ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of
Tees Archaeology

Seaton Carew Saltern
North Gare
Hartlepool

post-excavation assessment

report 6193.v3
July 2025

Contents

Photographs

Figures

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1. Summary

The project

1.1 This report presents the results of a topographic survey, geophysical survey and archaeological excavation conducted at North Gare, Hartlepool. The works were undertaken as a community archaeological project on behalf of Tees and as part of the National Lottery Heritage funded 'SeaScapes' project. The works comprised topographic survey, geophysical survey (magnetometer and earth electric resistance) and excavation.

1.2 The works were commissioned by Tees Archaeology and conducted by Archaeological Services Durham University, Tees Archaeology, and volunteers.

Results

Earthwork survey

1.3 The topographic survey recorded a mound, an earth bank at the western edge of the survey area, and a dry river inlet to the east thought to relate to a medieval saltern. An earth bank on the eastern edge of the survey area is probably related to the modern car park.

Geophysical survey

1.4 Anomalies reflecting probable burnt ash and other industrial waste deposits including slag, clinker, and possible brick rubble, have been detected broadly coextensive with the mound.

1.5 Possible structural elements have been identified, including possible kerbs, and salt pans. An earth bank, of uncertain age and purpose, has been detected in the west of the survey area.

1.6 Natural variation typical of wetland environments has been detected across the survey area. Occasional small areas of disturbed ground have been identified beyond the mound.

Excavation

1.7 Three trenches were excavated. Laminated deposits and layers of soil were recorded in trenches 1 and 2 forming the upper part of a mound; the base of the mound was not reached. These were interpreted as being waste deposits from the 'sleeching' process during salt production. Industrial residue was present in several of the deposits, including a large quantity of fuel ash slag, too large for domestic debris, which could also be related to salt production. Briquetage was however absent, which is unusual for this type of site.

1.8 Bromine was also recorded within some of the industrial residues, potentially indicating they had been in contact with salt water. The samples comprise deposits of coal and cinder with some having large amounts of burnt concreted material possibly consistent with saltern waste residues. There are also assemblages of marine and brackish-water molluscs alongside a few fish bones. Charred plant macrofossils are absent and there are only traces of charcoal. Based on the palaeoenvironmental evidence there is nothing diagnostic in terms of dating the features, although the predominance of coal waste is consistent with a medieval or later date and may reflect the importance of this fuel for the industrial activity undertaken at this site.

Recommendations

1.9 There is scope for further archaeological work at the site, particularly focused on exposing the full depth of the mounds and any areas relating to possible structural remains of the salterns.

2. Project background

Location (Figure 1)

2.1 The site is located at North Gare, Hartlepool (NGR centre: NZ 53190 28177). It covers an area of approximately 0.76ha. It is situated within Seaton Carew Common and is bounded by marsh land to the north and west, North Gare Road with further marsh land beyond to the south, and a car park with a golf course, sand dunes and North Gare Beach beyond to the east.

Project background

2.2 The works were undertaken as part of the National Lottery funded 'SeaScapes' Tyne to Tees, shores and seas project that aims to deliver 23 projects which will enhance the natural, cultural and built heritage of the Durham Heritage Coast, increasing its understanding and engagement with local communities.

Objective

2.3 The objective of the project was to:

- identify, excavate and record significant archaeological features identified during excavation
- understand the site
- to determine if there is evidence of structures relating to a medieval saltern
- to date the last use of the site
- to engage local people and volunteers with the project, including those who are new to archaeological excavation

Research objectives

2.4 The updated regional research framework *North-East Regional Research Framework for the Historic Environment* (NERRF 2.0) (https://researchframeworks.org/nerf/ accessed 26-09-2024) contains an agenda for archaeological research in the region. The scheme of works was designed to address agenda items:

- MD5: How can we better understand other medieval industries?
- MD6: How can we better understand medieval trade and economy?

Specification

2.5 The works have been undertaken in accordance with a Project Design provided by Tees Archaeology, a Methods Statement provided by Archaeological Services Durham University and national standards and guidance.

Dates

2.6 Fieldwork was undertaken between 23rd and 27th September 2024. This report was prepared for December 2024, and revised in July 2025.

Personnel

2.7 Fieldwork was conducted by local volunteers supervised by Jeffrey Lowrey, Dr Ronan O'Donnell and Richie Villis (Archaeological Services Durham University) and Dr Emma Watson (Tees Archaeology).

2.8 The volunteers involved in the project were Steve Walker, Clifford Cordiner, Angela Jobson, Debra Willison, Sandra Anderson, Richard Betts, Kristian Myer, Judith Arber, Natalie Hall, Paul Shannon, Maria Shannon, Peter Smart, Walter Flanagan, Lee Harrison, Terry Jones,

Susan Adamson, Morris Adamson, Graham Hall, Alan Newham, Paul Vincente, Mark Featherstone and Karen Featherstone.

2.9 This report was prepared by Jeffrey Lowrey, Natalie Swann and Richie Villis, with illustrations by David Graham and Dr Helen Drinkall. Specialist reporting was conducted by Dr Louisa Gidney (animal bone); Jemima Cowey and Dr Emily Williams (pXRF and SEM-EDX analysis), Jennifer Jones (other artefacts), Dr Carrie Armstrong (palaeoenvironmental), and Richie Villis (earthwork and geophysical survey). The Project Manager for Archaeological Services was Natalie Swann, the project was directed by Dr Emma Watson of Tees Archaeology.

Archive/OASIS

2.10 The site code is **SCS24**, for **S**eaton **C**arew **S**altern 20**24**. The archive is currently held by Archaeological Services Durham University and will be transferred to Tees Archaeology in due course. The palaeoenvironmental residues were discarded following examination. The flots and charred plant remains will be retained at Archaeological Services Durham University. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-528436**.

Acknowledgements

2.11 Archaeological Services Durham University is grateful for the support of Hartlepool Borough Council, Jenny Swainston (SeaScapes Delivery Manager) and the assistance of Joe Campbell (tenant) and the volunteers in facilitating this scheme of works.

3. Landuse, topography and geology

3.1 At the time of the works, the study area comprised low lying marsh land with varying densities of vegetation.

3.2 The average elevation of the site was between 1.9m OD and 2.2m OD. The base of the earthwork mound sat at between 2m OD and 2.8m OD, rising to 4.2m OD at the top of the mound.

3.3 The underlying solid geology of the area comprises Permian and Triassic strata of the Sherwood Sandstone Group, which are overlain by Tidal Flat Deposits of sand, silt and clay from the Quarternary period (www.bgs.ac.uk). The soil is characterised as 'Soilscape 21: Loamy and clayey soils of coastal flats with naturally high groundwater' (www.landis.org.uk/soilscapes).

4. Historical and archaeological background

Previous archaeological works

4.1 No previous archaeological work has taken place on the site.

The prehistoric and Roman periods (up to 5th century AD)

4.2 There is no direct evidence of prehistoric or Romano-British activity on the site, though the surrounding area was exploited in prehistory. Archaeological work on the coast and at Seaton Common has recorded peat deposits possibly associated with the Hartlepool Submerged Forest (HER 1603) that dates from around 4000 to 8,000 BC. Significant prehistoric and Romano-British settlements have been excavated to the west of Hartlepool at Catcote (HER 3458) and Brierton (HER 649) which suggest that the surrounding land is likely to have been managed in the period.

4.3 It has been suggested that there was a small trading post in the area to the north of Seaton Carew due to occasional finds of Roman period artefacts from the beach (i.e. HER 242, HER 801, HER 660). The Iron Age settlement at Catcote (HER 3458), 4km to the north-west, continued in use into the Roman period and Roman material has been recovered from there.

The medieval period (5th century to 1540)

4.4 There is no record for early medieval settlement at Seaton Carew, although the place name originates in the period. Seaton combines the Old English sǣ (sea) and tūn (enclosure; a farmstead; a village; an estate) meaning 'Sea farm/settlement' (http://kepn.nottingham.ac.uk). The Carew element is a later addition associated with Robert de Carew, who held land in Owton in the reign of Henry I (r.1100-1135, Watts 2002, 109).

4.5 Setone (Seaton Carew) (HER 952) is first recorded between AD 1146 and 1151 when Robert de Brus held 90 acres of demesne land there which had previously been in the field of Owton (Page 1928, 367). De Brus is also recorded as giving a chapel at Seaton and its mother church at Stranton to Guisborough Abbey. Seaton is mentioned in 1189 when Peter Carew held it and Owton for one knight's fee (Ibid.). The grange or manor house at Owton was the seat of the Belasyses and Salvins and was to the west of the site (Surtees 1823, 132). Medieval field systems are recorded approximately 750m west (HER 475) and 450m north-west (HER 4832).

4.6 A chapel is mentioned at Seaton in AD 1200 (HER 780) when a chantry was granted to Walter de Carew. The chapel was dedicated to St. Thomas of Canterbury. The chapel was still in existence between 1577-88 but was in ruins by 1622, although still recognised as a chapel in 1646 (Page 1928, 376). There is no firm evidence of the location of the chapel; anecdotal evidence suggests that a site to the south of the village might be likely. In 1953 Mr. Dearlove, the green keeper at Seaton Golf Club, gave testimony to E. Geary that 'the previous green keeper, now dead, said that the old chapel stood in the hollow behind the 4th green, 1km north of the site. He made no mention of any remains having been found there, and I have made no discoveries in the area'. This local knowledge was echoed by Canon Booth, the vicar in 1953, 'It is said that the chapel of Seaton stood on that part of the sand dunes now occupied by the golf course, but I cannot give definite sources of information'. These accounts concord with a legend on the 1857 Ordnance Survey edition map on Seaton Dunes which reads 'Chapel Open' adjacent to a small break in the dune system.

4.7 Medieval field systems are recorded near the site. 700m west of the site a field of ridge and furrow (HER 4745) was identified during a rapid desktop assessment of Seaton Common (Rowe 1999). The ridge and furrow has been truncated to the west by Tees Road and subsequent redevelopment of land. To the east of Tees Road an unusual crescent of ridge and furrow survives, likely land reclaimed from the marsh which lies slightly higher than the surrounding area.

4.8 A second complex of ridge and furrow (HER 4832) was recorded 500m north of the site during the same rapid assessment (*ibid*). It lies on the eastern edge of Seaton Common and consists of a block of ridge and furrow aligned north/south, abutted by a second block to its east aligned east to west.

4.9 The medieval village at Seaton Carew (HER 952) is first recorded between 1146 and 1151 AD when Robert de Brus held lands here. The medieval village was on the coast to the north of the site and probably comprised four rows of cottages around a central square on the site of The Green. The village would have been surrounded by agricultural land.

4.10 Records associated with the landowners during the medieval period provide evidence for landuse, settlement and industry. Around 1387, Isabel Umphraville is recorded as holding in dower eight messuages (dwelling houses), twelve cottages, seventeen salt pits, 200 acres of arable, and twelve acres of meadow in Seaton Carew. She also retained a life interest in four further messuages, four oxgangs and an additional four salt pits (Page 1928, 367). Salt pits are again recorded in the manor in Inquests of 1421 to 1439 (Surtees 1823, 131). Seaton Carew had an important salt production industry. Due to competition from Tyneside the industry declined towards the end of the medieval period.

4.11 The Tees Archaeology Historic Environment Record (HER) records 21 possible salterns or waste mounds (HER 1637-1658) on Seaton Common, including the two that are the subject of this report (HER 1646, HER 1647). A further 26 are recorded 3km to the south-west at Greatham (HER 1712-1738). Evidence for saltern mounds has also been recorded 4km south-west of the site at Greatham (Archaeological Services 2018).

The post-medieval period (1541 to 1899)

4.12 Saxton's 1576 map of Durham records Seton (Seaton Carew) as a minor settlement located close to the coast. The site would have been on land to the west of Seaton, although the scale of the map does not detail the area.

4.13 The manor of Seaton Carew remained divided between several owners through the 17th and 18th centuries; recorded amongst the owners were the Andersons and the Dents. In 1755 John Dent was part owner of the Seaton Carew manor and some ten years later was a claimant to the manor along with Robert Preston (Page 1928, 367).

4.14 In 1874 the Durham and Yorkshire Golf Club founded a 14-hole course on the eastern parts of Seaton Common (HER 5508), north-east of the site. The course was later expanded to 18 holes and the club renamed Seaton Carew Golf Club in 1887.

The modern period (1900 to present)

4.15 In May 1940 General Ironside was appointed as Commander-in-Chief of the Home Forces. His first task was to develop a strategy to defend the nation against a German invasion. The area around Hartlepool was suitable for invasion by beach landing, particularly at Hart Warren, North Sands and Seaton Carew, and as a result this area was heavily defended with pillboxes, anti-tank ditches, obstacles and minefields. Most of these defences have been lost to coastal erosion, encroaching of dunes, and post-WWII development. The closest surviving examples to the site include a line of anti-tank cubes running parallel to the coast between the North Gare Breakwater and Seaton Carew (HER 1011). The line is now partly buried by shifting dunes but was visible on aerial photographs in 1948, and partly in 1971. A pillbox survives on the coast at Seaton Sluice Jetty (HER 977).

5. The earthwork survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geospatial Survey Specifications for Cultural Heritage* (Andrews *et al*. 2024).

Field methods

5.2 The survey was conducted using Leica Viva GS15 global navigation satellite systems (GNSS), with real time kinematic (RTK) correction, typically providing locational accuracy of 10mm. The GNSS receiver was used to take points to define features at intervals of 0.10-1.5m, as appropriate to the earthworks being recorded. The survey recorded the top and base of earthworks, breaks of slope, and any apparent variations or erosion. Profiles were also recorded across the probable saltern mound.

5.3 Breaks of slope are shown planimetrically on Figure 8. Profiles are shown on Figure 6. 3D visualisations of the mound overlain with the geophysical survey data (discussed below) have also been provided (Figure 5).

Results

5.4 An irregular oval mound has been recorded, presumed to be the remains of a saltern or other coastal industrial practices (**E1**; Photo 1). The mound is broadly oval in plan, with its longest axis approximately 42m aligned broadly east-north-east/west-south-west. North-north-west/south-south-east the mound is approximately 22m at its widest point, which is slightly east of centre. The crown of the mound is east, and very slightly south, of centre. The crown is aligned more north-north-west/south-south-east than the base, and measures approximately 16m x 10m. The whole mound rises from approximately 2.27m at its north to a crown height of approximately 4.22m. The western part of the mound was a gentler slope and slightly stepped. On the northside the slope of the mound shouldered slightly northwards.

5.5 To the west of the mound was a shallow channel, visibly waterfilled in Google Earth aerial photographs. This is bound on the west side by an earth bank, approximately 11m wide and up to 0.70m high (**E2**; Photo 2). The bank was aligned north-north-east/south-south-west. This bank separates two channels visible in the LiDAR data and aerial photographs and extends to the north and south of the survey area to a total length of 135m. It is possible that this feature represents a land boundary, or it may be spoil from the excavated channel possibly related to the saltern mound, perhaps as a source or storage of salt water.

5.6 A second, dendritic channel has been recorded to the east of the mound (**E3**; Photo 3). This also extends southwards beyond the surveyed area but got gradually shallower before petering out to the north. This channel is approximately 12m from bank to bank and has a shallow U-shaped profile, approximately 0.7m at its deepest point. A series of narrower dendritic channels opened out from the main trunk. This almost certainly is a naturally occurring seasonal water-channel/stream, which was dry at the time of survey. It is possible that this now dry stream was used as a source of water for the saltern.

5.7 A mound was noted in the east of the area, along the edge of the car park. This was visually assessed and deemed to be related to the construction of the car park and therefore of limited to no archaeological interest. Due to time-constraints during the survey this was not recorded.

6. The geophysical survey

Standards

6.1 The surveys and reporting were conducted in accordance with the Chartered Institute for Archaeologists (CIfA) *Standard and Guidance for archaeological geophysical survey* (2020); the *EAC Guidelines for the Use of Geophysics in Archaeology* (Schmidt *et al*. 2016); and the Archaeology Data Service & Digital Antiquity *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2013).

Technique selection

6.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

6.3 In this instance, based on the expected presence of a probable medieval saltern, it was considered likely that a variety of features including hearths, temporary structures, access ramps, pottery, clay brining pits and lead-lined pans would be present on the site.

6.4 Given the anticipated nature and depth of targets, and the non-igneous geological environment of the study area two complementary techniques, fluxgate gradiometry and earth electrical resistance, were considered appropriate for detecting the types of feature mentioned above.

6.5 Fluxgate gradiometry is a magnetic technique with involves the use of magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

6.6 Earth electrical resistance survey can be particularly useful for mapping stone and brick features. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

Field methods

6.7 A 20m grid was established across the survey area and related to the Ordnance Survey (OS) National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

6.8 Magnetic gradient measurements were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was effectively 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 1,600 sample measurements per 30m grid unit.

6.9 Measurements of earth electrical resistance were determined using a Geoscan RM15D Advanced resistance meter with MPX15 multiplexer and a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was 0.05ohm, the sample interval was 1m and the traverse interval was 1m, thus providing 400 sample measurements per 20m grid unit.

6.10 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

6.11 Geoplot v.4 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. Trace plots of the data were examined but are not presented in this report. The greyscale images and geophysical interpretations are presented in Figures 2 and 3; archaeological interpretations are presented in Figure 4. In the greyscale images, positive magnetic/high resistance anomalies are displayed as dark grey and negative magnetic/low resistance anomalies as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm, as appropriate.

6.12 The following basic processing functions have been applied to the magnetometer data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also, generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
de-stagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
de-spike	locates and suppresses iron spikes in gradiometer data
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

6.13 The following basic processing functions have been applied to the resistance data:

add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges
de-spike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

6.14 Colour-coded geophysical interpretation plans are provided. One types of magnetic anomaly has been distinguished in the data:

dipolar magnetic paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and utilities) and/or fired structures such as kilns or hearths

6.15 Two types of resistance anomaly have been distinguished in the data:

high resistance regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble

low resistance regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

6.16 A colour-coded archaeological interpretation plan is provided (Figure 4). For ease of reference, anomaly labels shown bold in the text below (e.g. **G1**, **G2**, etc) are also shown on the archaeological interpretation plan.

6.17 A concentration of relatively strong dipolar magnetic anomalies has been detected broadly coextensive with the probable saltern mound (**G1**; **E1**). These almost certainly reflect fired waste and other burnt material, including possible industrial ash and clinker and fired clay like brick or other ceramics. These correspond to high resistance anomalies, which almost certainly represent the mound material itself, including probable free-draining sands and gravel as well as brick-rubble and other industrial waste. Some of these anomalies could also reflect *in situ* burnt features, such as hearths or kilns.

6.18 An intense magnetic anomaly (**G2**) has been detected broadly defining the south-western extent of the mound and extending into the channel to the north-west. This could possibly reflect brick kerbing or another brick structure, or possibly a layer of metal slag or other industrial waste. There is no obvious corresponding high-resistance anomaly, as would usually be expected with a brick wall or structure. In this instance the resistance anomalies defining the mound are slightly weaker here, with some higher spikes probably from probe contact with near-surface gravel and rocks. A single narrow linear anomaly detected in the resistance data could possibly represent a kerb or other structure (**G3**).

6.19 Occasional narrow linear resistance anomalies have been detected across the mound, on the north-western edge of the crown and on the north-eastern shoulder (**G4**). These could possibly represent the remains of structural elements, such as walls or kerbs, or possibly brick lined pits or saltpans.

6.20 An elongated oval area of lower resistance has been detected on the crown of the mound (**G5**); this could possibly represent a pit of hollow in the mound material which could possibly be related to salt production.

6.21 The channel to the west of the mound corresponds to an area of much lower resistance, which is typical of waterlogged ground. The ground here was noticeably wetter than across the mound during survey. The bank (**E2**) bordering the channel is higher resistance (**G6**) than the surrounding ground, as would be anticipated by upcast material above the waterlogged deposits. The dipolar magnetic anomalies detected here almost certainly reflect the adjacent Heras fencing rather than below ground features associated with the bank. There is no evidence in the geophysical survey data of possible palisading, nor can any conclusions be drawn from the data alone to the specific nature/purpose of this mound.

6.22 Occasional smaller concentrations of dipolar magnetic anomalies have been detected beyond the extent of the mound (e.g. **G7**). These almost certainly reflect small collections of industrial waste or burnt/ferrous material, possibly related to the mound.

6.23 Beyond the mound the magnetic data is characterised by swirling weaker dipolar magnetic anomalies. These types of anomalies are typical of drained wetland environments and almost certainly reflect natural variation in the underlying soils. No distinct anomalies have been detected apparently related to the dendritic gully to the south-east of the mound.

6.24 The only other anomalies detected here are small, discrete dipolar magnetic anomalies. These almost certainly reflect near-surface items of ferrous and/or fired debris, such as horseshoes and brick fragments. Magnetic anomalies detected on the north-eastern and south-western edges of the survey area correspond to the adjacent Heras fencing.

7. The excavation

Introduction

7.1 Initially 5 trenches were planned based on the results of the geophysical survey. Due to time and weather constraints only three trenches were excavated. Trenches 1 and 2 targeted geomagnetic anomalies within a circular mound, believed to have been part of a medieval saltern, and trench 3 targeted geomagnetic anomalies immediately south of the mound. All trenches were hand excavated by volunteers. Context data is summarised in Table 1.1. Trench plans and sections are given in Figures 8-9.

Trench 1 (Photo 4)

7.2 This trench was excavated to a maximum depth of 0.66m. The earliest deposit reached was a dark purple-grey sandy silt with frequent fragments of coal [13: 0.23m long, 0.41m wide, depth unknown], recorded at the north-west corner of the trench. Overlying this was an orange-grey silty sand containing shell and a sherd of medieval pottery [12: over 1.22m long by over 1.05m wide, 0.08m deep]. Both deposits probably resulted from the 'sleeching' process of salt production (see 10.7 below for further discussion).

7.3 Above this was a compact layer of iron slag [F6=F9: over 1.18m long by over 0.64m wide, over 0.1m thick: Photo 5], indicating that industrial activities other than salt making have also been practiced on the site; this deposit was left *in situ*. This was overlain at the east end of the trench by orange silty sand with frequent flecks of coal [5: over 2.5m long by over 1m wide, 0.12m deep]. Above this was a light grey-brown sandy silt loam [4: all trench, 0.29m deep]. Over this was a dark brown-grey topsoil [3: 0.1m-0.2m deep], from which a shotgun cartridge and a fragment of clay tobacco pipe were recovered.

Trench 2 (Photo 6)

7.4 This trench was excavated to a maximum depth of 1m. The earliest deposit reached was within a small sondage (Photo 7) at the south-west corner of the trench, comprising a light brown sandy clay silt [22: over 0.87m long by over 0.38m wide, over 0.24m deep]. Above this was a dark grey deposit of compact silt, slag and fuel ash slag (FAS) which spread across the trench [21: 0.08m thick: Photo 5]. The quantity of FAS is too large for domestic debris and must be the result of some form of industrial activity, though there is no evidence for metalworking in the residues.

7.5 Deposit 21 was overlain by a layer of brown-grey sandy silt [17: all trench, 0.12m thick] which was sealed by a layer of compacted orange-brown sandy clay [14=16: all trench, 0.05m deep]. Above this at the south end of the trench was a lens of shell [23: 0.6m long, 0.03m thick: Photo 7]. Overlying this was light grey-brown sandy silt containing bone from a goose and a dog, possibly a companion animal, shells, and a sherd of medieval pottery [2: 0.4m deep]. These deposits probably resulted from the 'sleeching' process. Cutting this at the north-west corner of the trench was a partially exposed steep sided pit [F18: over 0.64m long by over 0.22m wide, over 0.6m deep: Photo 8]. Cut from just below the topsoil, it is likely to be of modern origin. It was filled by yellow-grey silty sand [19]. The dark brown-grey topsoil [1: 0.1m-0.2m deep] overlay the trench.

Trench 3 (Photo 9)

7.6 This trench was excavated to a maximum depth of 0.7m. Natural subsoil, a grey-yellow patchy sandy silty clay [11], was identified 0.62m below ground level. Overlying this was a light grey-brown sandy clay [8: 0.46m deep]. No archaeological features were identified and no artefacts recovered. The dark brown-grey topsoil [1=3=7: 0.1m-0.2m deep] overlay this.

8. The artefacts

Pottery

Results

8.1 Eight fragments of medieval pottery were found, (30g weight), four of them small fragments which probably originated from the same sherd.

8.2 Context [2] had a small body sherd of medieval glazed ware, red-slipped internally and with an external greenish glaze. A body sherd of brown-glazed medieval pottery with external, shallow ribbed decoration was found in deposit context [12] in trench 1. This piece had either been over-fired or burnt, as the glaze was partly bubbled. Deposit [16] in trench 2 produced two body sherds, one very similar in fabric and glaze to the sherd from [2], the other green/orange-glazed internally and splash-glazed and sooted externally. The four small, probably associated, fragments from the sample residue from deposit context [21] were pieces of pale buff/orange sandy ware, which may originally have had an external glaze over the remains of a white slip.

Discussion

8.3 This is a very small assemblage, but is notable for its limited date range of *c.*13th – *c.*14th century. However, it would be unwise to use these few dateable artefacts to assign definitive dating to all the activity on site.

Recommendation

8.4 No further work is recommended.

Animal bone

Results

8.5 There were very few faunal remains. The majority of the finds were marine shells.

Bone

Context [2] Goose-sized coracoid, weathered on one side, plus a cattle tooth fragment.
Context [10] Two unidentifiable fragments.
Context [21] Dog radius, proximal fused.

Shell

Context [2]
Mussel fragments: minimum 19 shells
Cockle fragments: minimum 4 shells
Whelk fragments: minimum 1 shell
Razor shell fragment: 1 shell
Winkle: minimum 4 shells
Clam fragment: I shell

Context [10]
Mussel fragments: minimum 6 shells
Cockle: minimum 4 shells
Razor shell fragment: 1 shell
Winkle: 1 shell

Context [23]
Mussel fragments: minimum 3 shells
Cockle: 1
Winkle sp.: 1
Clam fragment: 1 shell

Discussion

8.6 The scant remains of bones suggest that meat-based food was rarely prepared or consumed on site. The single dog limb bone may suggest interment of a companion animal.

8.7 The marine shells are common species to be expected on the littoral. Mussel shells are most frequent. It is possible that these shellfish were eaten, but very little food is represented by these shells.

Recommendation

8.8 No further work is recommended.

Clay pipe

Results

8.9 Topsoil context [1] in trench 2 contained a fragment (*c*.30%) of a plain pipe bowl, with no heel and no decoration. The surviving shaping suggested an 18th or 19th century date.

Recommendation

8.10 No further work is recommended.

Glass

Results

8.11 Deposit context [5] in Tr1 contained a very small (<2g weight) piece of dark coloured, melted glass. This find may have been associated with fragments of broken and semi-melted glass found adhering to a piece of industrial residue from this context.

Recommendation

8.12 No further work is recommended.

Building materials

Results

8.13 Deposit [10] in trench 1 had a fragment of hard-fired, orange brick or tile with no intact measurable dimensions. The fragment, at 16mm, did not survive to its full thickness and had sparse inclusions of very small, slaggy fragments and fine sand. Probably of post-medieval date.

8.14 The sample residue from trench 2 deposit context [21] contained a few very small flakes and fragments of hard-fired, oxidised ceramic building material, <4g total weight.

Discussion

8.15 While none of this small quantity of material preserved any dateable characteristics, the hardness of the piece from [10] suggested a post-medieval date.

Recommendation

8.16 No further work is recommended.

Iron objects

Results

8.17 Two nail fragments were recovered. Layer [2] had a highly corroded nail shank, 36mm long, with an intact point. It was rectangular in section, *c*.9 x 10mm. Undateable.

8.18 The sample residue from context [17] had two highly corroded, joining nail shank fragments, 42mm long together, oval in section, *c*.6 x 5mm. These had adhering industrial residue which contained chips of coal.

Recommendation

8.19 No further work is recommended.

Copper alloy objects

Results

8.20 Topsoil context [1] produced a shotgun cartridge, 47mm long x 12mm diameter, its closed end intact. Probably of 19th or 20th century date.

Recommendation

8.21 No further work is recommended.

Lead objects

Results

8.22 A small, moderately corroded lead sheet offcut was found in context [2], 19mm long x 5.5mm wide x 3mm thick max. One long edge was curved and appeared to have been cut. Undateable.

Recommendation

8.23 No further work is recommended.

Industrial residues and fuel waste

Results

8.24 A total of 17860g of material thought to possibly be industrial residue from salt production was collected from 12 contexts (Table 1.2). When washed, pieces could be seen to be very variably coloured, with areas of black/grey/purple/white/yellow/green. Many were highly vesicular internally with occasional 'glassy' areas and were light in weight for their size. X10 microscopic examination identified occasional fragments of burnt and unburnt fuel, broken shell and ?brick or fired clay fragments within the structure and pieces of burnt and unburnt coal and shell. Evidence of plasticity could be determined from the flowing shape of the fragments. No pieces were found with shaping to suggest containment within vessels, but some with 'wavy' edges indicated limits to the plastic flow of the residue. The pieces varied in size from *c*.114 x 131 x 41mm thick down to fragments with dimensions of less than 10mm. Some appeared abraded, but others appeared to have been recently broken. Photographs were taken of selected residues for inclusion in the site archive.

8.25 Examination did not identify any briquetage. Most fragments were relatively hard and could not be broken, but some were softer, quite easily broken apart and were more orange/pink in colour. X10 microscopic examination found these to have relatively large quantities of crushed shell and coal chips within the fused matrix.

8.26 In order to try to determine whether this was debris from salt production, following a review of analytical literature, it was decided to use pXRF to identify the presence of Bromine, one of the tracer elements for seawater. Bromine has been chosen by some researchers over Chlorine, as Bromine is usually not found in clays used for pottery vessels, unlike chlorine (Alessandri et al, 2024, 3). A total of 19 samples were selected from the unwashed residues, including the surrounding soil. pXRF analysis was followed up by further SEM-EDX analysis of some of the samples. Detailed results of the analyses can be found in Appendix 2.1.

Discussion

8.27 The cleaned appearance of the fragments and X10 microscopic examination of the surface and matrix suggests that these are fragments of fuel ash slag (FAS). Fuel ash slag is produced during combustion when the non-organic components of fuels react with silicates present in earth, stone or ceramic. It contains a range of common earth elements, including silica, iron, aluminium, sodium, phosphorus and potassium. It can form at temperatures achievable in a domestic fire or conflagration, or can be a by-product of industrial activity.

8.28 Here, the relative thinness of many of the pieces with intact surfaces (<50mm), and the uneven, flattish surfaces on the presumed undersides, suggests that the residue formed on a ground surface, the result of fairly intense fires or bonfires. The shape of the pieces suggests an open area of burning not contained within a vessel or structure. The heat has partly melted and fused the sand and shell-rich ground with the remains of the fuel used and has occasionally partly melted and incorporated small rocks present on the ground surface. Coal fragments and chips, burnt and unburnt, suggest that coal was in use, but the overall appearance of the debris suggests this was not the only fuel. There is no indication of metalworking in the residues.

8.29 Bromine was detected by pXRF in all but one of the samples analysed, but was only a weak signal in 6 of the results. It was detected in just 7 of the SEM EDX analyses. This does not necessarily rule out salt production, as the material tested turned out to be FAS and not structural remains or briquetage. However, the total absence of identifiable briquetage is very unusual for a saltern site.

8.30 The quantity of FAS is too large for domestic debris and must be the result of some form of industrial activity. With the finding of silt deposits, characteristic of sleeching, salt production on site remains a possibility.

8.31 Only the four very small pottery fragments from [21] came from a residue-producing context. These remain very tenuous dating evidence for the extent or duration of the industrial activity.

Recommendation

8.32 No further work is recommended.

Conservation

Results

8.33 Nineteen samples, comprising soil and industrial residue fragments, were selected for pXRF analysis to attempt to determine whether bromine, an indicator element for seawater, was present or absent. Samples were analysed with a Bruker S1 Titan pXRF, at 50kV for 60 seconds, using the Geoexploration 50 mode via the Artax program.

8.34 Based on the relative strengths of the peaks within the K- α line, 7 samples were chosen to run through the SEM-EDX for further analysis and as a comparison. Methodology and analytical results can be found in Appendix 2.2.

9. The palaeoenvironmental evidence

Introduction

9.1 Four bulk samples were submitted for palaeoenvironmental assessment. The samples were from deposits provisionally dated to the medieval period associated with a probable saltern mound and salt production, and an associated pit which intercut the mound of saltern deposits.

Methods

9.2 The samples were manually floated and sieved through a 500µm mesh. The flots were examined for waterlogged and charred botanical remains, using a Leica MZ6 stereomicroscope at up to x60 magnification. Residues were fully scanned for additional charred plant material, industrial residues, and finds such as small bones (animal, fish and bird), marine shell and snails. This included microscopic examination of the fine fraction where appropriate.

9.3 The snail and marine shell assemblages were scanned and the most frequently occurring remains were identified to species using the descriptions of Cameron (2008) and Macan (1977). Nomenclature follows Anderson (2005), and habitat classifications follow Cameron (2008) and Macan (1977).

9.4 The works were undertaken in accordance with the palaeoenvironmental research aims and objectives outlined in the regional archaeological research framework and resource agendas (Petts & Gerrard 2006; Hall & Huntley 2007; Huntley 2010), including the updated version: North-East Regional Research Framework for the Historic Environment (NERRF 2.0) (https://researchframeworks.org/nerf/accessed 30/10/2024).

Results

9.5 The samples produced small to moderate-sized flots and the deposits primarily comprise of quantities of fragmented coal/cinder. Burnt concreted material, possibly reflecting waste from salt production, was also present in all deposits, and five pottery fragments were recovered from deposit [21]. Fragments of marine shell and small snails were universally present together with a small number of fish bones. The very few uncharred plant remains and roots are probably modern intrusions.

9.6 Charred material was limited to occasional traces of highly fragmented charcoal, including oak, and a few charred soil fungus sclerotia. While the small oak sapwood charcoal fragment from deposit [17] may have sufficient carbon for C14 dating purposes, this is not recommended, as such small/sparse remains have a high potential to be intrusive. Detailed palaeoenvironmental results are presented in Table 1.3.

Discussion

9.7 The deposits deriving from possible salt production waste are all typified by fuel waste and frequent fragments of burnt concretions. The two deposits associated with possible sleeching waste, [17] and [10], both contain abundant coal and cinder fragments, although the size of the fragments differs between the deposits with those from [17] particularly fragmented whereas more frequent larger pieces (>10mm) were present in [10]. Deposit [21] also had abundant fragments of coal and cinder and contained not only frequent burnt concretions but also a few pot fragments. However, it should be noted that all the mound deposits contained significant quantities of burnt concretions, and these were particularly abundant in deposit [10]. The presence of only traces of charcoal and much coal and cinder likely reflects the use of coal as the primary fuel in the industrial activity at the site. The deposit from intercutting pit [F18] contains more limited quantities of fuel waste and burnt concretions than those forming the mound itself, potentially reflecting the accidental incorporation of such material into the feature from the underlying deposits.

9.8 The mollusc assemblages are characterised by species typical of estuarine habitats and coastal brackish and salt waters. Fragments of marine shell include mussels and cockles as well as oysters, periwinkles, cowries and small dog whelks. Small brackish and marine snail shells included mudsnails (Peringia ulvae- Pennant 1777), spire snails (Ventrosia ventrosa- Montagu 1803) and the Moss chrysalis snail (Pupilla muscorum- Linnaeus 1758) present in all deposits but particularly abundant in sleeching deposit [17] which also contains the greatest variety of species. Some of these shells may have been accidentally incorporated with the movement of seawater or silts as part of the salt production process, or during flood events.

9.9 Small numbers of charred sclerotia from the soil fungus Cenococcum geophilum were observed in mound deposits [17], [21] and intercutting pit deposit [19]. Such charred material has been associated with the remnants of burnt turves (Hall 2003), perhaps here relating to turves being utilised either as fuel or as filtration in the salterns as has been suggested elsewhere. However, from such very small numbers and the lack of other turf indicators this interpretation is tentative. The absence of further charred plant macrofossils demonstrates the industrial nature of the site, with a lack of incorporation of domestic waste into the features.

Recommendations

9.10 No further palaeoenvironmental work is required for these samples due to the general absence of diagnostic material. If further work is undertaken at the site, the results of this assessment should be added to any additional palaeoenvironmental data found.

10. Discussion

10.1 The topographic survey recorded the probable saltern mound, an earth bank at the western edge of the survey area and a dry river inlet to the east. All are likely to be related to the saltern. An earth bank on the eastern edge of the survey area is probably related to the modern car park.

10.2 The geophysical survey detected anomalies reflecting probable burnt ash and other industrial waste deposits including slag, clinker, and possible brick rubble. Possible structural elements have been identified, including possible kerbs and salt pans.

10.3 An earth bank, of uncertain age and purpose, has been detected in the west of the survey area.

10.4 Natural variation typical of wetland environments has been detected across the survey area and occasional small areas of disturbed ground have been identified beyond the mound.

10.5 The excavation recorded laminated deposits and layers of soil forming the upper part of a mound; the base of the mound was not reached. Industrial residue was present in several of the deposits, including a large quantity of fuel ash slag, too large for domestic debris, which could also be related to salt production. However, the absence of briquetage is unusual for this type of site.

10.6 Bromine was also recorded within some of the industrial residues, potentially indicating they had been in contact with salt water. The samples comprise deposits of coal and cinder with some having large amounts of burnt concreted material possibly consistent with saltern waste residues. There are also assemblages of marine and brackish-water molluscs alongside a few fish bones. Charred plant macrofossils are absent and there are only traces of charcoal. Based on the palaeoenvironmental evidence there is nothing diagnostic in terms of dating the features, although the predominance of coal waste is consistent with a medieval or later date and may reflect the importance of this fuel for the industrial activity undertaken at this site.

Excavation

10.7 Deposits of fine sand and silt recorded in the trenches indicates that salt was produced through 'sleeching'. This involved the collection of salt-rich soil deposits (known as 'sleech') that would accumulate on the mud flats at high tide. These would then be diluted in seawater to create a concentrated brine, which would be boiled for up to 6 hours to extract the salt. According to the latest experimental research by Yvette Marks (pers. comm. to Dr Emma Watson at Tees Archaeology), the concentrated brine would be slowly heated for up to 3 days, not 6 hours. This is because, although salt crystals can be created at speed, this faster process makes the crystals very small and light easy to blow away (especially in such an exposed area at the coast). By slowly heatng the brine, the crystals take longer to form, are larger, easier to transport and therefore makes this slower process much more likely. The de-salted sleech would then be thrown into a waste heap, along with any associated fuel waste, which over time would form a saltern mound (Barford et al 1998, 6; Murphy 2009, 39), such as the one recorded here. This was primarily a medieval technique (ibid) which fits with the pottery recovered from the layers.

10.8 Comparable saltern mounds and complexes survive across the country but in a lot of cases little or no archaeological work has been conducted on them. 4km south-west of this site at Greatham (Archaeological Services 2018), laminate deposits and thin layers of soil were identified, forming mounds of a comparable size to the one recorded at North Gare. These were interpreted as being waste deposits from the 'sleeching' process during salt production. Industrial residue was present in several of the laminate deposits, which is consistent with the sleeching process. No other features associated with salt production were identified during the works, though organic deposits were identified at both saltern sites, indicating former channels beneath the saltern mounds.

10.9 Geophysical survey followed by trial trenching was undertaken at Greatham Creek (Annis 1993) 3.8km south-west of the site in advance of flood defence work. The magnetometer survey found a number of anomalies but no sign of intense heating of the soil. The excavation uncovered the remains of three hearths and two clay-lined hollows for steeping silt scraped from the foreshore. The lack of burning in the clay soil and the regular shape of the hearths suggests that the evaporation of the reinforced brine was carried out in metal pans. An earlier excavation on the same site, by Helen Burns (1977, unpub.), uncovered brine storage pits or tanks cut into the clay. Dating evidence from the excavation was limited to a single sherd of local 13th-century pottery recovered in 1977 (Nenk *et al* 1993).

10.10 Various phases of excavation were carried out on a site at Wainfleet St Mary, Lincolnshire, which identified filtration tanks and channels, but the saltern mounds themselves had been levelled so the reports contain little comparable data (Albone 1999; McAvoy 1994). Excavations undertaken on salterns near Whitstable, Kent in 1955 identified mounds of similar dimensions to those at North Gare, with pits, wooden hurdles, burnt areas and tracks recorded both within and beneath the mound deposits (Thompson 1956). However, there was little discussion about the mound deposits themselves, some of which had been bulldozed prior to excavation. More recently, a saltern excavated at Walpole, Norfolk recorded several layers of clays, silts and sands in the base of the mound, which were interpreted as natural silting up and development of the salt marsh. Pits, tanks, troughs and revetments were all also identified (Clarke 2011).

10.11 One example of a saltern that has been subject to extensive excavation is at Bramber, in West Sussex (Ridgeway 2000). Here, the salt-production is believed to date from around the 13th to the 16th century. At the time of the excavation, the saltern mound stood up to 0.5m high (compared to the height of 2.3m at North Gare), though it is possible that this had slightly eroded. The relative height differential is unlikely to be significant. The deposits forming the mound at Bramber were very similar to those identified during these works, consisting of "dumped deposits…interleaved with very finely laminated silts and sands" (ibid, 139). However, several features were also recorded at Bramber, including a ditch around the base of the mound, a pebbled surface, a small bank, a hearth and a filtration tank, all located on the top of the mound. Pottery recovered from this excavation indicates that salt-production occurred here for at least three centuries. However, it must be remembered that this site is located in West Sussex; just because salt-production took place on top of the saltern mound here does not mean that the same practices took place in the north-east of England. At North Gare, no archaeological features were recorded within the mounds themselves, so although the level of excavation at Bramber provides a lot of information, it is only really the mound deposits themselves that are comparable.

11. Conclusions

11.1 As the above examples show, little in-depth excavation work, or work utilising different disciplines such as geophysical survey, has been done on saltern mounds, with most of the work tending to focus on the associated features, such as pits and filtration tanks, as the mounds themselves do not always survive. It is therefore difficult to find comparable data for the mound at North Gare, but this serves to enhance the importance of this work. Despite not identifying any associated archaeological features, the excavation provides valuable evidence of salt working in the area, and also ties in with the Regional Research Framework's (https://researchframeworks.org/nerf/ accessed 26-09-2024) agenda items:

- MD5: How can we better understand other medieval industries?
- MD6: How can we better understand medieval trade and economy?

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Other
Tees Archaeology HER

Appendix 1: Data tables

Table 1.1: Context data

The • symbols in the columns at the right indicate the presence of artefacts of the following types: P pottery, B bone, M metals, I industrial residues, G glass, O other materials.

No	Area	Description	P	B	M	I	G	O
1	TR2	Topsoil			•			
2	TR2	Subsoil?	•	•		•		
3	TR1	Topsoil				•		
4	TR1	Subsoil?				•		
5	TR1	Sand deposit				•		
F6	TR1	Slag deposit same as [F9]						
7	TR3	Topsoil						
8	TR3	Subsoil?						
F9	TR1	Slag deposit same as [F6]						
10	TR1	Sand and shell deposit below [F6]	•					•
11	TR3	Natural						
12	TR1	Sand deposit below [F9]	•					•
13	TR1	Sand and coal deposit below [12]						
14	TR2	Sandy clay deposit						
15		Void						
16	TR2	Light grey silt deposit						
17	TR2	Ashy sand deposit						
F18	TR2	Pit cut						
19	TR2	Pit fill						
20		Void						
21	TR2	Slag and clay waste deposit		•		•		•
22	TR2	Sandy clay silt deposit						
23	TR2	Shell deposit						

Table 1.2: Industrial residues

Context	Weight (g)	No of pieces	Includes
1	259	c12	Industrial residues, burnt fuel
2	837	c35	Industrial residues, some softer, semi-burnt fuel
3	125	21	Industrial residues, mainly small pieces
4	2771	c105	Industrial residues, burnt and unburnt coal
5	4300	c90	Industrial residues, mainly flattish pieces
10	3830	51 + 3-400 small pieces	Industrial residues, burnt rock, unburnt coal, shell fragments
13	877	c95	Industrial residues, mainly small pieces, some softer
14	2118	c110	Industrial residues, some softer
16	12	3	Burnt rock
17	149	c75	Very small industrial residue fragments from samples
19	83	c50	Very small industrial residue fragments from samples
21	2499	c250+ several hundred small pieces	Industrial residues, some softer
Total	**17860**	**c897+**	

Table 1.3: Data from palaeoenvironmental assessment

Sample	Context	Feature	Volume processed (l)	Flot volume (ml)	C14 available	Palaeo Rank	Notes (including a proposed date based on the palaeoenvironmental evidence)
1	10	T1 sleeching deposit	10	80	N	*	Small flot comprising common coal and cinder fragments, mostly <1mm but some larger fragments also. A few burnt coal shale fragments. No charred plant macrofossils. Two tiny (<4mm) charcoal fragments only, one of which is oak. Abundant burnt concretions and some semi-vitrified fuel waste. Common marine shell fragments mostly mussel and cockle, generally fragmented but some whole shells and occasional small snails including mostly mudsnails, also spire snails, the Moss chrysalis snail, small dog whelks and periwinkles. A trace of unburnt bone and a few fired clay fragments. **Nothing diagnostic but consistent with medieval or later fuel waste.**
2	21	T2 deposit	9	150	N	*	Moderate-sized flot comprising common coal and cinder, with fewer larger fragments than deposit [10]. A few charred soil fungus sclerotia and traces of tiny (<4mm) charcoal fragments including oak (6mg). Burnt concretions are common in the residue. Five small pot fragments. A trace of fish bones and occasional marine shell fragments, mainly quite fragmented mussel and cockle, also occasional small snails including mostly mudsnails and spire snails, periwinkles, cowries and small dog whelks. A trace of fired clay. **Nothing diagnostic but consistent with medieval or later fuel waste.**
3	17	T2 sleeching deposit	13	50	(?)	*	Small flot comprising common coal fragments, mostly extremely fragmented, and a few cinder fragments in residue only. Traces of charcoal including a small oak sapwood fragment (13mg) and a few charred soil fungus sclerotia. Occasional burnt concretions in the residue. Two metal objects. Traces of fish bone, occasional marine shell including mussel, oyster, cockle, cowrie and periwinkle, quite fragmented and abundant small snails with a variety of species including mudsnails, small dog whelks, spire snails, and also possible common necklace snails and a possible member of the topshell family. **Nothing diagnostic but consistent with medieval or later fuel waste.**
4	19	F18 – pit intercutting saltern mound	11	100	N	*	Moderate flot comprising common coal and occasional cinder fragments, mostly <4mm. A single charred soil fungus sclerotia and a tiny indeterminate charcoal fragment. A few fragments of burnt concretions in the residue. Some fish bone and very occasional quite fragmented marine shell including mussel, oyster and cockle. A tiny calcined bone fragment. Occasional small snails including mudsnails, periwinkle, Moss Chrysalis snails and small dog whelks. Common modern roots. **Nothing diagnostic but consistent with medieval or later fuel waste.**

[Palaeo rank: *: low; **: medium; ***: high; ****: very high concentration of palaeoenvironmental evidence.
(?) = There is material for AMS dating, but not recommended due to long-lived species, small size and sparsity]

Appendix 2: pXRF and SEM analysis

Durham University

Artefact Conservation Service
Department of Archaeology × Durham University
South Road × Durham × DH1 3LE × tel 0191 334 1139 × fax 0191 334 1101
conservation-services@durham.ac.uk × www.dur.ac.uk/archaeological.services

Conservation record:		
Site Code: SCS24	Conservator: J. Cowey	Date: 04/11/2024

Description:
A selection of 19 samples (including soil and fragments) from a suspected saltern site were selected for pXRF analysis to attempt to determine whether bromine was present or absent.

Methodology:

- All samples provided were analysed using Bruker S1 Titan pXRF, using 50kV for 60 seconds, using the Geoexploration 50 mode via the Artax program (results in Appendix 2.1).

- The existing default calibrations on the pXRF filter out bromine when calculating the relative abundance of elements in the samples, so identification relied on the presence or absence of bromine peaks within the spectra. Without significantly more sampling, a reliable calibration could not be created in order to quantify the bromine levels, so identification remains qualitative.

- Based on the relative strengths of the peaks within the K- α line, 7 samples were chosen to run through the SEM-EDX for further analysis (see Appendix 2.2), and as a comparison.

- The SEM-EDX was run using 15kV for 120 seconds, and whilst the program did not automatically identify the bromine peaks, when forced to, it identified the peaks and provided a quantification (Appendix 2.2). The limitation in using 15kV is the inability to capture bromine's K-α and K-β lines, relying instead of the L-α line (which lies close to aluminium's K-α line), with the presence of aluminium within the samples potentially interfering with the accurate identification and quantification of bromine when using this method.

- A sample of soil was taken from outside the Durham Dawson building as a comparison and run through the SEM-EDX. This also showed the presence of bromine, at apparently similar levels to the soil sample (2) from the site.

Appendix 2.1: Results

Sample	Presence of bromine according to pXRF peak (50kV)?	Presence of bromine according to SEM-EDX (15kV)
02 Soil	Yes	Yes
02A	Yes	-
02B	Yes	-
04 Soil	Yes	Yes
04A	Small weak peak	-
04B	No	Yes
05 Soil	Small weak peak	Yes
05A	Yes	-
05B	Small weak peak	-
13 Soil	Yes	-
13A	Small weak peak	-
13B	Yes	Yes
13C	Yes	-
14A	Yes	-
14B	Small weak peak	Yes
14C	Yes	-
21 Soil	Yes	-
21A	Yes	-
21B	Small weak peak	Yes

pXRF Spectra, taken using Bruker S1 Titan, 50kV for 60 seconds, on Geoexploration50 mode.

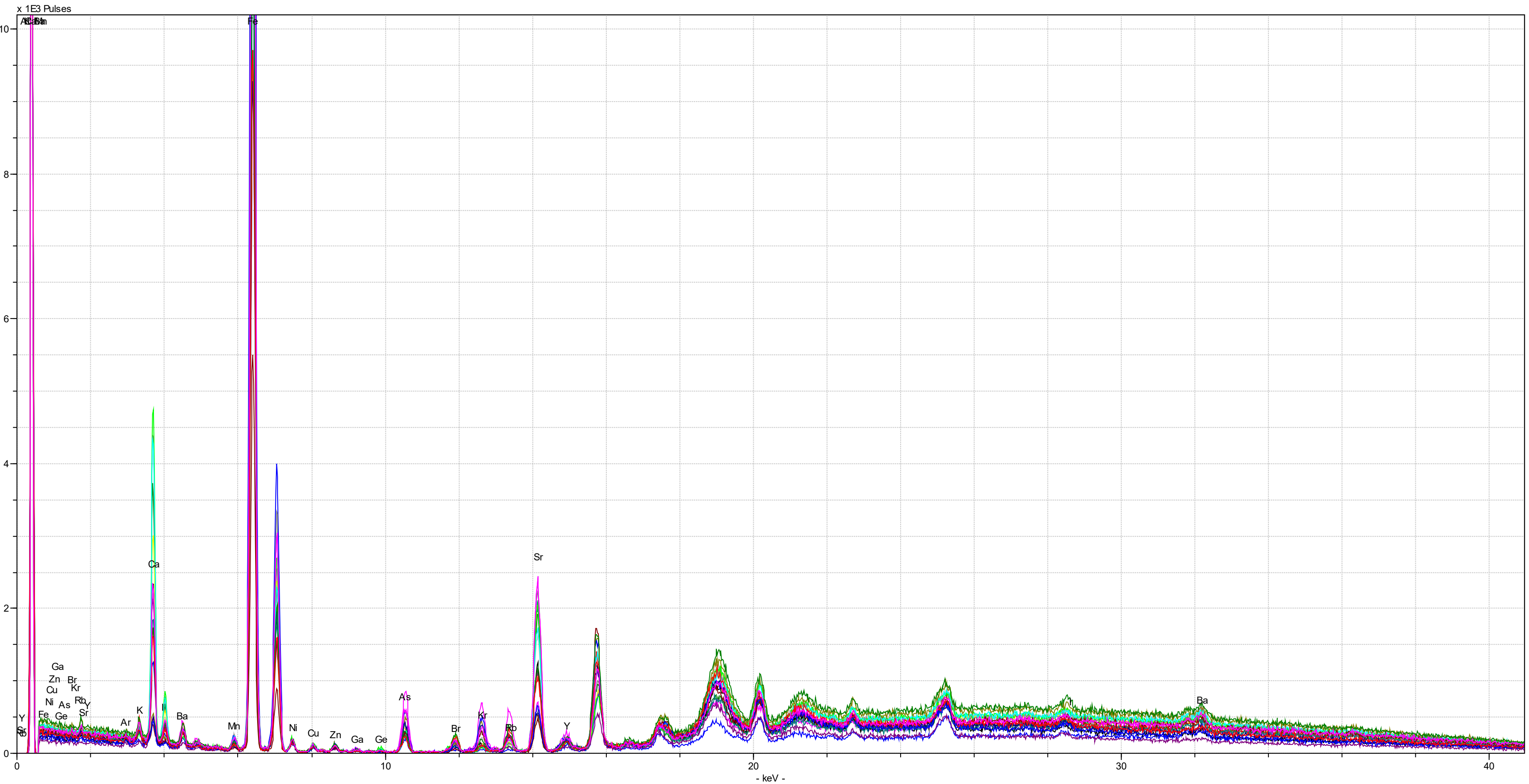


Figure 1. All spectra, showing consistent elemental peaks between the samples

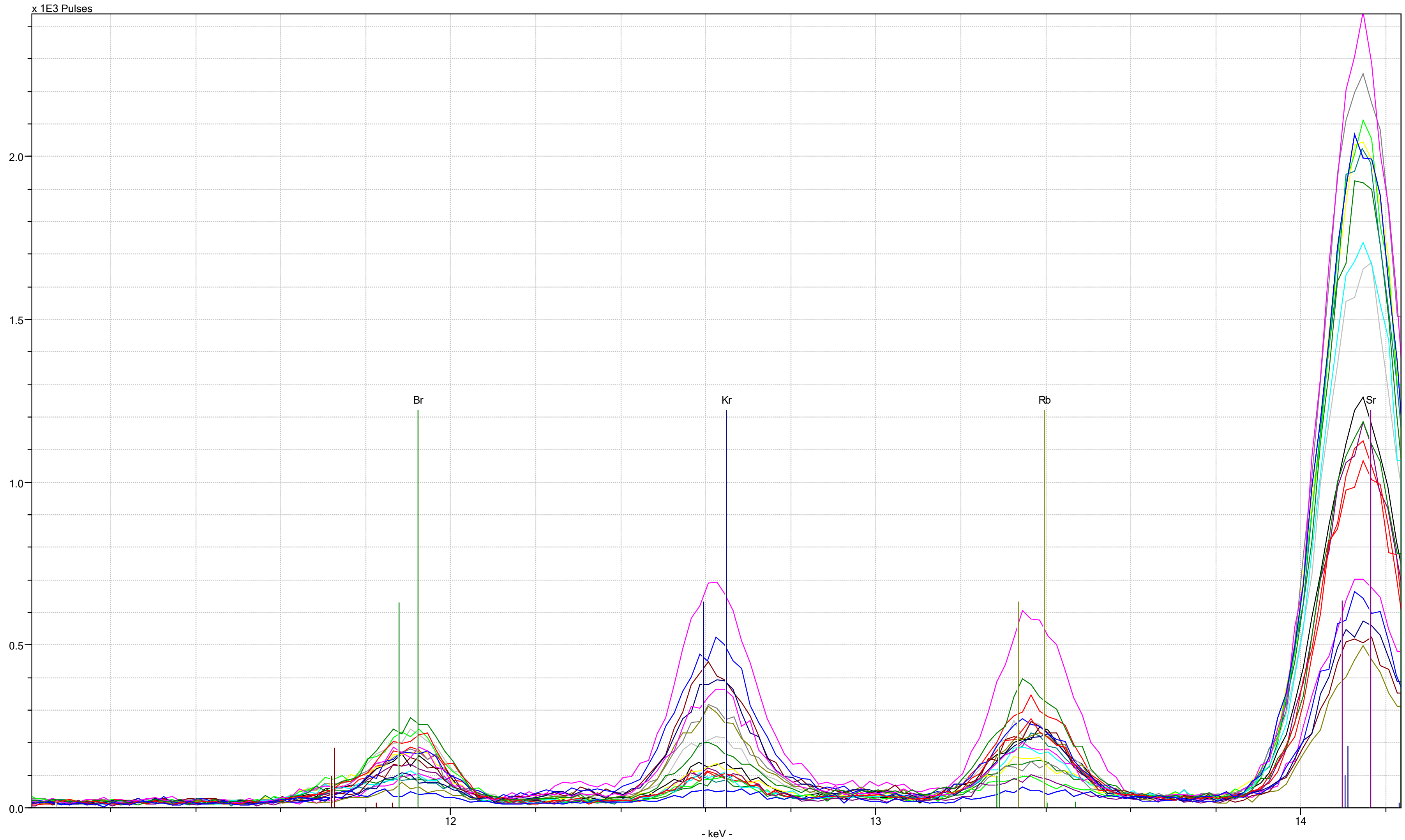


Figure 2. All spectra, showing the bromine K- α peaks.

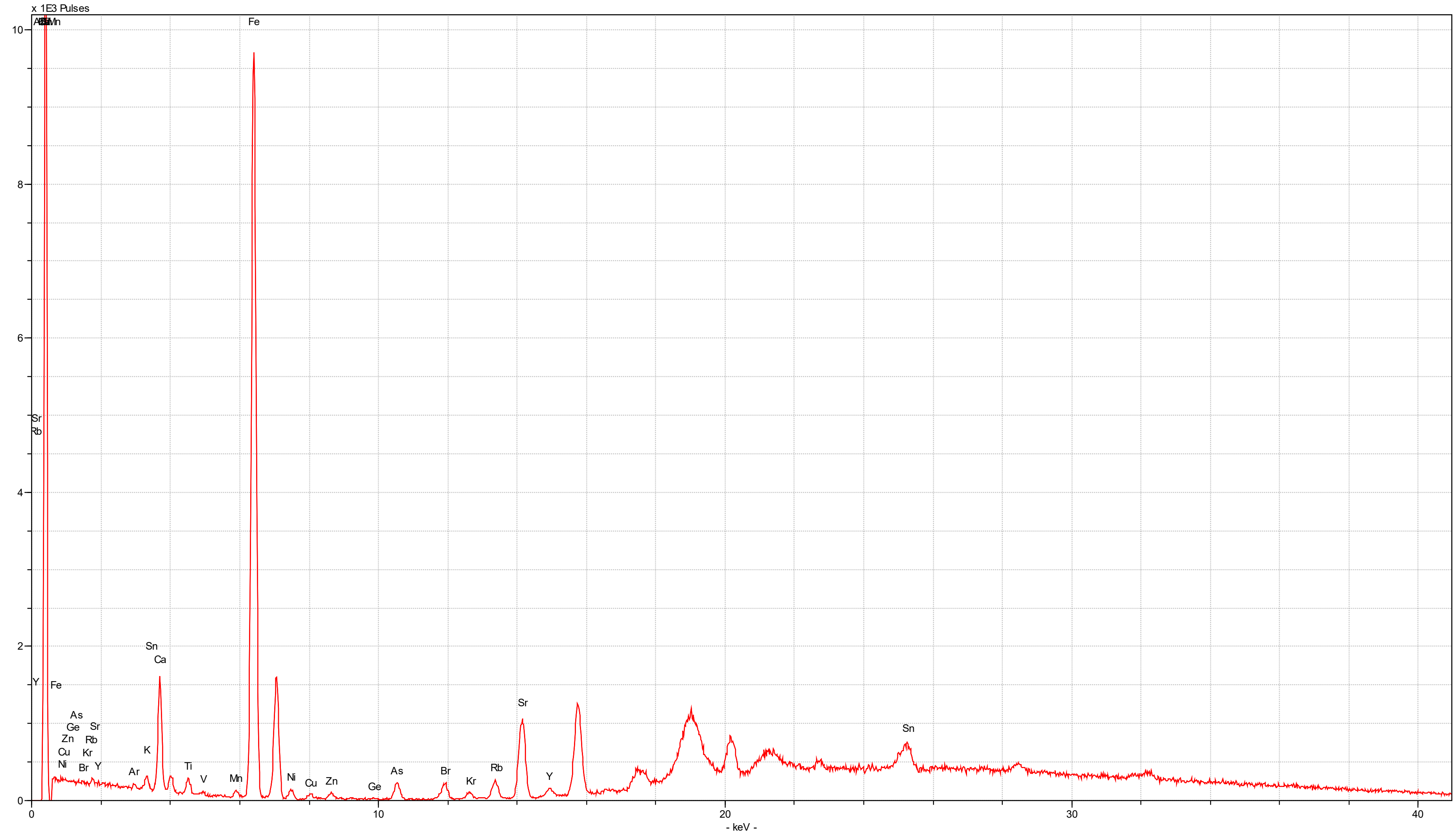


Figure 3. Sample context [2] Soil

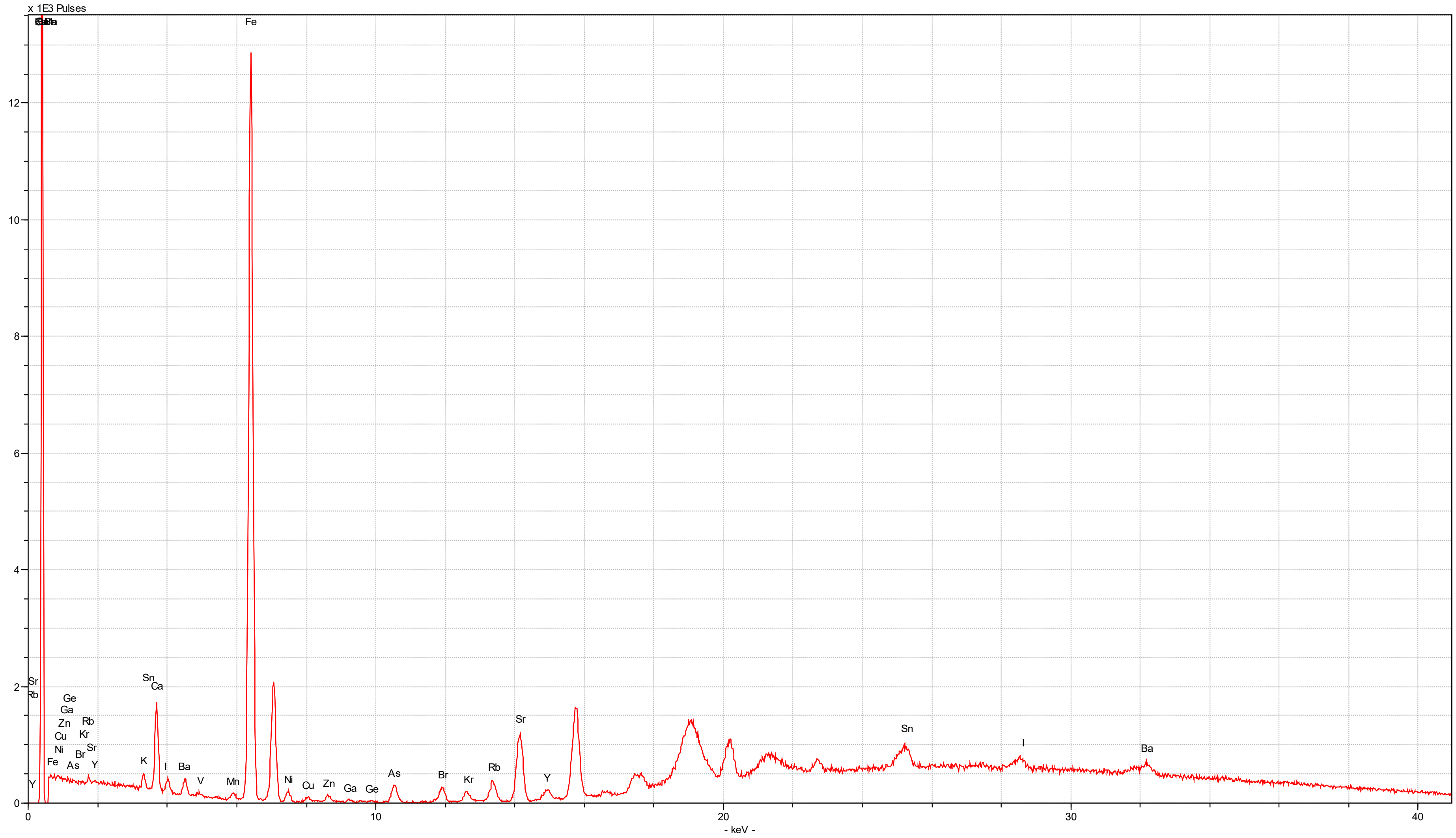


Figure 4. Sample [2]A

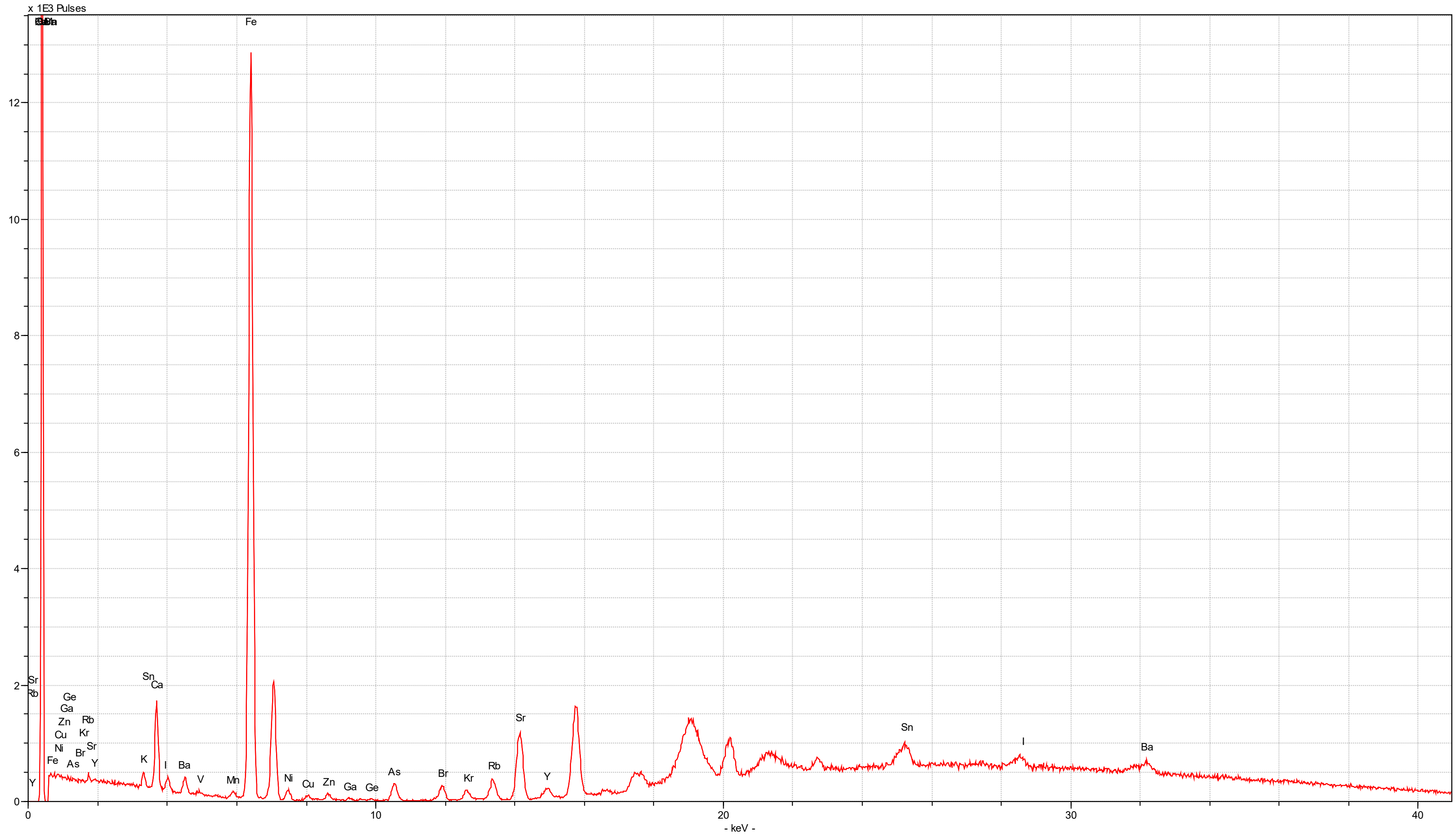


Figure 5. Sample [2]B

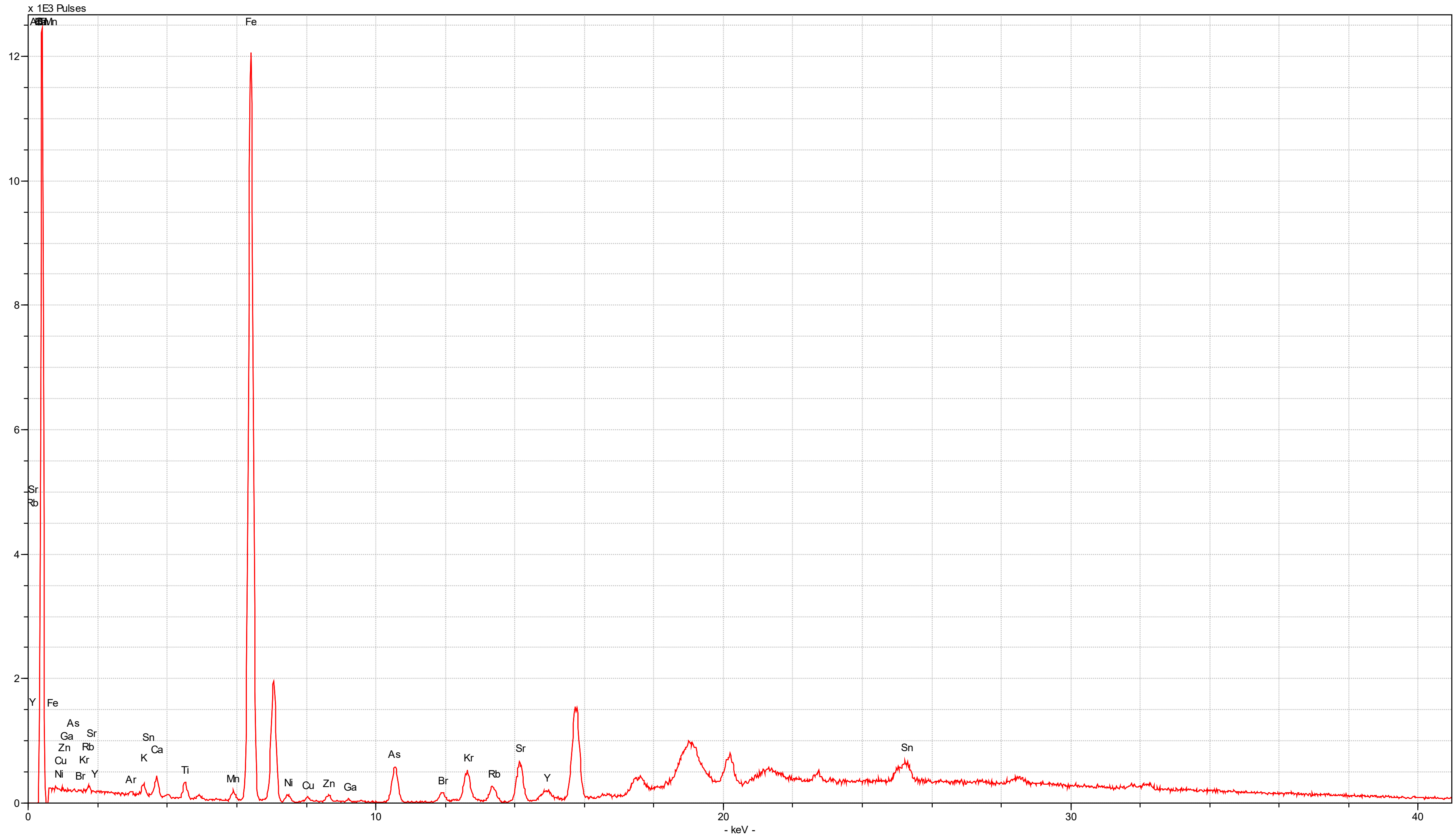


Figure 6. Sample [4] Soil

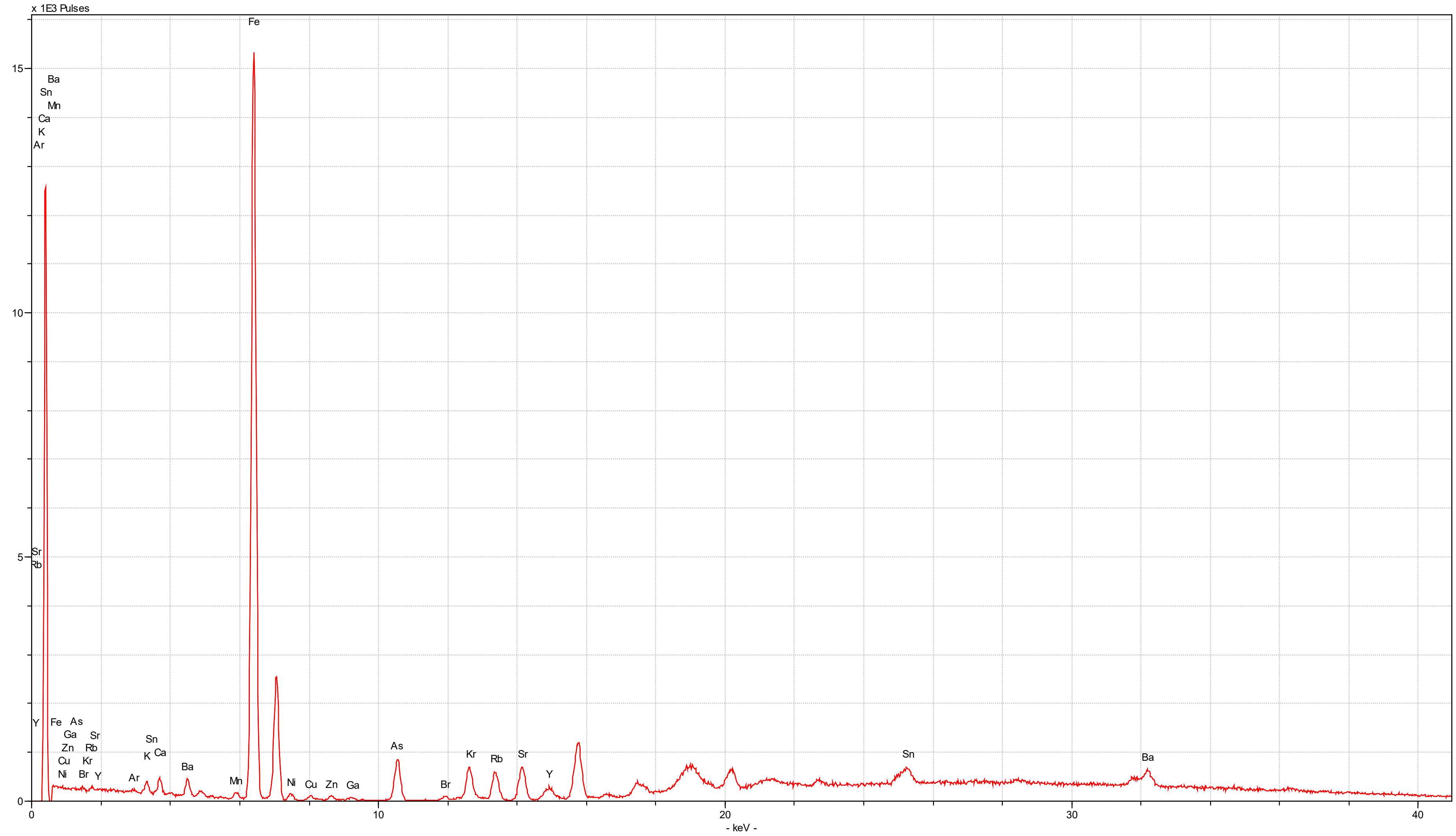


Figure 7. Sample [4]A

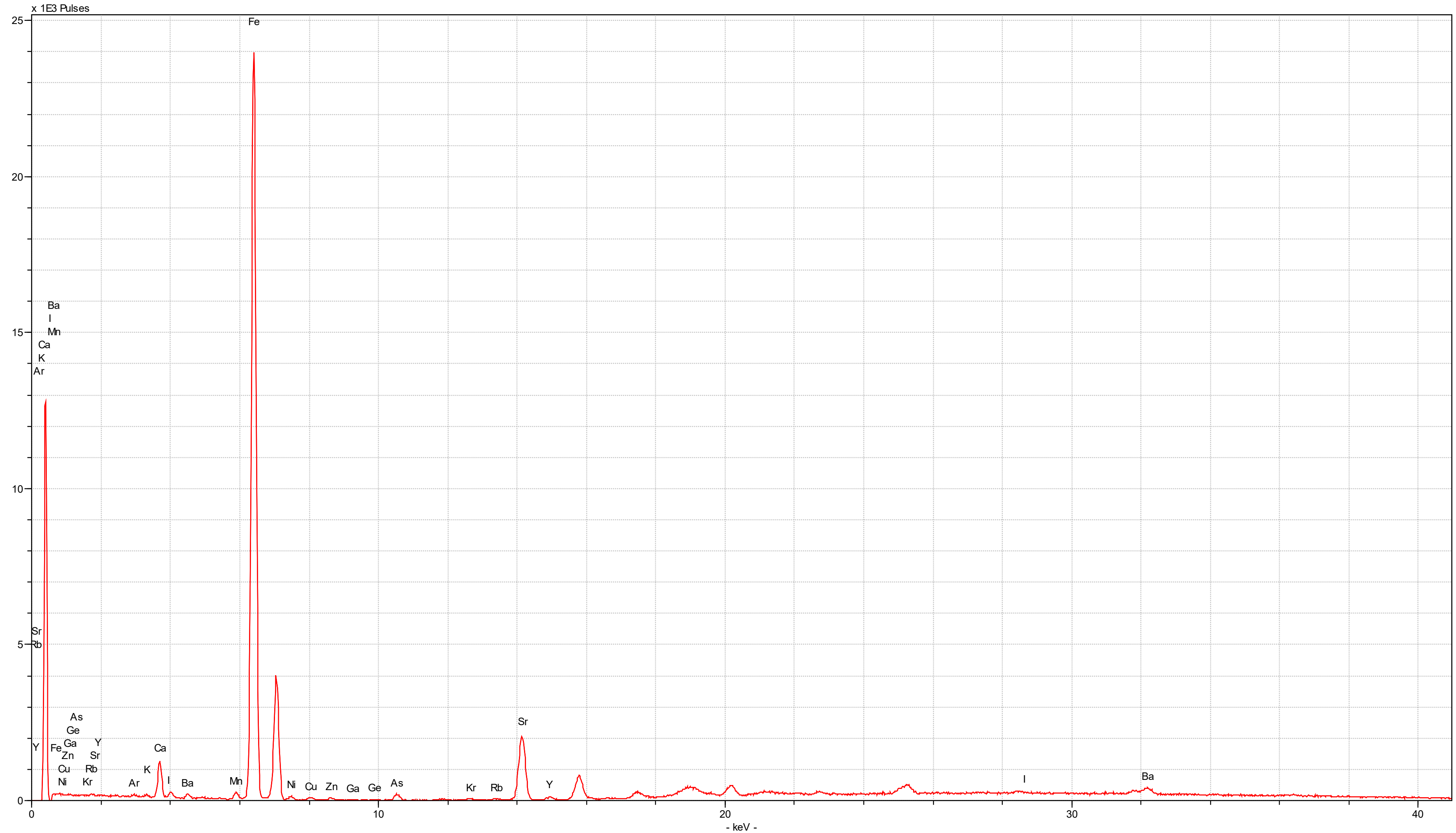


Figure 8. Sample [4]B

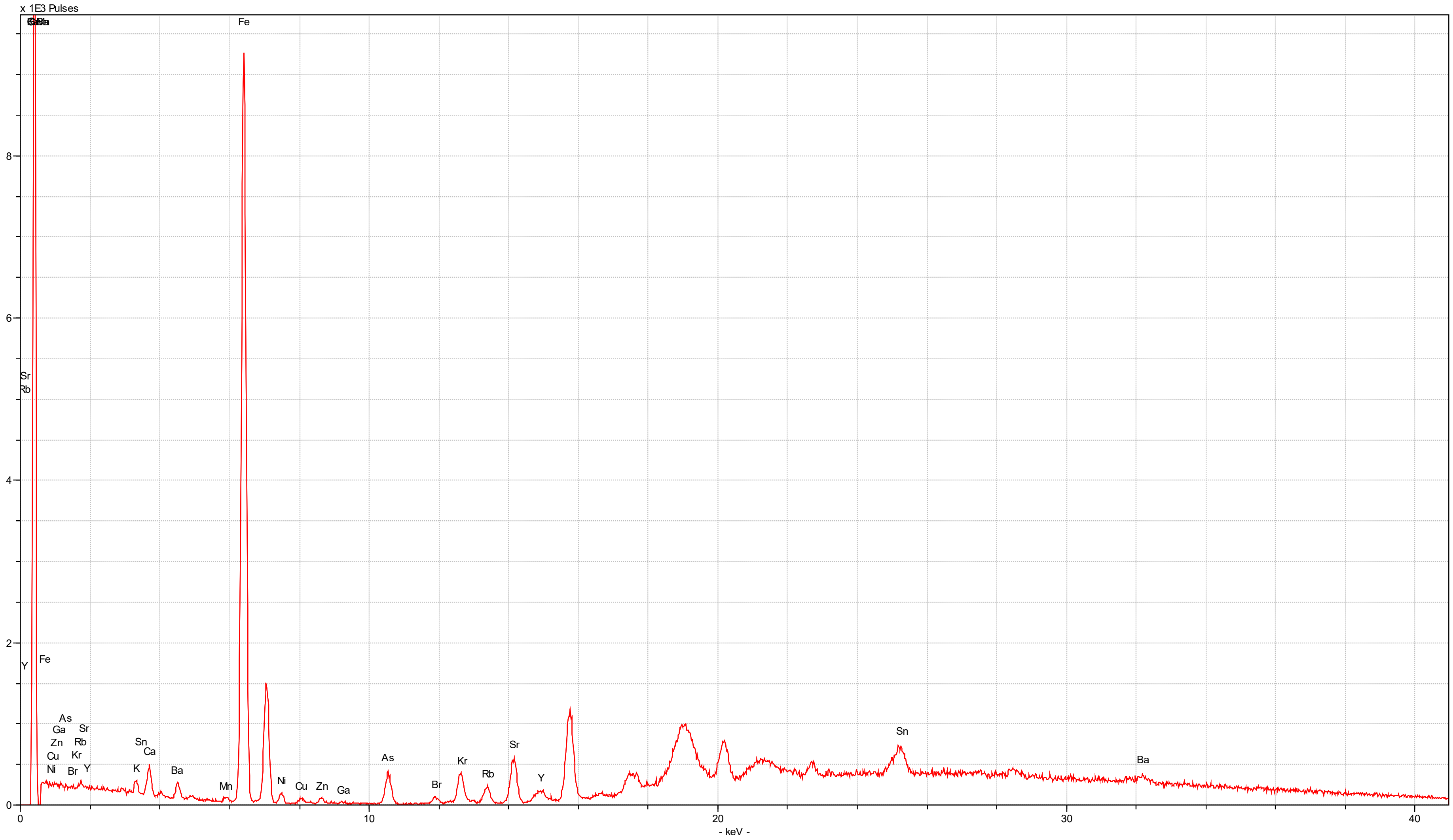


Figure 9. Sample [5] Soil

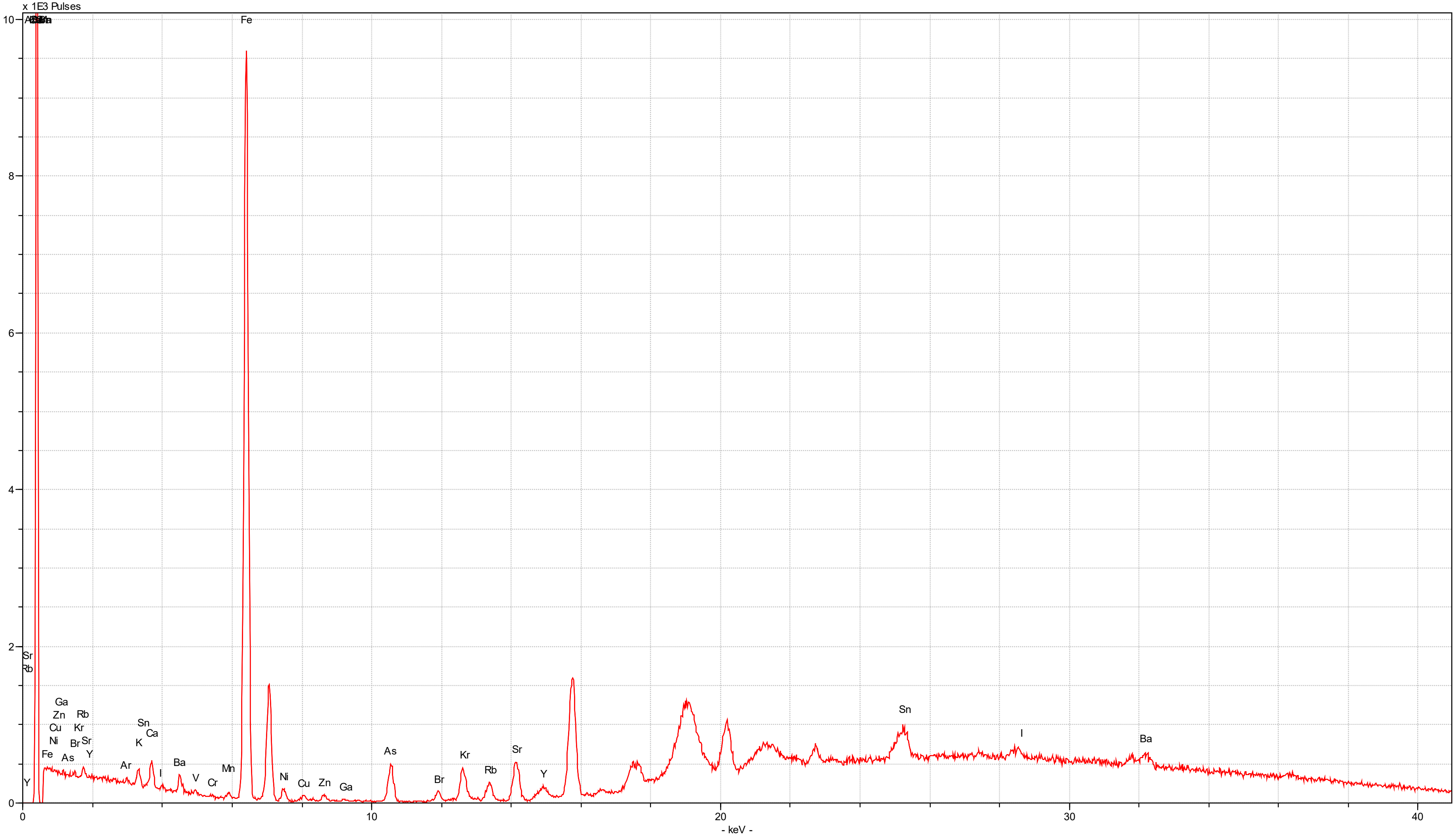


Figure 10. Sample [5]A

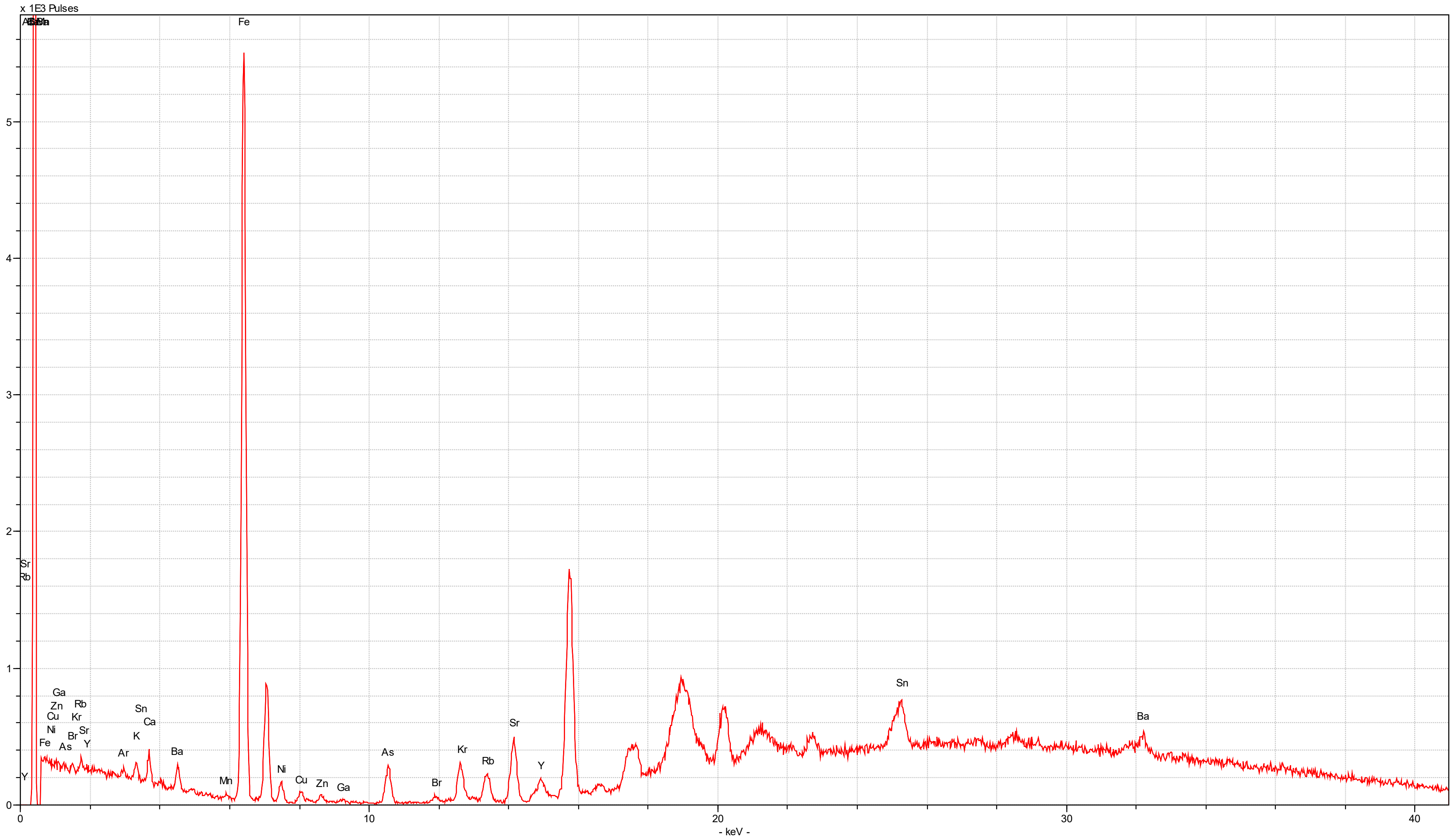


Figure 11. Sample [5]B

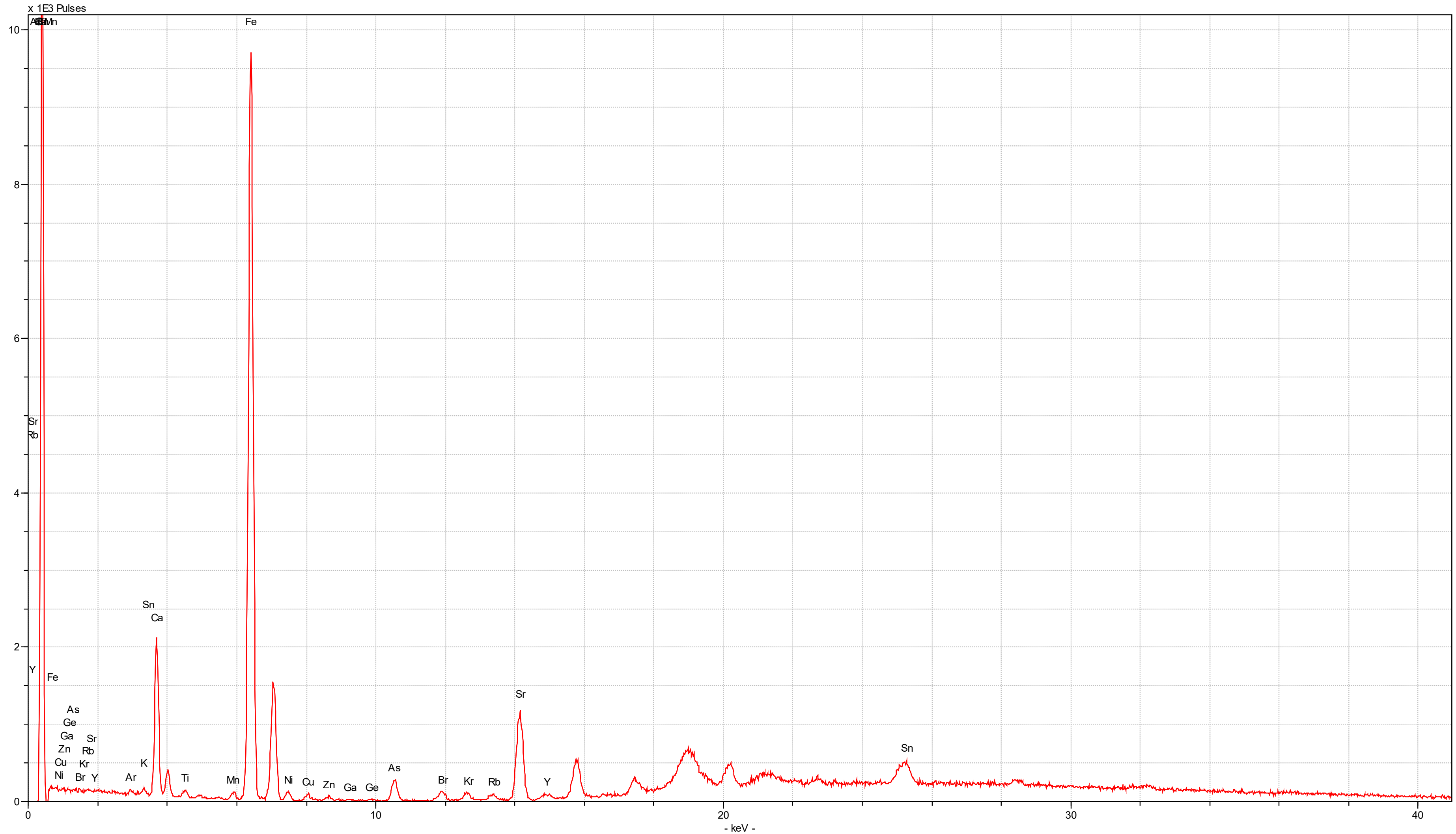


Figure 12. Sample [13] Soil

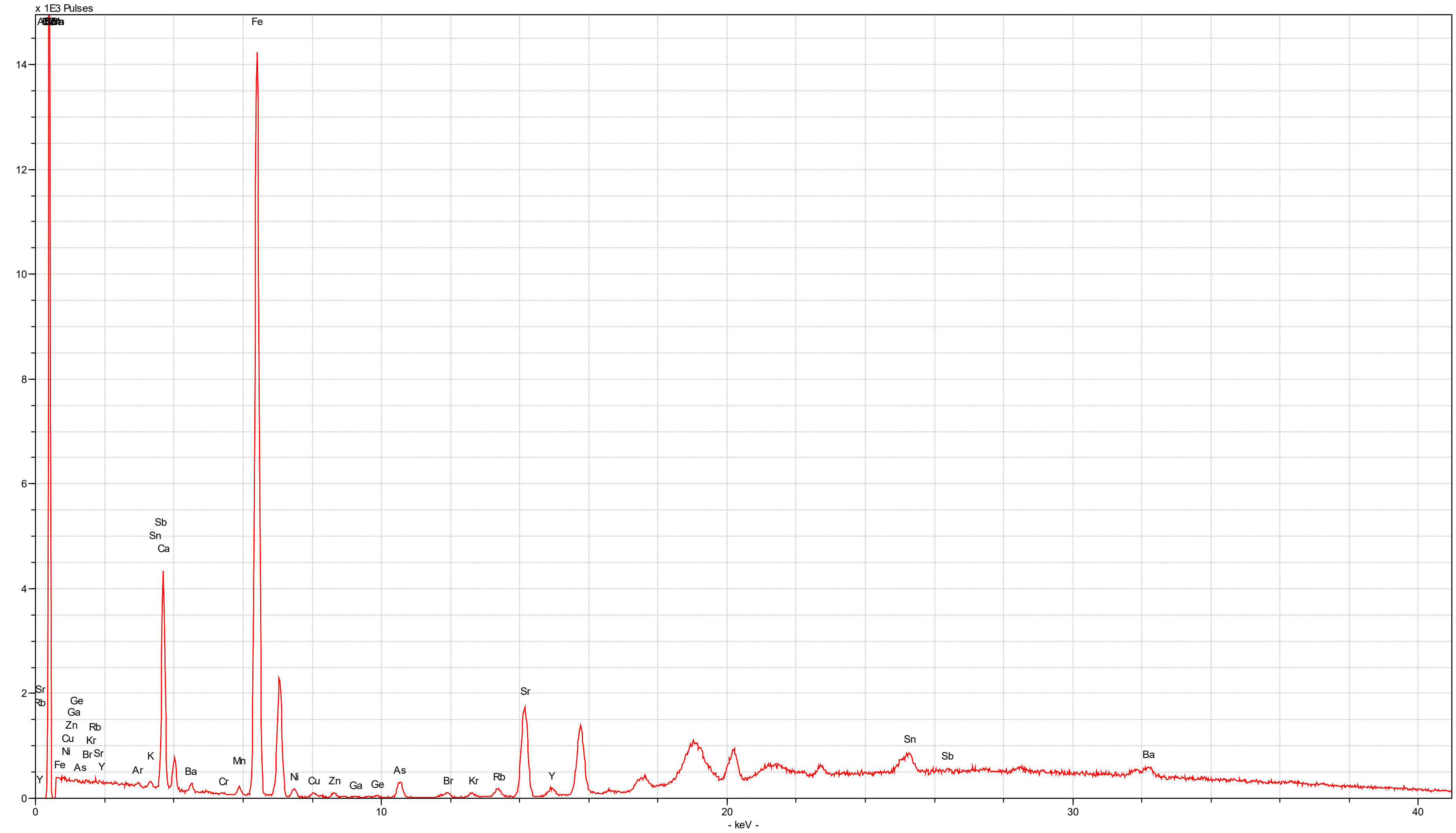


Figure 13. Sample [13]A

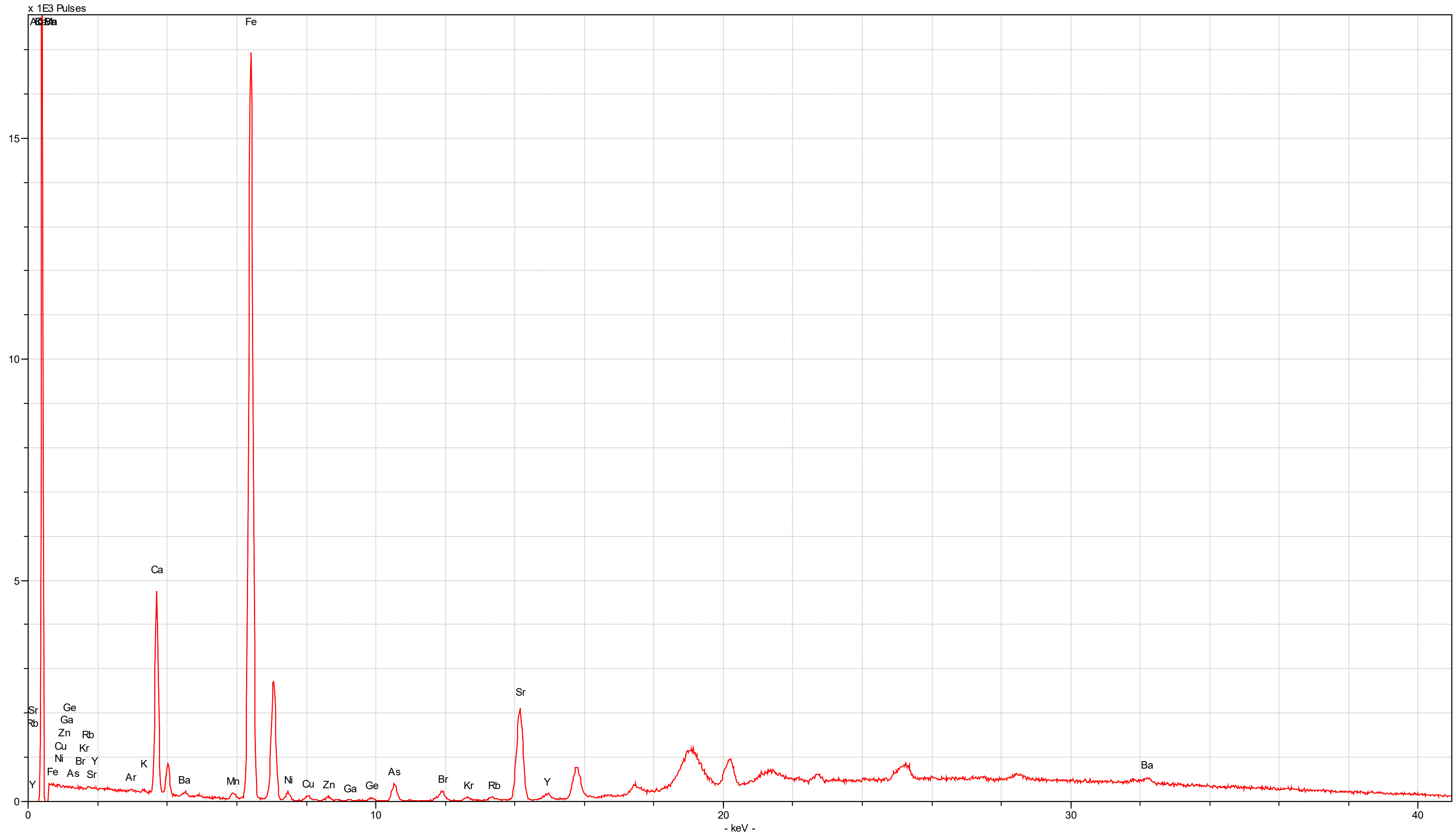


Figure 14. Sample [13]B

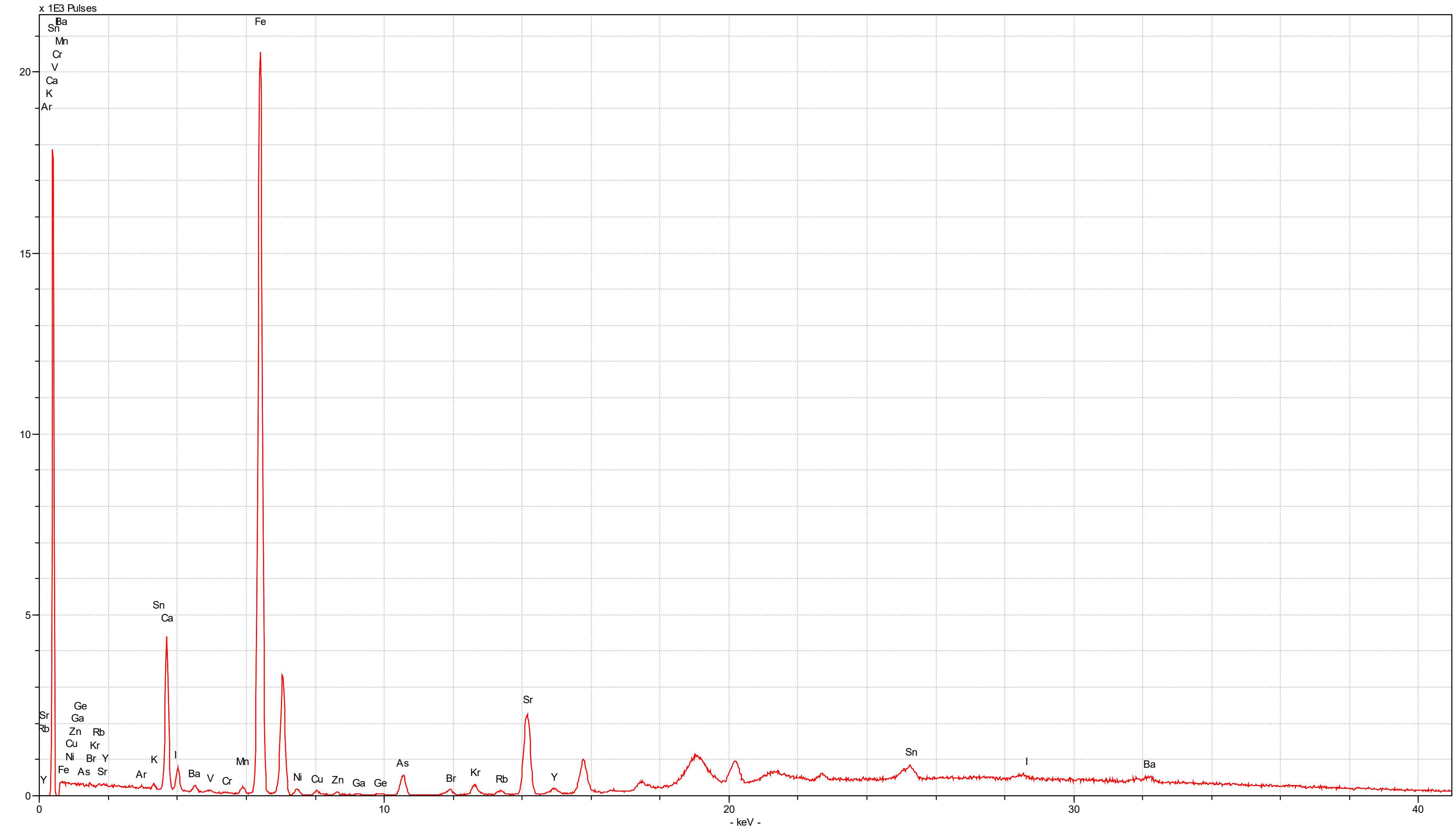


Figure 15. Sample [13]C

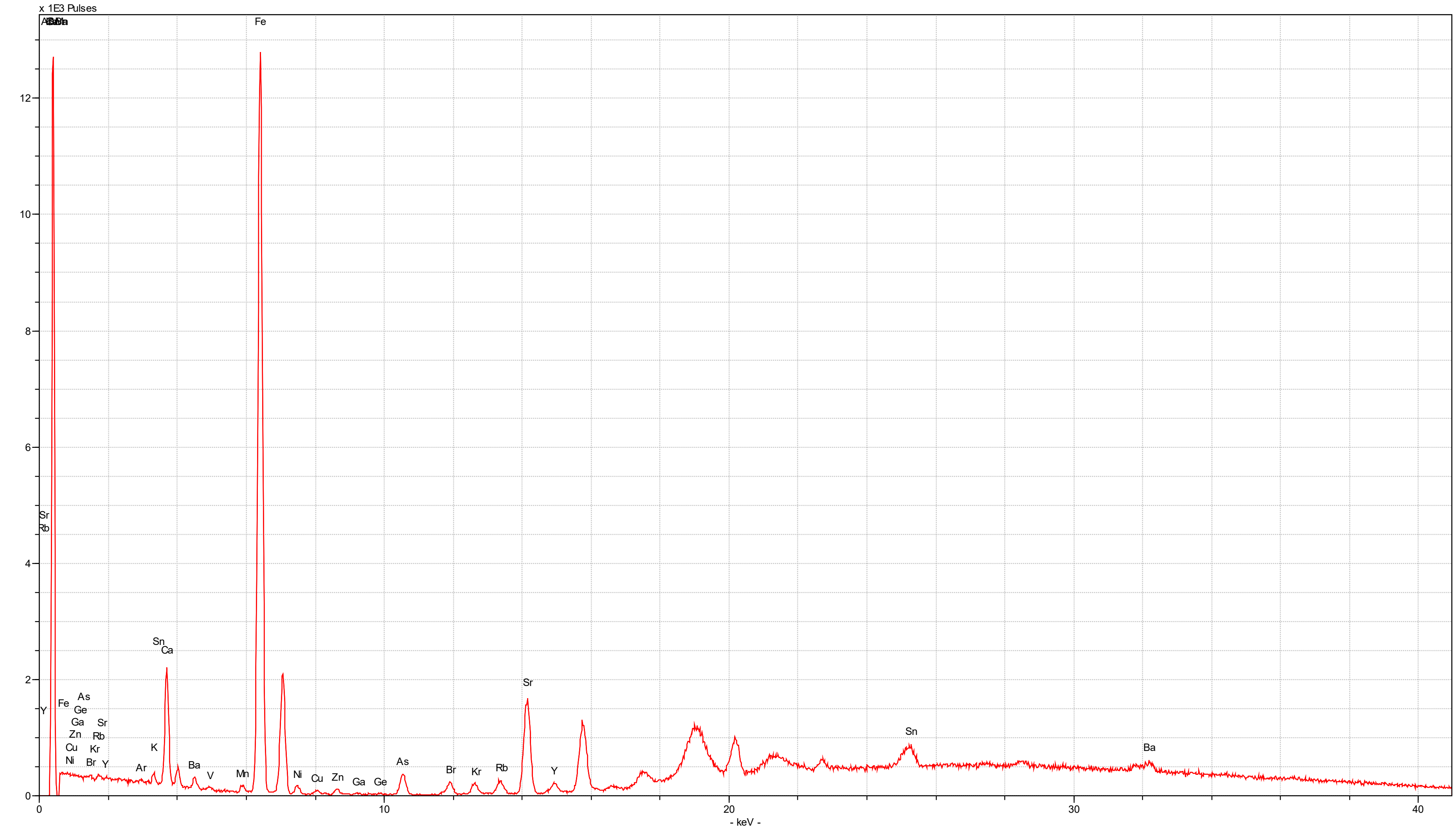


Figure 16. Sample [14]A

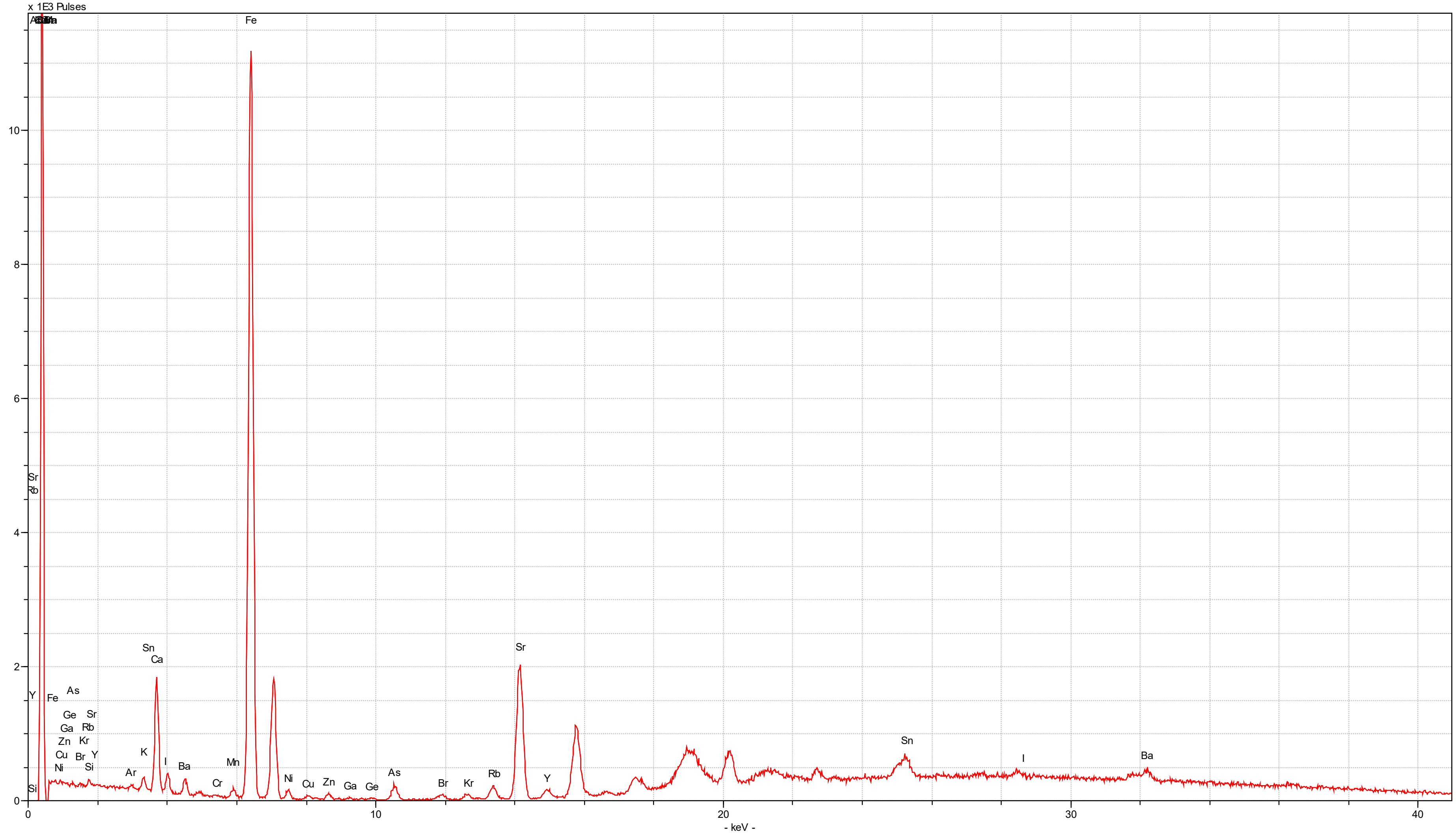


Figure 17. Sample [14]B

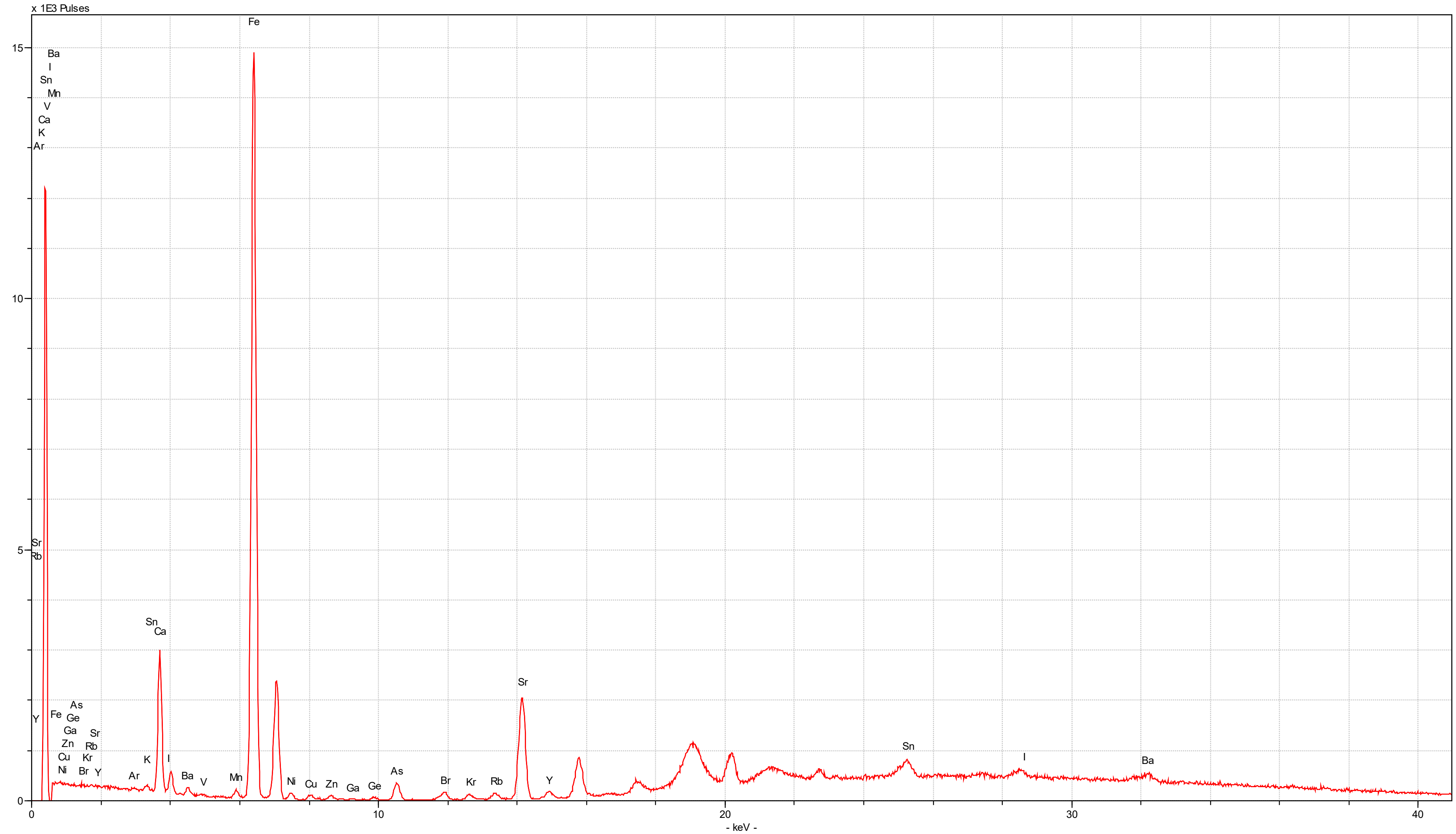


Figure 18. Sample [14]C

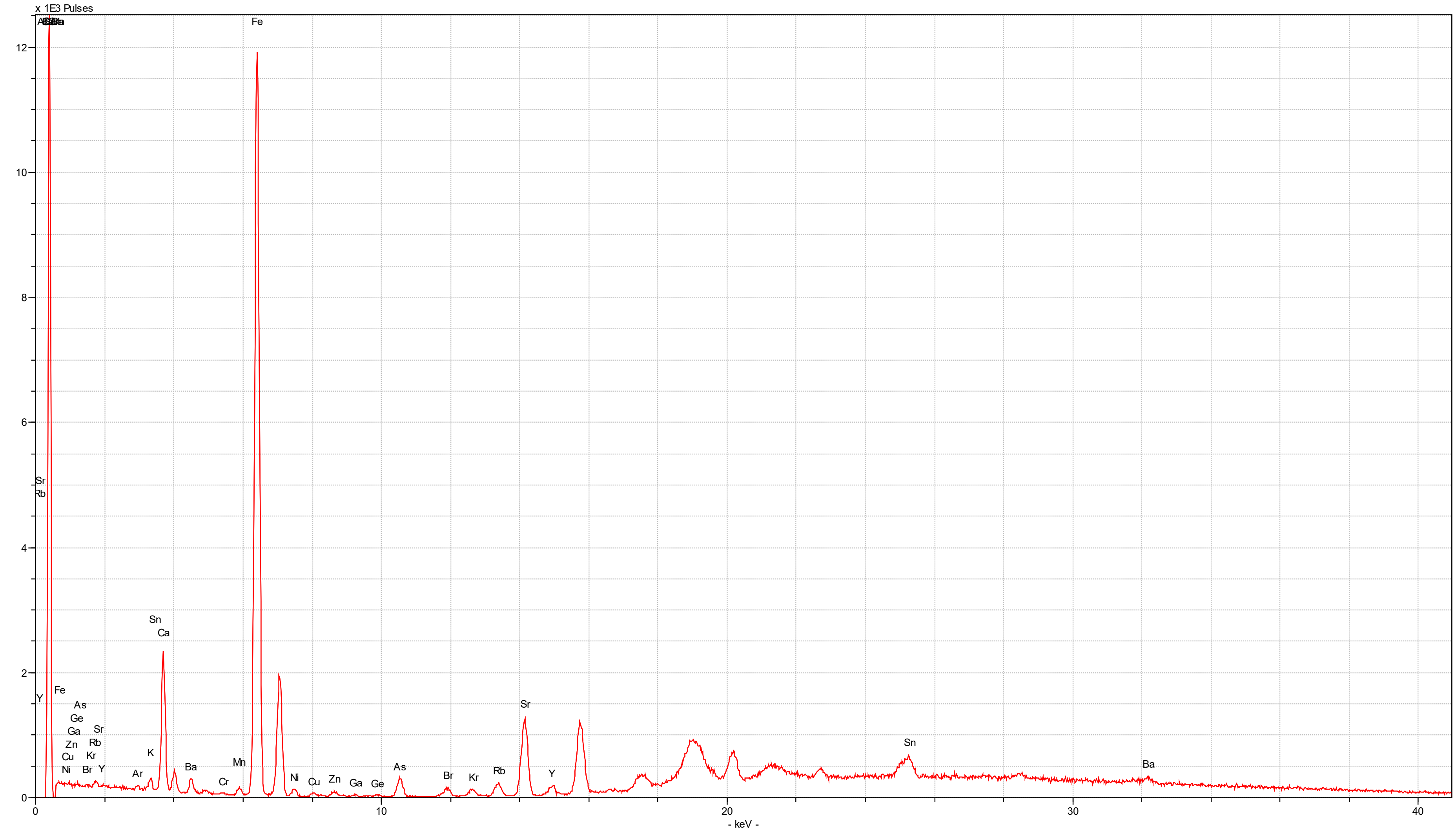


Figure 19. Sample [21] Soil

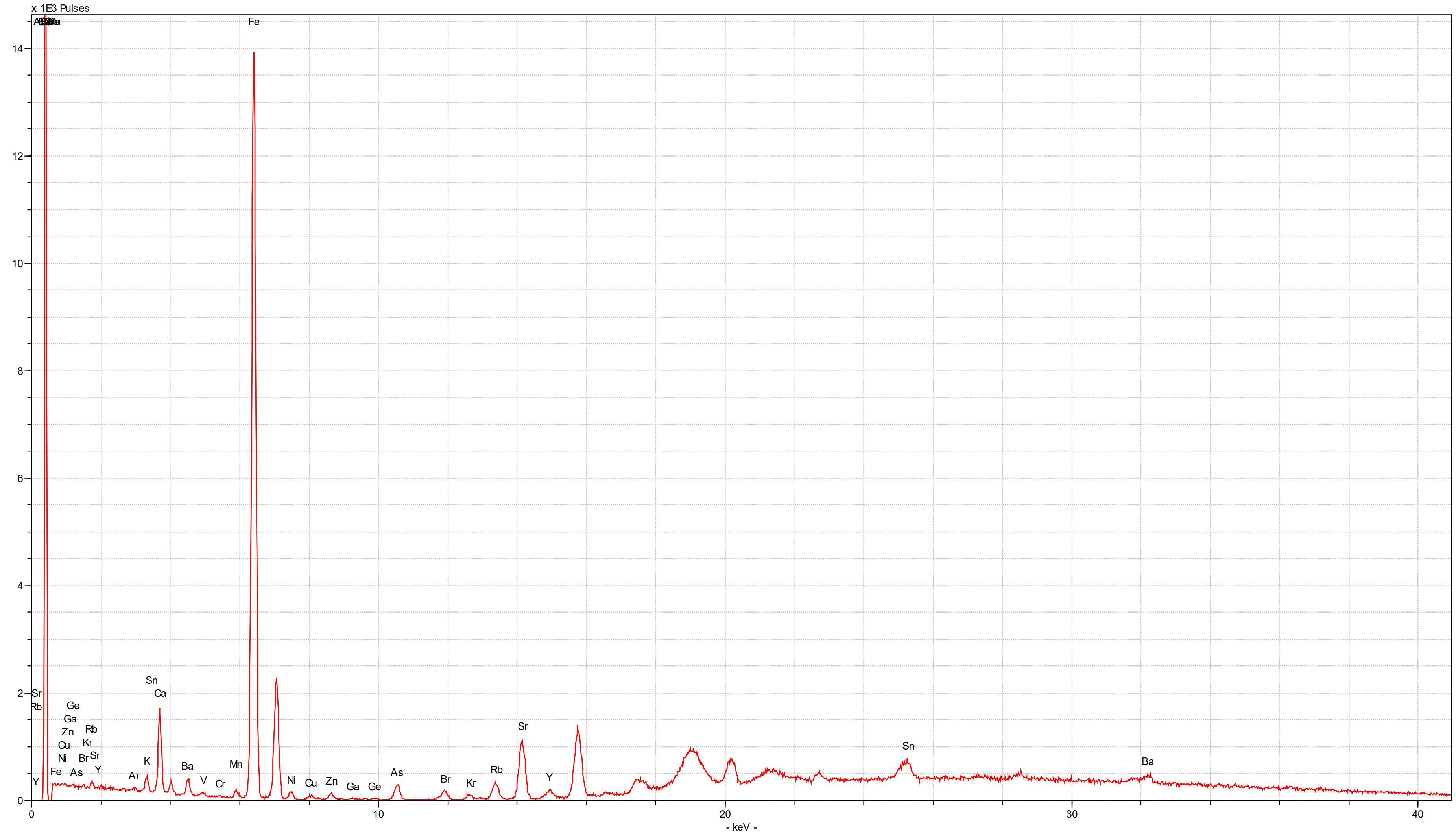


Figure 20. Sample [21]A

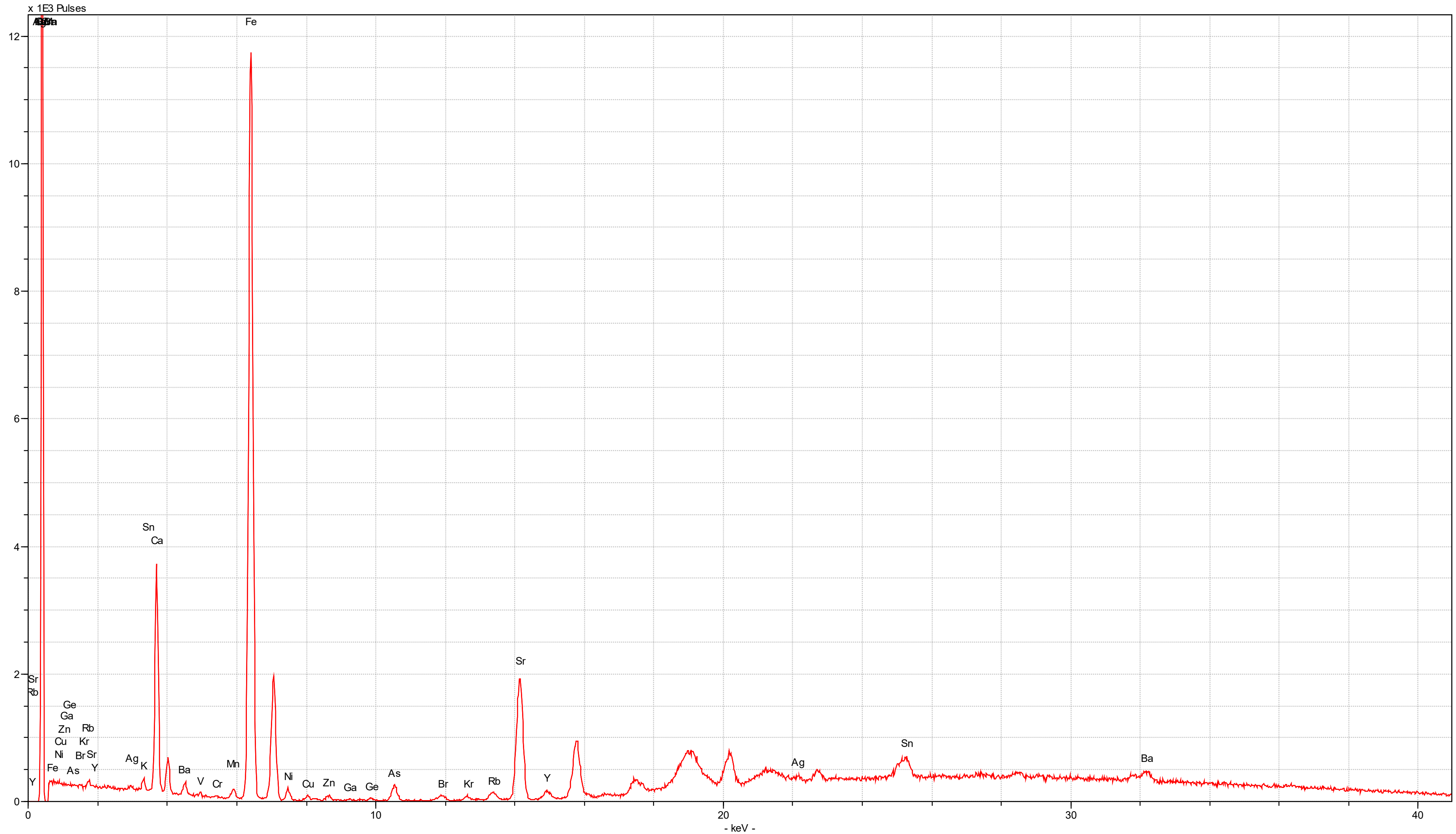
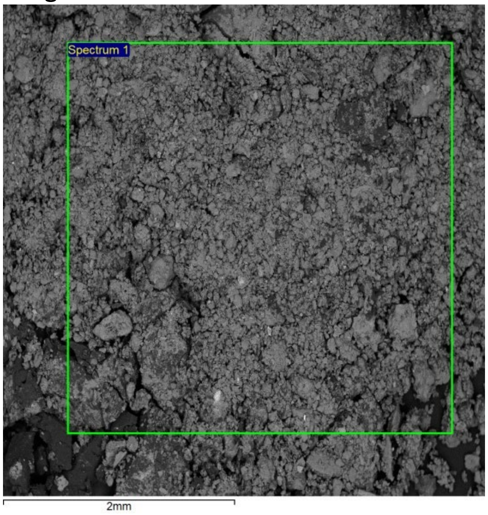


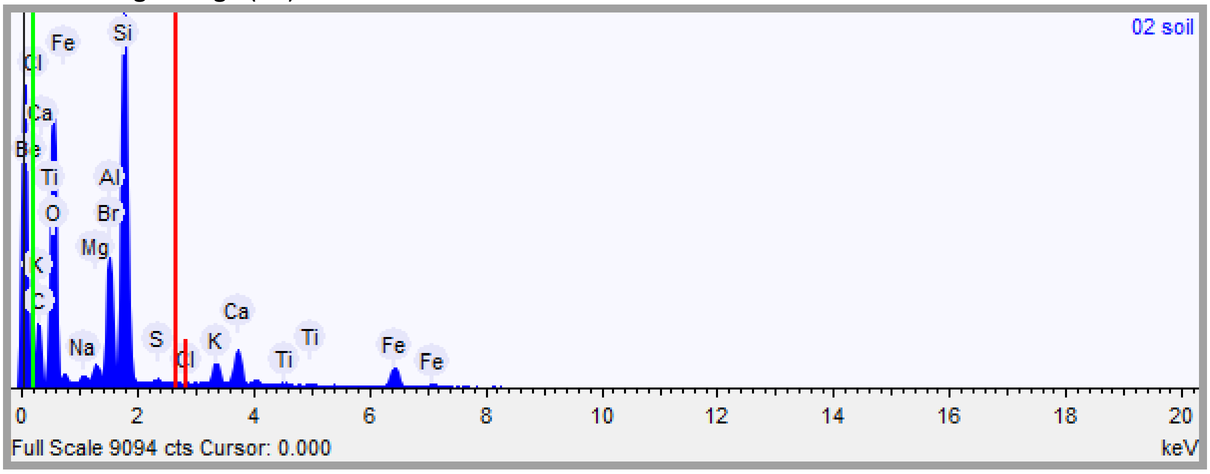
Figure 21. Sample [21]B

Appendix 2.2 – SEM-EDX Results
Spectrum details
Context [2] soil

Electron Image
Image Width: 4.152 mm



Acquisition conditions
Acquisition time (s) 119.7 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

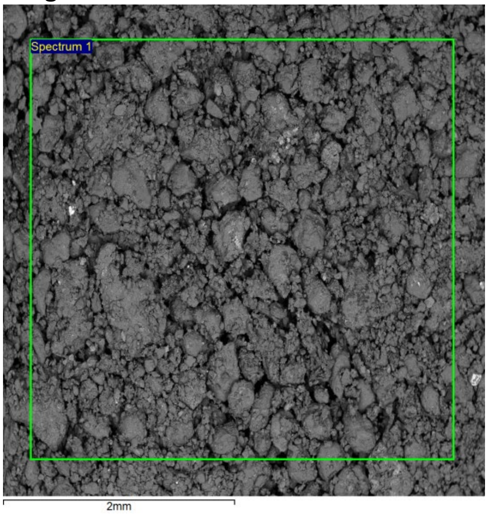
Summary results

Element	Weight %	Weight % σ	Atomic %
Carbon	18.166	1.580	26.964
Oxygen	49.393	1.031	55.040
Sodium	0.376	0.041	0.292
Magnesium	0.761	0.041	0.558
Aluminium	4.502	0.280	2.974
Silicon	16.107	0.345	10.224
Sulfur	0.204	0.029	0.113

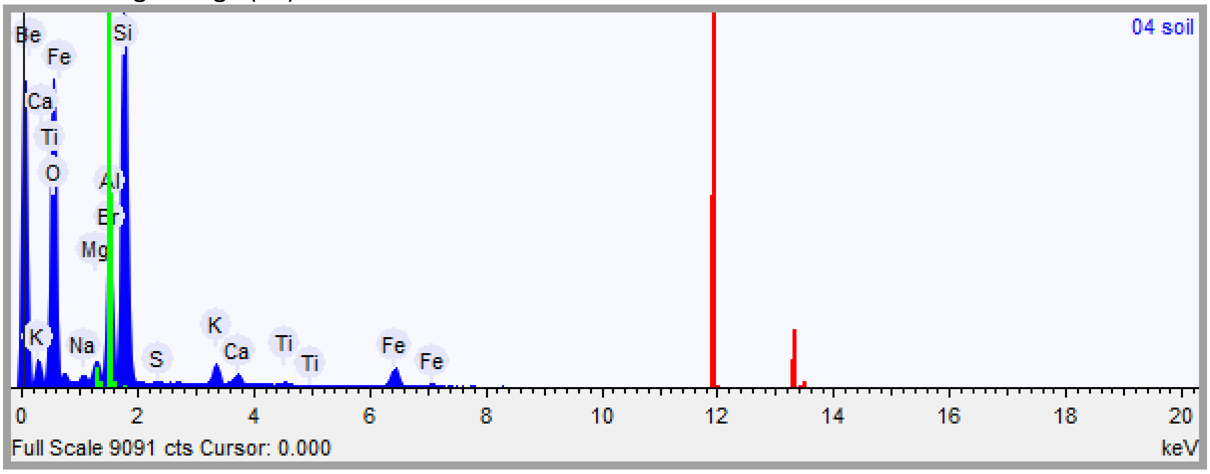
Chlorine	0.033	0.027	0.017
Potassium	1.465	0.053	0.668
Calcium	2.686	0.077	1.195
Titanium	0.295	0.044	0.110
Iron	5.232	0.161	1.670
Bromine	0.778	0.585	0.174

Spectrum details
Context [4] soil

Electron Image
Image Width: 4.152 mm



Acquisition conditions
Acquisition time (s) 120.4 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

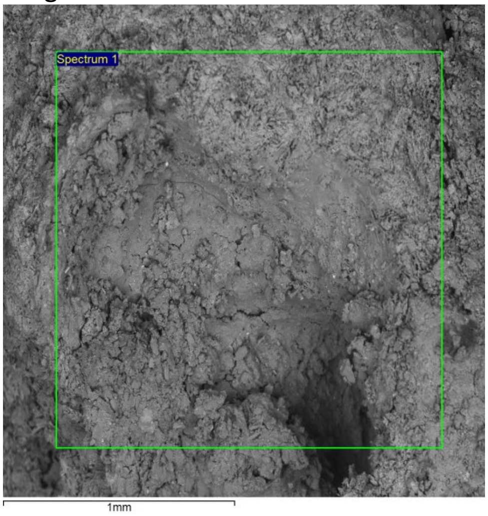
Summary results

Element	Weight %	Weight % σ	Atomic %
Oxygen	55.684	0.575	71.473
Sodium	0.571	0.058	0.510
Magnesium	1.264	0.056	1.067
Aluminium	6.174	0.378	4.699
Silicon	23.592	0.271	17.250
Sulfur	0.116	0.038	0.075
Potassium	1.969	0.061	1.034
Calcium	1.093	0.054	0.560

Titanium	0.414	0.059	0.178
Iron	7.316	0.173	2.690
Bromine	1.807	0.830	0.464

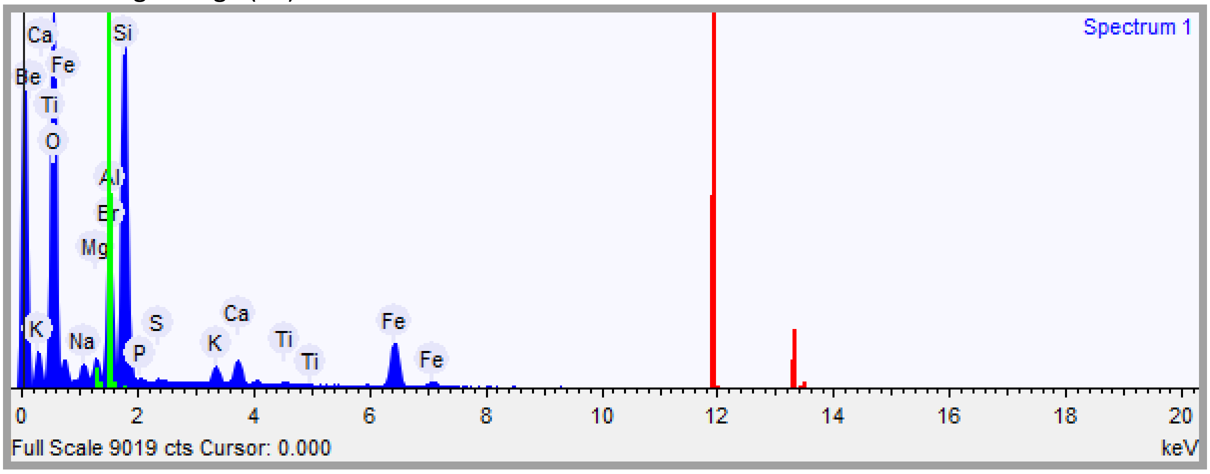
Spectrum details
Sample [4]B

Electron Image
Image Width: 2.076 mm



Acquisition conditions

Acquisition time (s) 120.3 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings

Quantification method All elements (normalised)
Coating element None

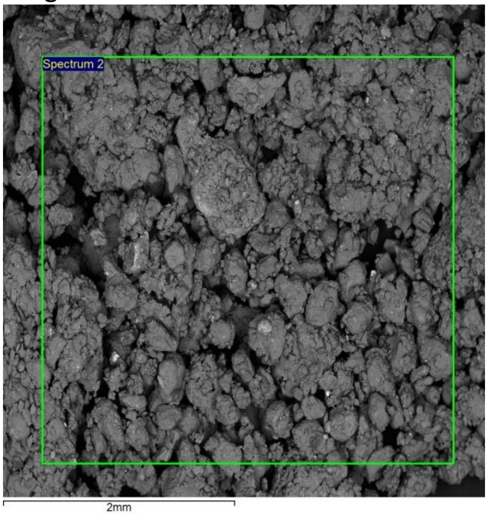
Summary results

Element	Weight %	Weight % σ	Atomic %
Oxygen	53.975	0.503	71.535
Sodium	1.338	0.066	1.234
Magnesium	1.205	0.053	1.051
Aluminium	5.506	0.336	4.327
Silicon	18.395	0.198	13.887
Phosphorus	0.208	0.044	0.143
Sulfur	0.200	0.036	0.132
Potassium	1.384	0.050	0.751
Calcium	2.194	0.059	1.161
Titanium	0.372	0.052	0.165

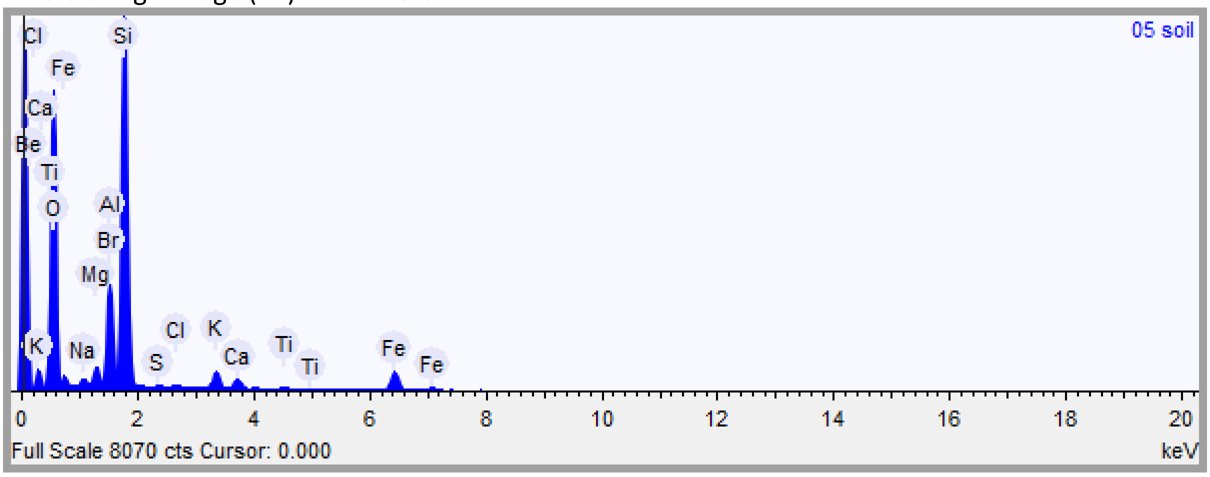
Iron	13.787	0.211	5.234
Bromine	1.435	0.737	0.381

Spectrum details
Context [5] soil

Electron Image
Image Width: 4.152 mm



Acquisition conditions
Acquisition time (s) 119.8 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

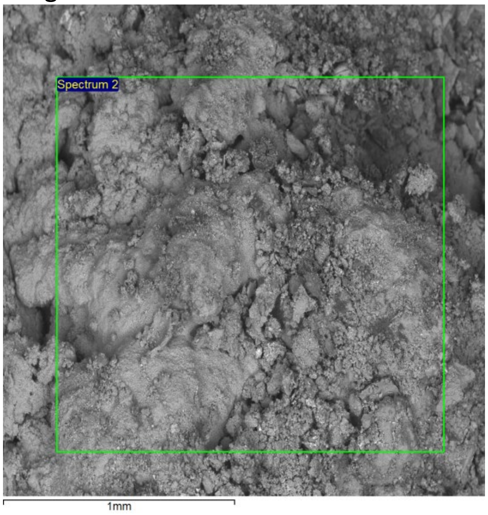
Summary results

Element	Weight %	Weight % σ	Atomic %
Oxygen	56.102	0.600	71.903
Sodium	0.510	0.063	0.455
Magnesium	1.140	0.059	0.961
Aluminium	5.147	0.389	3.912
Silicon	24.172	0.290	17.648
Sulfur	0.143	0.041	0.091

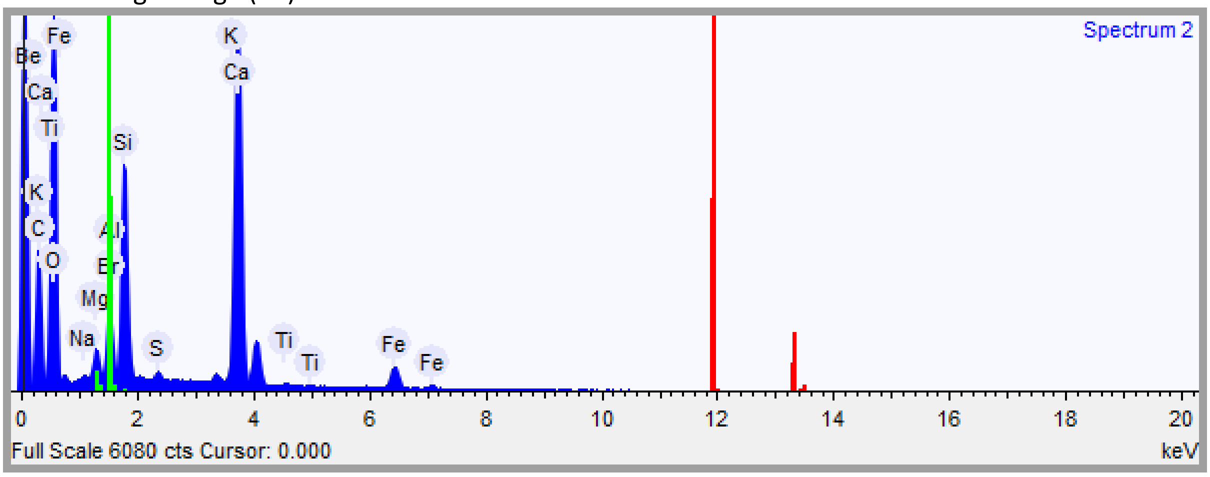
Chlorine	0.311	0.044	0.180
Potassium	1.751	0.062	0.918
Calcium	1.104	0.058	0.565
Titanium	0.359	0.059	0.154
Iron	7.568	0.189	2.779
Bromine	1.693	0.851	0.434

Spectrum details
Sample [13]B

Electron Image
Image Width: 2.076 mm



Acquisition conditions
Acquisition time (s) 120.2 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

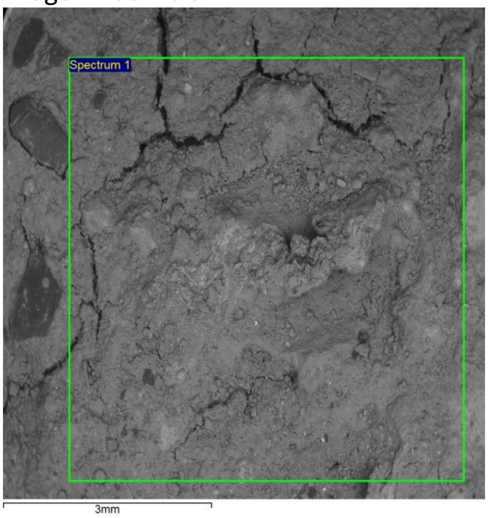
Summary results

Element	Weight %	Weight % σ	Atomic %
Carbon	11.631	1.140	18.228
Oxygen	55.244	0.800	64.993

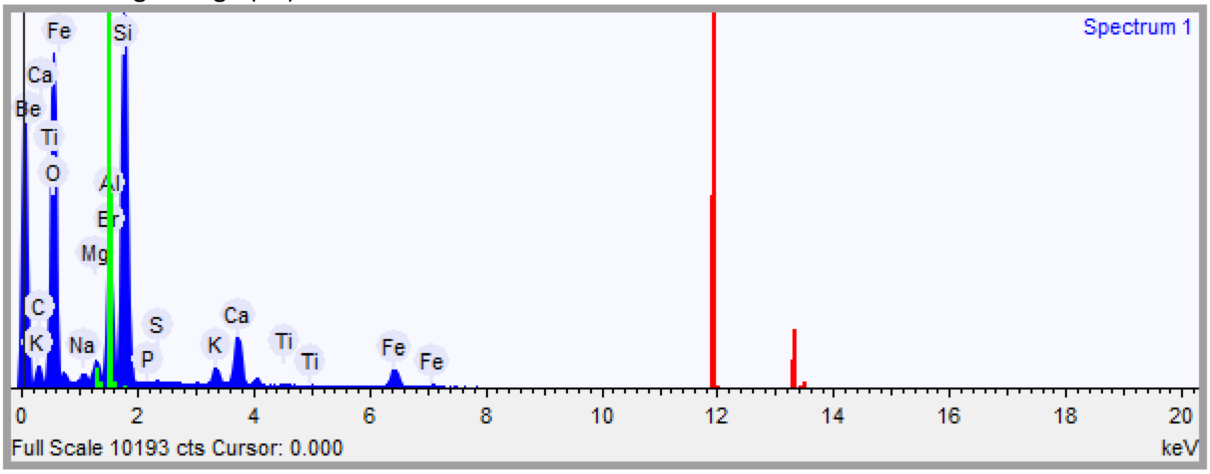
Sodium	0.178	0.043	0.146
Magnesium	0.975	0.043	0.754
Aluminium	1.394	0.201	0.972
Silicon	6.188	0.109	4.147
Sulfur	0.272	0.030	0.160
Potassium	0.391	0.035	0.188
Calcium	18.663	0.290	8.765
Titanium	0.222	0.043	0.087
Iron	4.125	0.127	1.390
Bromine	0.718	0.428	0.169

Spectrum details
Sample [14]B

Electron Image
Image Width: 6.921 mm



Acquisition conditions
Acquisition time (s) 119.9 Process time 5
Accelerating voltage (kV) 15.0



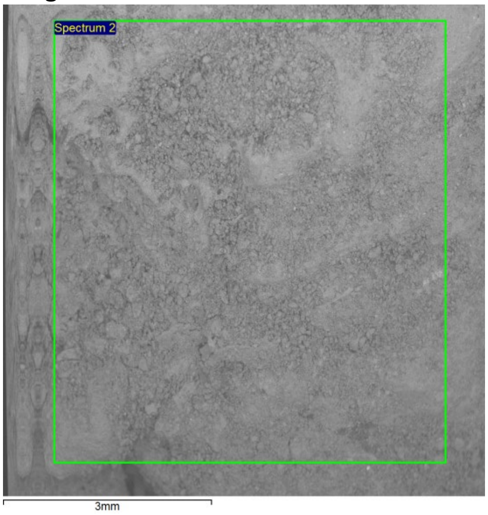
Quantification Settings
Quantification method All elements (normalised)
Coating element None

Summary results

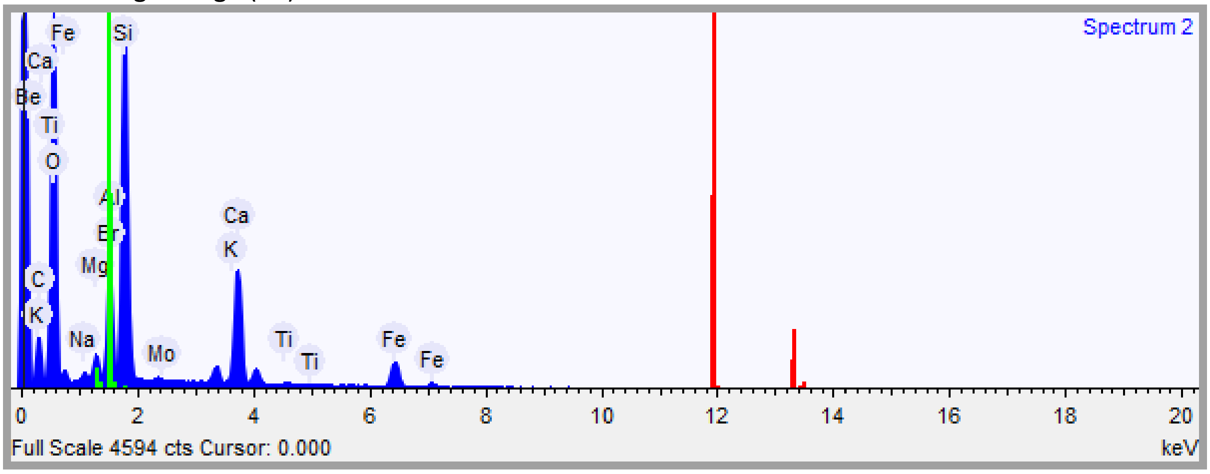
Element	Weight %	Weight % σ	Atomic %
Carbon	6.408	1.502	10.266
Oxygen	55.972	1.002	67.321
Sodium	0.512	0.047	0.428
Magnesium	1.073	0.047	0.849
Aluminium	4.691	0.295	3.346
Silicon	18.272	0.340	12.519
Phosphorus	0.175	0.034	0.109
Sulfur	0.127	0.029	0.076
Potassium	1.292	0.048	0.636
Calcium	4.378	0.099	2.102
Titanium	0.368	0.044	0.148
Iron	5.577	0.154	1.922
Bromine	1.156	0.624	0.278

Spectrum details
Sample [21]B

Electron Image
Image Width: 6.921 mm



Acquisition conditions
Acquisition time (s) 120.3 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

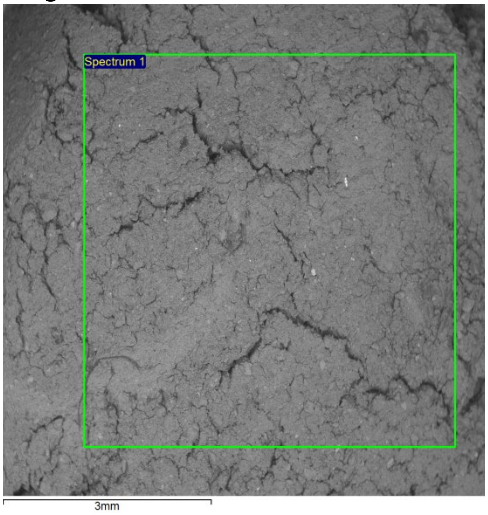
Summary results

Element	Weight %	Weight % σ	Atomic %
Carbon	8.740	1.915	13.913
Oxygen	55.350	1.287	66.149
Sodium	0.426	0.061	0.354
Magnesium	1.026	0.061	0.807
Aluminium	3.380	0.349	2.395
Silicon	13.674	0.337	9.309
Potassium	1.020	0.058	0.499
Calcium	8.325	0.219	3.972

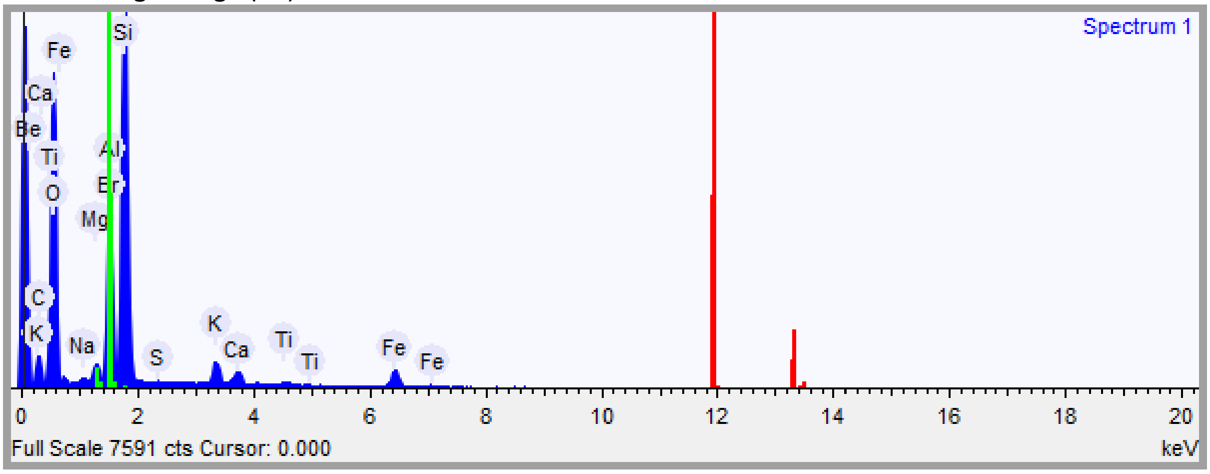
Titanium	0.286	0.058	0.114
Iron	6.275	0.219	2.148
Bromine	1.014	0.741	0.243
Molybdenum	0.484	0.117	0.097

Spectrum details
Durham soil sample for comparison

Electron Image
Image Width: 6.921 mm



Acquisition conditions
Acquisition time (s) 120.0 Process time 5
Accelerating voltage (kV) 15.0



Quantification Settings
Quantification method All elements (normalised)
Coating element None

Summary results

Element	Weight %	Weight % σ	Atomic %
Carbon	8.318	2.056	13.121

Oxygen	54.170	1.333	64.150
Sodium	0.221	0.049	0.183
Magnesium	0.922	0.053	0.719
Aluminium	6.877	0.397	4.829
Silicon	19.618	0.495	13.234
Sulfur	0.114	0.036	0.068
Potassium	1.964	0.074	0.952
Calcium	1.192	0.062	0.564
Titanium	0.516	0.059	0.204
Iron	5.234	0.192	1.776
Bromine	0.854	0.814	0.202

Appendix 3: Stratigraphic matrices

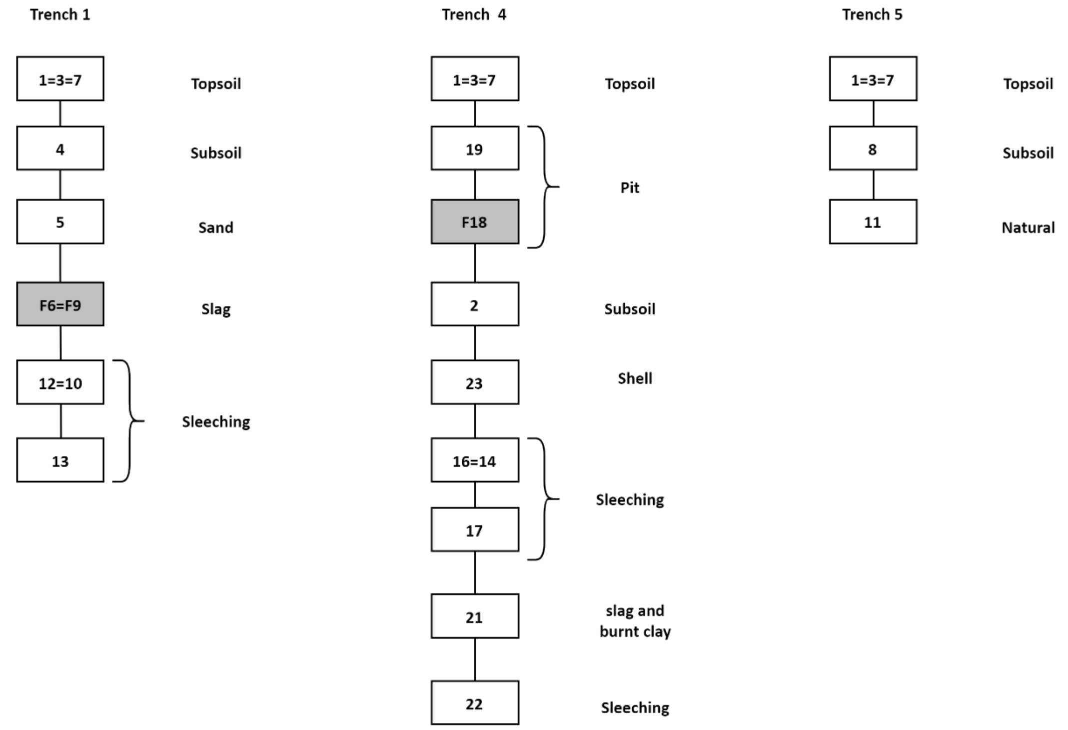


Photo 1: The mound (**E1**), looking north

Photo 2: Bank (**E2**) and channel in the west of the survey area, looking north

Photo 3: Channel (**E3**) to the east of the mound, looking north

Photo 4: Trench 1, looking east

Photo 5: Trench 1, slag deposit [F6=F9] at the east end of the trench, looking east

Photo 6: Trench 2, looking west

Photo 7: Trench 2, section of the south end of the trench showing deposits, looking south

Photo 8: Trench 2, section of the north end of the trench showing pit [F18], looking west

Photo 9: Trench 3, looking north

Photo 10: Volunteer undertaking topographic survey

Photo 11: Volunteers undertaking geophysical survey

Photo 12: The excavations getting underway

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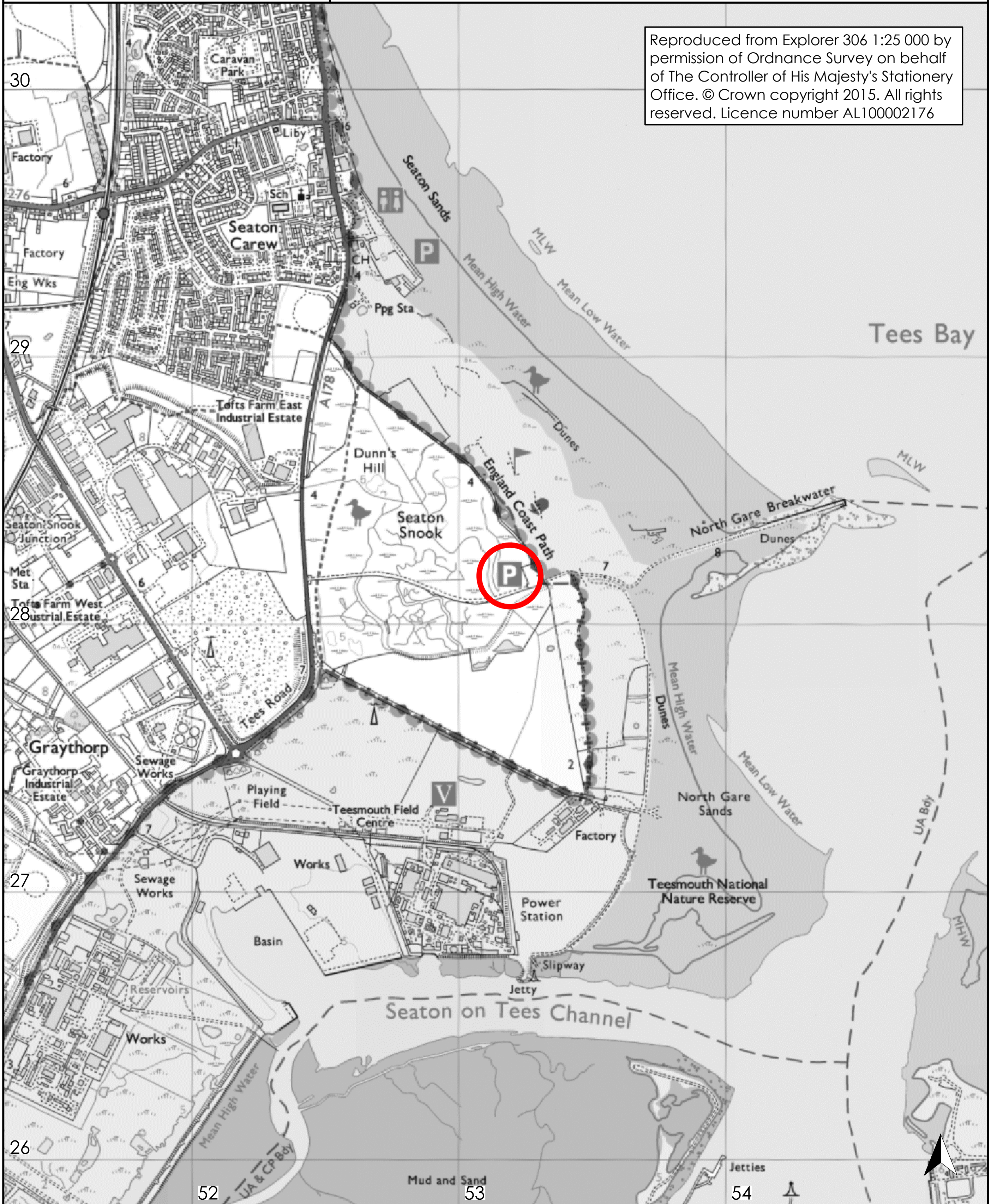
Figure 1: Site location



site location

0 1km
scale 1:20 000 for A4 plot

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magnetometer survey

-4 nT 6

dipolar magnetic anomaly

0 50m
scale 1:1000 for A3 plot

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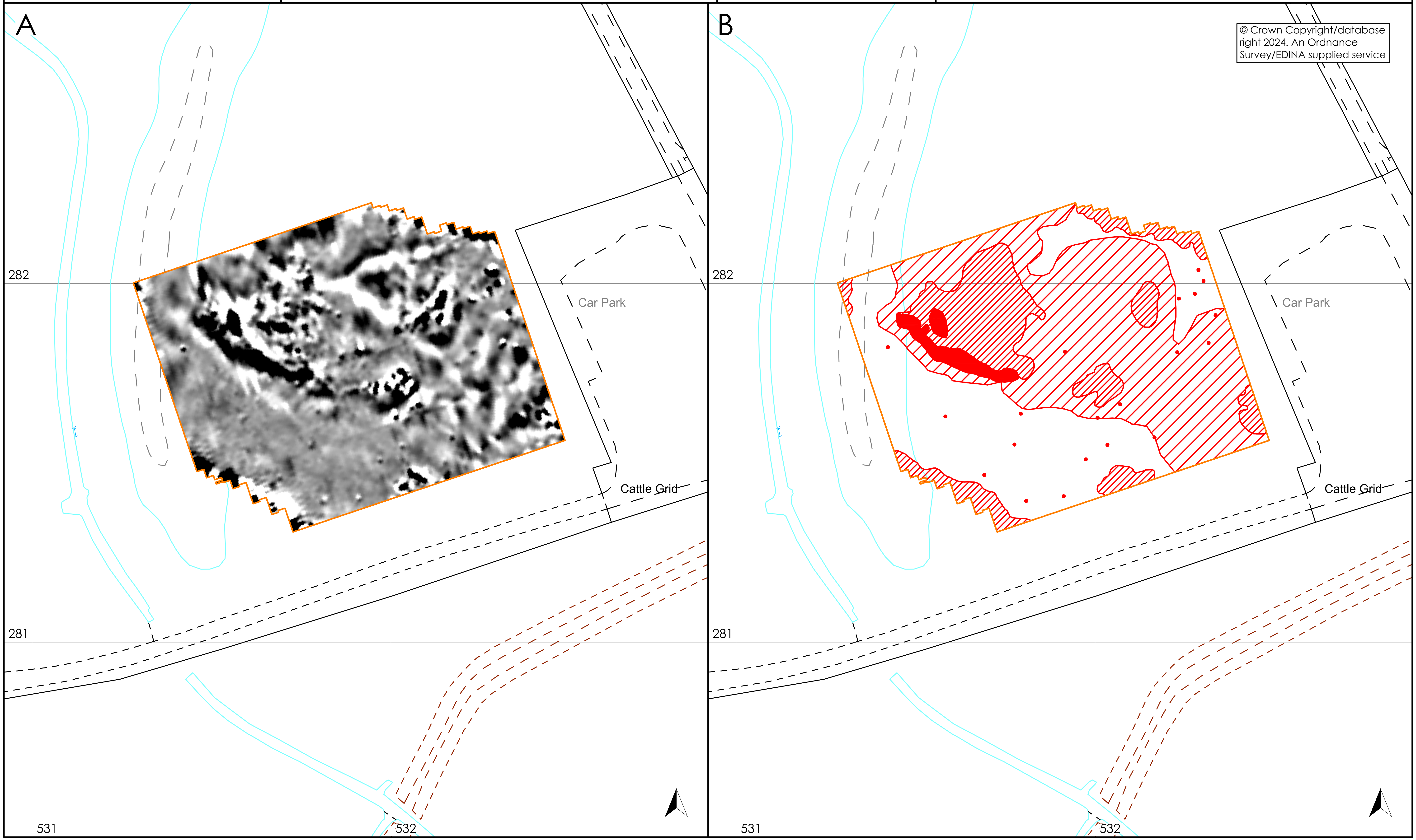
Figure 2: Magnetometer survey (A) and geophysical interpretation (B)



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resistance survey

0 ohm 65

high resistance anomaly

low resistance anomaly

0 50m
scale 1:1000 for A3 plot

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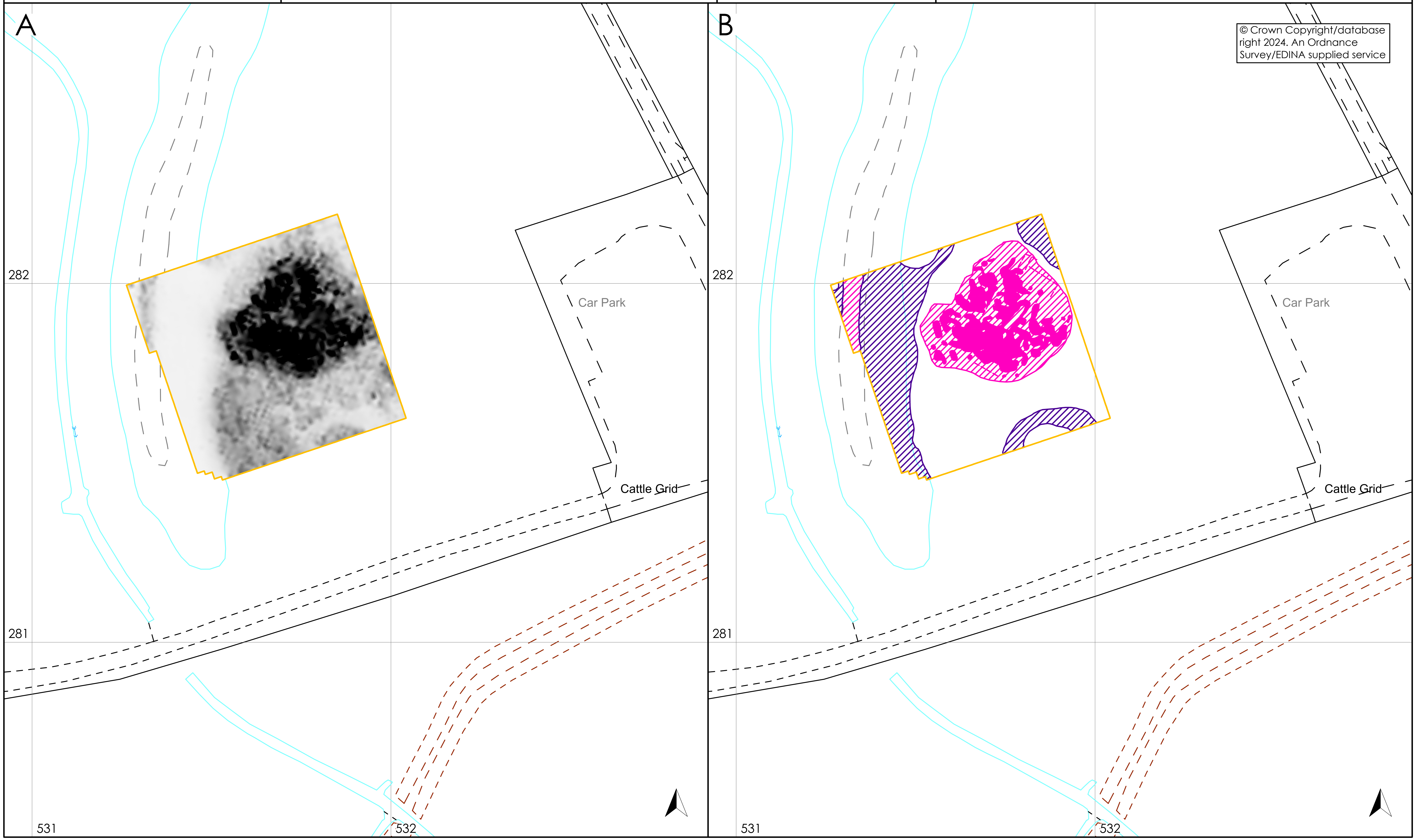
Figure 3: Resistance survey (A) and geophysical interpretation (B)



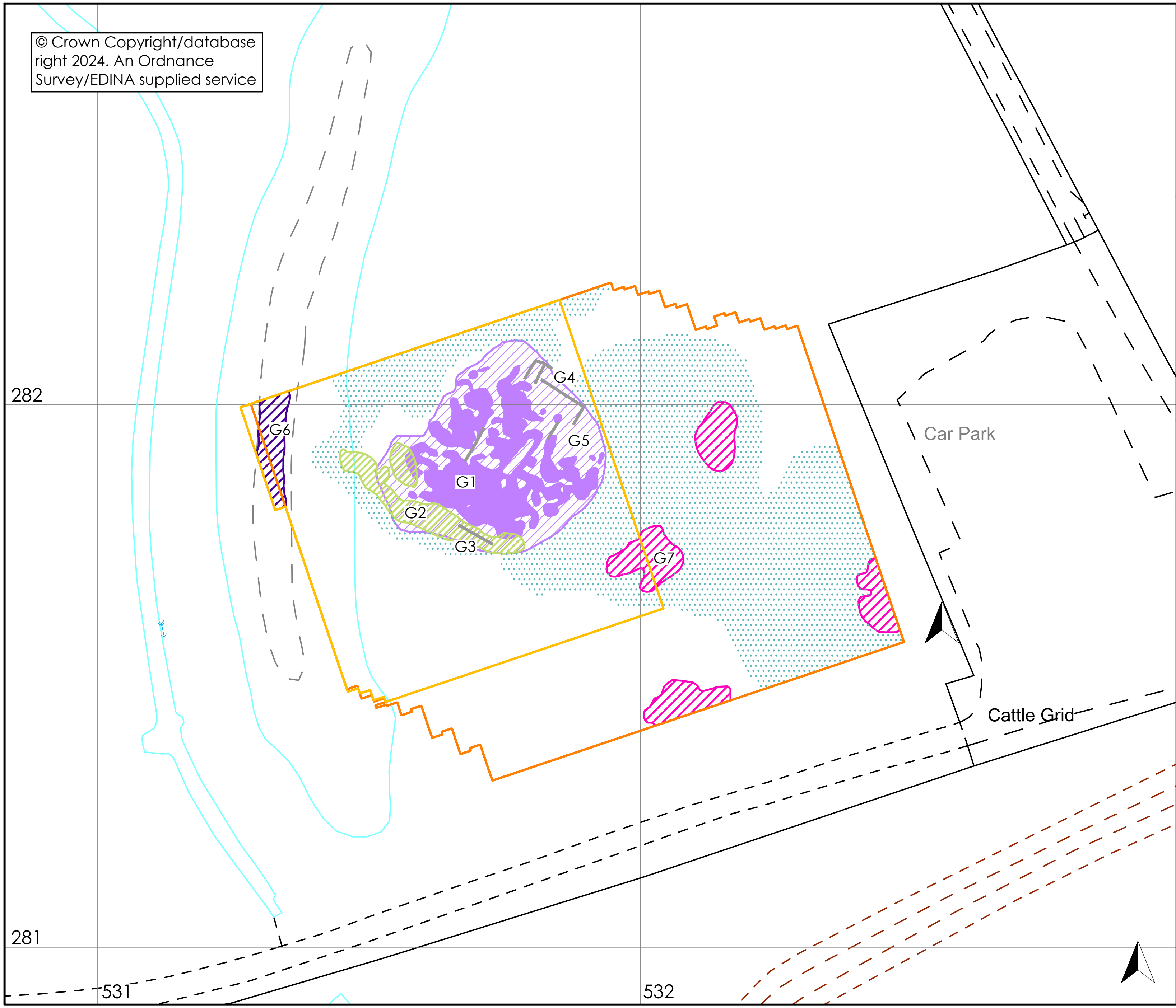


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Figure 4: Archaeological interpretation of geophysical surveys

0 — 50m
scale 1:1000 for A4 plot

- magnetometer survey
- resistance survey
- possible structure
- disturbed area
- geological feature
- bank
- probable slag
- burnt clay and ash

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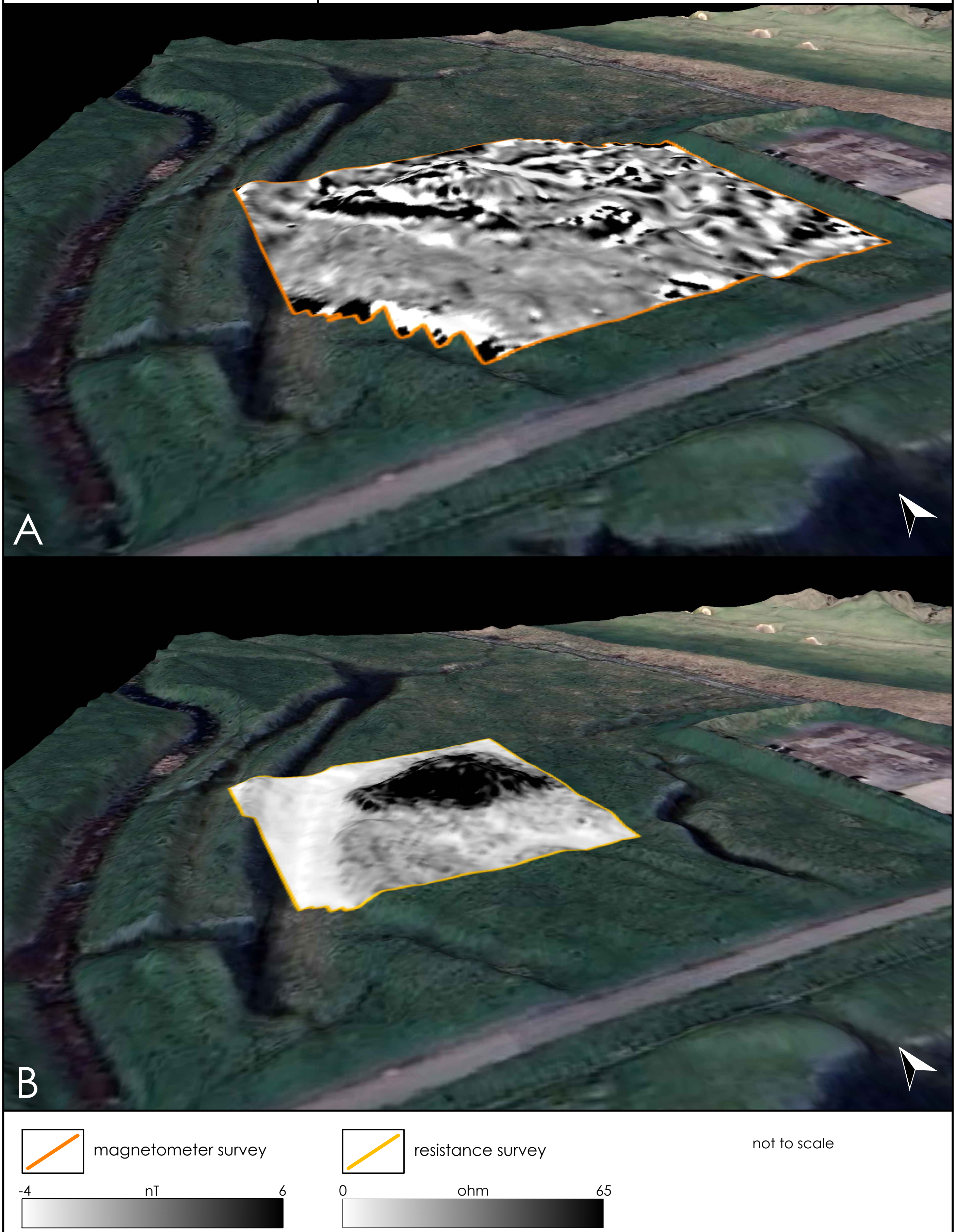
Figure 5: Magnetometer (A) and resistance (B) surveys overlying derived LiDAR surface



not to scale

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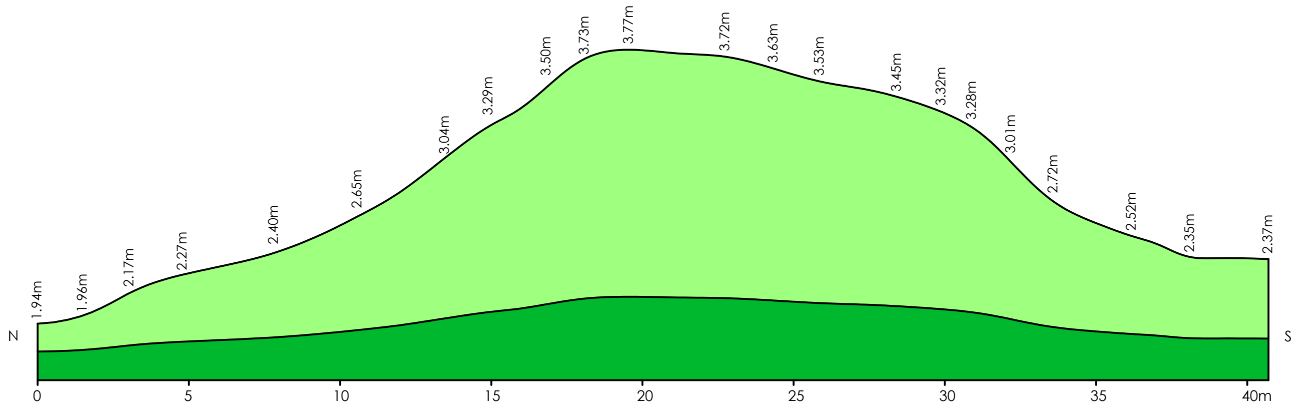
Figure 6: Profiles of saltern mound

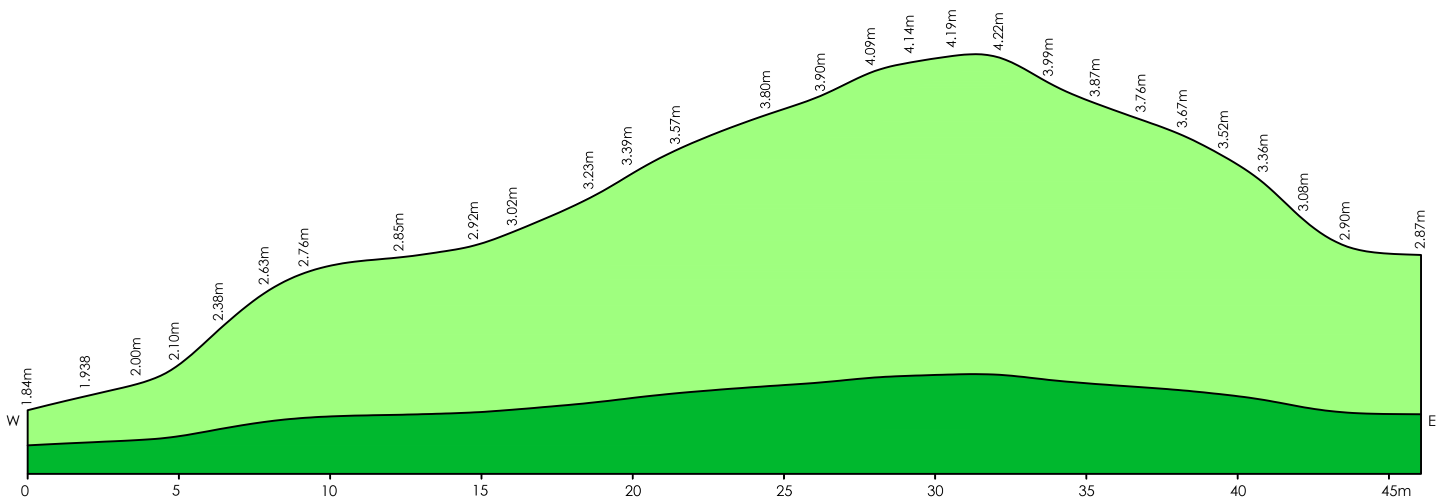
0 10m
scale 1:250 for A4 plot

profile x1

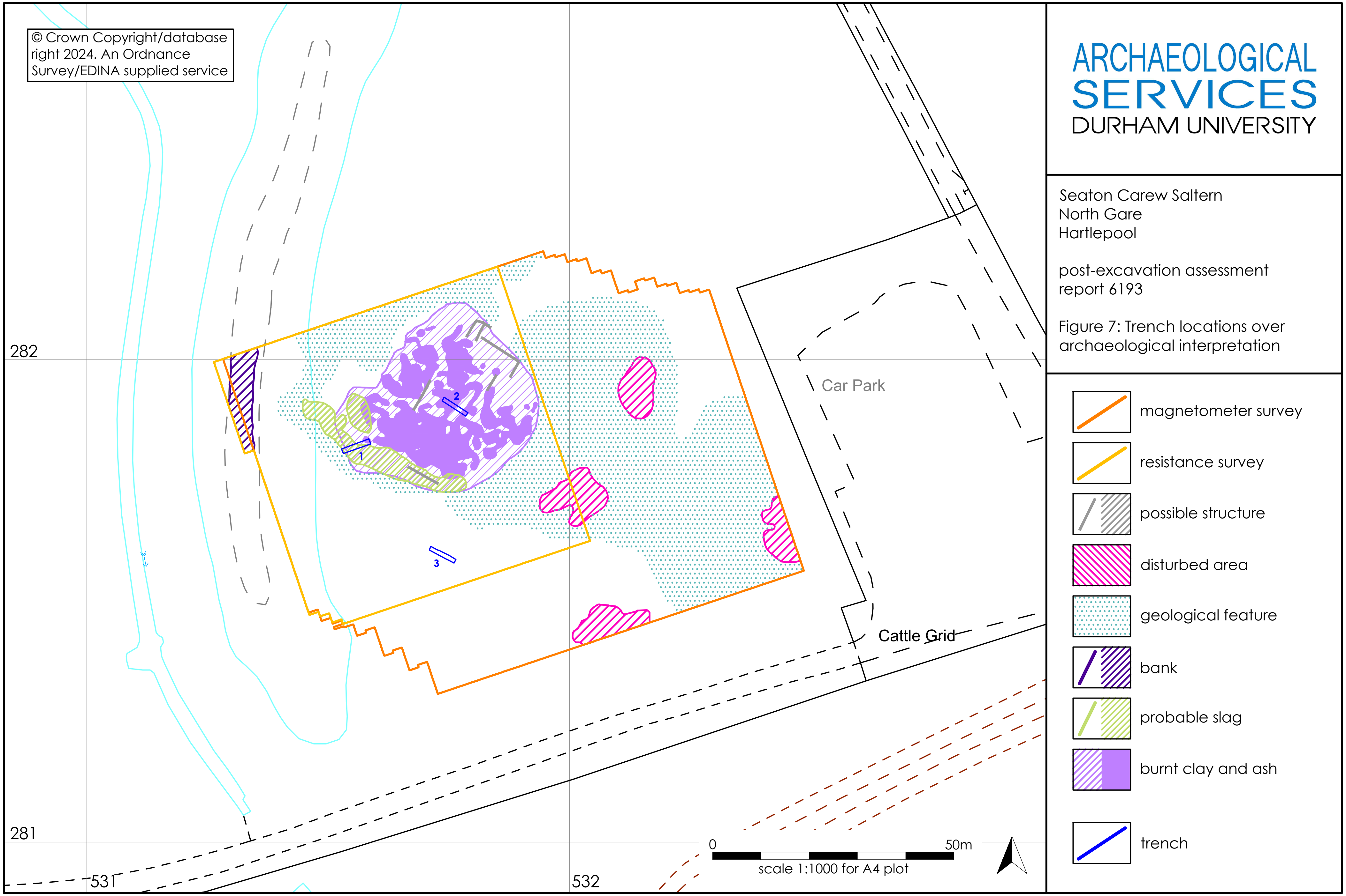
profile x5



N-S profile



W-E profile


© Crown Copyright/database right 2024. An Ordnance Survey/EDINA supplied service
282
281
531
532
Car Park
Cattle Grid
1
2
3
0
50m
scale 1:1000 for A4 plot
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North Gare
Hartlepool
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Figure 7: Trench locations over archaeological interpretation
magnetometer survey
resistance survey
possible structure
disturbed area
geological feature
bank
probable slag
burnt clay and ash
trench

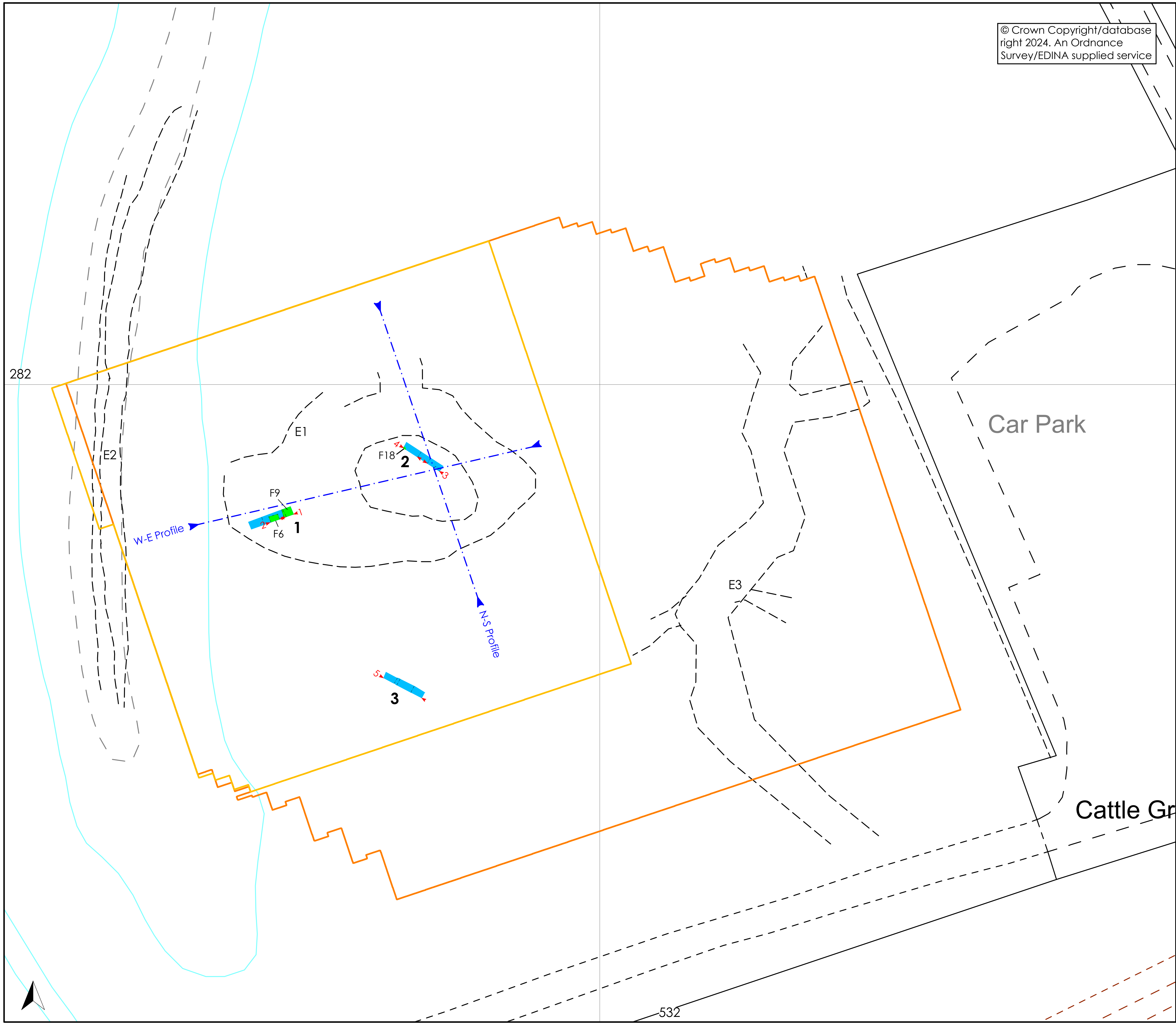

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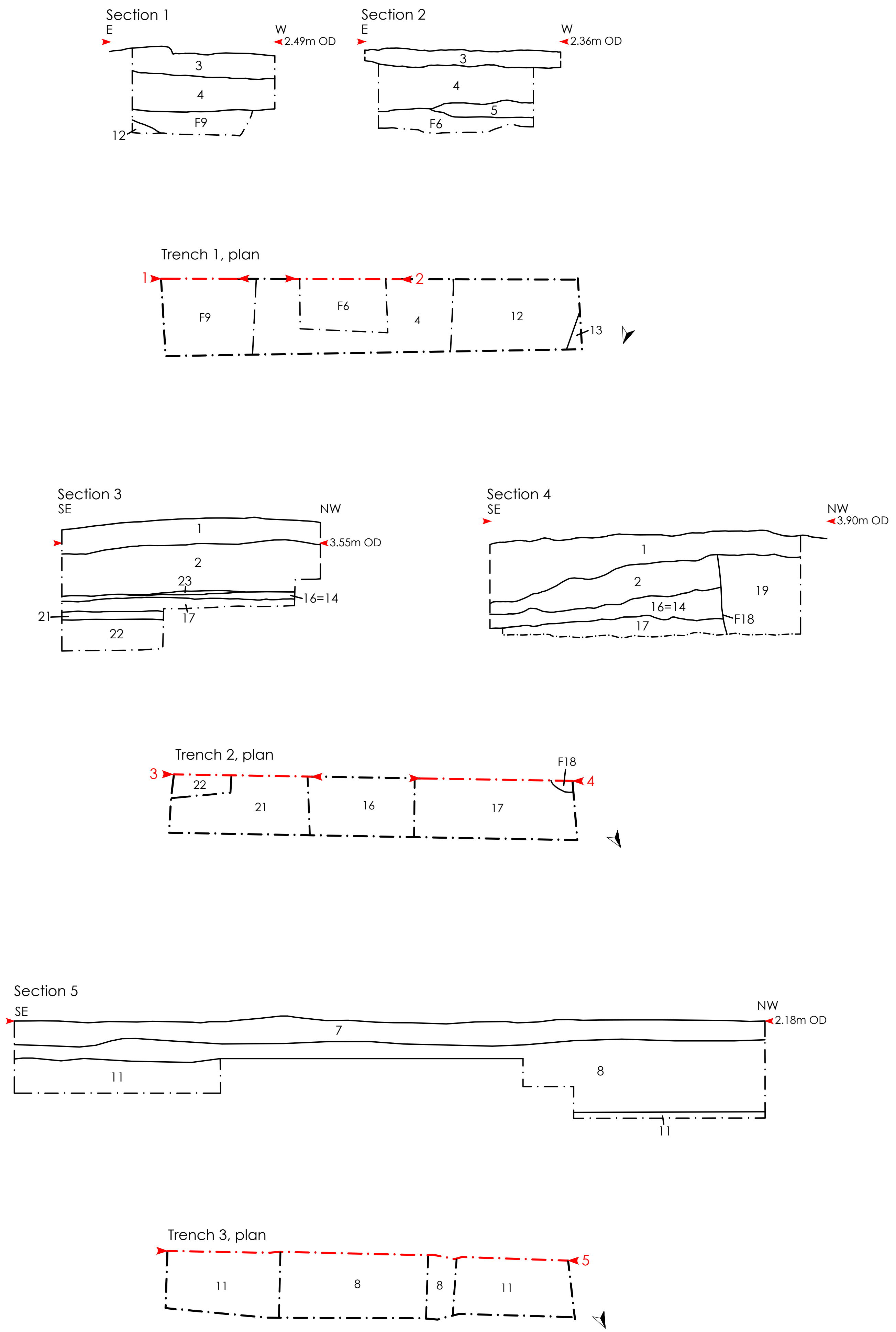
Figure 8: Trench locations and excavated features

0 25m
scale 1:500 for A3 plot

- magnetometer survey
- resistance survey
- trench
- edge of excavation
- section
- archaeological feature
- topographic feature
- topographic profile



ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

Seaton Carew Saltern
North Gare
Hartlepool

post-excavation assessment
report 6193

Figure 9: Trench plans and sections

0 2m
section scale 1:40 for A3 plot
0 3m
plan scale 1:75 for A3 plot

edge of excavation

section