

REGIONAL PETROPHYSICS: PERTH BASIN 2022–23

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REGIONAL PETROPHYSICS: Perth Basin 2022–23

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PERTH 2023



**Geological Survey of
Western Australia**

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Terra Petrophysics Pty Ltd carried out petrophysical measurements under contract to the Geological Survey of Western Australia, funded by the Exploration Incentive Scheme.

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Acknowledgement of Country

We respectfully acknowledge Aboriginal peoples as the Traditional Custodians of this land on which we deliver our services to the communities throughout Western Australia. We acknowledge their enduring connection to the lands, waterways and communities and pay our respects to Elders past and present.

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Cover photograph: Down core petrophysical data shown in relation to crustal scale density and velocity models

Introduction

The Geological Survey of Western Australia's (GSWA) regional petrophysics project provides high-quality petrophysical measurements to assist with the interpretation of geophysical data. The project commenced in 2021, in collaboration with Terra Petrophysics, and is funded by the Exploration Incentive Scheme (EIS). Petrophysical data were collected from EIS co-funded drillcore, company drillcore, and GSWA stratigraphic drillcore. All cores sampled for petrophysics have, or will have, HyLogger data and most have open-file company assay data available through the Mineral Exploration reports database (WAMEX).

Terra Petrophysics conducted petrophysical analyses on 106 samples from four diamond drillholes (Fig. 1, Table 1) drilled into the Perth Basin and Badgeradda Basin. Samples from the southern Perth Basin include quartzose sandstones of the Sabina Formation, and interbedded carbonaceous siltstones and sandstones of the Sue Coal Measure. From the northern Perth Basin, samples comprise siltstones and limestones of the Caynginia Formation, and interbedded carbonaceous siltstones and sandstones of the Irwin River Coal Measure. Samples from drillcore CSD01 located on the eastern side of the Darling Fault in the Badgeradda Basin comprise interbedded argillites and arenites, and laminated siltstones and sandstones. Where sedimentary rocks samples from the weathering profile were competent enough, they were also submitted for petrophysical analysis.

Physical properties measured include:

- Induced Polarization (Chargeability) and Galvanic Resistivity
- Inductive Conductivity
- Magnetic Susceptibility
- Remanent Magnetization: the ratio of induced- to remanent-magnetization intensity of the sample (known as the Koenigsberger Ratio, Q), as well as an estimate of the total remanent vector (relative to drillhole)

- Dry Bulk Density
- Apparent Porosity
- P-wave Sonic Velocity
- Spectral Radiometrics.

GSWA provides a datasheet (with petrophysical measurements, lithological information, and supplementary material), a photo of each sample, and a description of the methods. Terra also produces a report with an analysis of the petrophysical data for drillholes located within common geological terranes. All of these datasets and reports can be downloaded from [MAGIX](#) and the [eBookshop](#), respectively.

GSWA drillholes and reporting

The drillcores sampled for petrophysics in this Report are located at the Perth Core Library. Three of the drillcores were either donated to GSWA, or formed part of an EIS-funded drilling program. Open-file data and reports for these drillholes are available from the department's WAMEX online database under the file names in Table 1. Separately, the Whicher Range 3 drillcore is an onshore petroleum well and, as part of the legislative requirements for petroleum and geothermal drilling, the drillcore and drill cuttings are stored at the Perth Core Library. Well completion reports, and downhole survey and sampling data for the Whicher Range 3 drillcore can be downloaded through the department's WAPIMS online petroleum exploration database.

Table 1. Drillcore identification names/numbers, collar details, MAGIX reference numbers, and WAMEX report numbers for the drillcores sampled for petrophysics in this Report

Drillhole ID	Latitude	Longitude	Elevation (m)	Azimuth (degrees)	Dip (degrees)	Depth (m)	Number of petrophysical samples	Source of core	MAGIX registration number	WAMEX file number
AR15	-28.5362	115.2034	187.00	000	-90	121.00	3	Company – donated*	72493	A36217
CSD01	-27.0254	115.4423	258.00	285	-55	498.30	61	EIS	72493	A117371
GHD-3	-29.9988	115.0687	68.00	000	-90	690.00	14	Company – donated*	72493	A35874, A35987, A36016
Whicher Range 3	-33.8709	115.3942	138.00	000	-90	2619.00	28	Company – donated*	72493	Report112**

* Stored at the Perth Core Library

** Additional drillcore information can be accessed through WAPIMS

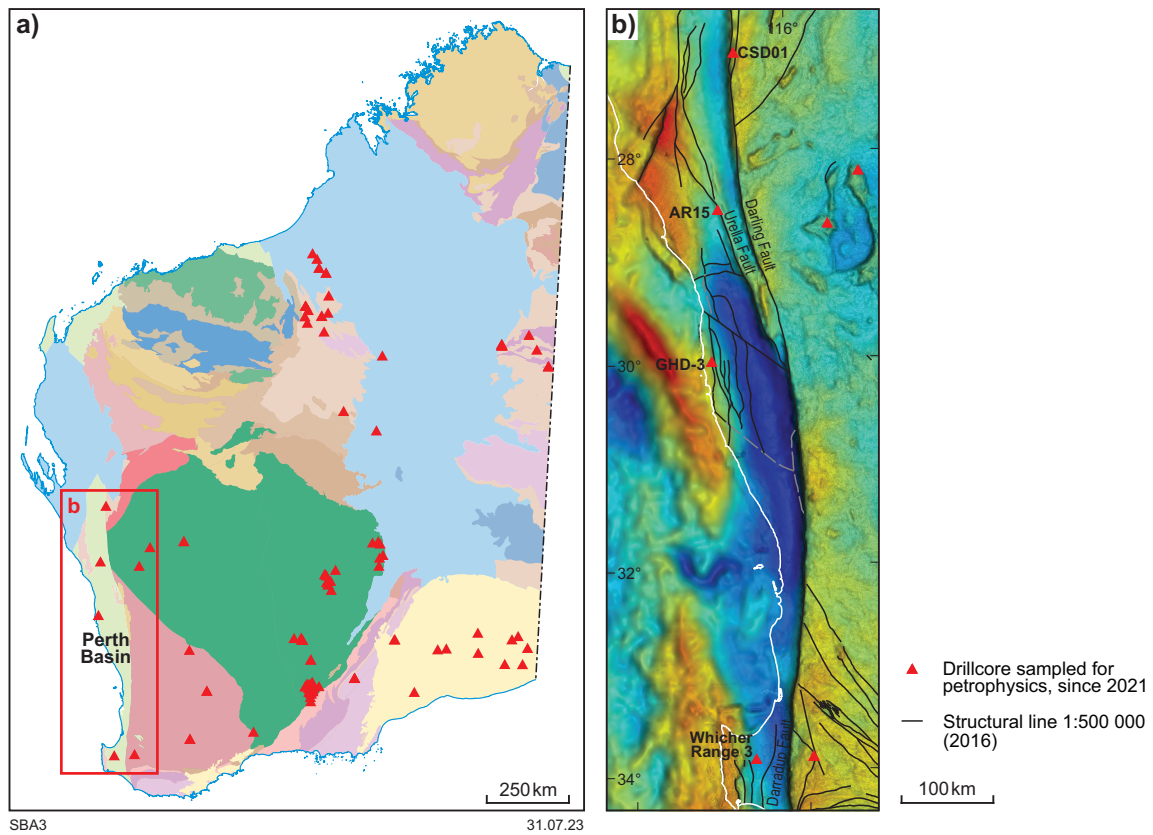


Figure 1. Drillcore locations sampled for petrophysics: a) statewide drillcores sampled since 2021, shown on tectonic units map (2021) with major crustal boundaries; b) location of four drillholes sampled for petrophysics (this Report) shown on a first vertical derivative of the reduced-to-pole total magnetic intensity data (grey scale, 80 m cell size) draped with Bouguer gravity anomaly data (colour, 400 m cell size)

TERRA PETROPHYSICS PTY. LTD.

(ABN 71 613 484 807)

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PERTH BASIN

WESTERN AUSTRALIA

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June, 2023

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TERRA
PETROPHYSICS

TABLE OF CONTENTS

	Page
1. INTRODUCTION	3
2. PETROPHYSICS	3
2.1 Sample Preparation	3
2.2 Inductive Conductivity	4
2.3 Induced Polarization and Resistivity	4
2.4 Wet/Dry Bulk Density and Porosity	4
2.5 Magnetic Susceptibility and Remanence	5
2.6 Velocity	5
2.7 Spectral Radiometrics	5
3. RESULTS	6
4. REFERENCES	23
APPENDIX 1 – DATA TABLES	24
APPENDIX 2 – SAMPLE PHOTOS	28

1. INTRODUCTION

Terra Petrophysics have performed petrophysical analysis of 106 core samples for the Geological Survey of Western Australia (GSWA) from the Perth Basin in Western Australia. These samples have been provided by the GSWA to develop an understanding of physical properties of rocks in the region and to assist with the interpretation of geophysical field data. Petrophysical analysis includes measurement of the following physical properties:

- Induced Polarisation (Chargeability) and Galvanic Resistivity
- Inductive Conductivity
- Magnetic Susceptibility
- Remanent Magnetisation; the ratio of induced- to remanent-magnetisation intensity of the sample (known as the Koenigsberger Ratio, Q), as well as an estimate of the total remanent vector (relative to drill hole).
- Dry Bulk Density
- Apparent Porosity
- P-wave Sonic Velocity
- Spectral Radiometrics

During analysis, Terra Petrophysics utilises standards and reference samples to ensure precision and accuracy.

2. PETROPHYSICS

2.1 Sample Preparation

Samples for physical property measurements should be carefully selected for quality and representation of geology and/or alteration. Terra recommends samples between the sizes of 10cm to 15cm. In this study all samples were of adequate size and quality. The size and shape of the sample need to be determined for most physical property measurements (e.g., geometric and core size correction factors). All samples and cores are returned to the client.

All samples are photographed and marked with Terra sample numbers. Samples for which magnetic remanence vector measurements are requested should be oriented in space. All samples should be accompanied by a project name, a brief description of each sample, requested physical property procedures and final disposal requirement for the samples.

Physical property determinations are non-destructive procedures; however, sample preparation requires the sample to have flat/square ends and sometimes requires them to be cut with a rock saw. In addition, samples are required to be submerged in water for 24 hours before being measured. Samples containing clays can absorb water and break. Extra caution is taken with these samples.

2.2 Inductive Conductivity

The inductive conductivity measurement is made in the frequency domain at 10,000 Hz via an external magnetic field inducing a small current in the sample. The measurement is most influenced by sample material at the receiver coil and within a 10 cm radius from the centre of the sample.

Inductive conductivity is calculated from the difference in amplitude between the sample and free air measurements. The limits of detectability are 0.1 S/m (maximum 100,000 S/m) and resulting data are presented in S/m. Several inductive conductivity measurements will be made and reported when the sample size permits.

2.3 Induced Polarization and Resistivity

The apparent resistivity and induced polarization (or chargeability) determinations are measured in time domain. The resistivity and chargeability values are measured by passing a constant current through the sample and then switching it on and off at 2 second intervals. While the current is flowing through the sample, the resistivity (ohm-m) is calculated. When the current is switched off, the voltage across the sample drops and a decay curve is measured. The induced polarization (mV/V) is calculated from this decay between 450-1100 milliseconds after turn off (Newmont Standard). Resistivity and induced polarization values are stacked and averaged a minimum of 10 times for one reading. Terra provide the average results for two readings (minimum).

Some samples (for example, silica rich samples) can be so resistive as to act dielectric. Electricity does not flow through the sample as if it were conductive, but charged particles are shifted minutely from their original position. When the current is removed the charged particles slowly (due to the high resistivity of the sample) relax to their original state. Therefore, samples are measured to be more chargeable than would be recognised by a field IP survey.

2.4 Wet/Dry Bulk Density and Porosity

The density determinations are calculated using Archimedes Principle. Dry bulk densities are determined by dry weight divided by the buoyancy determined volume of each sample. Porosities are calculated from water saturated weights, dry weights, and the buoyancy-determined volume. All sample are soaked for at least 24 hours after dry weights are measured.

The accuracy of the buoyancy technique of density measurement is 0.01 grams per cubic centimetre (g/cm³). The results of the laboratory density determinations are reported in grams per cubic centimetre. Density measurements can be made on grab samples or drill core. Very large or heavy samples (>1 kg) require coring or breaking prior to the density determination.

2.5 Magnetic Susceptibility and Remanence

Magnetic susceptibility is measured by using a magnetic susceptibility meter to apply an external magnetic field to the sample at an operating frequency of 8 kHz. Magnetic susceptibility is calculated from the frequency difference between the sample and free air measurements. The limits of detectability are approximately 1×10^{-7} SI units and resulting data is presented in SI ($\times 10^{-3}$) units. The measurement is most influenced by sample material at the receiver coil and within a 10 cm radius from the centre of the sample. Magnetic susceptibility measurements can be made on core, hand and surface samples.

For magnetic samples ($>5 \times 10^{-3}$ SI) the magnetic remanence can be measured. The measurement of remanence (J_r) in the field and the ratio of remanence to the induced magnetization ($J_{rem}/J_{ind} = Q$) has in the past been problematic. The induced magnetization can be estimated using the susceptibility (k , where $J_{ind} = kH$ and typically $H = 40\text{-}50 \text{ Am}^{-1}$) which can be measured using a handheld meter, but magnetic remanence is more difficult.

A recent development in field instrumentation uses a miniature fluxgate magnetometer and a pendulum arrangement in which a magnetic rock may be swung generating a transient signal at the fluxgate which is converted to a magnetic moment and magnetization.

2.6 Velocity

Terra Petrophysics can acquire P-wave velocity measurements on samples with a minimum length of 15 centimetres. Measurements are taken at 50,000 Hz. The velocity measurement range is between 1500-9999 m/s.

2.7 Spectral Radiometrics

Terra Petrophysics reports on the following radionuclides: Potassium (K-40) %, Uranium (U) ppm and Thorium (Th-232) ppm. The measurements are acquired using a 256 and 1024 channel spectrometer with a 3"x3" (21ci – 0.35L) Sodium-Iodide (NaI) gamma detector which is operated within the confines of a lead laboratory shield.

The minimum detection sensitivities of the instrument are 0.3% K, 0.9 ppm U, and 1.5 ppm Th; and the gamma ray sensitivity is (1MBq Cs-137 1 m) 386 cps.

3. RESULTS

A total of 106 samples have undergone petrophysical analysis, the results table of which is included as APPENDIX 1 – DATA TABLES. Each sample is assigned a Terra ID, and photographs of the samples are included as APPENDIX 2 – SAMPLE PHOTOS. Raw data files for the induced polarization and resistivity measurements are included in the datasheet. Cross plots of the various petrophysical data are given in Figure 2 to Figure 14.

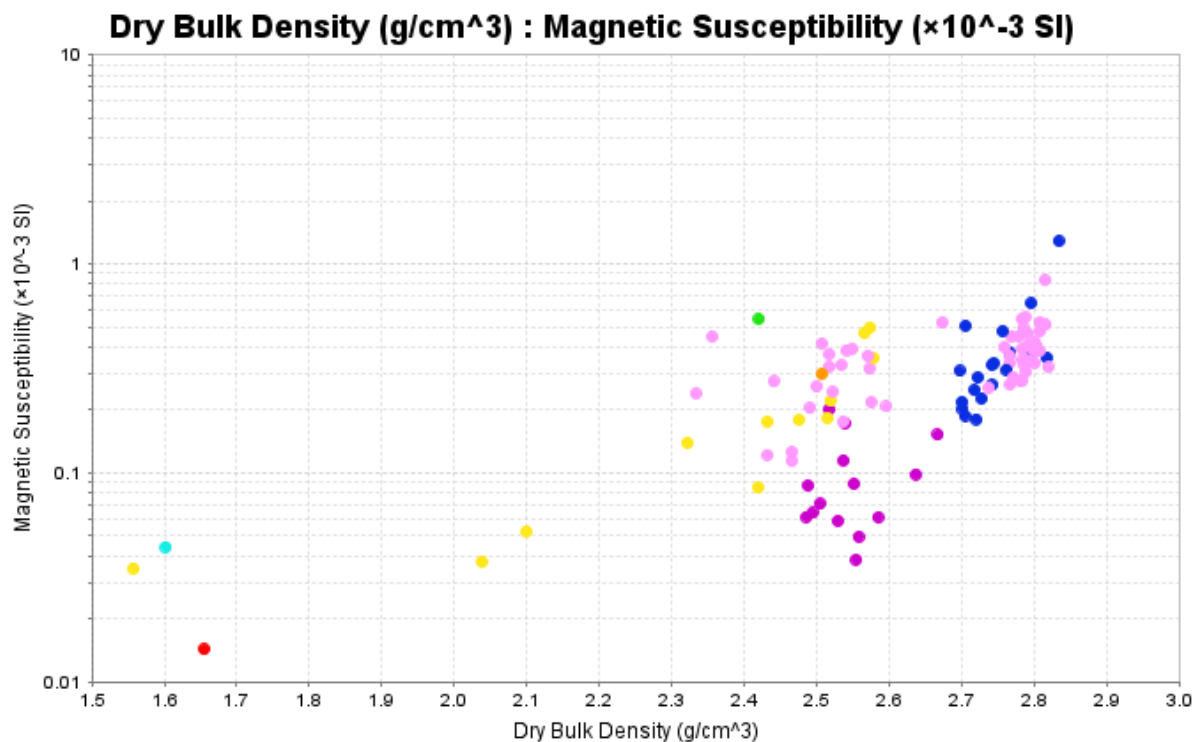
The data points are classified by lithology, which is represented by different colours (Figure 1).



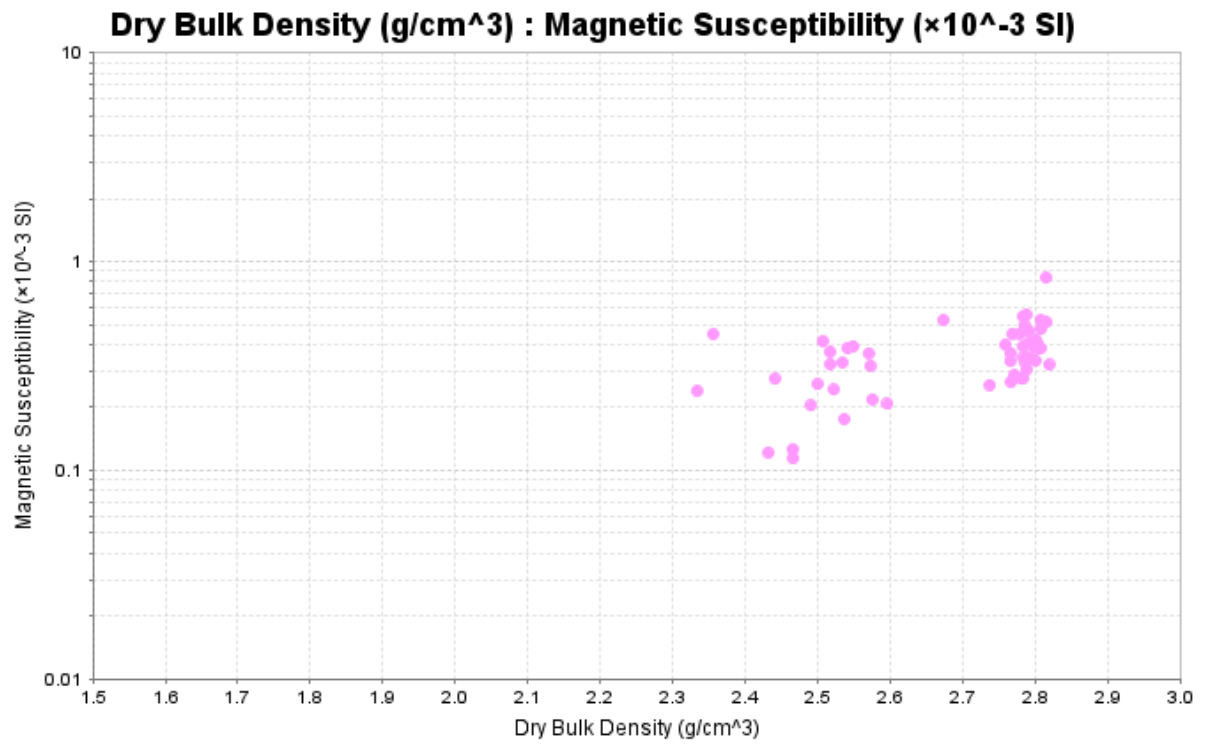
Figure 1. Legend corresponding to Figure 2, and Figure 5 to Figure 12.

A cross-plot of dry bulk density (DBD) and magnetic susceptibility data is given in Figure 2. Dry bulk density values range from 1.56 to 2.83 g/cm³ and magnetic susceptibility values range from 0.014 to 1.284 ($\times 10^{-3}$) SI. The following observations can be made from the figure below:

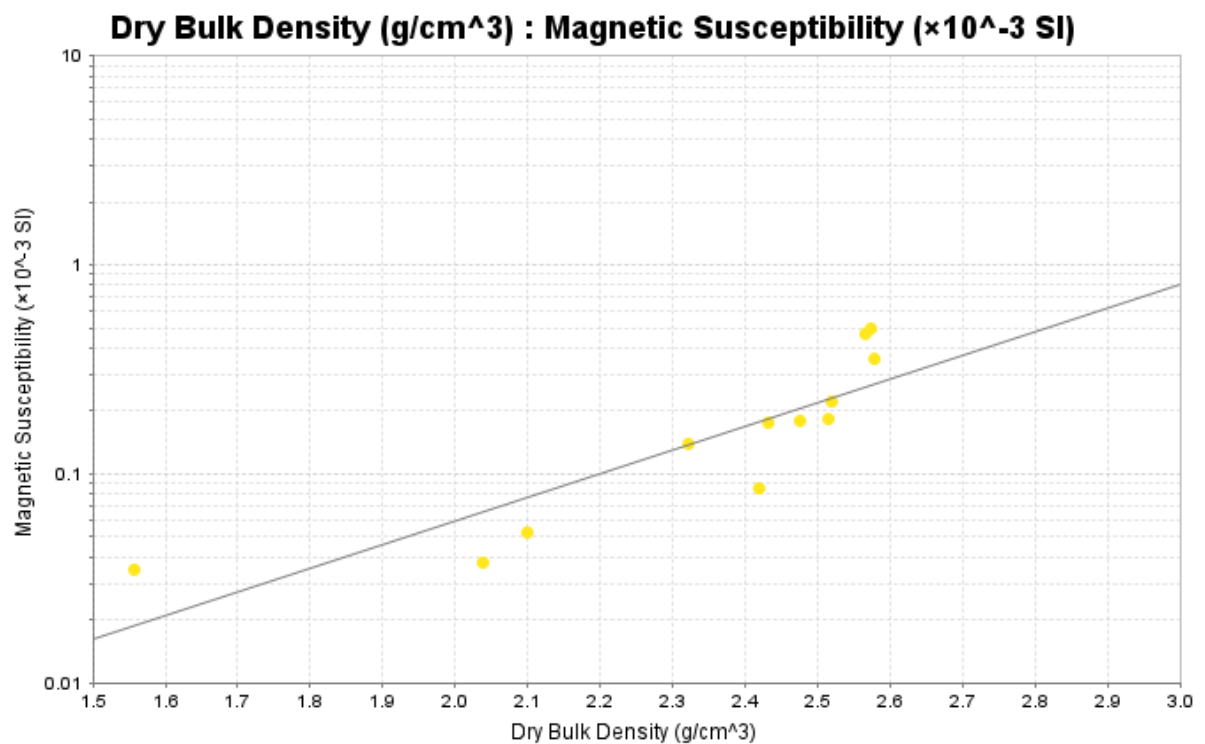
- Magnetic susceptibility is low for this dataset with all samples plotting below 2×10^{-3} SI.
- Interbedded siltstone and sandstone samples plot as two separate clusters: one around 2.8 g/cm³ and a second cluster with lower DBD between 2.5 - 2.6 g/cm³ (Figure 2 b).
- There appears to be a positive correlation between the properties in sandstones (Pearson correlation coefficient $r=0.69$, Figure 2 c).
- Coal, siltstone and a few sandstones plot with low DBD (< 2.1 g/cm³), which could be due to weathering/alteration.



(a)



(b)



(c)

Figure 2. Cross-plot of dry bulk density against magnetic susceptibility data. (a) shows all lithologies, (b) shows interbedded siltstone and sandstone and (c) shows sandstones.

A method of estimating magnetic mineral content from magnetic susceptibility via a simple relationship was devised by Emerson (1997) and is shown in Figure 3. Magnetic susceptibility data is low for this dataset, thus magnetite/pyrrhotite content is negligible.

Figure 4 shows ranges of density values for common rocks and minerals (Emerson, 1990). From this diagram, it can be noted this project shows a "low to medium" range of densities within the samples.

A cross-plot of dry bulk density and galvanic resistivity data is given in Figure 5. Galvanic resistivity values range from 6 to 28,124 Ωm .

Two clusters (circled in red) are visible in the plot: one with lower DBD ($2.4 - 2.6 \text{ g/cm}^3$) and lower resistivity ($< 500 \text{ } \Omega\text{m}$), consisting of interbedded siltstone and sandstone and siltstone/mudstone with pyrite mineralization and a second one with higher DBD ($2.7 - 2.8 \text{ g/cm}^3$) and higher resistivity ($> 500 \text{ } \Omega\text{m}$), consisting of interbedded siltstone and sandstone and arenites with sulfide mineralization.

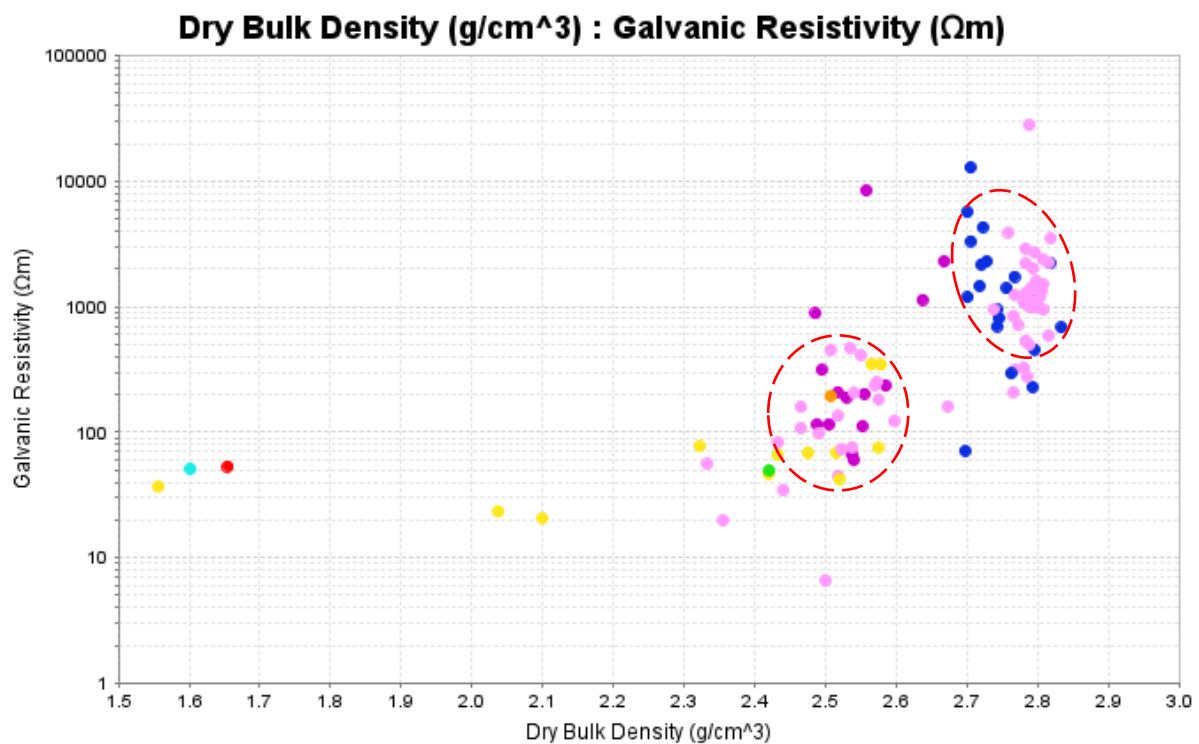
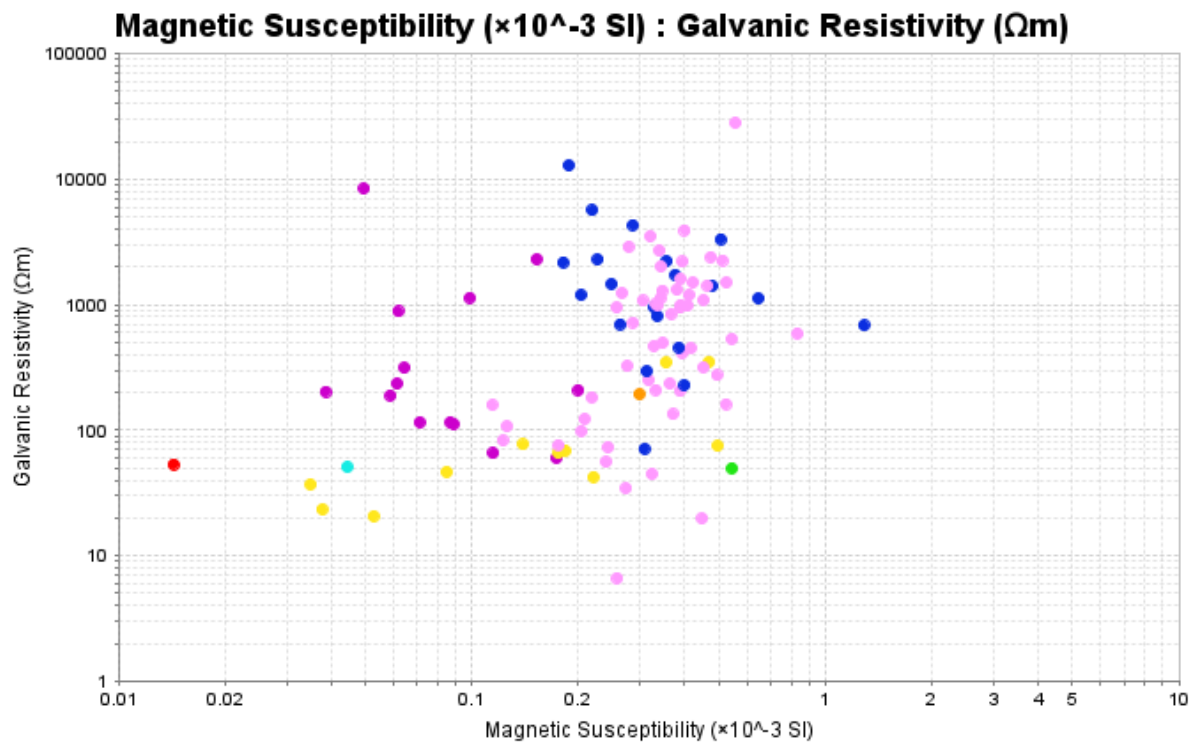


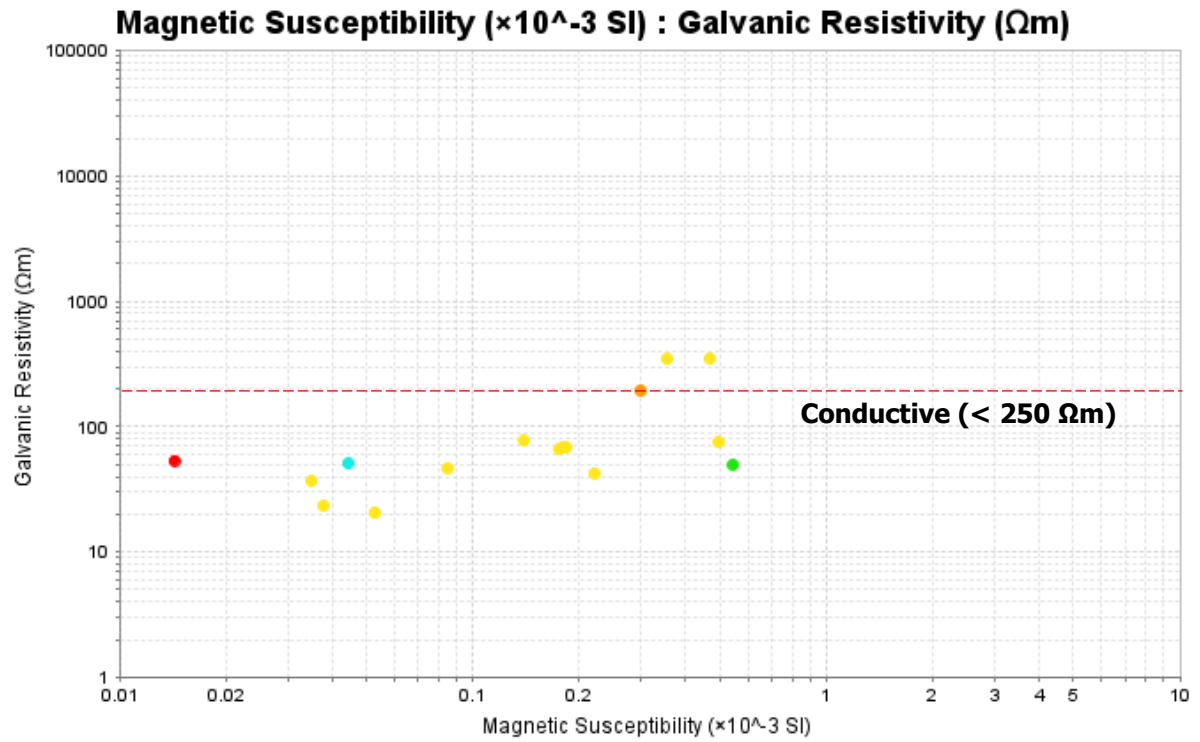
Figure 5. Cross-plot of dry bulk density against galvanic resistivity data.

A cross-plot of magnetic susceptibility and galvanic resistivity data is given in Figure 6. Magnetic susceptibility values range from 0.014 to 1.284 ($\times 10^{-3}$) SI and galvanic resistivity ranges from 6 to 28,124 Ωm .

Coal, dolerite, shale, siltstone and the majority of sandstone samples appear conductive and exhibit low galvanic resistivity ($\leq 200 \Omega\text{m}$).



(a)



(b)

Figure 6. Cross-plot of magnetic susceptibility against resistivity. (a) shows all lithologies and (b) shows coal, dolerite, sandstone, shale and siltstone samples.

A cross-plot of chargeability and galvanic resistivity data is given in Figure 7. Chargeability values range between 2.5 and 103.1 mV/V, but majority of the samples plot with chargeability < 20 mV/V. Outlier samples 22TR4013 (interbedded siltstone and sandstone) and 22TR3302 (siltstone) exhibit the highest chargeability 103.1 and 90.8 mV/V, which correspond to low galvanic resistivity of 6 and 53 Ωm . This is likely due to pyrite mineralization.

There is a strong negative correlation between the properties in sandstones (Spearman correlation coefficient $r=-0.72$).

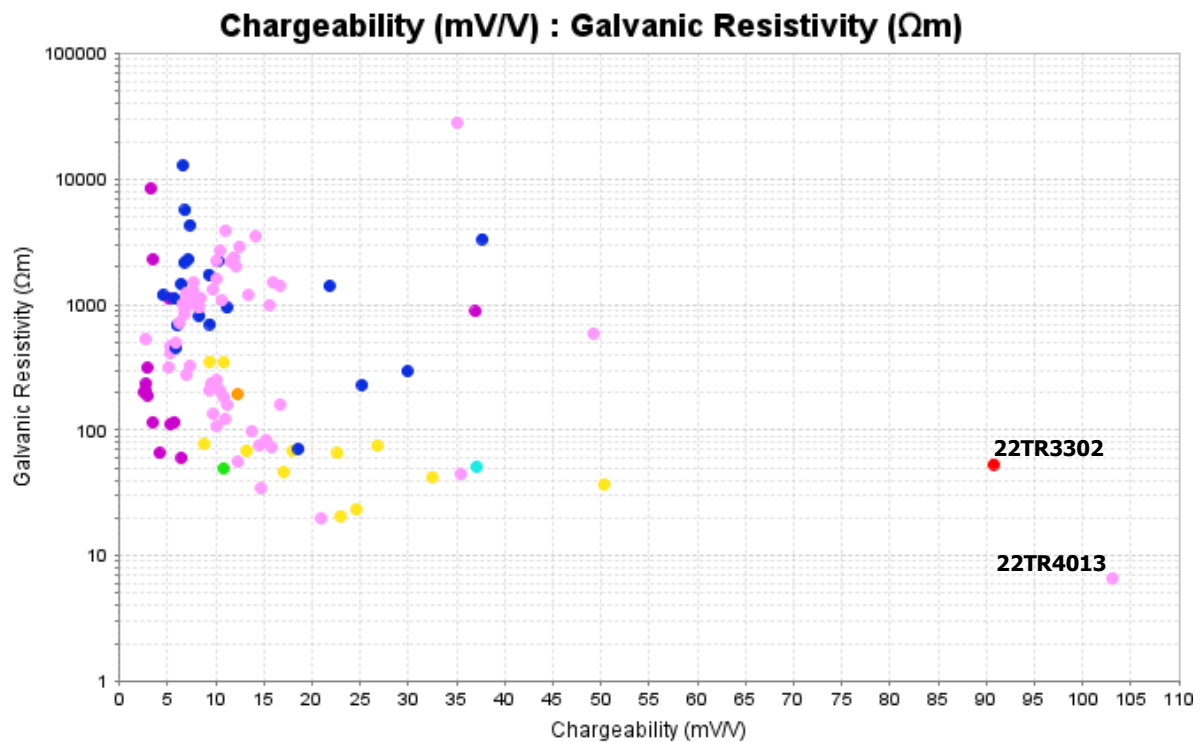


Figure 7. Cross-plot of chargeability against resistivity.

A cross-plot of chargeability and magnetic susceptibility data is given in Figure 8. Chargeability values range between 2.5 and 103.1 mV/V and magnetic susceptibility ranges from 0.014 to $1.284 (\times 10^{-3})$ SI.

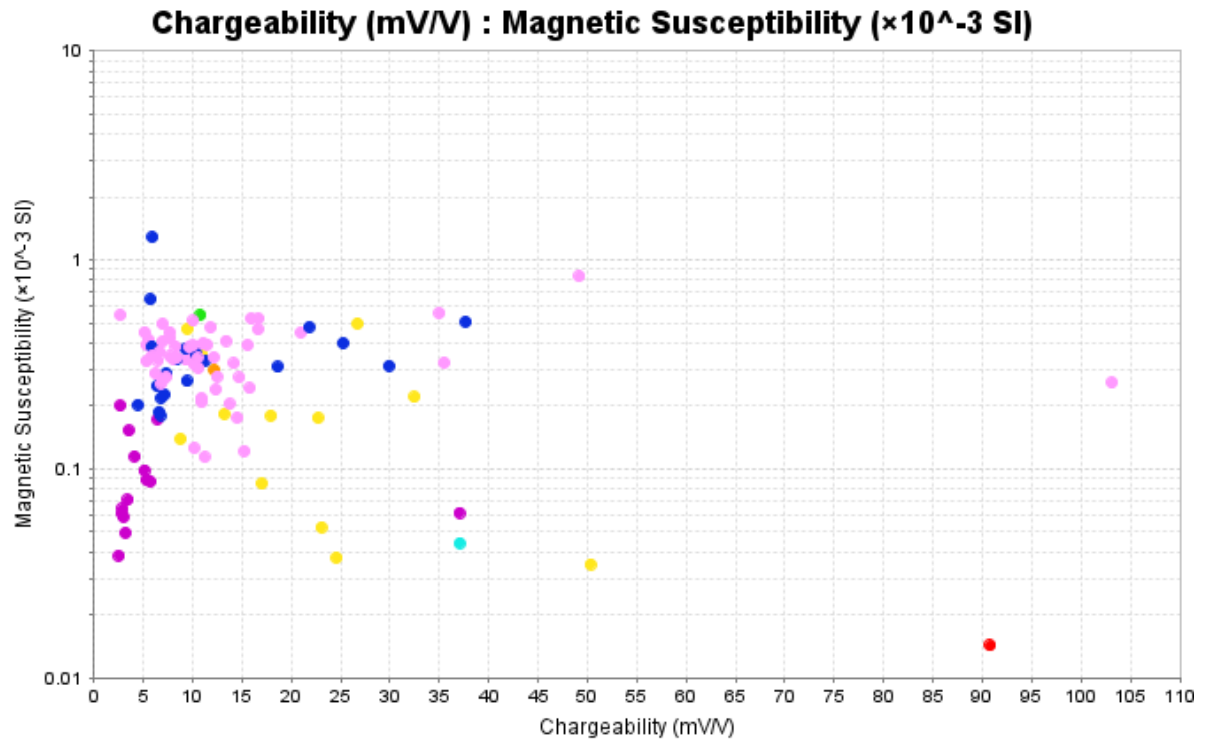


Figure 8. Cross-plot of chargeability against magnetic susceptibility.

A cross-plot of inductive conductivity and chargeability data is given in Figure 9. Only samples with a non-zero inductive conductivity value are included.

Chargeability of a material is dependent on 4 major factors: the degree of sulphide or metallic mineralisation, presence of clays, the pore-water salinity, and the overall tortuosity of the pore-space network within the rock. Both a high inductive conductivity and a high chargeability may be indicative of the presence of sulphides within the sample, although conductivity tends to better respond to massive (connected) sulphides, while chargeability responds better to disseminated (disconnected) sulphides.

Samples with a non-zero conductivity have a value of less than 1 S/m, which is low. These correspond to chargeability values ranging from 2.7 to 37.7 mV/V. Based on this, inductive conductivity (electromagnetic surveying) would not be recommended as an exploration tool for these samples.

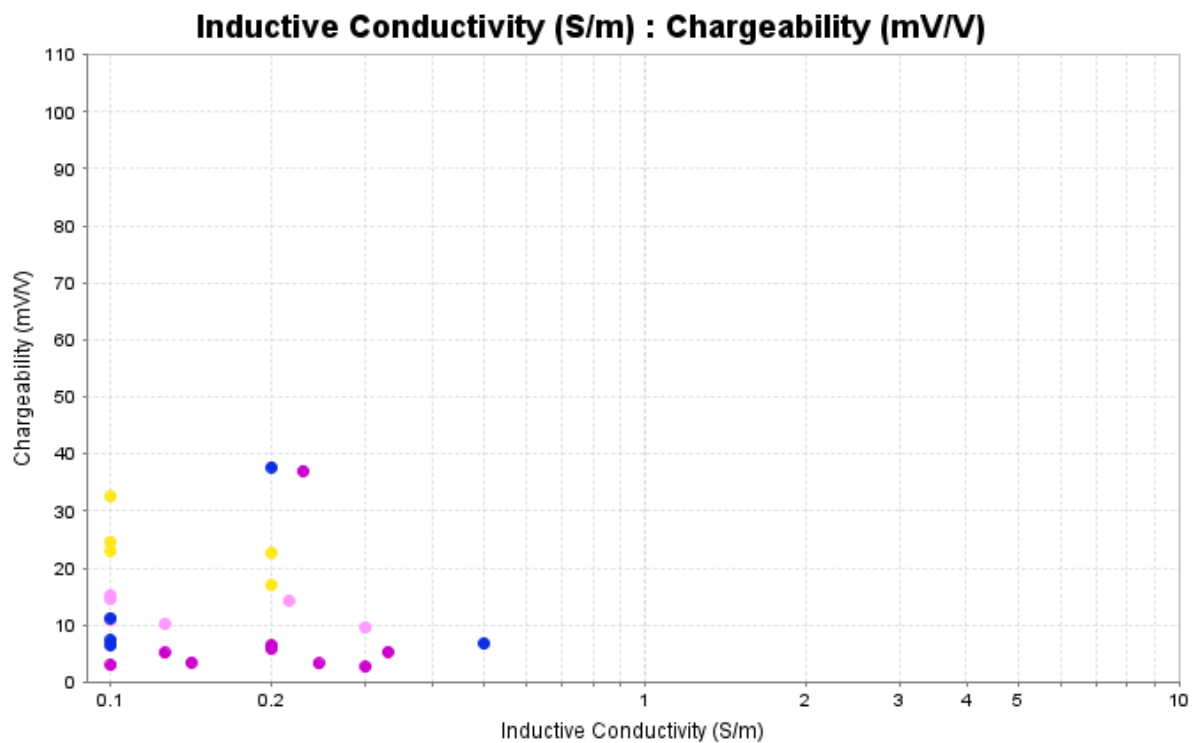
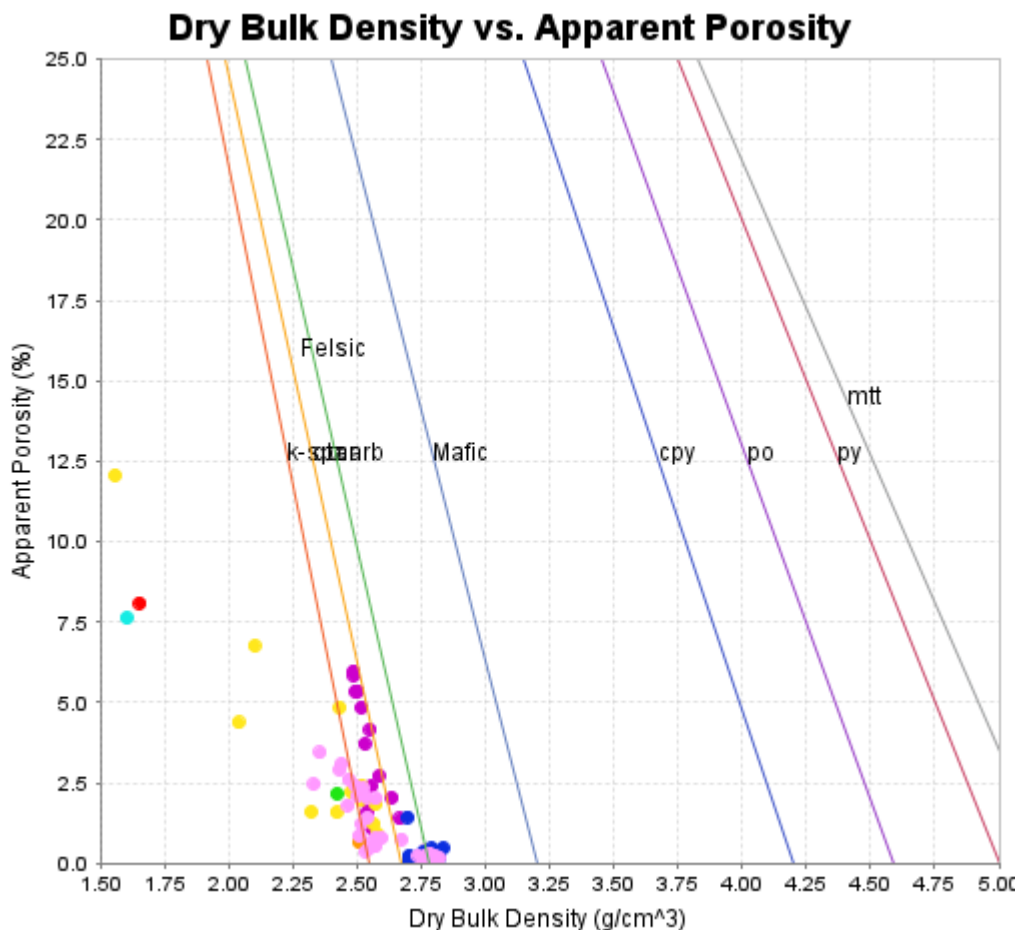


Figure 9. Cross-plot of inductive conductivity against chargeability.

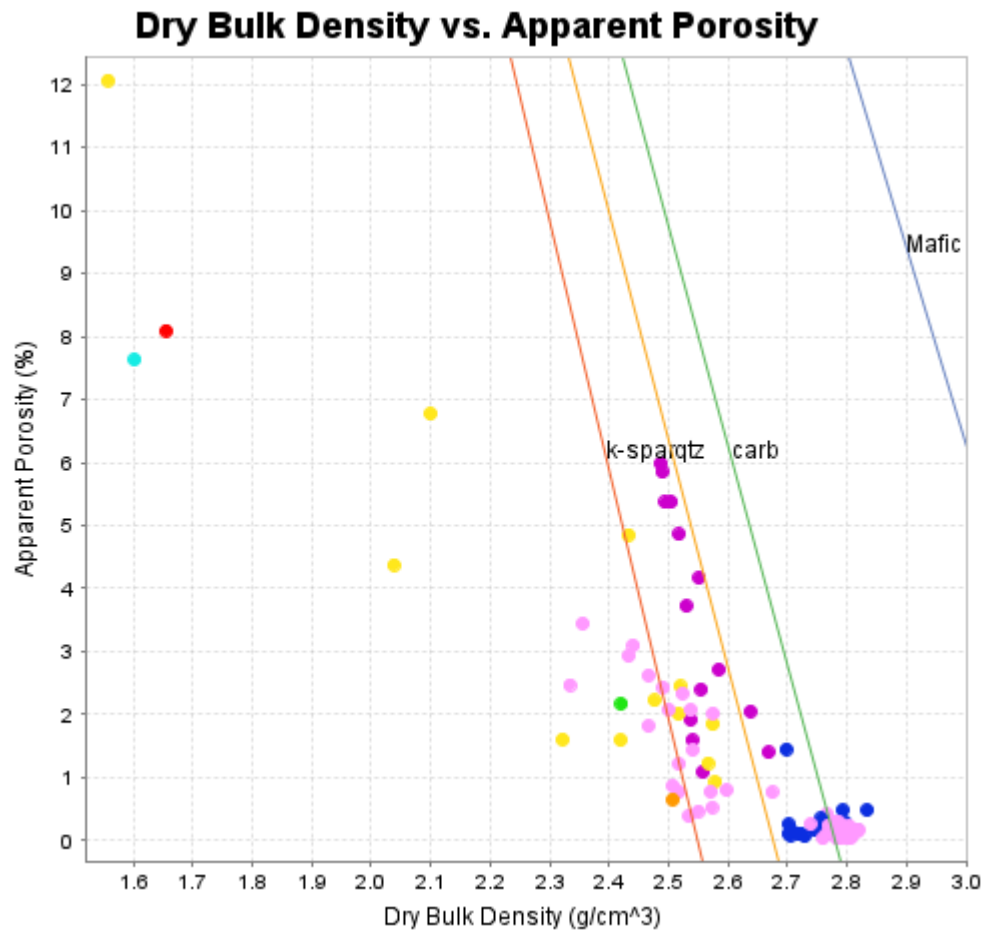
A cross-plot of dry bulk density and apparent porosity data against mineral trends (Emerson, 1997) is given in Figure 10. Apparent porosity values for the project range up to 12.1%, but the majority of samples plot with porosity < 2.5%. Dry bulk density ranges from 1.56 to 2.83 g/cm³, but the majority of samples plot between the 'k-spar' and 'carb' mineral trend line.

There appears to be some clustering between different lithology groups in the figures below. The following groups were distinguished:

- Siltstone/mudstone samples cluster around the 'qtz' mineral trend line
- Interbedded siltstone and sandstone samples plot as two separate clusters, the first one around the 'k-spar' mineral trend line with DBD ~ 2.50 g/cm³ and the second one around the 'carb' mineral trend line with higher DBD ~ 2.75 g/cm³.
- Arenites plot around the 'carb' mineral trend line ~ 2.75 g/cm³
- Sandstones exhibit a wider range of DBD (1.56 – 2.58 g/cm³) compared to other lithologies, which is likely due to weathering/alteration.



(a)



(b)

Figure 10. Cross-plot of dry bulk density against porosity; (a) shows the full diagram, (b) shows just the data range.

A cross-plot of dry bulk density and P-wave velocity data, with contours of acoustic impedance, is given in Figure 11. The separation between the contours represents the contrast required to produce a minimum reflection coefficient ($R=0.06$) detectable by the seismic reflection method. The more contours the data overlaps, the more likely the seismic reflection method is to map geological and/or lithological contrasts. P-wave velocity was unable to be measured on 19 samples due to insufficient sample length (<15 cm).

Data is distributed over 7 contours and the P-wave velocity ranges from 1,090 to 6,510 m/s. There are two populations visible in the figure, which seismic reflection would be able to discern: the first one with higher P-wave velocity (5,500 – 6,500 m/s) consisting of consisting of interbedded siltstone and sandstone and arenites with sulfide mineralization and the second one with lower P-wave velocity (1,500 – 3,500 m/s) consisting of interbedded siltstone and sandstone and siltstone/mudstones.

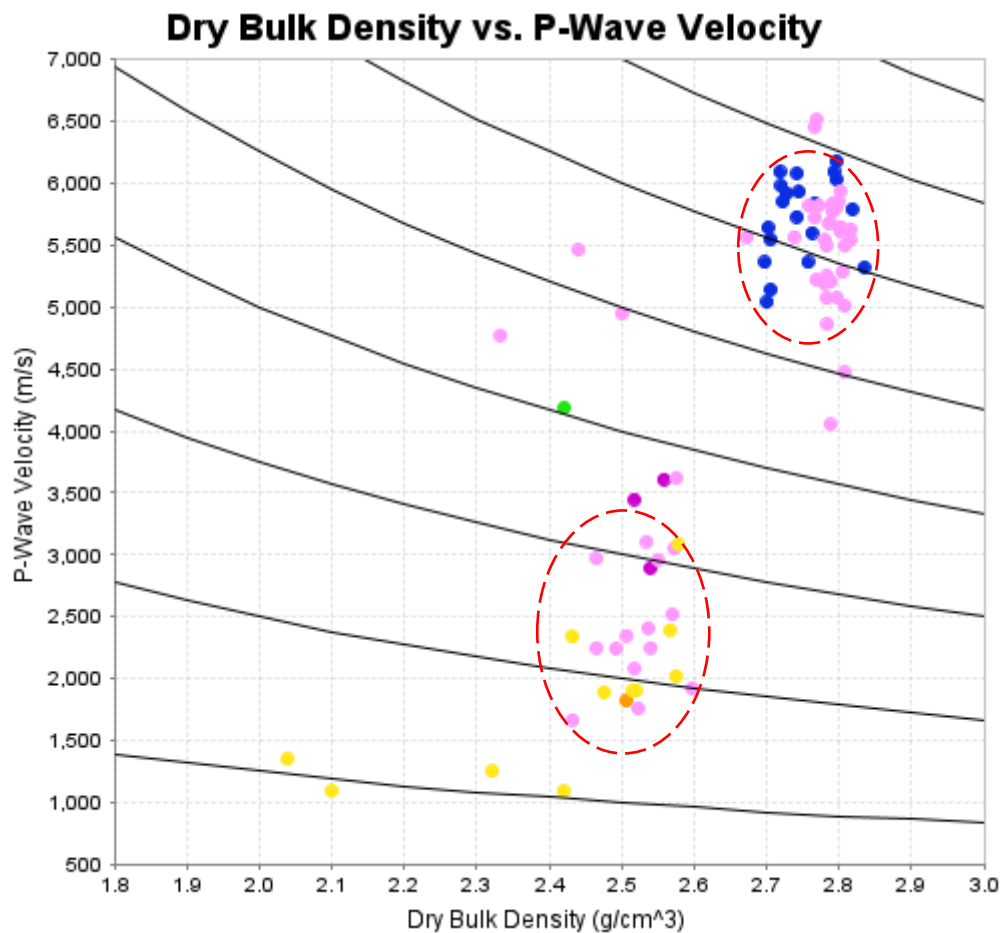


Figure 11. Cross-plot of dry bulk density against sonic (P-wave) velocity.

A ternary diagram of K, U and Th distributions is shown in Figure 12. Radiometric element content ranges from detection limit to 10.86% for K, 14.85 ppm for U and 54.33 ppm for Th.

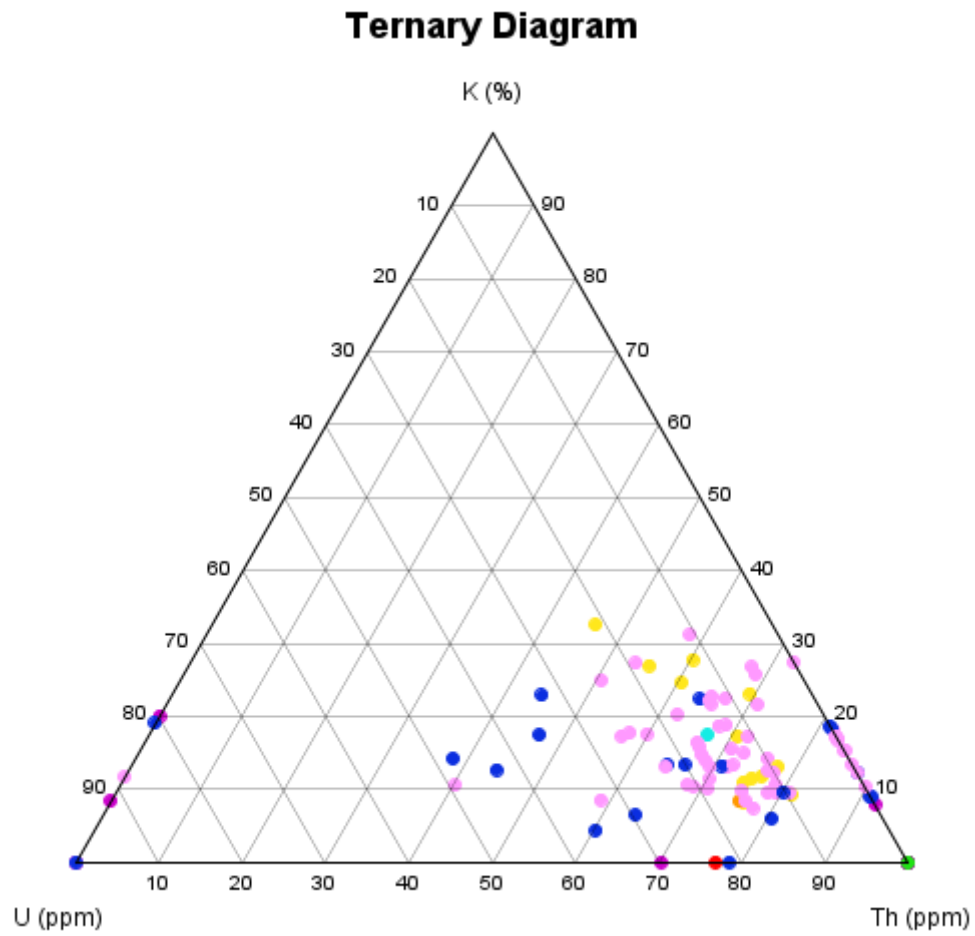


Figure 12 Ternary diagram of K%, U ppm and Th ppm.

A cross-plot of the intensity of the induced vs. remanent vectors (J_{ind} vs. J_{rem}) is given in Figure 13.

The components of induced and remanent magnetism were measured for nine samples. Seven samples are measured to be remanent-magnetisation dominant ($Q > 1$), with the remaining two samples being induced-magnetisation dominant ($Q < 1$).

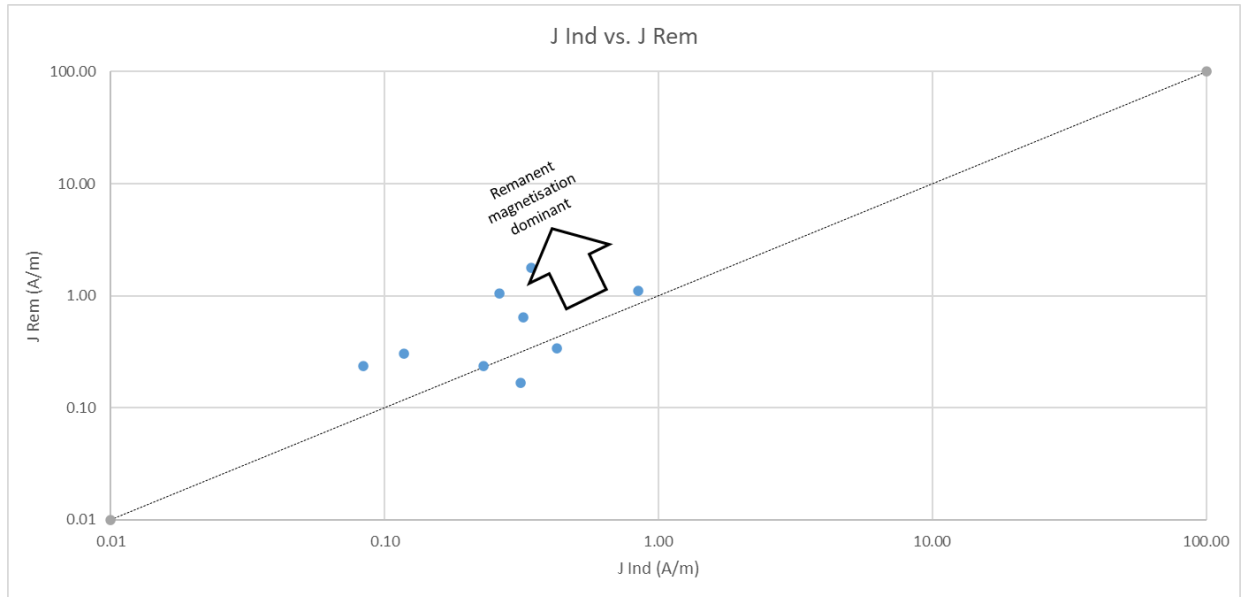


Figure 13. Cross-plot of intensity of J_{ind} versus J_{rem} . Samples above the trend line have Koenigsberger ratio (Q) greater than 1, indicating they are remanent-magnetisation dominant. Conversely, samples below the trend line have a Q value less than one, and are induced-magnetisation dominant.

A theoretical magnetic susceptibility value has been calculated from the J_{ind} vector intensity, and is compared with the measured magnetic susceptibility via a cross-plot (Figure 14).

Variation between the two values is expected. Samples with higher orders of magnitude differences between measured magnetic susceptibility and the calculated value may be attributed to remanent dominance and the associated cancellation of induced magnetisation. This is particularly observed in remanent magnetisation dominant samples with high pyrrhotite content. For this dataset, the same trend is observed for the induced-magnetisation dominant samples.

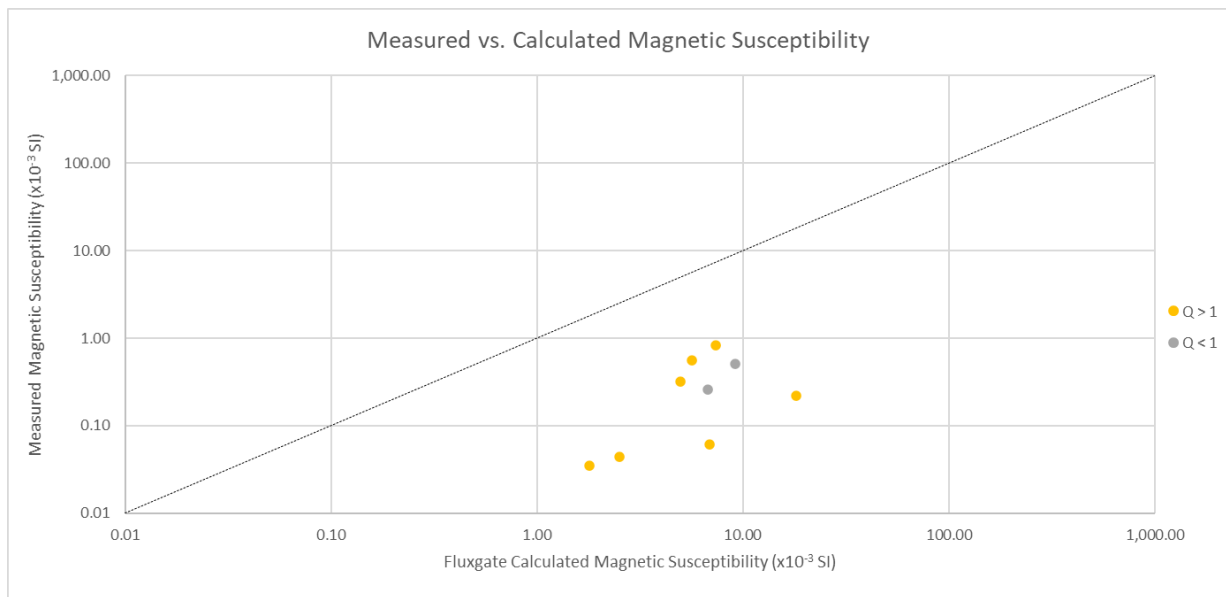


Figure 14. Logarithmic plot of magnetic susceptibility derived from fluxgate against measured magnetic susceptibility.

4. REFERENCES

Emerson, D.W., 1990, Notes on Mass Properties of Rocks – Density, Porosity, Permeability. *Exploration Geophysics*, 21, 209-216

Emerson, D.W., and Yang, Y.P. 1997, Insights from laboratory mass property Cross-plots. *ASEG Preview*, 70, 10-14.

APPENDIX 1 – DATA TABLES

Sample Information					Lithology Information		Magnetic Properties		Mass Properties			Seismic Properties		Electrical Properties			Gamma Ray		
TR Sample ID	Client Sample ID	Drillhole ID	From	To	GSWA Lithology	Formation	Magnetic Susceptibility	Koenigsberger Ratio (Q)	Dry Bulk Density	Apparent Porosity	Grain Density	P-Wave Velocity	Acoustic Impedance	Galvanic Resistivity	Chargeability	Inductive Conductivity	K	U	Th
			(m)	(m)			(×10 ⁻³ SI)		(g/cm ³)	(%)	(g/cm ³)	(m/s)	(g/cm ³)*(m/s)	(Ωm)	(mV/V)	(S/m)	(%)	(ppm)	(ppm)
22TR3302	260201	AR15	67.35	67.48	siltstone		0.009		1.66	8.10%	1.80	N/A	N/A	54	90.1	0.0	-0.30	2.98	9.90
22TR3303	260202	AR15	74.10	74.25	sandstone		0.019	2.82	1.56	12.07%	1.77	N/A	N/A	37	49.7	0.0	0.82	0.93	5.41
22TR3304	260203	AR15	75.07	75.20	coal		0.026	2.61	1.60	7.63%	1.73	N/A	N/A	51	37.1	0.0	1.21	1.06	4.64
22TR3968	255376	GHD-3	111.00	111.11	siltstone/mudstone	Carynginia Fm	0.061		2.58	2.71%	2.66	N/A	N/A	235	2.8	0.0	-0.30	-1.50	6.27
22TR3969	255377	GHD-3	111.77	111.94	siltstone/mudstone		0.039		2.56	2.40%	2.62	N/A	N/A	203	2.6	0.0	-0.30	-1.50	16.02
22TR3970	255378	GHD-3	112.25	112.42	siltstone/mudstone		0.059		2.53	3.72%	2.63	N/A	N/A	189	3.0	0.1	-0.30	-1.50	9.06
22TR3971	255379	GHD-3	113.45	113.60	siltstone/mudstone		0.050		2.56	1.08%	2.59	3610	9233.8	8431	3.2	0.2	-0.30	4.32	-0.90
22TR3972	255380	GHD-3	118.40	118.51	siltstone/mudstone		0.064		2.49	5.37%	2.64	N/A	N/A	313	2.9	0.0	-0.30	3.57	-0.90
22TR3973	255381	GHD-3	119.57	119.70	siltstone/mudstone		0.062	1.99	2.49	5.99%	2.64	N/A	N/A	882	37.0	0.2	1.98	7.91	-0.90
22TR3974	255382	GHD-3	124.25	124.40	siltstone/mudstone		0.087		2.49	5.85%	2.64	N/A	N/A	116	5.8	0.2	-0.30	-1.50	11.33
22TR3975	255383	GHD-3	124.95	125.12	siltstone/mudstone		0.071		2.50	5.37%	2.65	N/A	N/A	116	3.5	0.1	-0.30	-1.50	20.08
22TR3976	255384	GHD-3	128.52	128.69	siltstone/mudstone		0.099		2.64	2.05%	2.69	N/A	N/A	1141	5.1	0.1	-0.30	-1.50	-0.90
22TR3977	255385	GHD-3	129.70	129.90	siltstone/mudstone		0.089		2.55	4.17%	2.66	N/A	N/A	112	5.3	0.3	-0.30	-1.50	13.41
22TR3978	255386	GHD-3	133.00	133.20	siltstone/mudstone		0.152		2.67	1.40%	2.71	N/A	N/A	2305	3.5	0.0	2.07	-1.50	23.77
22TR3979	255387	GHD-3	134.10	134.30	siltstone/mudstone		0.173		2.54	1.59%	2.58	2890	7339.6	60	6.5	0.2	-0.30	-1.50	11.90
22TR3980	255388	GHD-3	139.39	139.55	siltstone/mudstone		0.200		2.52	4.86%	2.65	3450	8685.5	209	2.7	0.3	-0.30	4.93	11.68
22TR3981	255389	GHD-3	140.90	141.07	siltstone/mudstone		0.115		2.54	1.92%	2.59	N/A	N/A	66	4.2	0.0	0.83	9.08	-0.90
22TR3982	260401	Whicher Range-3	3885.54	3885.69	sandstone	Sabina Sandstone	0.038		2.04	4.38%	2.13	1350	2751.2	23	24.6	0.1	3.57	2.17	8.80
22TR3983	260402	Whicher Range-3	3888.53	3888.73	sandstone	Sabina Sandstone	0.053		2.10	6.77%	2.25	1090	2288.8	21	23.0	0.1	4.59	1.98	9.94
22TR3984	260403	Whicher Range-3	3893.82	3893.97	sandstone	Sabina Sandstone	0.140		2.32	1.61%	2.36	1250	2902.1	77	8.8	0.0	5.10	1.63	15.31
22TR3985	260404	Whicher Range-3	3986.03	3986.18	sandstone	Sabina Sandstone	0.085		2.42	1.59%	2.46	1090	2637.1	47	17.0	0.2	5.12	3.35	7.27
22TR3986	260405	Whicher Range-3	4020.65	4020.78	siltstone + sandstone	Sue Coal Measures	0.370		2.52	0.77%	2.54	N/A	N/A	134	9.8	0.0	4.08	2.80	21.72
22TR3987	260406	Whicher Range-3	4022.80	4022.95	siltstone + sandstone	Sue Coal Measures	0.323	1.02	2.52	1.21%	2.55	2080	5237.5	45	35.5	0.0	4.05	2.39	12.19
22TR3988	260407	Whicher Range-3	4034.90	4035.05	siltstone + sandstone	Sue Coal Measures	0.316		2.57	0.52%	2.59	3050	7846.0	249	10.1	0.0	4.24	4.22	31.23
22TR3989	260408	Whicher Range-3	4164.82	4164.97	sandstone	Sue Coal Measures	0.221	1.41	2.52	2.44%	2.58	1900	4786.4	43	32.5	0.1	2.31	4.45	21.48
22TR3990	260409	Whicher Range-3	4168.07	4168.20	shale	Sue Coal Measures	0.297		2.51	0.65%	2.52	1820	4562.5	194	12.2	0.0	3.71	7.19	33.64
22TR3991	260410	Whicher Range-3	4168.76	4168.89	sandstone	Sue Coal Measures	0.354		2.58	0.93%	2.60	3080	7943.7	345	10.9	0.0	5.97	4.18	35.70
22TR3992	260411	Whicher Range-3	4170.02	4170.17	sandstone	Sue Coal Measures	0.175		2.43	4.86%	2.56	2340	5693.1	65	22.7	0.2	2.48	1.71	10.18
22TR3993	260412	Whicher Range-3	4172.07	4172.22	sandstone	Sue Coal Measures	0.469		2.57	1.23%	2.60	2390	6132.4	352	9.4	0.0	3.43	3.49	30.20
22TR3994	260413	Whicher Range-3	4173.25	4173.42	sandstone	Sue Coal Measures	0.496		2.57	1.84%	2.62	2020	5200.2	75	26.7	0.0	4.35	4.28	28.10
22TR3995	260414	Whicher Range-3	4175.55	4175.70	sandstone	Sue Coal Measures	0.183		2.52	2.01%	2.57	1900	4780.3	69	13.2	0.0	4.96	3.23	10.18
22TR3996	260415	Whicher Range-3	4177.83	4177.98	sandstone	Sue Coal Measures	0.180		2.48	2.22%	2.53	1890	4679.6	68	18.0	0.0	2.72	3.50	18.41

Sample Information					Lithology Information		Magnetic Properties		Mass Properties			Seismic Properties		Electrical Properties			Gamma Ray		
TR Sample ID	Client Sample ID	Drillhole ID	From	To	GSWA Lithology	Formation	Magnetic Susceptibility	Koenigsberger Ratio (Q)	Dry Bulk Density	Apparent Porosity	Grain Density	P-Wave Velocity	Acoustic Impedance	Galvanic Resistivity	Chargeability	Inductive Conductivity	K	U	Th
			(m)	(m)			(×10 ⁻³ SI)		(g/cm ³)	(%)	(g/cm ³)	(m/s)	(g/cm ³)*(m/s)	(Ωm)	(mV/V)	(S/m)	(%)	(ppm)	(ppm)
22TR3997	260416	Whicher Range-3	4214.84	4214.96	siltstone + sandstone	Sue Coal Measures	0.208		2.60	0.80%	2.62	1920	4985.9	123	10.9	0.1	4.23	2.04	12.57
22TR3998	260417	Whicher Range-3	4220.55	4220.70	siltstone + sandstone	Sue Coal Measures	0.387		2.54	1.44%	2.58	2250	5716.9	204	10.5	0.0	4.96	4.03	31.21
22TR3999	260418	Whicher Range-3	4223.57	4223.71	siltstone + sandstone	Sue Coal Measures	0.204		2.49	2.43%	2.55	2240	5580.4	99	13.7	0.0	3.44	1.17	6.42
22TR4000	260419	Whicher Range-3	4225.60	4225.72	siltstone + sandstone	Sue Coal Measures	0.126		2.47	1.81%	2.51	2250	5547.5	107	10.1	0.1	3.62	0.73	9.19
22TR4001	255390	Whicher Range-3	4240.76	4240.90	siltstone + sandstone	Sue Coal Measures	0.122		2.43	2.93%	2.51	1670	4062.6	83	15.3	0.1	4.27	-1.50	11.24
22TR4002	255391	Whicher Range-3	4245.75	4245.92	siltstone + sandstone	Sue Coal Measures	0.243		2.52	2.34%	2.58	1760	4440.2	73	15.8	0.0	3.24	1.09	10.64
22TR4003	255392	Whicher Range-3	4248.15	4248.29	siltstone + sandstone	Sue Coal Measures	0.416		2.51	0.87%	2.53	2350	5891.9	452	5.5	0.0	4.17	6.41	32.03
22TR4004	255393	Whicher Range-3	4251.95	4252.12	siltstone + sandstone	Sue Coal Measures	0.363		2.57	0.78%	2.59	2520	6477.1	235	9.6	0.3	3.82	7.03	34.86
22TR4005	255394	Whicher Range-3	4256.77	4256.97	siltstone + sandstone	Sue Coal Measures	0.176		2.54	2.07%	2.59	2410	6113.4	76	14.6	0.1	3.30	0.70	8.78
22TR4006	255395	Whicher Range-3	4416.89	4417.06	siltstone + sandstone	Sue Coal Measures	0.394		2.55	0.46%	2.56	2960	7546.0	415	5.3	0.0	4.83	4.89	41.44
22TR4007	255396	Whicher Range-3	4422.15	4422.30	siltstone + sandstone	Sue Coal Measures	0.114		2.47	2.62%	2.53	2970	7324.5	159	11.2	0.1	3.57	2.49	7.03
22TR4008	255397	Whicher Range-3	4427.41	4427.57	siltstone + sandstone	Sue Coal Measures	0.219		2.58	2.02%	2.63	3620	9321.9	183	10.9	0.0	4.04	2.17	11.58
22TR4009	255398	Whicher Range-3	4429.48	4429.64	siltstone + sandstone	Sue Coal Measures	0.328		2.53	0.38%	2.54	3110	7882.0	470	5.3	0.0	4.31	5.02	35.91
22TR4010	260451	CSD01	86.67	86.87	siltstone + sandstone		0.240		2.33	2.47%	2.39	4770	11130.8	56	12.4	0.0	5.98	-1.50	33.37
22TR4011	260452	CSD01	114.03	114.19	dolerite		0.545		2.42	2.17%	2.47	4190	10143.5	50	10.8	0.0	-0.30	-1.50	8.43
22TR4012	260453	CSD01	131.10	131.30	siltstone + sandstone		0.273		2.44	3.10%	2.52	5460	13327.9	34	14.8	0.0	5.44	-1.50	24.64
22TR4013	260454	CSD01	133.28	133.45	siltstone + sandstone		0.258	0.61	2.50	2.08%	2.55	4950	12375.1	7	103.1	0.0	7.79	9.00	42.48
22TR4014	260455	CSD01	136.35	136.50	siltstone + sandstone		0.449		2.36	3.44%	2.44	N/A	N/A	20	21.0	0.0	0.94	7.11	-0.90
22TR4015	260456	CSD01	140.58	140.78	siltstone + sandstone		0.522		2.67	0.76%	2.69	5570	14891.4	162	16.7	0.0	-0.30	5.04	-0.90
22TR4016	260457	CSD01	144.10	144.40	siltstone + sandstone		0.332		2.77	0.41%	2.78	6460	17868.9	210	9.3	0.0	7.10	8.41	32.80
22TR4017	260458	CSD01	151.55	151.70	siltstone + sandstone		0.452		2.77	0.24%	2.78	6510	18026.2	318	5.1	0.0	5.45	4.77	25.02
22TR4018	260459	CSD01	158.05	158.25	arenite		0.307		2.70	1.45%	2.74	5360	14458.8	71	18.6	0.0	3.29	13.94	-0.90
22TR4019	260460	CSD01	164.57	164.72	arenite		1.284		2.83	0.48%	2.85	5320	15077.9	683	6.0	0.0	0.80	6.45	11.03
22TR4020	260461	CSD01	167.57	167.77	arenite		0.203		2.70	0.25%	2.71	5640	15237.2	1191	4.5	0.0	2.11	9.65	20.93
22TR4021	260462	CSD01	173.95	174.15	arenite		0.181		2.72	0.09%	2.72	5980	16269.3	2182	6.7	0.5	3.53	-1.50	15.62
22TR4022	260463	CSD01	181.10	181.30	arenite		0.286		2.72	0.11%	2.73	5850	15927.8	4333	7.3	0.1	2.46	-1.50	25.32
22TR4023	260464	CSD01	193.10	193.28	arenite		0.227		2.73	0.06%	2.73	5920	16150.7	2297	7.2	0.0	3.29	4.97	16.36
22TR4024	260465	CSD01	198.97	199.09	arenite		0.400		2.79	0.47%	2.81	6090	17007.7	229	25.2	0.0	5.45	5.79	45.23
22TR4025	260466	CSD01	203.30	203.50	arenite		0.249		2.72	0.11%	2.72	6090	16552.8	1468	6.4	0.1	1.80	4.02	24.17
22TR4026	260467	CSD01	208.00	208.20	arenite		0.647		2.80	0.11%	2.80	6180	17282.5	1123	5.8	0.0	-0.30	4.16	-0.90
22TR4027	260468	CSD01	215.15	215.35	arenite		0.386		2.80	0.29%	2.80	6030	16859.7	458	5.9	0.0	3.05	-1.50	13.27
22TR4028	260469	CSD01	217.45	217.63	arenite		0.263		2.74	0.22%	2.75	6080	16675.4	702	9.4	0.0	6.53	13.33	17.60
22TR4029	260470	CSD01	221.30	221.50	arenite		0.329		2.74	0.21%	2.75	5730	15713.5	942	11.2	0.1	8.03	11.42	15.63
22TR4030	260471	CSD01	227.06	227.21	arenite		0.334		2.74	0.16%	2.75	5930	16277.7	812	8.3	0.0	4.29	14.57	14.94
22TR4031	260472	CSD01	235.10	235.30	arenite		0.478		2.76	0.35%	2.77	5360	14777.2	1408	21.8	0.0	3.24	-1.50	32.57

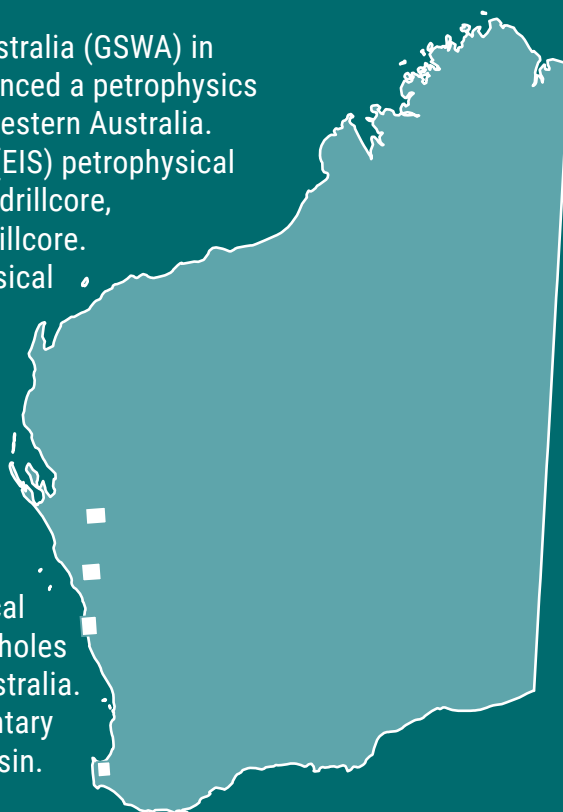
Sample Information					Lithology Information		Magnetic Properties		Mass Properties			Seismic Properties		Electrical Properties			Gamma Ray		
TR Sample ID	Client Sample ID	Drillhole ID	From	To	GSWA Lithology	Formation	Magnetic Susceptibility	Koenigsberger Ratio (Q)	Dry Bulk Density	Apparent Porosity	Grain Density	P-Wave Velocity	Acoustic Impedance	Galvanic Resistivity	Chargeability	Inductive Conductivity	K	U	Th
			(m)	(m)			($\times 10^{-3}$ SI)		(g/cm ³)	(%)	(g/cm ³)	(m/s)	(g/cm ³)*(m/s)	(Ω m)	(mV/V)	(S/m)	(%)	(ppm)	(ppm)
22TR4032	260473	CSD01	240.65	240.85	arenite		0.312		2.76	0.27%	2.77	5600	15468.5	294	29.9	0.0	3.63	12.13	9.75
22TR4033	260474	CSD01	246.87	247.07	arenite		0.356		2.82	0.16%	2.82	5790	16315.3	2227	10.3	0.0	5.16	6.12	27.70
22TR4034	260475	CSD01	254.80	254.96	arenite		0.188		2.70	0.08%	2.71	5550	15012.5	12865	6.6	0.0	-0.30	5.22	19.07
22TR4035	260476	CSD01	257.84	258.00	arenite		0.377		2.77	0.11%	2.77	5840	16160.2	1742	9.3	0.0	3.37	-1.50	24.00
22TR4036	260477	CSD01	261.77	261.97	arenite		0.219		2.70	0.11%	2.70	5040	13613.0	5650	6.8	0.0	2.12	3.53	10.22
22TR4037	260478	CSD01	267.61	267.77	arenite		0.506	0.76	2.71	0.17%	2.71	5140	13908.5	3345	37.7	0.2	10.86	6.69	31.01
22TR4038	260479	CSD01	281.45	281.63	siltstone + sandstone		0.835	5.42	2.82	0.16%	2.82	5540	15596.9	592	49.2	0.0	8.01	6.58	39.08
22TR4039	260480	CSD01	284.73	284.93	siltstone + sandstone		0.336		2.80	0.18%	2.81	5610	15716.5	1000	8.0	0.0	9.02	6.45	32.64
22TR4040	260420	CSD01	288.62	288.77	siltstone + sandstone		0.346		2.79	0.21%	2.79	5210	14529.2	494	5.9	0.0	8.30	6.91	50.43
22TR4041	260421	CSD01	294.76	294.91	siltstone + sandstone		0.407		2.79	0.23%	2.80	5840	16302.8	987	6.9	0.0	3.00	13.99	11.46
22TR4042	260422	CSD01	314.85	315.00	siltstone + sandstone		0.340		2.80	0.11%	2.80	5810	16250.7	2690	10.5	0.0	6.67	6.51	13.53
22TR4043	260423	CSD01	326.00	326.15	siltstone + sandstone		0.510		2.82	0.14%	2.82	5630	15855.4	2264	10.1	0.0	6.29	-1.50	54.33
22TR4044	260424	CSD01	334.50	334.65	siltstone + sandstone		0.257		2.74	0.26%	2.75	5570	15251.0	949	6.8	0.0	7.40	8.09	31.34
22TR4045	260425	CSD01	344.34	344.52	siltstone + sandstone		0.381		2.80	0.23%	2.81	5280	14808.5	1312	9.7	0.0	7.56	5.02	27.71
22TR4046	260426	CSD01	349.80	350.00	siltstone + sandstone		0.544		2.78	0.17%	2.79	5070	14111.7	535	2.7	0.0	7.28	10.82	23.96
22TR4047	260427	CSD01	352.06	352.21	siltstone + sandstone		0.524		2.81	0.13%	2.81	5010	14066.9	1500	15.9	0.0	3.15	6.31	20.23
22TR4048	260428	CSD01	356.98	357.17	siltstone + sandstone		0.557	3.98	2.79	0.03%	2.79	4050	11291.1	28124	35.0	0.0	3.22	5.18	20.02
22TR4049	260429	CSD01	363.25	363.45	siltstone + sandstone		0.343		2.79	0.10%	2.80	N/A	N/A	2023	12.1	0.0	4.37	8.72	45.38
22TR4050	260430	CSD01	365.95	366.11	siltstone + sandstone		0.395		2.78	0.12%	2.79	5250	14614.3	2195	11.5	0.0	6.60	12.42	46.25
22TR4051	260431	CSD01	376.01	376.21	siltstone + sandstone		0.391		2.80	0.21%	2.80	5080	14211.3	1001	15.6	0.0	10.72	14.85	34.92
22TR4052	260432	CSD01	385.50	385.70	siltstone + sandstone		0.452		2.78	0.29%	2.79	5190	14426.6	1091	7.7	0.0	7.66	10.07	40.74
22TR4053	260433	CSD01	389.81	389.98	siltstone + sandstone		0.411		2.80	0.14%	2.81	5650	15838.3	1191	13.4	0.0	8.48	8.87	34.29
22TR4054	260434	CSD01	391.67	391.82	siltstone + sandstone		0.345		2.78	0.04%	2.79	4860	13531.6	1302	7.7	0.0	9.30	8.08	28.45
22TR4055	260435	CSD01	398.28	398.43	siltstone + sandstone		0.387		2.81	0.15%	2.81	4470	12550.4	942	8.3	0.0	7.73	-1.50	37.14
22TR4056	260436	CSD01	403.90	404.05	siltstone + sandstone		0.475		2.81	0.05%	2.81	5500	15444.1	2405	11.9	0.0	4.79	9.51	31.91
22TR4057	260437	CSD01	411.15	411.30	siltstone + sandstone		0.389		2.80	0.08%	2.80	5850	16375.4	1601	10.1	0.0	7.99	-1.50	38.94
22TR4058	260438	CSD01	415.85	416.00	siltstone + sandstone		0.320		2.82	0.15%	2.82	N/A	N/A	3521	14.2	0.2	7.04	-1.50	38.85
22TR4059	260439	CSD01	421.69	421.84	siltstone + sandstone		0.277		2.78	0.04%	2.78	5490	15276.5	2896	12.5	0.0	5.47	-1.50	26.35
22TR4060	260440	CSD01	423.50	423.65	siltstone + sandstone		0.493		2.79	0.29%	2.79	N/A	N/A	274	7.0	0.0	4.06	-1.50	29.05
22TR4061	260441	CSD01	431.40	431.60	siltstone + sandstone		0.465		2.79	0.07%	2.79	5810	16220.7	1420	16.6	0.0	4.68	5.07	25.44
22TR4062	260442	CSD01	439.15	439.33	siltstone + sandstone		0.304		2.79	0.19%	2.79	5670	15813.3	1072	10.6	0.0	6.34	-1.50	31.37
22TR4063	260443	CSD01	444.84	445.00	siltstone + sandstone		0.341		2.79	0.08%	2.79	5770	16101.1	1130	8.5	0.0	3.55	6.11	17.44
22TR4064	260444	CSD01	451.65	451.80	siltstone + sandstone		0.365		2.77	0.11%	2.77	5720	15824.0	843	6.7	0.0	4.06	5.03	19.89
22TR4065	260445	CSD01	459.05	459.25	siltstone + sandstone		0.266		2.77	0.24%	2.77	5220	14447.5	1240	6.9	0.0	3.02	11.51	20.71
22TR4066	260446	CSD01	473.00	473.15	siltstone + sandstone		0.286		2.77	0.14%	2.78	5820	16134.4	722	6.2	0.0	5.08	6.45	41.95
22TR4067	260447	CSD01	478.53	478.68	siltstone + sandstone		0.400		2.76	0.03%	2.76	5820	16059.6	3935	11.1	0.0	6.16	3.55	18.00
22TR4068	260448	CSD01	486.00	486.17	siltstone + sandstone		0.332		2.79	0.08%	2.79	5680	15829.6	1009	6.5	0.0	6.37	-1.50	41.00
22TR4069	260449	CSD01	493.89	494.07	siltstone + sandstone		0.422		2.80	0.03%	2.80	5940	16639.6	1502	7.7	0.0	5.98	7.68	20.29
22TR4070	260450	CSD01	497.28	497.43	siltstone + sandstone		0.275		2.78	0.17%	2.79	5540	15405.2	324	7.3	0.0	7.18	4.43	30.14

APPENDIX 2 – SAMPLE PHOTOS

See attached document 'APPENDIX 2 – Sample Photos'.

In 2020, the Geological Survey of Western Australia (GSWA) in collaboration with Terra Petrophysics commenced a petrophysics project to sample diamond drillcore across Western Australia. Funded by the Exploration Incentive Scheme (EIS) petrophysical data have been collected from EIS co-funded drillcore, company drillcore, and GSWA stratigraphic drillcore. The aim of this project is to provide petrophysical datasets that can be used to assist with the planning and interpretation of geophysical data, including characterizing the physical property response of stratigraphic units, alteration and mineralization styles, and constraining geophysical models of the subsurface.

This Report provides a dataset of petrophysical analyses on 106 samples from four diamond holes located across the west coast of Western Australia. The drillholes penetrate Phanerozoic sedimentary sequences and volcanic units of the Perth Basin.



Further details of geoscience products are available from:

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