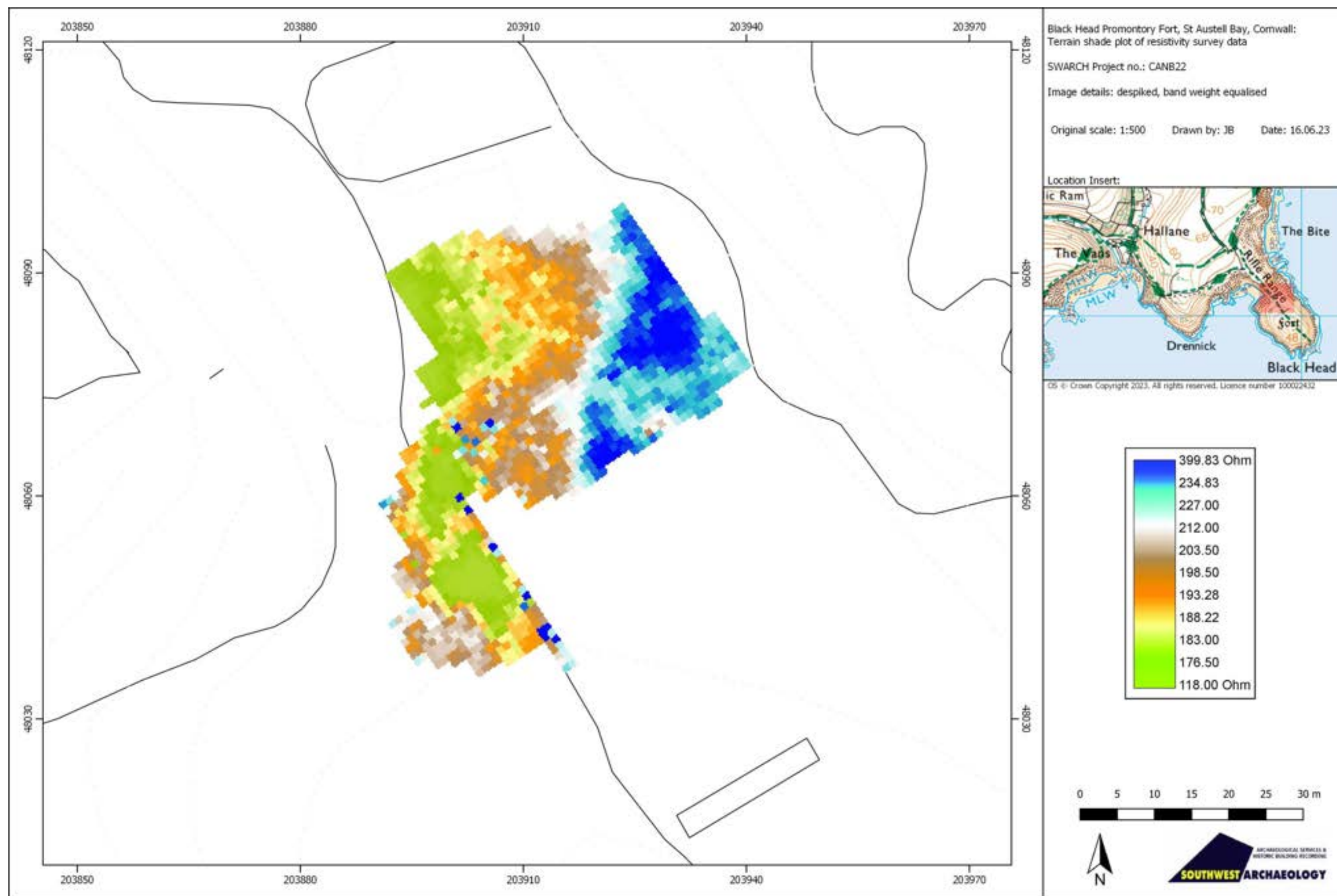


FIGURE 12: TERRAIN SHADE PLOT OF RESISTIVITY SURVEY DATA; DESPIKED ONCE; BAND WEIGHT EQUALISED.

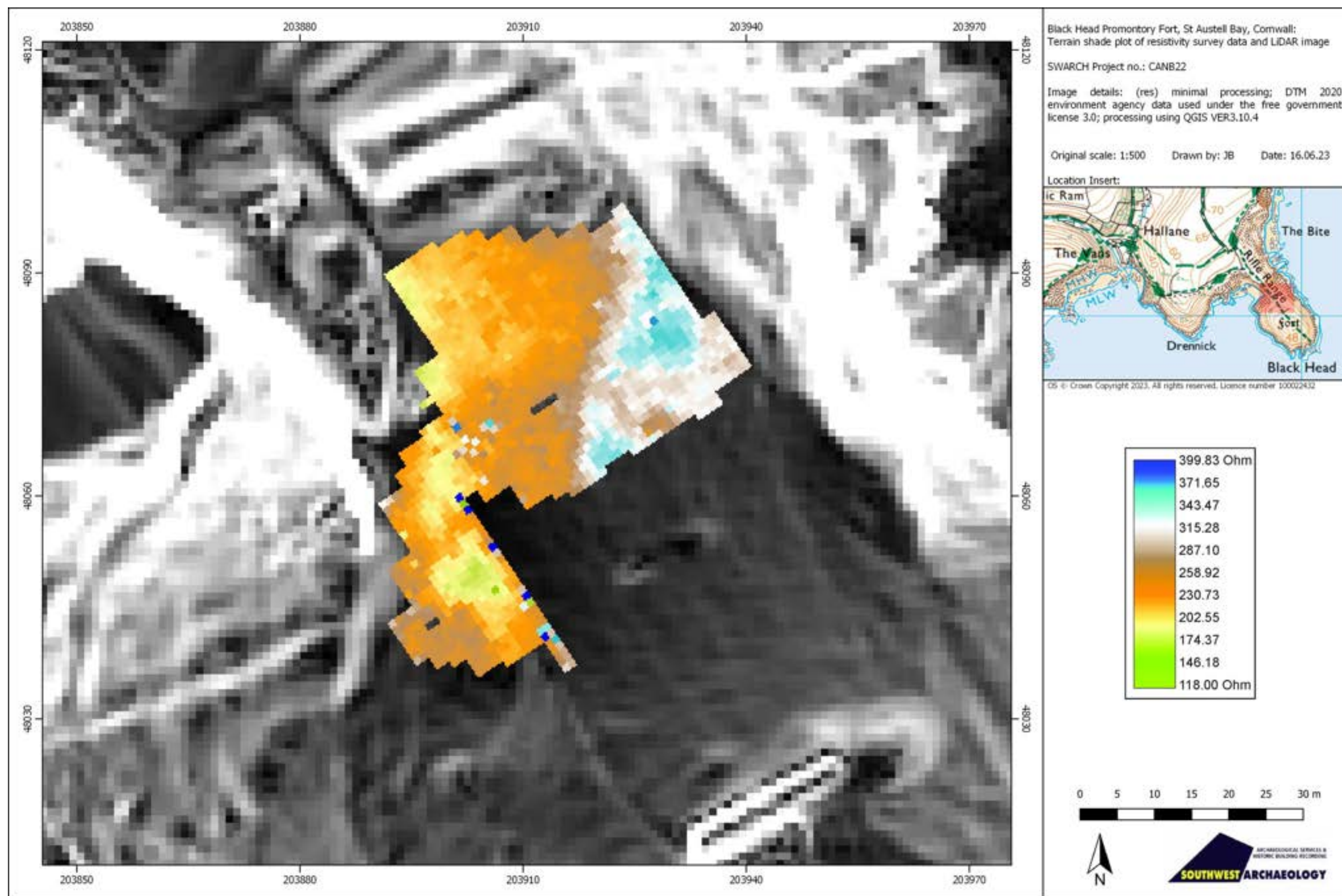


FIGURE 13: TERRAIN SHADE PLOT OF RESISTIVITY SURVEY DATA OVERLYING LIDAR IMAGE (DTM DATA SURVEYED 2020).

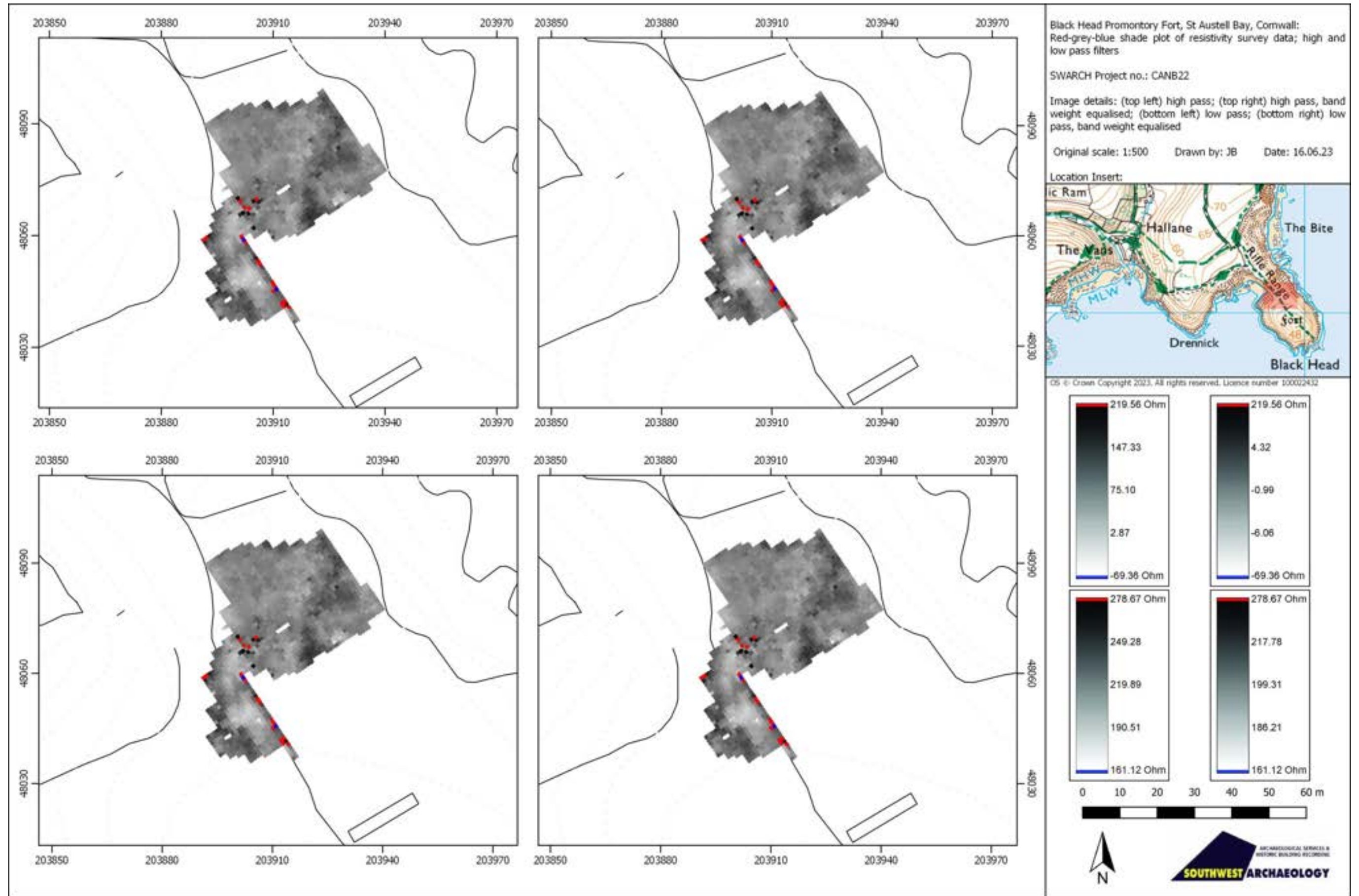


FIGURE 14: GREYSCALE SHADE PLOTS OF RESISTIVITY SURVEY DATA; HIGH- AND LOW PASS FILTER IMAGES.

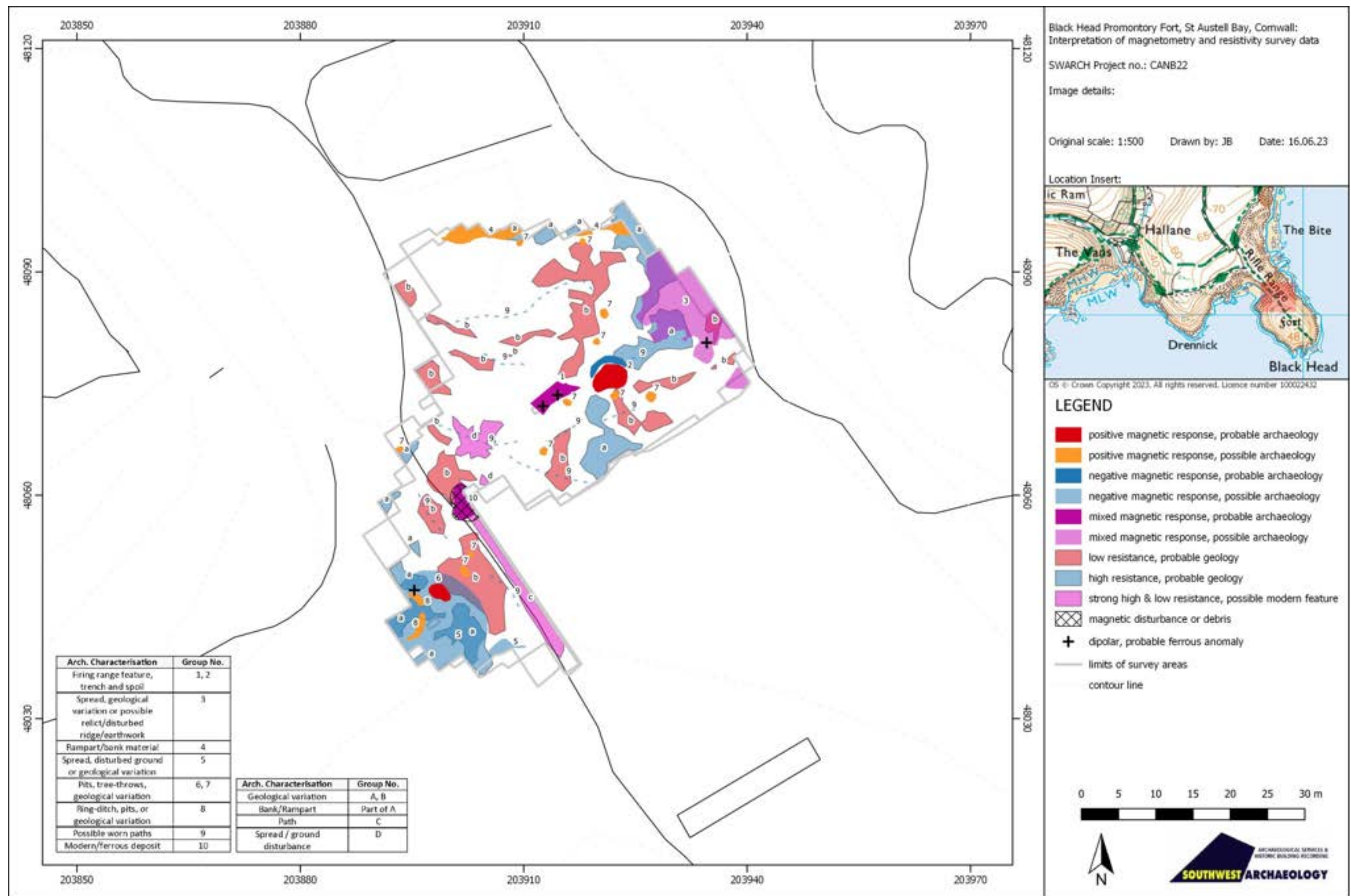


FIGURE 15: INTERPRETATION OF MAGNETOMETRY AND RESISTIVITY SURVEY DATA.

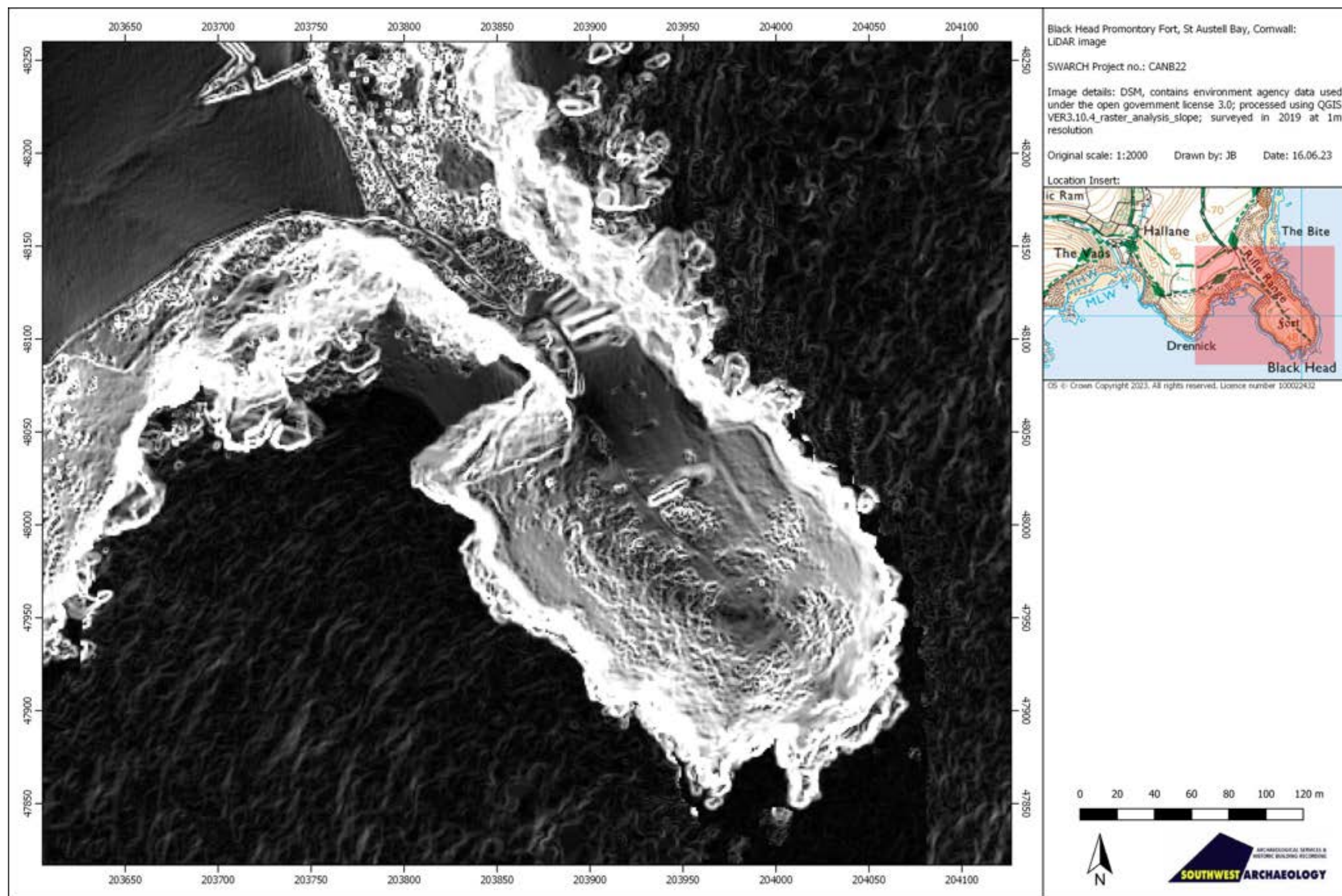


FIGURE 16: IMAGE DERIVED FROM LiDAR DATA; DSM SURVEYED 2019.

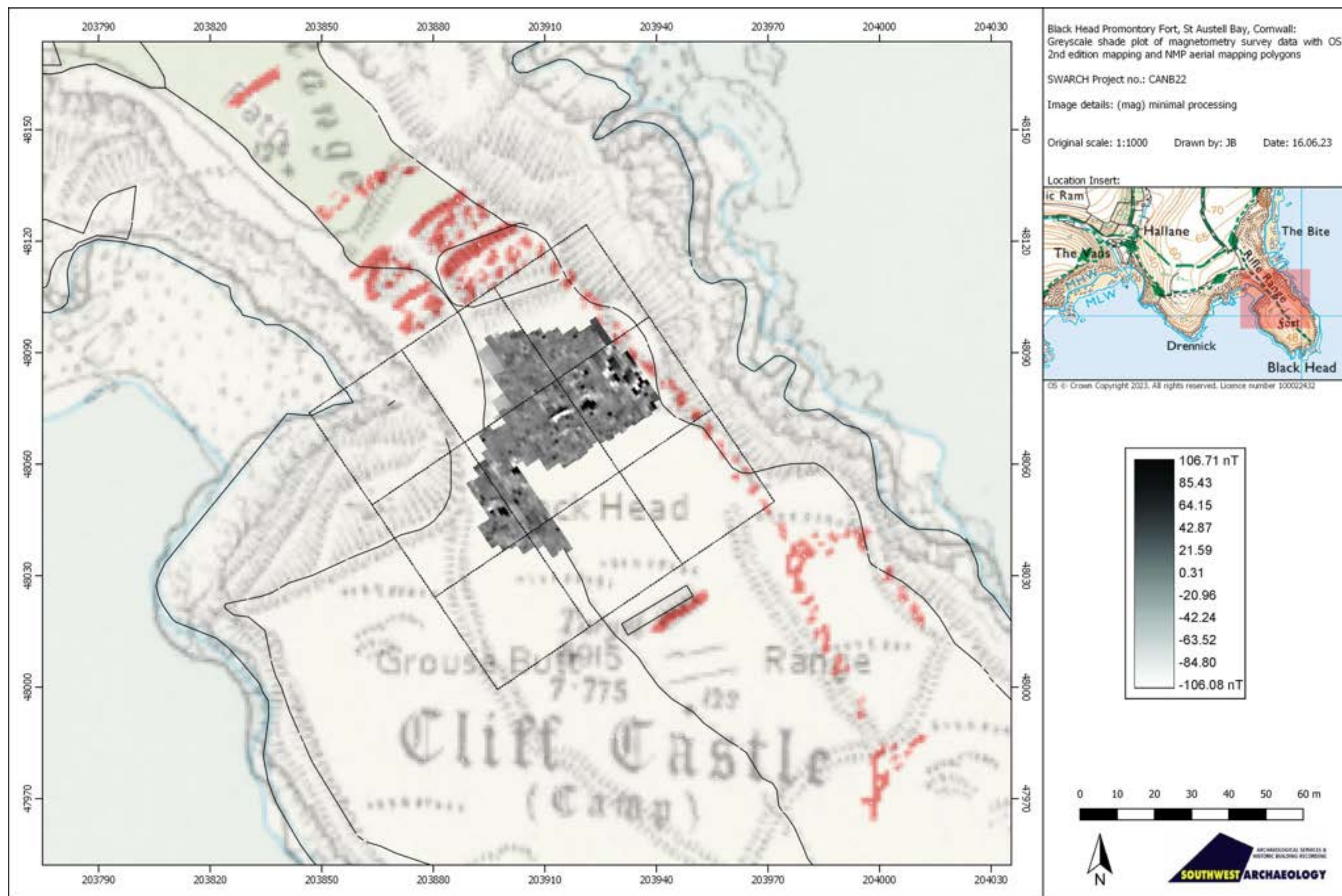


FIGURE 17: GREYSCALE SHADE PLOT OF MAGNETOMETRY SURVEY DATA OVERLYING OS MAPPING, PUBLISHED 1907, AND NMP MAPPING LINES/POLYGONS.

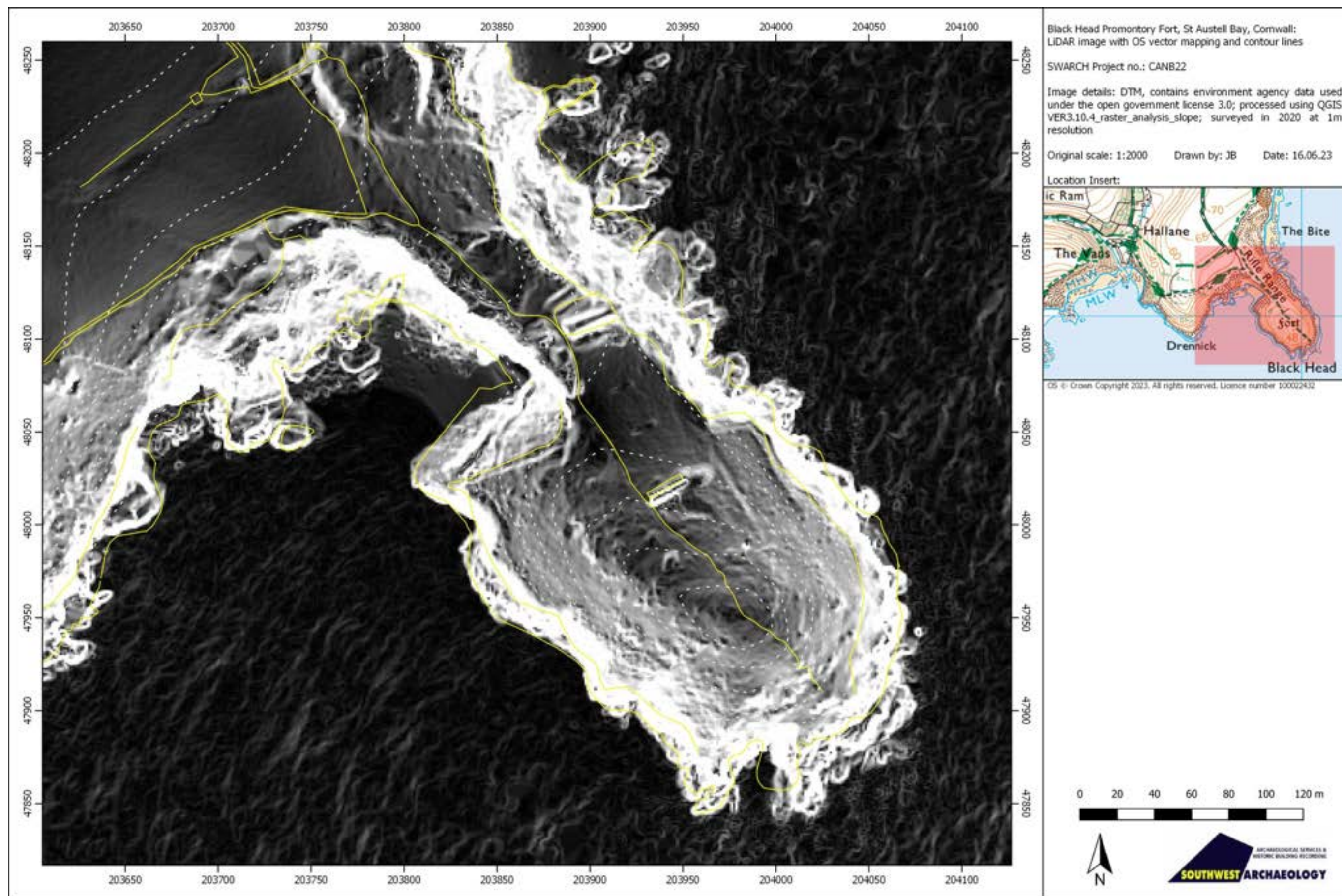


FIGURE 18: OS VECTOR MAPPING OVERLYING LIDAR IMAGE (DTM DATA SURVEYED 2020).

APPENDIX 2: SUPPORTING SOURCES



FIGURE 19: EXTRACT FROM THE SURVEYOR'S DRAFT MAP, c.1811; THE APPROXIMATE LOCATION OF THE SITE IS INDICATED (KK).





FIGURE 21: EXTRACT FROM THE ORDNANCE SURVEY 1ST EDITION, 25 INCH SERIES, PUBLISHED 1882; THE APPROXIMATE SURVEY AREA IS OUTLINED IN RED (NLS).



FIGURE 22: EXTRACT FROM THE ORDNANCE SURVEY 2ND EDITION, 25 INCH SERIES, PUBLISHED 1907; THE APPROXIMATE SURVEY AREA IS OUTLINED IN RED (NLS).

APPENDIX 3: SUPPORTING PHOTOGRAPHS



1. VIEW OF THE NORTH-WEST FACING SLOPE TO THE HILL NORTH OF THE BLACK HEAD HEADLAND, SHOWING EARTHWORKS; VIEWED FROM THE NORTH (NO SCALE).



2. VIEW OF THE BLACK HEAD HEADLAND FROM A NORTH-EASTERLY APPROACH ON THE SOUTH-WEST COAST PATH; VIEWED FROM THE NORTH (NO SCALE).



3. VIEW OF THE BLACK HEAD HEADLAND FROM A NORTH-EASTERLY APPROACH ON THE SOUTH-WEST COAST PATH; VIEWED FROM THE NORTH (NO SCALE).



4. VIEW OF THE BEACH ON THE WEST SIDE OF THE NECK OF THE PROMONTORY; VIEWED FROM THE SOUTH-EAST (NO SCALE).



5. EAST SIDE OF THE SURVEY AREA FROM THE RAMPARTS; VIEWED FROM THE NORTH-WEST (NO SCALE).



6. VIEW ALONG THE RAMPARTS ON THE NORTH EDGE OF THE SURVEY AREA; VIEWED FROM THE NORTH-EAST (NO SCALE).



7. VIEW ALONG THE TOP OF THE RAMPARTS ON THE NORTH SIDE OF THE SURVEY AREA; VIEWED FROM THE NORTH-EAST (NO SCALE).



8. THE RAMPARTS ACROSS THE NECK OF THE HEADLAND; VIEWED FROM THE EAST (NO SCALE).



9. VIEW ACROSS 'THE BITE', NORTH OF THE HEADLAND; VIEWED FROM THE SOUTH (NO SCALE).



10. BUMPY GROUND ON THE EAST SIDE OF THE SURVEY AREA; VIEWED FROM THE SOUTH-WEST (NO SCALE).



11. SPOIL AND TRENCH WITHIN SURVEY AREA; VIEWED FROM THE NORTH-WEST (NO SCALE).



12. HOLLOW AND BUMPY GROUND ACROSS NORTH-EAST QUARTER OF SURVEY AREA; VIEWED FROM THE SOUTH (NO SCALE).

APPENDIX 4: TECHNICAL SUMMARY TABLES OF SURVEY METHOD AND METADATA

TABLE 3: TECHNICAL SUMMARY OF MAGNETOMETRY SURVEY METHOD AND METADATA.

Site no.	Site Name	Site Type	Period	AONB Section
CANB22bh	Blackhead	Promontory Fort	Iron Age	9. South Coast - Central
Survey Type:	Magnetometry			
Equipment:	Twin sensor fluxgate gradiometer (Bartington Grad601) Leica CS15 GNSS Rover GPS			
Software:	Grad 601 - Version 3.16 TerraSurveyor - Version 3.0.36.0			
Instrument Settings / Parameters:	Survey Mode:	Grid Mode		
	Range:	100nT		
	Threshold:	2nT		
	Sensors:	2		
	Reject:	50 Hz		
Collection parameters:	Sample Intervals:	0.25m		
	Traverse Intervals:	1m		
	Traverse Pattern:	Zigzag		
	Traverse Direction:	South / 180°		
	Adjustment frequency:	0.5-1ha		
Survey Size Metadata:	Individual Grid Size	30m x 30m		
	Composite Area:	0.81ha / 90m x 90m		
	Area Surveyed:	0.16535ha		
Raw Response Metadata:	Max.:	100.00nT		
	Min.:	-100.00nT		
	Standard Deviation:	14.07nT		
	Mean:	-0.27nT		
	Median:	-0.82nT		
Processed Response Metadata: pre-clipping	Max.:	106.71nT		
	Min.:	-106.08nT		
	Standard Deviation:	12.61nT		
	Mean:	0.57nT		
	Median:	0.00nT		
Processes:	DeStripe all traverses, median			
	DeStagger all traverses out- and inbound by 0.50m (all Grids)			
	Clip at +/- 1SD (Standard Deviation)			

BLACK HEAD PROMONTORY FORT, ST AUSTELL BAY, CORNWALL: GEOPHYSICAL SURVEY RESULTS

TABLE 4: TECHNICAL SUMMARY OF RESISTIVITY SURVEY METHOD AND METADATA.

Site no.	Site Name	Site Type	Period	AONB Section
CAB22bh	Blackhead	Promontory Fort	Iron Age	9. South Coast - Central
Survey Type:	Resistivity			
Equipment:	Geoscan Research RM15-D Resistivity Meter with MPX15 multiplexer module Four sensor PA20 multprobe array system at 0.5m probe spacing Leica CS15 GNSS Rover GPS			
Software:	TerraSurveyor - Version 3.0.36.0			
Instrument Settings:	Survey / Log Mode:	Parallel Twin Log Mode 2		
	Gain:	x1		
	Current:	1 mA		
	Frequency:	137 Hz		
	Output Voltage:	40 V		
	Auto-log Speed:	Medium		
	High Pass Filter:	13 Hz		
	Mains Frequency:	50 Hz		
	Hardware:	PA5		
	Interface:	MPX15		
	Log Mode:	Parallel Twin		
	# Parallel Reads:	2 (4P)		
	Baud Rate:	9600		
	Collection parameters:	Sample Intervals:	1m	
Traverse Intervals:		1m		
Traverse Pattern:		Zigzag		
Traverse Direction:		South / Grid North / 0°		
Remote Probe Spacing:		Between 0.5m and c.1.5m		
Survey Size Metadata:	Individual Grid Size	30m x 30m		
	Composite Area:	0.81ha / 90m x 90m		
	Area Surveyed:	0.1646ha		
Raw Response Metadata:	Max.:	1815.50 Ohm		
	Min.:	9.00 Ohm		
	Standard Deviation:	61.07 Ohm		
	Mean:	206.80 Ohm		
	Median:	199.00 Ohm		
Processed Response Metadata:	Max.:	399.83 Ohm		
	Min.:	118.00 Ohm		
	Standard Deviation:	24.15 Ohm		
	Mean:	203.96 Ohm		
	Median:	199.00 Ohm		
Processes:	DeSpike threshold 1 window size 3×3, once			
	High Pass filter with Gaussian weighted window 21x21 intervals			
	Low Pass filter with Gaussian weighted window 3x3 intervals			



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