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Field Portable XRF analysis

COPPER RANGE LTD

**FPXRF analysis of water bore cuttings for the
Larrimah Phosphate Project**

EL28183, EL28184 & EL28185

Northern Territory

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A handwritten signature in black ink that reads 'Patrick Maher'.

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Attachment A.

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1 Introduction

1.1 Scope

CSA Global was commissioned by Copper Range Ltd to analyse water bore hole samples held at the Northern Territory Geological Survey (NTGS) core store in Darwin using a Field Portable XRF (FPXRF) unit. The water bore chipping samples were primarily to be tested for the presence of phosphate and calcium.

The aim of the test work was to generate data to assist with targeting future phosphate exploration programmes.

Copper Range also requested that further work to be carried out

- with the NTGS to identify the location of the written bore hole logging records.
- to investigate the written logging records so as to assist in the identification of the geology of each bore hole.

Furthermore, it was requested that an analysis of the various elements reported in the water bore hole sample results be carried out to assist in the identification of the local geology.

The work was carried by Andrew Margereson of CSA Global between the 16th and 27th May, 2011.

1.2 Water Bore Hole Selection

In the Northern Territory, The Department of Natural Resources, Environment, the Arts and Sport (NRETAS) is the custodian of water bores and associated information, excluding chip analysis results. The NTGS Darwin and Alice Springs core facilities store cuttings on behalf of NRETAS. The NTGS kindly provided CSA Global with an access and set up point for viewing and sampling the water bore cuttings.

Water bore hole locations over tenements EL28183, EL28184 and EL28185 were obtained from the Northern Territory Geological Survey (NTGS) database. At the time of writing this report the data was located at the following web address:

[http://www.nt.gov.au/d/Minerals_Energy/Geoscience/index.cfm?newscat1=&newscat2=&header=Water Bore Cuttings](http://www.nt.gov.au/d/Minerals_Energy/Geoscience/index.cfm?newscat1=&newscat2=&header=Water+Bore+Cuttings)

All water bore holes in and around these tenements were plotted to allow selection of bores for sampling. Water bore holes were selected primarily based on location to provide as much coverage as possible of the exploration licences. Water bore hole selection was restricted to those at least 60 metres deep unless geological logs indicated basalt was intersected. A map of the water bore hole locations can be seen in Figure 1. with the bore hole locational data detailed in Table 1.

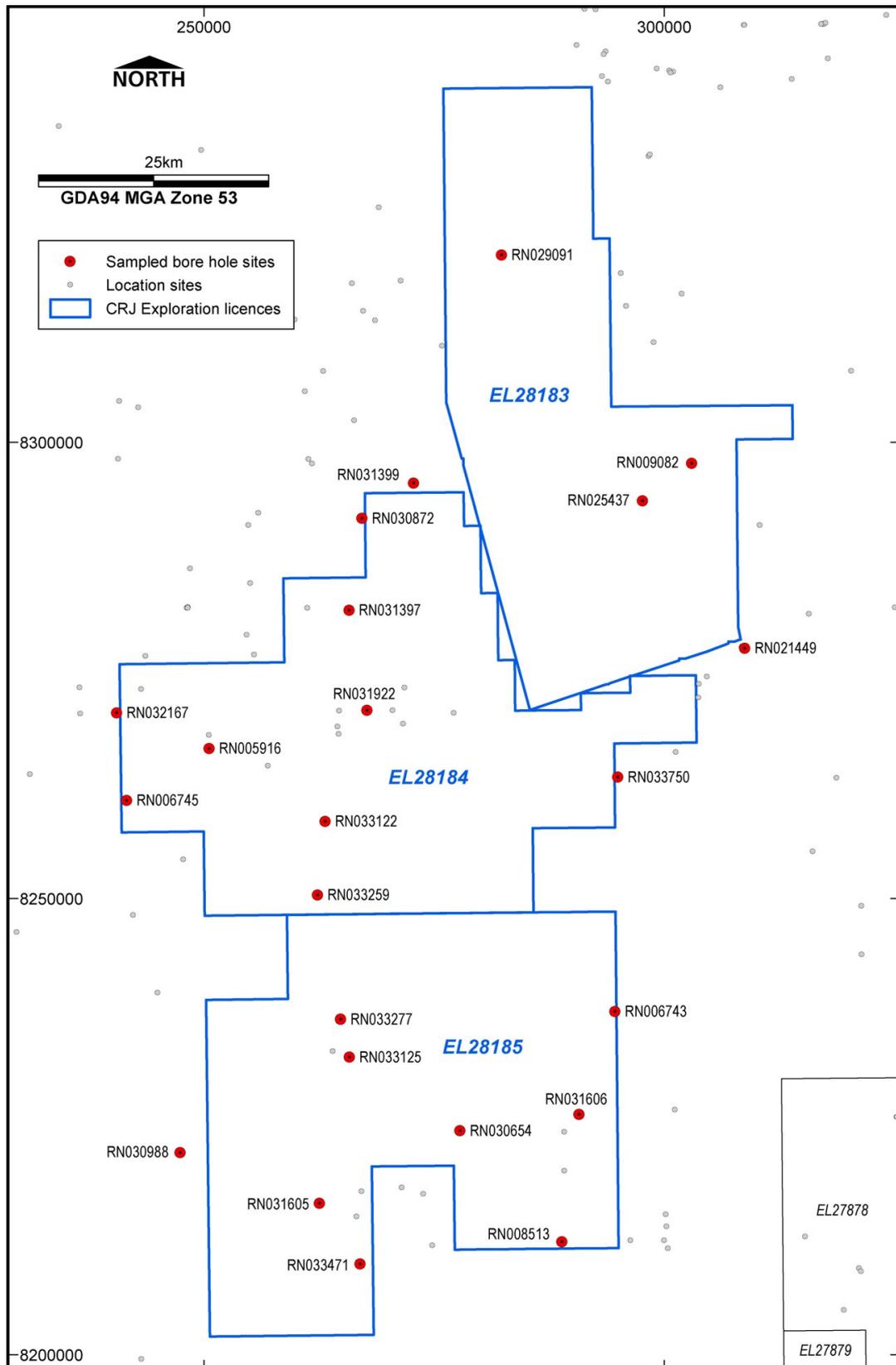


Figure 1. Location of water bore holes sampled

Site	Locality	Easting	Northing	Zone	Grid	Rack Location
RN005916	WESTERN CREEK STN	250577.7	8266466	53	MGA94	188
RN006743	SUNDAY CREEK STN DALY W. 5565	294663.4	8237615	53	MGA94	81
RN006745	WESTERN CREEK STN	241600.7	8260784	53	MGA94	188
RN008513	AVAGO STATION	288902.5	8212407	53	MGA94	82
RN009082	GORRIE \044940	302977.3	8297716	53	MGA94	189
RN021449	LARRIMAH CARAVAN PARK	308727.3	8277466	53	MGA94	349
RN025437	GORRIE STATION	297651.3	8293596	53	MGA94	189
RN029091	GORRIE STATION ROAD MATARANKA	282327.4	8320566	53	MGA94	KK70/07
RN030654	AVAGO STATION	277826.5	8224588	53	MGA94	KK60/01
RN030872	GORRIE STATION	267170.6	8291702	53	MGA94	KK60/01
RN030988	AVAGO STATION	247420.7	8222150	53	MGA94	KK61/09
RN031397	GORRIE STATION	265767.6	8281626	53	MGA94	KK60/01
RN031399	GORRIE STATION	272777.5	8295531	53	MGA94	KK59/03
RN031605	AVAGO STATION	262547.6	8216611	53	MGA94	KK58/03
RN031606	SUNDAY CREEK STN.D/WATERS 5565	290741.5	8226372	53	MGA94	KK58/03
RN031922	WESTERN CREK STATION	267704.6	8270633	53	MGA94	KK60/01
RN032167	GORRIE STATION	240527.7	8270366	53	MGA94	KK53/10
RN033122	TARLEE STATION	263179.6	8258480	53	MGA94	KK53/11
RN033125	AVAGO STATION	265809.6	8232645	53	MGA94	KK53/11
RN033259	BHR 105 TARLEE STATION	262352.6	8250401	53	MGA94	KK53/08
RN033277	WESTERN CK 5466	264854	8236779	53	MGA94	KK47/03
RN033471	MIDDLE CREEK 5465	266963	8209979	53	MGA94	KK47/01
RN033750	LARRIMAH 5566	294956	8263324	53	MGA94	KK47/03

Table 1. Water bore hole locational data
 (also detailed is the Rack location at NTGS core store in Darwin)

2 XRF Analysis

2.1 Instrument Details

The instrument used was an Olympus - Innov-X X-5000 portable benchtop XRF with a 10mm SDD detector and Tantalum anode. Mining Plus mode was used to test the samples (percentage level analysis). The beam timing was set to 30 seconds for the heavy element beam and 80 seconds for the light element beam as phosphorous was the focus of the project.

2.2 Sample Preparation and Analysis

The water bore cutting samples were found to be stored in plastic sample jars. The material ranged from fine powder to pebbles to solid clay. XRF analysis works best on fine powders so sample material was crushed by hand using a strong plastic spoon where possible. This was possible for almost all samples. In a few cases the sample could not be crushed. In these cases the sample was still tested but the result will be slightly less accurate than a crushed sample.

The sample was packed into a plastic XRF cup with a mylar film sampling window. The cup was placed over the XRF sampling window and the test was run.

Following a test the sample was returned to the plastic jar and the XRF cup cleaned for re-use. The mylar film was replaced when worn to maintain test accuracy. Cleaning of the sample cups was performed with air and paper towel to remove visible remnants of the sample. As this technique is volume dependant any remaining contamination would not affect subsequent tests in a measurable way.

3 Quality Analysis/Quality Control

3.1 Standards

As one of the primary aims of the test work was to generate data to assist with targeting future phosphate exploration programmes, three high calcium phosphorous standards were used to monitor the XRF analysis of the samples.

Calcium can influence phosphorous results as their spectral peaks occur in similar areas of the spectrum. The assay values for the standards which were prepared by Genalysis Laboratory Services for CSA Global can be found in Table 2 below:

Standard	Calcium (%)	Phosphorous (%)
XRF06	18.05794	0.461711
XRF07	18.60104	0.250494
XRF08	19.1227	0.148376

Table 2: Assay values for XRF standards.

(Values have been converted to the element concentrations from oxide values)

Standard XRF08 was used primarily to monitor phosphorous readings as it was closest to the values being encountered. Standards XRF06 and XRF07 were also run on occasion to monitor for variation in readings at higher concentrations.

A graph of the results for standards XRF06, XRF07 and XRF08 can be seen in Figures 2, 3 and 4 respectively. A comparison of the average XRF results to the Genalysis assay result can be seen in Figure 4.

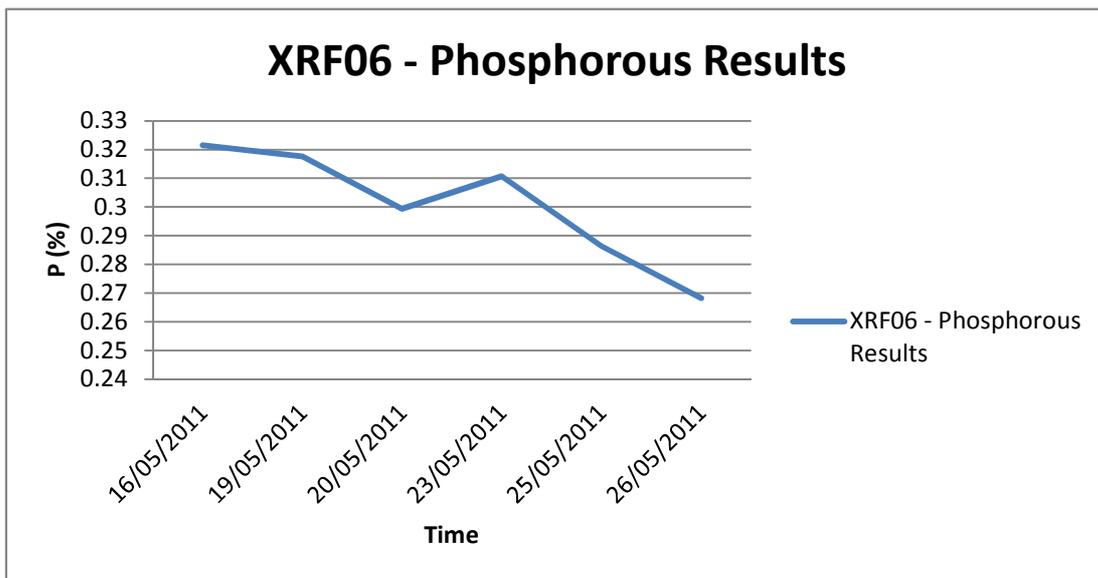


Figure 2. Results for analysis of standard XRF06

Figure 2 shows a gradual decline in readings for standard XRF06 over time, however this is likely the result of a small sample set.

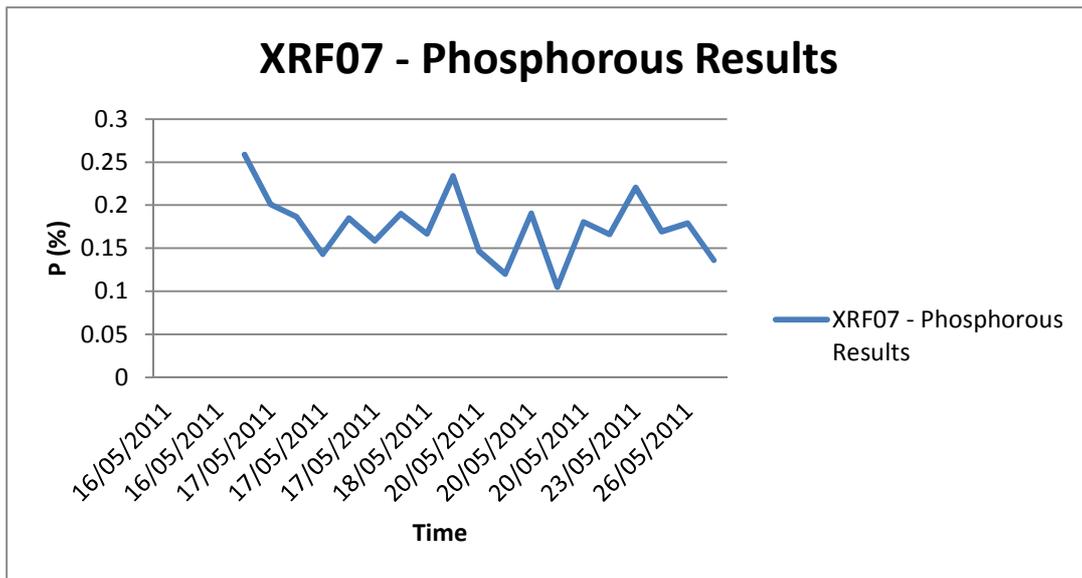


Figure 3. Results for analysis of standard XRF07

Figure 3 shows significant changes over time and indicates that small differences in phosphorous will not be detectable.

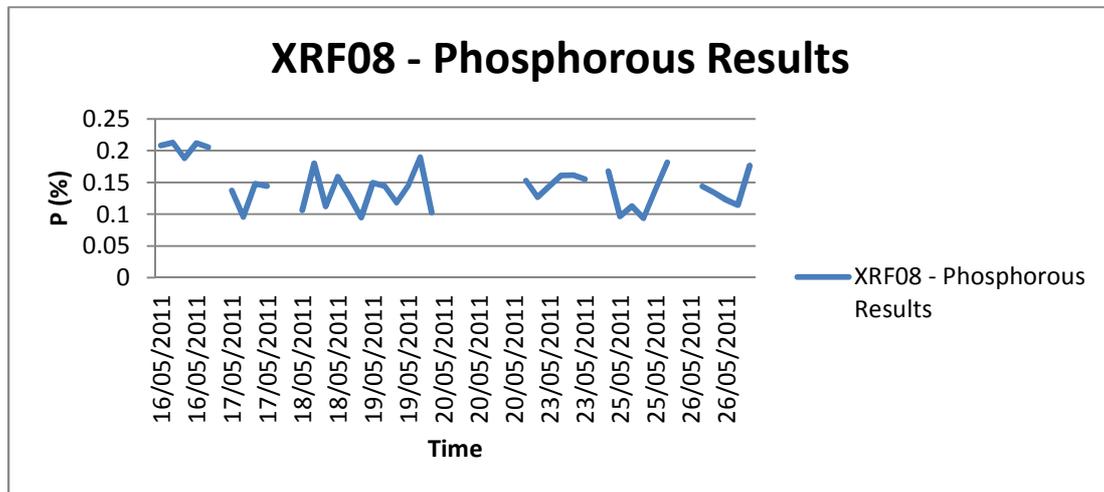


Figure 4. Results for analysis of standard XRF08 over time

Figure 4 shows significant variation in standard XRF08 over time. This is due to the standard being extremely close to the detection limit. In several cases there are breaks in the line which show where the level of phosphorous detected in the standard fell below the detection limit. It is important to note that FPXRF equipment does not have fixed detection limits. The detection limit for a particular reading is based on three times the standard deviation for that test. As the standard deviation will vary from test to test the detection limit will also vary.

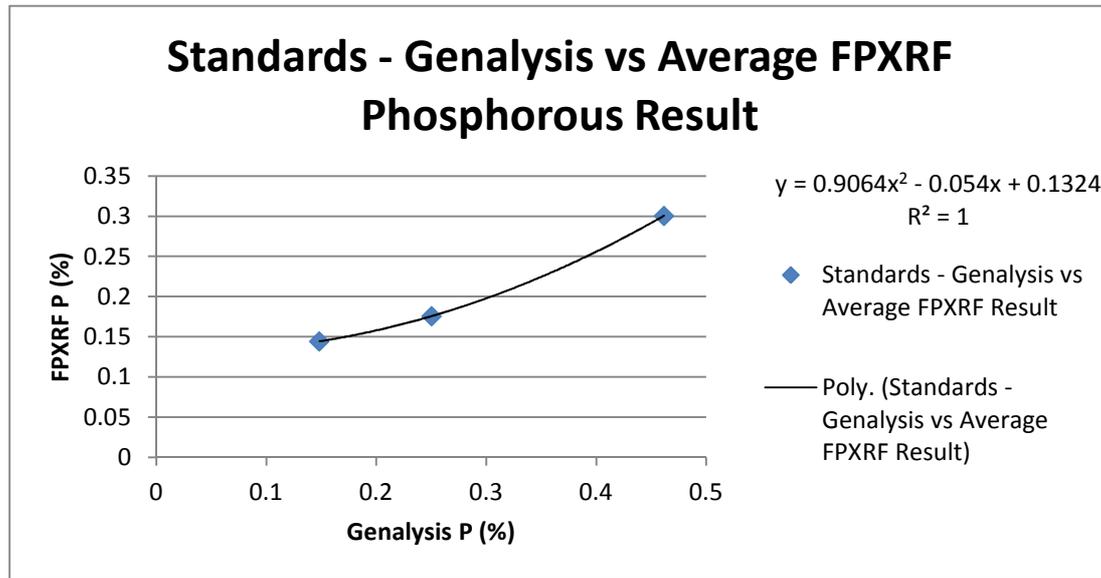


Figure 5. Genalysis assay results v's the average FPXRF result for each standard

Figure 5 shows that the FPXRF is reading the same value as the laboratory result in the lowest phosphorous standard and is producing lower values at higher concentrations. The results produced at the upper end of the scale will be lower than the actual concentration of phosphorous where high levels of calcium are present.

As no low calcium phosphorous standards were available the degree of bias effect for these samples is unknown. Assaying a small portion of the samples tested would allow the effect to be determined.

3.2 Duplicates

Duplicate tests were conducted every 20 samples to determine whether any variation was occurring from test to test to ascertain the FPXRF's precision. Duplicate samples were obtained by testing the same material twice. Duplicates were not created by taking a second portion of material from the sample jar. The results can be seen in Figure 6 as follows:

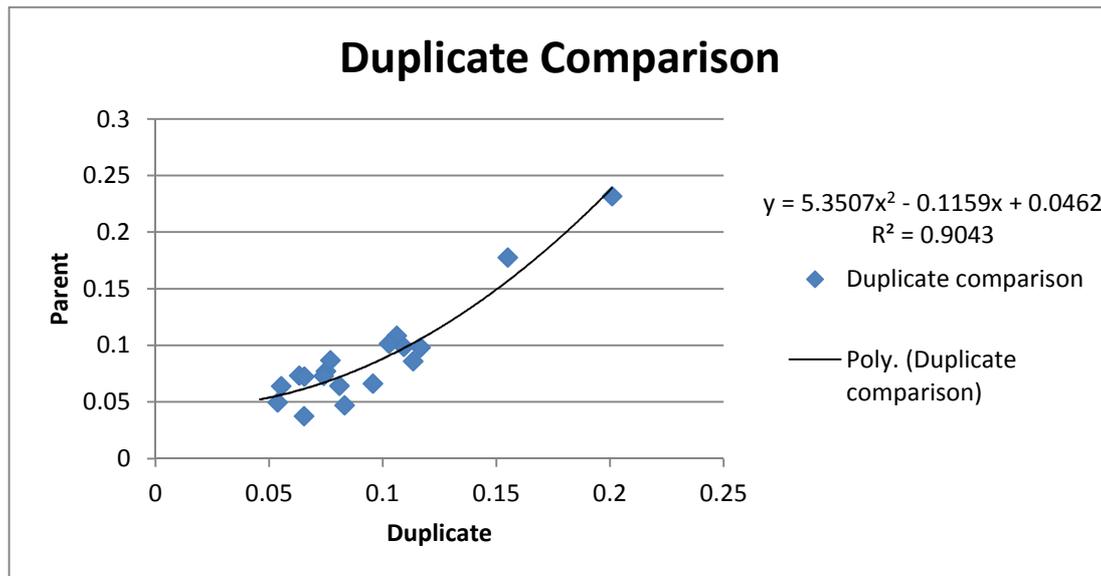


Figure 6. Comparison of duplicate samples

The duplicate tests do show some variation between parent and duplicate samples. This is to be expected at such low concentrations. Overall the duplicate tests form a clear trend with minimal scatter, demonstrating the variation encountered does not compromise the value of the data.

4 Results

4.1 Introduction

Results from FPXRF instruments are prone to bias due to geochemical and physical differences between the sample being tested and the samples used to calibrate the instrument. As assays of the material being sampled were not taken the data cannot be corrected and therefore is indicative only.

The full set of test results is attached to this report as Attachment A. The data sheet recording the correlation of the geology results with the FPXRF results is attached as Attachment B.

4.2 Phosphorous & Calcium

Phosphorous was present at very low concentrations across all samples and was very close to the detection limit of the instrument used, decreasing accuracy. The highest reading was 0.384% P which came from a sample logged as sandy clay (c.f. Appendix 1).

The results obtained for calcium indicate that it is present in high concentrations at consistent intervals or levels within the bore hole samples tested. The data correlates with the description of the limestone strata in the historical water bore hole logs (c.f. Appendix 2).

4.3 Other selected elements v's original logging sheets

The results for other elements were further compared to the original geology logs to verify their accuracy.

Iron

Iron occurrence in basalt is primarily in the six to nine percent range with a small number falling outside of this range. Iron occurrence in limestone is predominantly in the 0 to 2% range with few values appearing outside of this range (cf. Appendix 3).

Silicon

Silicon concentrations in basalt generally fall in the range of 15 to 20% with some samples falling anywhere between 10 and 30%. Silicon concentrations in limestone fall mostly in the 0 to 15% range (cf. Appendix 4).

Titanium

Titanium mostly occurs in basalt in the range of 0.4 to 1.0%. It occurs in limestone across the range of 0 to 0.2% with few higher values (cf. Appendix 5).

5 Conclusions & Recommendations

The results of the FPXRF analysis indicate that in the water bore holes sampled within the boundary area of EL28183, EL28184 & EL28185:

- phosphorous is present in quantities between 0 and 0.384%
- calcium is present between 0 % and 35.79%

The analytical results for calcium reported in the water bore hole sample results can be used assist in the identification of the local geology.

When the results for the selected range of iron, silicon and titanium elements were further compared to the original geology logs to verify their accuracy, it was found that

- the X5000 elemental analysis correlates well with the historic bore hole logs for each bore hole sampled
- silicon may be used to distinguish between basalt and limestone.
- titanium can be used to distinguish between basalt and limestone.
- the usefulness of iron concentration as a tool for identifying geology is limited even though it can distinguish a change between basalt and limestone.

This data generated may be used to assist with the targeting of future exploration.

It is recommended that EL's 28183, 28184 & 28185 be investigated further for their phosphate potential using different exploration methods such as RAB or RC drilling techniques. The results obtain from this FPXRF program do not record sufficiently high phosphorus values to accurately predict the presence of phosphate within the Exploration Licence areas.

Due to the presence of high calcium and low iron values in the analytical results at various intervals in the water bore holes tested, the licence areas should be further investigated for its clean limestone potential. The licences may contain limestone material suitable for use in cement making manufacture and fertilisers.

Appendix 1. Phosphorous lithology and clay concentration

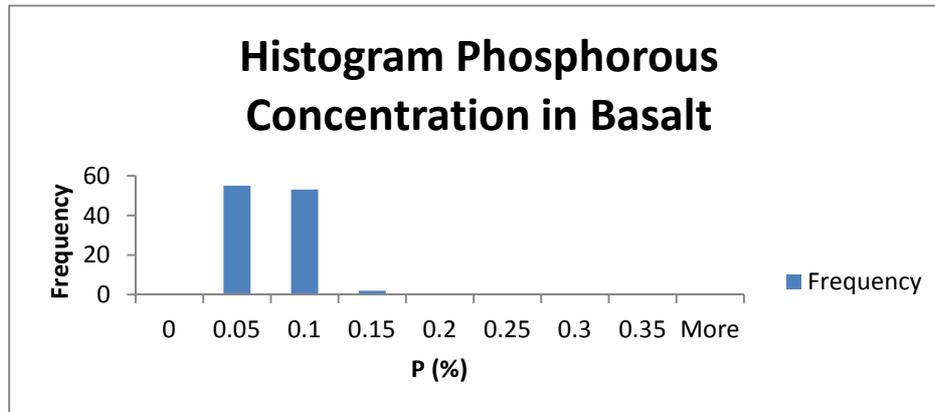


Figure 7. Histogram of phosphorous concentration in basalt

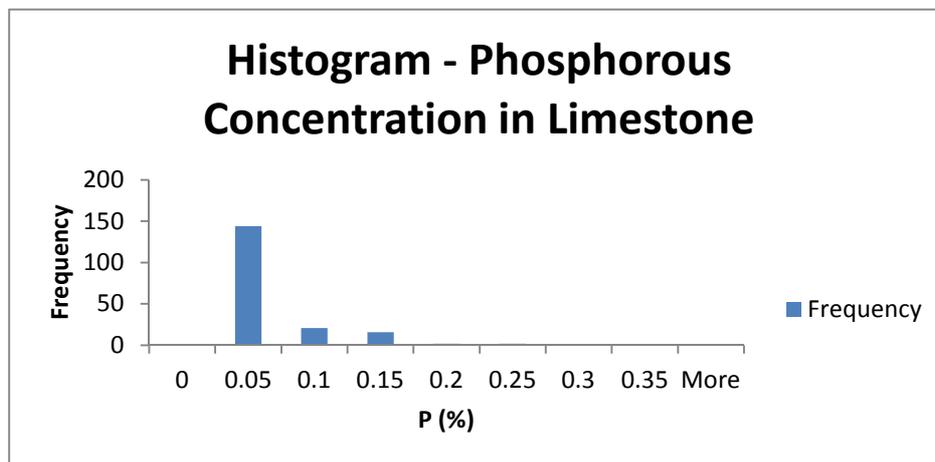


Figure 8. Histogram of phosphorous concentration in limestone

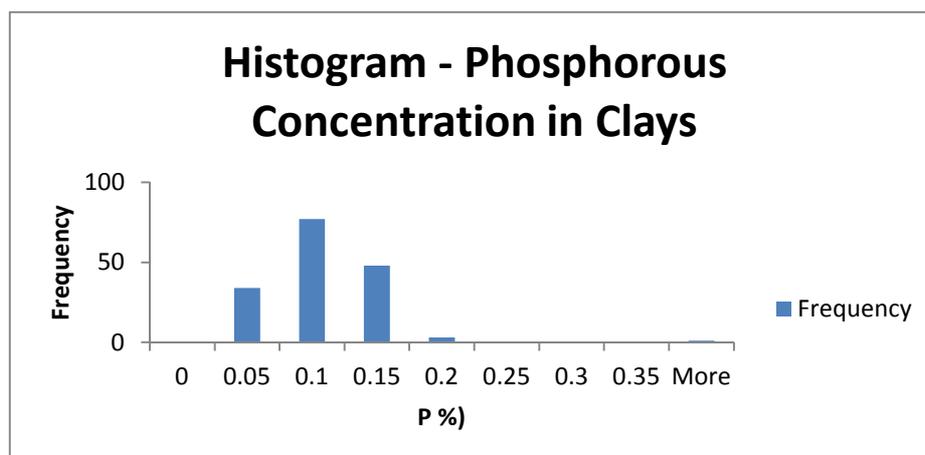


Figure 9. Histogram of phosphorous concentration in clays

Appendix 2. Calcium lithology and clay concentration

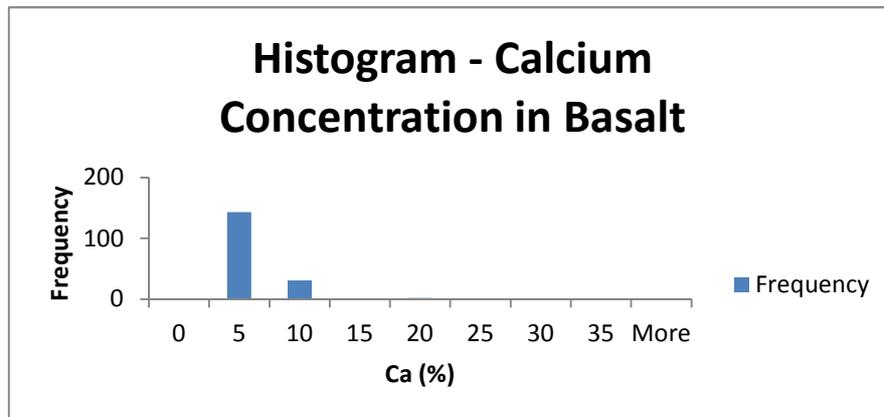


Figure 10. Histogram of calcium concentration in basalt

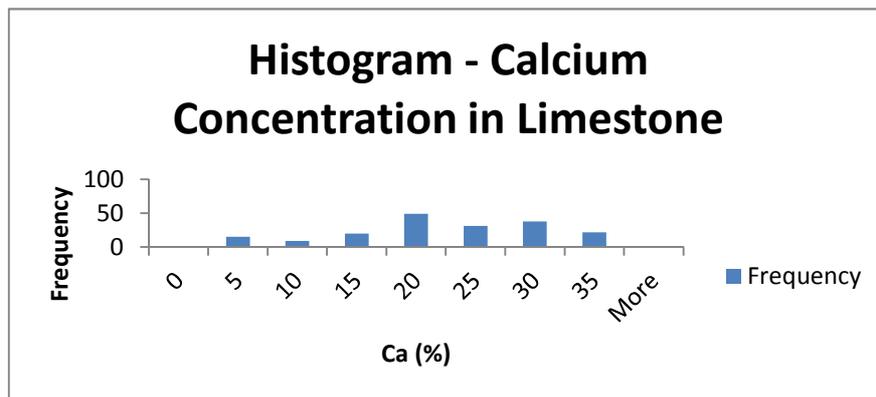


Figure 11. Histogram of calcium concentration in limestone

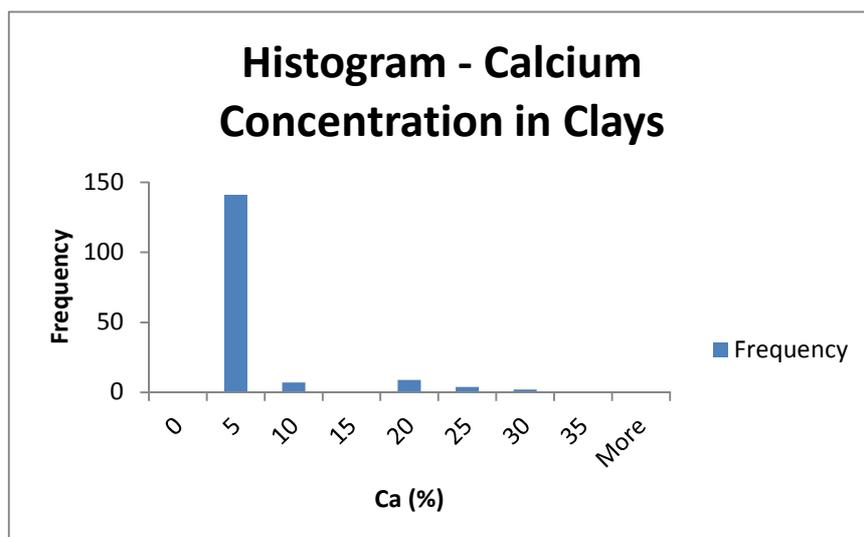


Figure 12. Histogram of calcium concentration in clays

Appendix 3. Iron lithological concentration

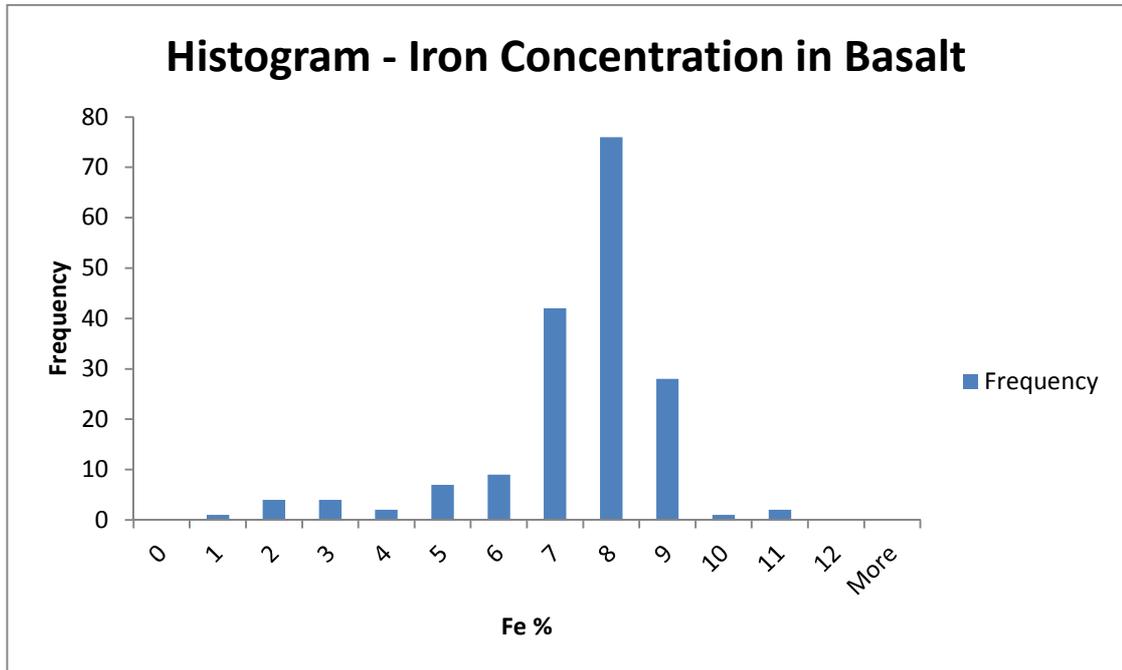


Figure 13. Histogram of iron concentration detected in Basalt

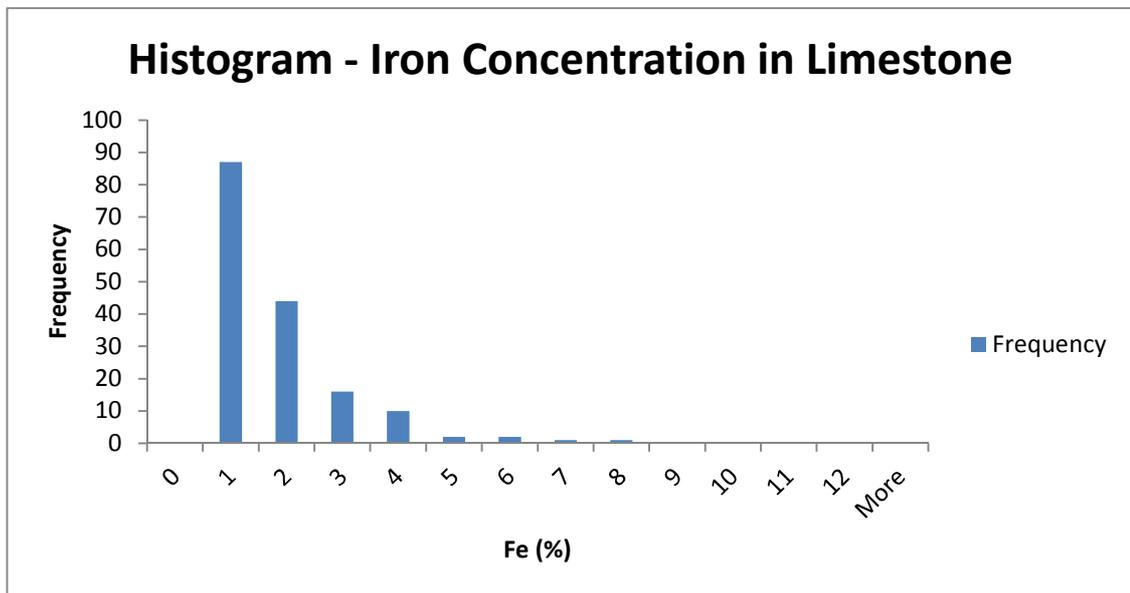


Figure 14. Histogram of iron concentration detected in Limestone

Appendix 4. Silicon lithological concentration

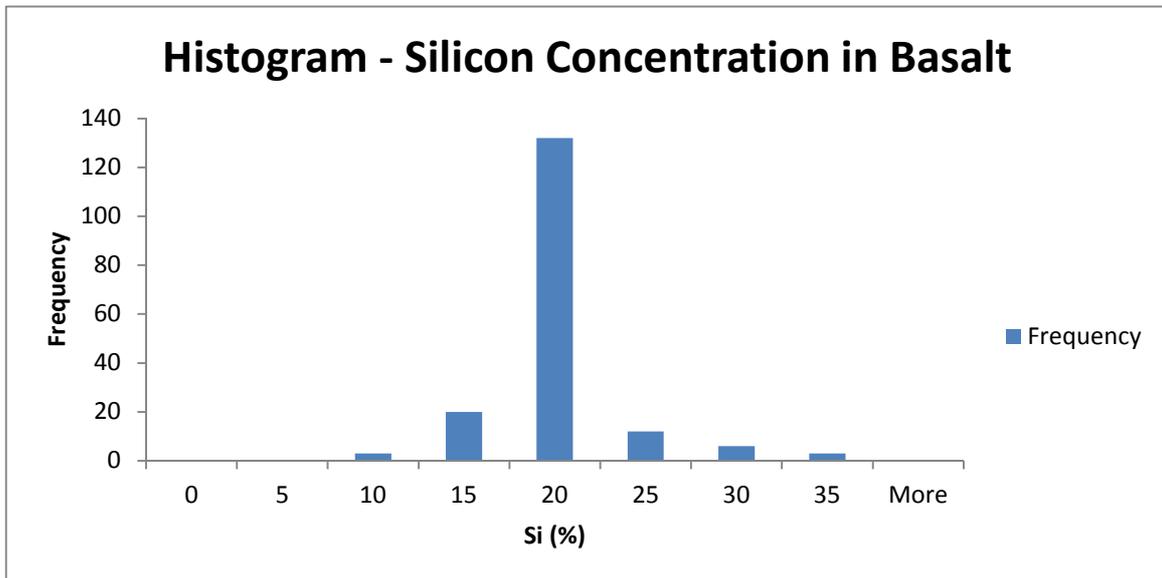


Figure 15. Histogram of silicon concentration in basalt

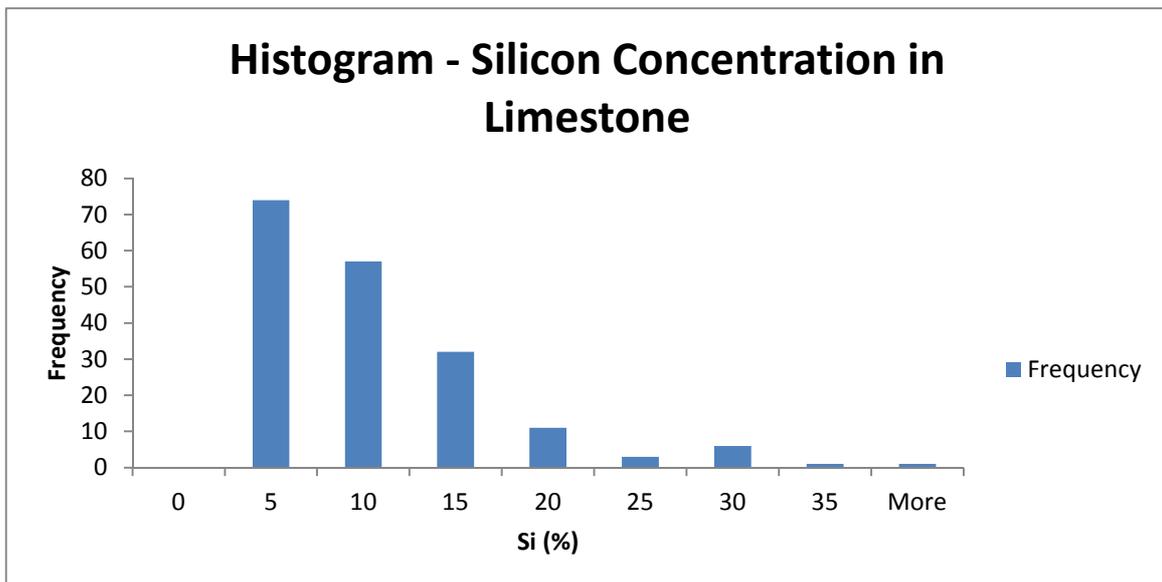


Figure 16. Histogram of silicon concentration in limestone

Appendix 5. Titanium lithological concentration

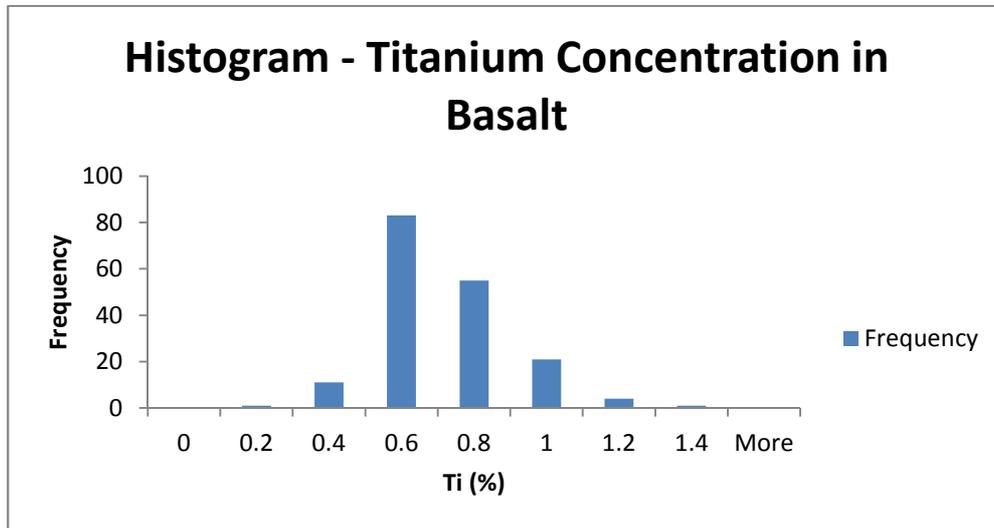


Figure 17. Histogram of titanium concentration in basalt

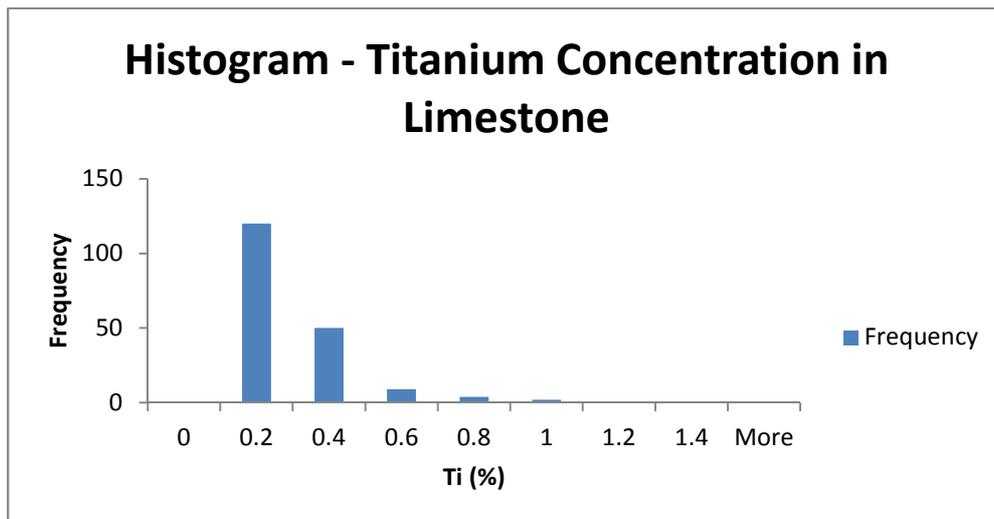


Figure 18. Histogram of titanium concentration in limestone