Interreg North-West Europe NWE-REGENERATIS

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D. I1.2.4. SITE SPECIFIC DATASET FOR GEOPHYSICAL CHARACTERIZATION METHOD ON TEESSIDE SITE (UK)

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SUMMARY

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3 INTRODUCTION

The following report describes the site-specific datasets for investigation studies of Teesside that will be used for: (1) the creation of the geophysical database needed to design the NWE-SMARTIX (WP T2- A4) and (2) the performance reports on the Geophysical Characterization Method (WP T3- A1).

Regarding the creation of the geophysical database needed in the NWE-SMARTIX, one of the goals of the software is to suggest a selection of geophysical methods that will be applied efficiently on site to characterize the volume of materials potentially revalorized. The validation of the tool will be done by processing built datasets from the different pilot and additional sites, including the results from Teesside.

Regarding the performance reports on the geophysical characterization method, the dataset on Teesside will help determining the pros and cons of each geophysical methods for the characterization of the volume of materials potentially revalorized (estimation of resources potential and existing pollution).

First, we introduce a decision tree composed of a series of questions that have been used to develop this module. Then we present a geophysical dataset representative of the type of industrial waste and raw materials found on the investigated area chosen at Teesside. In particular the latter dataset is composed of measurements of electrical resistivity tomography and induced polarization methods- which were the most suitable for the characterization.

3.1 THE STUDY AREA

The Teeswork area, formerly known as the South Tees Development Corporation [STDC] site, is a large site (1500 ha) with a 160-year history of iron and steel production and the processing of finished products. The site has been used, at varying periods, for the storage of feedstock, products, by-products, and waste streams.

Figure 1: a) Location of studied area within the Teeswork complex; b) Digital terrain model of the studied area with indications on the different geophysical profiling and mapping measurements undertaken, and the surface samples collected on the Teesside site.

The specific site selected for NWE-REGENERATIS project is located within the Long Acre zone (https://www.teesworks.co.uk/the-development/zones/long-acres) (see Figure 1a). It is called CLE31. It is mostly composed of deposited slag materials, though various pieces of scrap materials are also noted. Vegetation growth exists in some areas within the CLE31 zone. Whilst much of the zone is flat and accessible, there are some piles and evidence that the deposits are not fully secure, likely due to the presence of layers within the slag deposit, and resulting air pockets (see Figure 1b).

The site was active from 1970’s to July 2002. On satellite image, the site looks like unchanged from 2000 to nowadays. The backfill deposit is caracterized by high iron (3960-297000 mg/Kg) and zinc (76.8-2170 mg/Kg) contents over a thickness of 10 m according to the phase 2 sketch (see Figure 2).

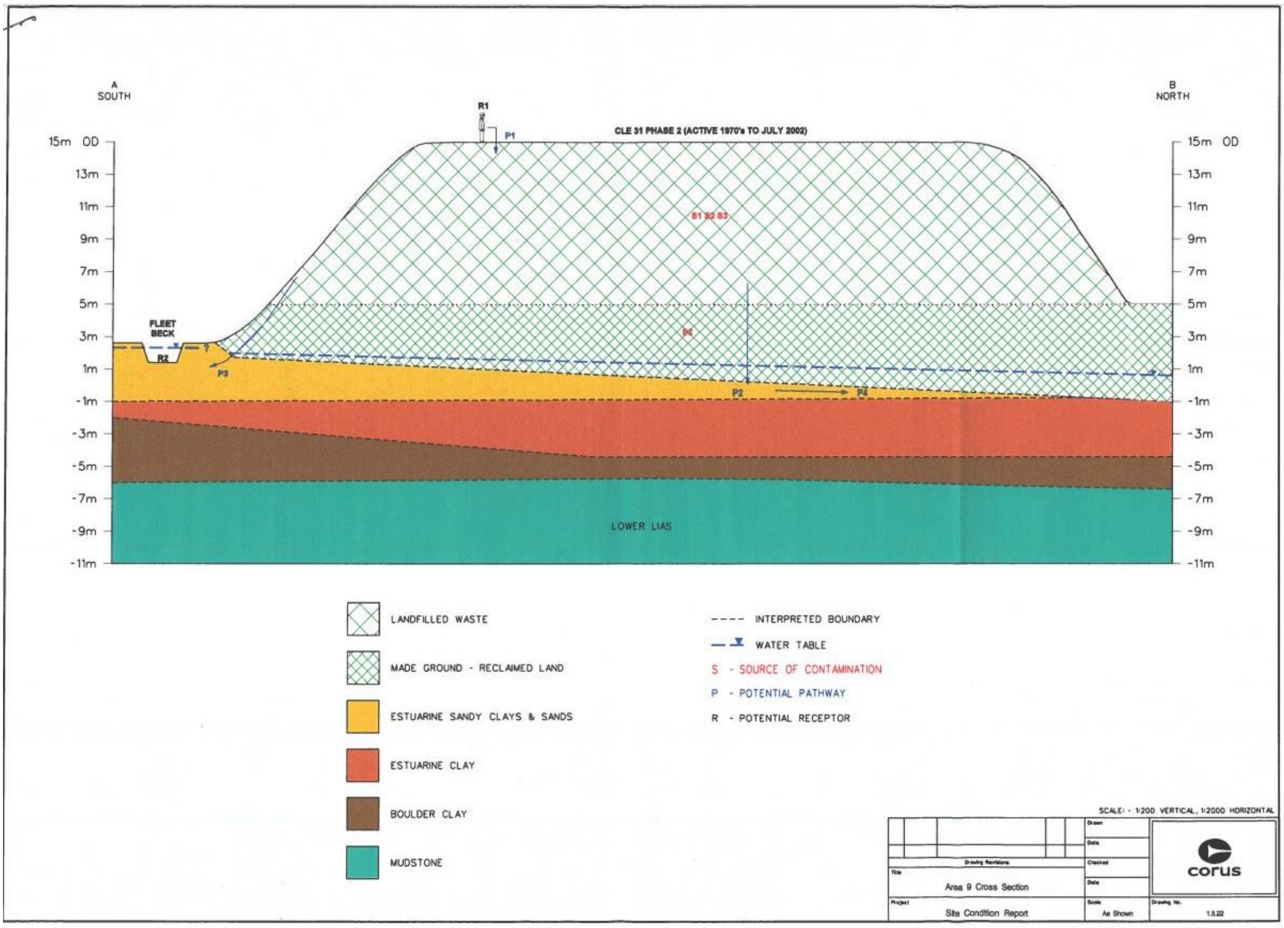

Figure 2: Schematic cross-section of the studied area CLE31 (Corus, 2003)

In may 2022,the BRGM and ULiege team used several methods during the geophysical survey:

- 3 mapping methods: electromagnetic induction, magnetic measurements (with a magnetometer) and surficial magnetic susceptibility measurements (wih a kappa-meter)
- 2 profiling methods: electrical resistivity and induced polarization tomographies.

4 Decision tree – Geophysical characterization module

4.1 Description

This decision tree was built by U. of Liège and BRGM (see Figure 3). More details regarding the description of the tree can be found in deliverable DI3.2.4.

The main objective of this decision tree is to define, set-up and carry out a geophysical survey in order to estimate the volume(s) of material(s) of interest.
Secondary objectives of the geophysical survey, that are not included in the decision tree, include the potential detection of water table(s), cavities and large concrete blocks. This information could be valuable for the definition of the recovery plan, and thus use as input of the related decision tree(s).

The inputs of the decision tree are the historical studies and available online data (e.g., remote sensing: aerial images) as well as the information obtained during site visits (i.e., current physical situation of the site: presence of vegetation, power lines at the vicinity, level of slopes…).

The header of the diagram defines:

- the different mapping (i.e. magnetic and electromagnetic induction methods) and profiling (i.e. ground penetrating radar, electrical resistivity tomography, induced polarization, seismic refraction tomography, multiple analysis of surface waves) geophysical methods that are considered in this decision tree for the field survey. A detailed description of each of these methods in the post metallurgical site and deposits context can be found in deliverable DT1.3.1.
- the Relevance (R) for each geophysical method: it defines the suitability of using a method according to available information. Its value ranges from 0 % (non-informative method) to 100 % (volume estimation possible using this method). The initial Relevance is put to 100 % *a priori* for all the methods. The detailed relevance rating of the output, split in 5 categories) is explained in
- Table 1.

The decision tree is composed of modules which are displayed in numerical order. Each module has a set of questions which are ordered continuously through all modules:

- **Module 1** is oriented to gather and organize information from historical studies and available online data of the site. Based on this, the Relevance of each method is updated.
- **Module 2** aims to update the method's Relevance after site visits where the current physical situation is considered.
- **Module 3**, based on Module 1 and 2, defines whether or not it is possible to estimate volume(s) of deposits of interest using geophysical characterization (used together with ground truth data from sampling).

The version of the decision tree presented below in Figure 3 has been updated from the initial version, based on the geophysical characterization results obtained for the pilote sites of La Louvière and Pompey, as well as the additional sites of Vieille Montagne, Nyrstar, STPI and La Campine. Indeed, the first version of the decision tree was too strict and would lower the score of the methods too drastically, when the methods actually were useful for the characterization of the PMSD.

Warning: For the sake of simplification, only basic questions, that can be applied to all the PMSD sites, have been kept in the decision tree. The results obtained are thus only indicative, and intended to help the site owner or the decision maker to target the most useful information in the available information, in order to discuss with the geophysicists. It cannot replace the expertise of a geophysicist, that is site-dependent.

Moreover, the decision tree only considers each method individually, when, in a lot of cases, it is the combination of several geophysical methods, combined with sampling characterization, that allow to extract the most qualitative (and quantitative) results. This will need to be considered in later versions of the decision tree and the NWE-SMARTIX tool.

Table 1: Final Relevance (R) rating in selected methods of the output

Method Relevance (R)		Description
0%	Non-informative	selected methods may be non-informative or non-applicable to the site
25%	Low interest	0< R≤ 25 % refers to methods of low interest
50%	Qualitative interpretation	if selected methods have a relevance of 25< R≤ 50 % a qualitative interpretation can be developed
75%	Quantitative interpretation	50< R≤ 75 % selected methods can be used to obtain a quantitative interpretation
100%	Volume(s) estimation	if 75< R≤ 100% an estimation of volume(s) is possible

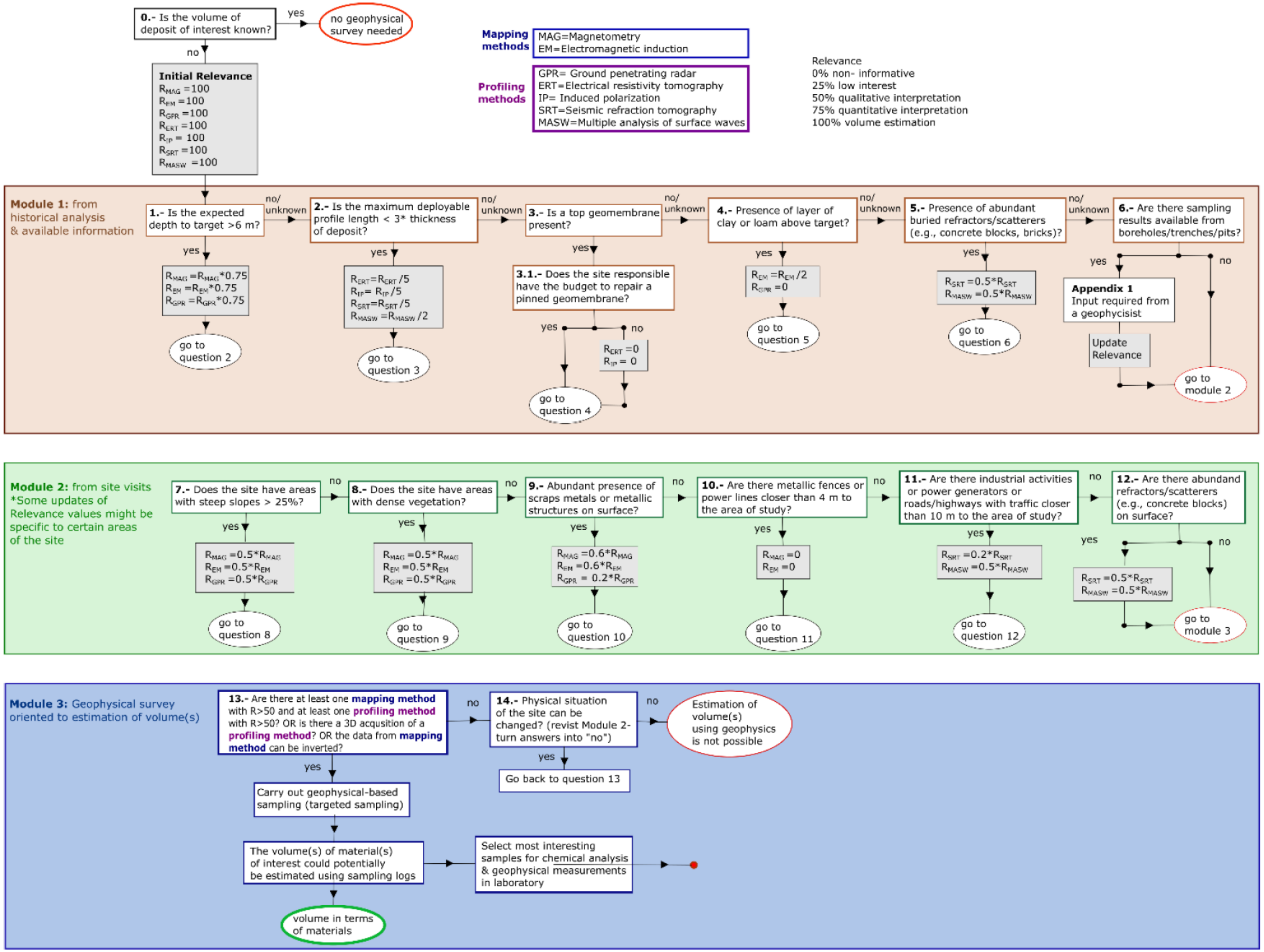

Figure 3: Decision tree for the Geophysical Characterization module

4.2 INPUT OF THE DECISION TREE

In Table 2, we illustrate the information from Teesside site as input in the decision tree. The far right column indicates with 1's and 0's the answers "yes" and "no" respectively.

Table 2: Input of the decision tree for the Pompey pilote site

Questions			Description	Teeside
Module 1: from available information	Q1	Is the expected depth to target >6m?		**1**
	Q2	Is the max deployable profile length <3 * thickness of deposit?		**0**
	Q3	Is a top geomembrane present?		**0**
	Q4	Presence of layer of clay or loam above target?		**0**
	Q5	Presence of abundant buried refractors/scatterers?		**1**
	Q6	Are there sampling results available from boreholes/trenches/pits?		**0**
Module 2: from site visite	Q7	Does the site have areas with steep slopes >25%?	if yes, it might only be in certain areas and not the entire site	**0**
	Q8	Does the site have areas with dense vegetation?	if yes, it might only be in certain areas and not the entire site	**0**
	Q9	Abundant presence of scraps metals or metallic structures at the surface?		**0**
	Q10	Are there metallic fences or power lines closer than 4m to the area of study?		**0**
	Q11	Are there industrial activities or power generators or road with traffic closer than 10m to the area of study?		**0**
	Q12	Are there abundant refractors scatterers (e.g. concrete blocks) on the surface?		**0**

4.3 Relevance per method

After answering questions Q1-Q12 the final Relevance obtained per method are presented in Table 3. According to the results of the decision tree,

- the seismic refraction tomography (SRT) and the multiple analysis of surface waves (MASW) can be used for **qualitative interpretations** (50% - see Table 1) to estimate the volume of the deposits
- the ground penetrating radar (GPR), the magnetic mapping (MAG) and the electromagnetic induction mapping (EM) could lead to **quantitative interpretation** on the location of the deposits, above all laterally
- the electrical methods (ERT and IP) are the most suited for **volume estimation** of the PMSD deposits to be revalorized.

In the field survey, carried out in May 2022 (see deliverable D I1.2.1), we used electrical tomography (both ERT and IP), EM and MAG mapping tools.

After data processing and interpretation of the methods used in the geophysical survey, we concluded that the most useful methods were ERT and IP. They allowed the detection of the various interfaces and layers within the deposits. In particular, the IP data allowed to identify tilted layers with the highest potential for metal recovery (larger chargeability and metal factor – see DI1.2.2).

The MAG measurements were run using both: (1) a magnetometer in vertical gradient mode to measure the magnetic field amplitude gradient over the whole heap top; (2) a kappa-meter that allows only surface measurements (< 5cm depth) of the magnetic susceptibility over the whole heap top.
Regarding the magnetic field gradient results, no trends were identified on the map, and large local variations are visible on the interpolated map. This might be due to deposited wastes with very variable magnetic susceptibility at a decametric scale. The first MAG method is therefore not indicated to allow quantitative interpretation. Only qualitative information on the variability of the wastes' magnetic nature can be extracted.
Regarding the surficial magnetic susceptibility map, three homogeneous areas can be identified, including a central area, with developed vegetation, indicating the presence of a topsoil (see DI1.2.2). The second MAG method could allow quantitative lateral interpretation in terms of areas. However, because it targets only the first 5 cm of the deposit, it is relevant only for surficial material classification, and cannot be used for volume estimations.

For the EM tool, the survey provide qualitative mapping of the shallower part of the slag heap. However, the measurements are noisy and impacted by the high concentration of metallic slag and scraps at the surface. These latter disrupt the primary electromagnetic field modifying the usual hypothesis behind the instrument utilization. EMI is sensitive to magnetic susceptibility magnitude. As the magnetic susceptibility of wastes is highly variable as MAG has shown, EMI variations are similar to MAG variations. The conductivity maps obtained are then only qualitative information. After several trials, no processing schemes were found to set-up a quantitative interpretation of the EM maps.

No GPR, SRT or MASW tools were used on site because they were not the most relevant tools for this site according to the decision tree. Moreover, all the geophysical tools were brought from France and Belgium, to the UK, so the team had limited space to carry materials to the site and selected only the most relevant methods to be applied on site. The relevance of these methods is thus not evaluated on site.

It must be noted that the slags present on the Teesside site are expected to be magnetic. The GPR is irrelevant on highly magnetic material because GPR signal is attenuated by magnetic compounds. Its penetration depth is there for very limited on this type of material. Consequently, on the Teesside site, the GPR method needs to be considered as low interest to non-informative on the Teesside site. **The decision tree table should be updated so that these considerations are including, and the GPR score lowered.**

Table 3: Relevance per method, updated for each question of the decision tree that gave a 'yes' result (see Table 2). The final relevance Rout is colored according to the rating in

Table 1. The columns in grey are the ones not investigated on site during the geophysical field survey.

method	MAG	EM	GPR	ERT	IP	SRT	MASW
R_{ini} [%]	100	100	100	100	100	100	100
M1-Q1	75	75	75	100	100	100	100
M1-Q5	75	75	75	100	100	50	50
R_{out} [%]	**75**	**75**	**75**	**100**	**100**	**50**	**50**

4.4 OUTPUT OF THE DECISION TREE

Here we describe the main and secondary objectives that were or were not achieved for the Teesside site, based on the methods used in the geophysical survey (see Table 4). Most of the objectives were achieved using the ERT and IP data, with the help of EM data in the first 2 meters for the lateral variations.

As the ERT and IP acquisitions were performed on 5 different 2D profiles, including one that was crossing the five others perpendicularly, it was possible to map the lateral and vertical variations of the electrical resistivity (ρ) and the chargeability (*M*) in the slag deposit.

However, it was not possible to develop a quantitative estimation of the targeted volumes because deeper sampling on site was not achieved during the time of the project. Because of the heterogeneous nature of the deposits observed by the geophysical tools, a quantitative interpretation will only be possible after targeted samples will be analyzed at the laboratory scales, both for geochemical concentration estimations of chemical elements and geophysical properties.

Table 4: Output of objectives achieved and not achieved

Objectives	Achieved?	Description
Coverage of lateral variations	partially	The coverage of the mapping tools (MAG and EM) is good, but the heterogeneous nature of the deposits makes it hard to identify large areas of interest. The 5 ERT/SIP profiles measured allow to detect partially the lateral variations.
Coverage of vertical variations	partially	Layers detected by the 5 ERT and SIP 2D profiles. Necessity to validate these layers by targeted sampling analysis.
Qualitative interpretation of volumes	yes	Achieved using lateral and vertical variations coverage with ERT/IP data.
Quantitative estimation of volumes	No	The heterogenous nature of the site doesn't allow any quantitative estimations only based on geophysical fild results. Targeted sampling is necessary to go further.
Estimation of volume(s) of material(s) (per type(s))	No	Targeted sampling and laboratory geochemical analysis is necessary to go further.
Identification of cavities	no	no existing cavities
Identification of water table(s)	no	the site is too heterogeneous to detect the water table

5 SITE-SPECIFIC GEOPHYSICAL DATASET

In this section, we present the geophysical dataset that we obtained from the MAG (surficial magnetic susceptibility map = kappa-meter), EM, ERT and IP measurements, only in the field. Indeed, in the deliverable DI1.2.1, we suggest locations for boreholes to extract samples and get geophysical and geochemical analysis in the laboratory. However, these boreholes could not be achieved during the period of the project. For the MAG results, the area of investigation was limited, so values were not recorded for the outer sampling points (sl2, sl9-11 and sl13-14) (see Figure 1).

The results presented here are only based on samples taken at the surface (10-30cm deep maximum) by Cranfield University (See Figure 1b and deliverable DI1.2.2). These samples provide first results of interest to compare to geophysical dataset. However, deeper samples are needed to correctly interpret geophysical and geochemical correlation. Indeed, EM, ERT and IP methods are integrative, and their depth of penetration is much larger than a few centimeters. Comparison is thus difficult at this stage. The best comparison in terms of volume of investigation can be made with the MAG results since its investigation depth is equal to 5 cm. The geophysical properties for each samples location are given in Table 5 and Table 6.

*Table 5: Extracted geophysical field data and corresponding selected geochemical data for samples **sl1 to sl8**. The resistivity and chargeability values are taken at the surface. For the EM results, PRP is for perpendicular configuration of the loops and HCP for Horizontal Coplanar. PRP1 and HCP1 correspond to a spacing of 1 m between the loops, PRP2 and HCP2 2 m, and PRP4 and HCP4 4 m.*

		Sample	sl1	sl2	sl3	sl4	sl5	sl6	sl7	sl8
	Coordinates	X (WGS84 UTM 31N)	622178	622255	622214	622182	622173	622155	622146	622101
		Y (WGS84 UTM 31N)	6053464	6053518	6053532	6053545	6053548	6053552	6053556	6053571
		Z (m amsl)	66.35	66.48	68.13	67.95	67.41	67.77	68.01	67.32
Geophysical field data	Electrical results	Resistivity (ohm.m)	nan	117.33	110.37	108.54	381.37	147.43	250.92	146.47
		Chargeability (mV/V)	nan	17.16	16.41	11.90	27.86	34.66	62.49	40.14
	Mag. results	Mag. suscept. (10-5 SI)	1722		2631	1476	816	689	968	2567
	EM results	PRP1.1 cond (mS/m)	114.24	79.71	161.14	75.05	52.99	47.80	67.07	172.45
		PRP2.1 cond (mS/m)	48.46	32.71	67.32	29.73	42.93	30.46	31.98	62.88
		PRP4.1 cond (mS/m)	20.65	15.92	23.86	19.96	27.29	21.97	18.93	20.23
		HCP1 cond (mS/m)	20.12	2.03	10.08	-1.88	18.05	-4.70	-1.46	-20.55
		HCP2 cond (mS/m)	-7.99	-4.19	-11.28	1.47	19.06	7.02	0.01	-26.22
		HCP4 cond (mS/m)	2.51	4.93	-2.90	9.05	5.76	10.87	7.14	-4.66
		PRP1.1 inph (ppm)	1.45	5.50	6.40	6.34	1.56	2.20	5.69	7.71
		PRP2.1 inph (ppm)	9.73	11.54	16.70	11.15	8.41	8.04	10.95	17.92
		PRP4.1 inph (ppm)	14.19	13.33	22.60	11.14	10.50	19.52	20.21	24.92
		HCP1 inph (ppm)	-11.43	-11.20	-15.25	-8.54	-6.38	-9.22	-9.83	-17.86
		HCP2 inph (ppm)	-10.20	-8.08	-12.69	-4.87	-5.77	-14.19	-11.00	-14.64
		HCP4 inph (ppm)	-15.37	-17.50	-15.34	-13.25	-9.05	-20.01	-17.84	-17.45
Geochemical lab data	Iron	**mean_Fe**	1.38E+05	8.36E+04	1.84E+05	1.10E+05	2.95E+04	7.48E+04	1.38E+05	1.91E+05
		sd_Fe	7.30E+03	3.13E+04	2.16E+04	2.08E+04	1.30E+03	1.07E+04	3.15E+04	2.24E+04
	Manganese	**mean_Mn**	7.52E+03	4.68E+03	7.73E+03	5.67E+03	1.07E+03	3.99E+03	6.27E+03	7.40E+03
		sd_Mn	1.56E+02	9.36E+02	6.88E+02	5.64E+02	1.62E+02	4.00E+02	1.39E+03	6.82E+02
	Titanium	**mean_Ti**	1.09E+03	2.22E+03	1.04E+03	8.50E+02	2.61E+03	2.13E+03	9.63E+02	1.06E+03
		sd_Ti	4.52E+01	1.18E+02	1.98E+02	2.36E+02	9.11E+01	1.49E+02	1.47E+02	8.39E+01
	Baryum	**mean_Ba**	3.41E+02	4.17E+02	3.45E+02	3.33E+02	2.95E+02	4.73E+02	2.81E+02	3.29E+02
		sd_Ba	1.29E+01	1.40E+01	3.03E+01	6.91E+01	9.82E+00	2.98E+01	4.81E+01	9.40E+00
	Zinc	**mean_Zn**	2.43E+02	2.36E+02	1.93E+02	1.05E+02	1.15E+02	4.04E+02	1.62E+02	1.90E+02
		sd_Zn	4.39E+01	9.68E+00	4.09E+01	4.85E+01	2.63E+01	2.83E+01	1.72E+01	8.54E+00
	Zirconium	**mean_Zr**	1.33E+02	1.67E+02	9.71E+01	6.86E+01	2.22E+02	2.34E+02	1.67E+02	2.13E+02
		sd_Zr	2.61E+01	4.88E+00	1.70E+01	1.46E+01	3.04E+01	3.06E+00	1.35E+02	1.28E+02
	Copper	**mean_Cu**	2.51E+01	3.13E+01	2.80E+01	2.32E+01	1.98E+01	7.23E+01	2.26E+01	2.52E+01
		sd_Cu	3.74E+00	2.84E+00	5.32E+00	1.89E+00	9.34E-01	1.59E+01	1.38E+00	9.46E-01

*Table 6: Extracted geophysical field data and corresponding selected geochemical data for samples **sl9 to sl17**. The resistivity and chargeability values are taken at the surface. For the EM results, PRP is for perpendicular configuration of the loops and HCP for Horizontal Coplanar. PRP1 and HCP1 correspond to a spacing of 1 m between the loops, PRP2 and HCP2 2 m, and PRP4 and HCP4 4 m.*

		Sample	sl9	sl10	sl11	sl12	sl13	sl14	sl15	sl16	sl17
	Coordinates	X (WGS84 UTM 31N)	622278	622103	622103	622162	622164	622173	622133	622095	622223
		Y (WGS84 UTM 31N)	6053512	6053365	6053365	6053621	6053637	6053669	6053502	6053593	6053600
		Z (m amsl)	64.82	67.03	67.00	66.17	65.96	63.43	68.10	67.24	66.81
Geophysical field data	Electrical results	Resistivity (ohm.m)	280.63	139.70	139.70	166.27	87.75	90.68	52.93	475.72	101.07
		Chargeability (mV/V)	22.63	30.04	30.04	84.47	16.52	18.12	37.68	35.29	11.23
	Mag. results	Mag. suscept. (10-5 SI)				1763			1323	2421	2817
	EM results	PRP1.1 cond (mS/m)	64.78	164.61	164.61	55.31	35.20	35.75	124.68	128.36	43.75
		PRP2.1 cond (mS/m)	12.17	77.91	77.91	40.45	24.63	39.67	49.28	45.28	15.57
		PRP4.1 cond (mS/m)	19.27	28.08	28.08	24.27	18.38	28.85	16.35	17.10	27.92
		HCP1 cond (mS/m)	-72.53	33.56	33.56	23.05	31.88	31.67	25.71	13.69	-33.08
		HCP2 cond (mS/m)	-7.58	-11.61	-11.61	16.84	14.58	24.33	-10.88	-14.29	17.45
		HCP4 cond (mS/m)	15.19	-2.90	-2.90	10.48	15.70	11.42	0.74	-0.73	22.44
		PRP1.1 inph (ppm)	13.75	5.57	5.57	1.31	-0.80	-0.28	0.50	2.74	7.47
		PRP2.1 inph (ppm)	19.53	13.37	13.37	7.34	1.88	1.92	5.27	15.82	5.15
		PRP4.1 inph (ppm)	20.31	16.70	16.70	15.11	8.40	8.58	18.28	24.11	4.58
		HCP1 inph (ppm)	-11.45	-13.67	-13.67	-9.83	-5.40	-2.36	-9.85	-16.77	-2.54
		HCP2 inph (ppm)	-6.18	-9.28	-9.28	-12.62	-9.97	-4.31	-14.23	-14.49	-0.92
		HCP4 inph (ppm)	-7.83	-16.19	-16.19	-17.70	-17.93	-11.86	-28.10	-16.88	-15.97
Geochemical lab data	Iron	**mean_Fe**	2.22E+04	1.38E+05	1.77E+05	6.54E+04	2.30E+04	2.57E+04	1.28E+05	1.33E+05	8.38E+04
		sd_Fe	1.64E+03	1.33E+04	1.20E+04	7.36E+03	1.22E+03	5.09E+02	1.03E+04	4.10E+04	2.33E+04
	Manganese	**mean_Mn**	5.15E+02	6.67E+03	7.30E+03	5.22E+03	7.15E+02	5.99E+02	6.68E+03	6.38E+03	5.04E+03
		sd_Mn	2.67E+01	2.59E+02	5.50E+02	4.28E+03	6.30E+01	2.26E+01	5.95E+02	8.72E+02	1.86E+03
	Titanium	**mean_Ti**	2.12E+03	1.03E+03	1.27E+03	2.92E+03	2.15E+03	2.59E+03	6.55E+02	9.27E+02	1.45E+03
		sd_Ti	5.86E+01	1.23E+02	1.53E+02	1.80E+02	1.76E+02	9.34E+01	7.50E+01	2.41E+02	1.26E+03
	Baryum	**mean_Ba**	2.00E+02	3.06E+02	3.51E+02	3.25E+02	2.25E+02	2.37E+02	3.11E+02	3.15E+02	2.85E+02
		sd_Ba	9.04E+00	6.36E+00	2.77E+01	1.54E+01	1.47E+01	2.84E+00	1.55E+01	8.93E+00	3.88E+01
	Zinc	**mean_Zn**	7.34E+01	1.41E+02	2.69E+02	2.72E+02	1.10E+02	7.31E+01	1.40E+02	1.49E+02	1.01E+02
		sd_Zn	5.40E+00	7.33E+00	2.38E+01	3.26E+01	4.00E+00	6.11E+00	1.88E+01	4.37E+01	2.12E+01
	Zirconium	**mean_Zr**	2.28E+02	1.16E+02	1.13E+02	1.88E+02	1.61E+02	2.45E+02	7.67E+01	1.54E+02	9.96E+01
		sd_Zr	1.15E+01	3.54E+01	1.40E+01	1.90E+01	1.40E+01	1.10E+01	3.06E+00	4.48E+01	6.77E+01
	Copper	**mean_Cu**	1.23E+01	2.22E+01	3.47E+01	3.43E+01	1.86E+01	1.67E+01	3.93E+01	2.57E+01	1.67E+01
		sd_Cu	1.30E+00	1.84E+00	4.94E+00	5.10E+00	8.14E-01	1.08E+00	2.84E+01	1.08E+01	8.82E-01

6 CONCLUSIONS

In this report, we presented the different geophysical datasets that were built for the former slag heap investigated on the site of Teesside (UK).

First, the two datasets that are used for the design of the NWE-SMARTIX and the performance report on the Geophysical Characterization Method are presented. The first one gives a value of relevance per method used on site, and the second one lists the objectives achieved (or not) in terms of volume estimations (qualitative and/or quantitative) and also cavity detection and water level estimations. They both depend on the geophysical decision tree tool.

The ground truth could not be tested for several methods: SRT, MASW and GPR.

For the other methods, the results obtained as output of the decision tree are close to the field experience observed at the Teesside site, although some methods such as EM and MAG were ranked as “quantitative interpretation”, when in the end, they are only providing “qualitative information”, due to the alleged heterogeneity of the deposited slag materials. MAG and EM are thus overrated in the decision tree for the Teesside site.

The most useful geophysical methods at the Teesside site are the ERT and IP methods. They allow giving volume estimations of the materials to revalorize. They allowed the detection of the various interfaces and layers within the deposits. In particular, the IP data allowed to identify tilted layers with the highest potential for metal recovery. However, due to the heterogeneous nature of the slags observed in the electrical results, a volume estimation of the parts of the deposit to revalorize will only be possible once samples will be collected and analyzed in the lab over the entire depths of the slag heap.

Samples were only collected at 17 locations at the surface of the slag heap (see Figure 1). A site specific dataset was built between the geochemical analysis led on these 17 samples, and the geophysical field data collected at the same locations. The lab geochemical dataset was built using the x-ray fluorescence measurements that were run at Cranfield University. Except for the kappa-meter results, the comparison between the geophysical and geochemical datasets should be taken with precaution since the investigated volumes are not the same. The Geochemical (and lab geophysical) analysis of borehole samples at all the depths of the slag heap is recommended to go further.

7 REFERENCES

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DI1.2.2: Site specific report on geophysical survey on Teesside site. *Deliverable from the NWE-REGENERATIS project.*

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