University of Nevada, Reno

Pilot Study using Elemental Geochemistry as a Means of Discriminating Chert Stratigraphy in the Roberts Mountains Allochthon, Nevada

A thesis submitted in partial fulfilment of the

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by

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Abstract

Biogenic chert beds in the Roberts Mountain Allochthon (RMA) are analyzed for major and trace element geochemistry with the goal of developing a geochemical means to differentiate units. This detailed chemical profile will allow for the identification of unknown cherts through the use of chemical data instead of time intensive, and sometimes difficult fossil identification. The data set consists of 82 samples used for handheld XRF analysis and 66 for ICP-MS and ICP-OES analysis. Samples were collected from 6 localities in 5 ranges, all with known ages based on radiolarian biostratigraphy. These samples are assigned to either the Slaven, Cherry Spring, or upper Vinini chert, or equivalent units. Several analytical methods were employed to test their effectiveness in discriminating the cherts. The methods used are a handheld Niton XRF (pXRF) on hand samples, ICP-OES to determine percent oxide concentrations, and ICP-MS for trace element concentrations. Data were analyzed using multivariate linear discriminant analysis (LDA) to develop a classification model on known samples, and the LDA models were tested with several prediction functions. Based on the sample set size, the Leave One Out Cross Validation method (LOOCV) proved to be the most reliable statistical tool for evaluating model performance between the analytical methods. The pXRF, data on *in situ* samples, while the fastest and cheapest form of analysis, was the least reliable prediction method correctly predicting 61.6% of the time on a subset of data that removed elements where the majority was below detection limits (LOD). Performing pXRF on powdered samples increased the predictability from 61.6% to 75.4% using the LOOCV test on data where elements returning >50% LOD (lower than detection) were removed. Increased run time on powdered pXRF samples did decrease the number of lower than detection (LOD) values, but did not increase the predictability. The ICP-MS data, returning trace elements, including REE’s is a slightly more reliable method of prediction over the powdered pXRF, although more expensive to run. The LOOCV test of the ICP-MS model correctly predicted units 78.9% of the time. ICP-ES data were not a useful predictor of unit, but provided some information regarding provenance. Together ICP-ES and REE data rule out an open ocean setting for the RMA chert units, and instead point to a continental margin environment of deposition, based on the presence of an Eu anomaly and lack of a Ce anomaly. Collectively, these data show that it is possible to discriminate between the chert units in the RMA using geochemistry, even when correlating chert from the Independence to the Shoshone range, and that there are tradeoffs between cost and reliability between pXRF and ICP-MS data. They further illustrate the utility of these geochemical data as a means of evaluating geologic provenance of chert.

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Introduction

Marine basinal facies rocks in Paleozoic orogenic belts pose challenges for detailed stratigraphic interpretation because of their monotonous and repetitive lithology, poor exposure, and structural complexities. Radiolarian-bearing chert is a common component of these sequences, and can serve as marker beds due to its erosional resistance and ridge forming behavior, within the more generally monotonous nature of the upper plate units. Despite their potential benefits in mapping and stratigraphic reconstructions, distinguishing different chert units visually in the field can be difficult in the Great Basin of North America. Past successes have employed radiolarian biostratigraphy as a chief tool to discern age differences and then subsequently recognize subtle sedimentological differences between chert units that allow for their more detailed mapping (Murchey, 1990; Jones, 1990 Noble and Finney, 1999). This coupled biostratigraphic and field mapping technique is time intensive, requires special training, and is not always met with success. For this reason, the addition of an alternative method of geochemical discrimination could aid in the identification of unknown chert units. Multiple chemical analysis methods that provide a range of trace and rare earth elements (REEs) are evaluated in this study, including portable X-ray fluorescence (pXRF), ICP-AES, and ICP-MS to help ascertain both their reliability and practicability of each method in distinguishing units. Determining the effectiveness of the pXRF is of particular interest, given portable XRF analyzers are widely used by mining and mineral exploration companies. This paper evaluates the applicability of elemental geochemical analysis for discriminating chert units within the upper plate rocks of the Roberts Mountains allochthon (RMA) (Fig. 1) based on geochemical composition, and discusses is applicability in future mapping campaigns.

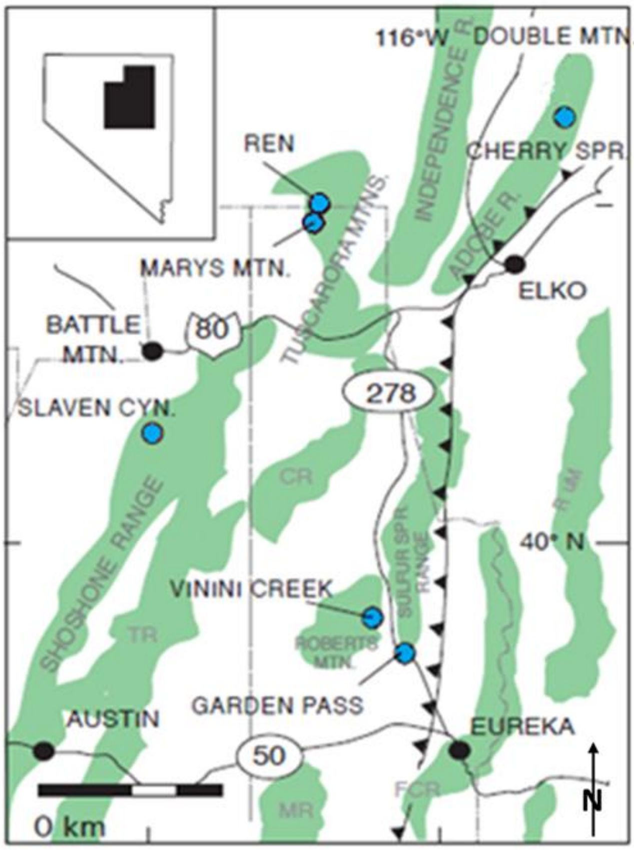

Figure 1. Generalized map showing the Roberts Mountain allochthon edge with sampled localities indicated by blue dots. Green areas represent major mountain ranges. Modified from Noble (2000).

Previous Work

Multiple studies indicate the efficacy of using major and trace element geochemistry to characterize chert units in stratigraphic sequences (Reifenstuhl, 2009; Peh and Halamić, 2010; Gauthier et al., 2012), and to use these elemental signatures as a means for determining provenance and alteration of these units (Murray et al., 1990, 1991, 1992; Murray, 1994, Tanner et al. 2013). For example, Reifenstuhl et al. (2009) used chemical analysis from five type localities in the Tanana B-1 Quadrangle located in east-central Alaska to produce a geochemical model for the known chert beds. These data were then used to test samples from unknown and uncertain geologic units. Their findings show that the chemical signatures of the cherts are sufficiently distinctive to predict a unit for the unknown samples with only a few exclusions (Reifenstuhl et al, 2009).

REEs, and trace elements have also been used in the provenance classification of chert (Murray et al., 1991; Tanner et al., 2013). REEs may be able to help with the interpretation of the depositional setting of chert relative to the continental margin, and help with possible tectonic reconstructions of areas (Murray et al,. 1991). Another advantage to analyzing for REEs is they are less susceptible to remobilization after deposition making them reliable indicator elements if there is significant variation in abundance between units (Murray et al., 1991). REEs and trace elements have also proved reliable in determining provenance of material that has been structurally deformed and undergone regional metamorphic effects (Tanner et al. 2013). Chemical analysis of the cherts by Tanner et al. (2013) used REE and trace elemental data from known depositional environments within ocean basins to compare and classify cherts of unknown origin in Scotland. Their research produced chemical profiles for the unknown cherts that were reproducible and showed that, even though the area has been metamorphosed, the REEs and some other trace elements were not significantly altered to prevent identification of original tectonic depositional environment (Tanner et al. 2013).

The studies listed above used very reliable and precise methods of chemical analysis for their samples. One purpose of this study is to determine the effectiveness of a handheld pXRF for quick classification of an unknown chert unit. This type of work has been conducted in the field of archaeology for some time in order to determine the provenance of chert artifacts produced by Native American cultures (Gauthier et al., 2012). Chert quarries that were used in the past were analyzed using energy dispersive X-ray fluorescence (ED-XRF) to obtain a geochemical signature (Gauthier et al., 2012). While the ED-XRF is a more powerful machine than the pXRF, the Niton should be able to produce some elemental data that can be used for chert identification. Gauthier et al. (2012) were able to identify the quarries that many of their archeological samples came from.

Material and Methods

Choice of samples studied

All samples for analysis were collected from the RMA from the Ordovician Vinini, Silurian Elder, and Devonian Slaven Formations, (Fig. 2). All three formations have well-established age control through previous biostratigraphic work (Noble 2000; Cellura 2004; Hall 2006). The Slaven chert is Late Frasnian (Boundy-Sanders et al., 1999). Cherry Spring is Llandoverian (Nobel et al., 1998 & Noble, 2000) The porcellanite is Upper Caradocian to Lower Ashigillian (Noble & Finney, 1999). Coordinates of outcrops sampled are given in Appendix 1. The Roberts Mountains yielded porcellanite and Slaven equivalent units located at the type locality for the Vinini formation at Vinini Creek with age control provided by Noble and Finney, 1999 (Fig, 1). The Slaven equivalent is a cliff-forming unit located in a drainage on the north side of Vinini Creek with an overall greenish color along with some light browns and grays. Two pXRF readings were taken in the field and 6 hand samples were collected along the outcrop. Porcellanite located upslope from the Slaven equivalent outcrop consists of a few resistant protruding beds surrounded by float covering the surface, beds have a white porcelain appearance. Two pXRF readings were taken in the field and 5 hand samples were collected from outcropping beds of porcellanite.

The southernmost extent of the Sulfur Springs Range at Garden pass provides outcrops of Cherry Spring Chert directly off Highway 278 with age control provided by Noble et al. 1998 (Fig, 1). Weathered surfaces of the Cherry Spring chert in this area are stained brown to red while freshly fractured surfaces range from green to gray with the presence of sulfide-bearing zones that appear leached. One outcrop reading with the pXRF along with five hand samples were collected from this locality.

Cherry Spring chert in the Northern Adobe Range forms resistant ridge-forming outcrops with age control provided in Noble et al., 1997 (Fig, 1). Weathered surfaces are similar to the Sulfur Springs locality; sulfide leaching and staining is prevalent throughout the outcrop, fresh surfaces gray to greenish gray. A total of 8 hand samples were collected, with no pXRF readings performed in the field.

Mary’s Mountain and the Ren property are both located in the Tuscarora Mountains. Cherry Spring, porcellanite, and Slaven located at Mary’s Mountain were originally dated by Cellura, 2004 (Fig, 1). Porcellanite or the PK chert sampled at the Ren locality were originally dated and mapped using biostratigraphy by Cluer et al., 1997 (Fig, 1). Cherry Spring at Mary’s Mount crops out as a resistant bed on a low ridge with brown-red and green weathered surfaces. Fresh surfaces are typically gray-brown with some green tinted zones, and some leaching of sulfides bearing lenses. A total of 7 pXRF readings were taken at the outcrop and 5 hand samples. Porcellanite crops out on the edge and in a small gully. Weathered surfaces are light gray with fresh surface dark gray to black. A total of 8 hand samples were collected with no pXRF readings taken in the field. Slaven chert crops out as a resistant bed running from the base of a gully upwards. Weathered surfaces are dark gray to nearly black with fresh surfaces of browns and varying shades of gray. A total of 3 pXRF readings were taken in the field and 7 hand samples were collected. PK chert at Ren forms a resistant ridge top outcrop with an off-white to light gray and tan weathered surface, and light to medium gray fresh surface. A total of 12 hand samples were collected with no pXRF readings taken in the field.

Slaven Canyon, located on the north end of the Shoshone Range is the type locality for the Slaven chert. It was dated by Boundy-Sanders et al., 1999 (Fig, 1). Two areas were sampled in the Shoshone Range. First samples were collected from an outcrop near the mouth of Slaven Canyon, where the Slaven chert forms a resistant ridge. Weathered surfaces are gray to black with some red staining, fresh surfaces range from brown to gray-black. Three samples were collected from in Slaven Canyon. Samples were also collected from the Slaven open pit barite mine. The highwall in the open pit displayed more oxidation alteration as well as visible barite and similar brown to gray-black weathered chert. Three samples were collected at the barite pit and no pXRF data was taken in the field at either of these localities in the Shoshone Range.

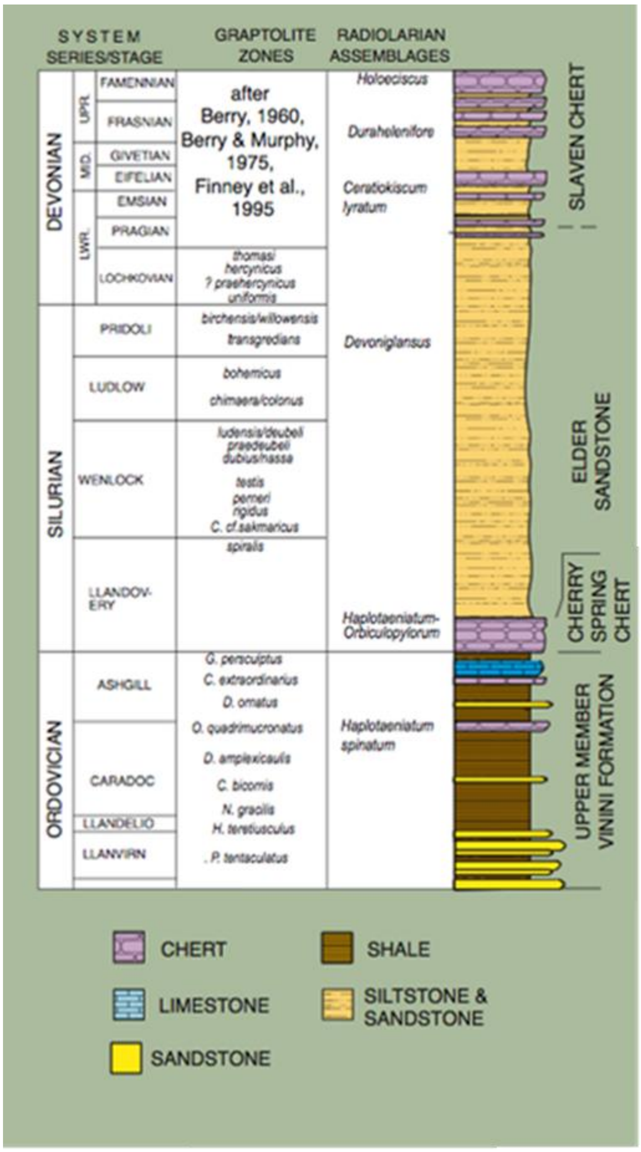

Figure 2. Generalized stratigraphic column displaying target units (after Noble, 2001). Porcellanite is the small chert bed depicted in the Ordovician that fall from upper Caradocian to lower Ashigillian (Noble & Finney, 1999).

All localities were sampled in 2014 or 2015 during the course of this study. All resampling of these localities was guided by the field geologists who originally collected and dated each locality, to assure that the same beds sampled for geochemistry had, in fact, yielded the fossil material used to date them, with the exception of the Slaven Canyon Slaven chert localities.

Sample Preparation

Samples were broken using a jaw crusher and cone crusher. From these crushed samples, shards were picked out for analysis, taking care to avoid pieces with oxidized or vein-filled surfaces, although for some samples it was not possible avoid veins or oxidation. Three samples, which had the cleanest picked shards for analysis, are designated with an A after the sample number. A duplicate sample containing weathered, oxidized, and veined material, in order to compare the freshest material to that with alteration using all analytical methods, is designated with a B after the sample number. Samples were pulverized using a tungsten carbide ring and puck grinder. The grinder was cleaned between samples with compressed air, brushing, and wiping down with a paper towel. The final pulverized sample was used for ICP-MS, ICP-ES and pXRF analysis.

Slabs were cut from 15 samples and used to make polished thin sections for transmitted light microscopy to check for degree of alteration. Three of these samples were then examined with a JEOL JSM-6010 scanning electron microscope (SEM) with the back-scattered electron (BSE) used for imaging and energy dispersive spectroscopy (EDS) used for elemental analysis. SEM working distance of 10 mm and voltage of 20kV were used.

Analytical Methods

A pXRF analyzer, a Thermal Scientific Niton XRF model number XL3t900S with a silver cathode tube, was used on outcrops in the field as well as on collected samples. Data collected using the Niton represents point data from the surface of the material being analyzed. The Test All Geo mode was used with each of 4 filters running for thirty seconds (120 seconds total). Fresh surfaces were analyzed by fracturing the outcrop or hand sample in order to avoid analyzing weathered or altered rock. The pXRF was also used on a subset of 66 samples that were powdered for ICP analysis. Powdered material is used to determine if the more homogenized nature of the powdered samples produces higher resolution data than surface point data. Plastic containers were loaded with powdered sample and cotton filler was used to compact the powder against 4μ polypropylene X-ray film covering. Plastic containers were placed over the analyzer and analyzed in the All Geo Mode for 30 seconds on each filter (120 seconds total) , and one minute on each of the four filters (total of 240 seconds) to examine the variance between shorter and longer run times. Samples were not moved between time runs to ensure the same area was being analyzed. Comparisons between the two different run times and powdered vs. surface point data are included in the “Results” section below. Data from pXRF analysis, gathered from samples collected over the summers of 2014 and 2015 field seasons, is included in the “Supplementary Materials.”

ICP-ES was used to obtain major element concentrations in oxide form and trace elements Sr, and Ba and was run on a Jobin-Yvon Ultima-C ICP-ES at Boston University. Pulverized sample was fused with lithium metaborate flux, molten sample was dissolved in HNO_3 for both ICP-ES and MS analysis. Precision and analytical accuracy were monitored during ICP-MS and ICP-ES by running the certified reference material (BHVO-2) and analyzing two samples in triplicate. ICP-MS was used as the preferred method for determining all of the REE and a large suite of trace elements, the detection limit capabilities for ICP-MS are significantly lower (1-10 ppb) than ICP-ES (Wolf, 2005), especially where concentrations of trace and REEs are significantly lower due to the high silica content of chert. ICP-MS was performed on a VG Plasma Quad ExCell ICP-MS at Boston University. From personal correspondence with Dr. Thomas Ireland ICP-MS was performed initially using 1 mL of HF, 3 mL of HNO_3, and 1 mL of HCl. The high SiO_2 content of the chert resulted in incomplete digestion of the samples and re-digestion with 1.5 mL of HF had to be performed. Re-digestion worked for the majority of samples though seven porcellanite and three Slaven samples from Mary's Mountain still contained residue, these samples are reported with an asterisk at the end of the sample number in Supplementary Table 1. Ideally, samples with incomplete digestion would have been discarded from data analysis; unfortunately, that would have eliminated all seven of my porcellanite samples and three of seven Slaven samples from Mary's Mountain. These samples are used in the final data analysis, otherwise there would be too few from Mary's Mountain for adequate model building.

Data Analysis

Multivariate data analysis and prediction of unknowns was performed using the MASS package (Venables & Ripley 2002) in R, which is an open source software. Additional data analysis and figures were produced using ioGAS and PAST software. The first step in data analysis is the performing of multivariate analysis of variance or MANOVA. MANOVA is a robust statistical test for data that departs from normality, as most geochemical data does (Dillon and Goldstein, 1984). MANOVA produces two important values for determining variance within a data set. First is Wilks' Lambda, a value that ranges from 0-1 with the desired value being as close to zero as possible. MANOVA also produces a *p*-value with the standard cut off for significance being $p < 0.05$. The Wilks' Lambda value can vary as long as the $p < 0.05$ parameter is met (Dillon and Goldstein, 1984). Data analysis is similar to that conducted on cherts in the Tanana B-1 Quadrangle in Alaska, which includes linear discriminant analysis (LDA) of data (Reifenstuhl et al. 2009).

LDA is used when there are multiple known groups with the goal of maximizing the variance between separate groups as opposed to the variance that exists within an individual group (Dillon and Goldstein, 1984). LDA results in the variables of the original data set, in this case periodic elements, being recalculated into discriminate scores that are used to determine a linear discriminate function (Maindonald & Braun, 2010). LDA results in a predictive discriminant model that is trained using known groups and can then be applied to classification of unknowns if the groups are found to plot separately from one another (Dillon and Goldstein, 1984). After LDA was performed on the locations with known ages additional statistical analysis was performed to test the model's usefulness in identifying specific chert beds.

To test the model, three different methods were used. The simplest model is the predict function in R on the entire data set that was used to train the model. After the LDA is performed, each individual sample is then run as an "unknown" and classified by the model into its predicted unit. Since each sample is included in the training data set the predict function typically results in greater predictability when the same samples are run as an unknowns owing to an exact match included in the training set (Maindonald & Braun, 2010). The next method is Leave One Out Cross Validation (LOOCV). This method withholds each sample one at a time while the LDA is being run and then plugs it back in as an unknown. This method is more robust than the previous prediction method due to the samples withdrawal from the training set. A standard method to test the predictability of the model is to withhold a set of samples completely from the training set and use them as the unknowns. In all cases, the same 9 samples were withheld from each dataset. A drawback of this method is the reduction in size of the overall training set.

Data produced with the pXRF received the most modification before being used for statistical analysis. The pXRF utilizes a Ag cathode x-ray source resulting in erroneous Ag values, necessitating removal of Ag from analysis. There are known interferences between certain elements when using the pXRF including W and Ag therefore W is removed from pXRF analysis, there are possible interferences between Sb and Ca however these were left in the data set owing to high detection numbers. Additionally, Pd, Nb, Bi, Re, Ta, Sc, and Hf, are removed from all pXRF analysis due to complete lack of detection or returning of only one to two detections per element. Owing to the large number of less than limit of detection (LOD) values returned by the pXRF, two methods of data transformation were used on the *in situ* pXRF data in order to manage the LOD values. Data transformation method 1 involves changing all of the LOD values returned for various elements into one-half the LOD reported by the instrument. This was done to make use of the maximum number of elements that the pXRF had detected even if there were only a few readings for that element. For example, molybdenum was detected in the porcellanite but had few to no detections in the other two units, and was retained in the dataset using this transformation. Data transformation method 2 simply excludes elements that had detection values of LOD ≥50% of the time, resulting in a reduced elemental data matrix, where Mo, U, Th, Pb, Au, Se, As, Hg, Co, and P were removed from the *in situ* rock surface analyses, and U, Th, Pb, Au, As, and Hg were removed from the pulverized analyses. The larger *in situ* pXRF elemental data matrix from transformation 1 is referred to hereafter as T1 data, and the smaller *in situ* pXRF data matrix produced from transformation 2 is referred to as T2 data.

Spider diagrams were constructed for REE data plus yttrium normalized to the North American Shale Composite (NASC) (Gromet et al. 1984). In order to evaluate the REE data in the context of geologic provenance, calculations of both cerium and europium anomalies were performed. The calculation for the cerium anomaly (Ce/Ce*) was based on equation 1 from the De Baar et al. (1987): Calculation of the europium anomaly was done using equation 2 from Taylor and McClennan. (1985) equation, and normalized to the NASC:

[1] $$\frac{Ce}{Ce^{*}} = 3\ x\ \frac{(Ce_N)}{[(2\ x\ La_N)+(Nd_N)]}$$

[2] $$\frac{Eu}{[2Eu^{*}} = \frac{Eu_N}{[(Sm_N)(Gd_N)]^{0.5}}$$

Results

pXRF whole rock surface data

Surface point data consist of nine readings taken at outcrop localities plus 123 readings from 63 hand samples collected in the field, for a total of 132 analyses (Appendix 1). MANOVA analysis of the data gives a low *p*-value ($p < 0.000$) indicating that the groups are statistically different from one another and therefore the results produced by discriminant analysis can be considered statistically significant (Table 1). Summary statistics for both T1 data (with LOD replaced by half) and T2 data (>50% LOD elements removed), are found in Appendix 2.

Table 1. *Test of multivariate significance and LDA for pXRF data for T1 data (LOD replaced by half) and T2 data (>50% LOD removed).*

	LOD replaced by half	>50% LOD removed	pXRF 120 s run	pXRF 240 s run
No. of variables	34	24	21	21
Wilks' lambda	0.2036	0.3263	0.06631	0.05637
p-level	*p*<0.000	*p*<0.000	*p*<0.000	*p*<0.000
Eigen value				
DP1	1.441	0.9371	4.233	4.022
DP2	1.012	0.582	1.882	2.532
Eigen (%)				
DP1	58.8	61.7	69.2	61.4
DP2	41.2	38.3	30.8	38.6

LDA results with all T1 data (Fig. 3A) display a general differentiation of the three units into groups, with Porcellanite and Cherry Spring grouped along the x-axis or discriminate projection one (DP1) which explains 58.8% of the variance. The Slaven is separated from the other units along the y-axis or discriminant projection 2 (DP2), which explains the other 41.2% of variance (Table 1). Despite some degree of grouping there is still overlap between all three units. The plot of variable loadings (Fig. 4A) gives the geochemical explanation for unit separation. Sr and Zr are the elements with the largest effect with values greater than 0.5. Sr draws almost exclusively on the x-axis, while Zr differentiates the units along the y-axis. Examination of the summary statistics (Appendix 2) showed variation in mean values between units for the elements with larger variable loadings; Sr, Fe, Co, Cl, Si, Rb, Se, Mo, and Zr, box plots of these elements are presented in Figure 5. The mean value for Sr, (Fig, 5) is higher in the Cherry Spring (67.39ppm) than in the porcellanite (24.36ppm) and Slaven (36.85ppm). Cherry Spring having a higher mean Sr value explains why this element is having the largest effect in the variable loadings (Fig. 4A), for breaking out the Cherry Spring unit. Zr displays also has a higher mean value in the Slaven chert (30.97ppm) compared to the porcellanite (19.23ppm) and the Cherry Spring (15.34ppm). The higher mean Zr value in the Slaven explains its strong effect on breaking out the Slaven from the other two cherts (Fig. 5).

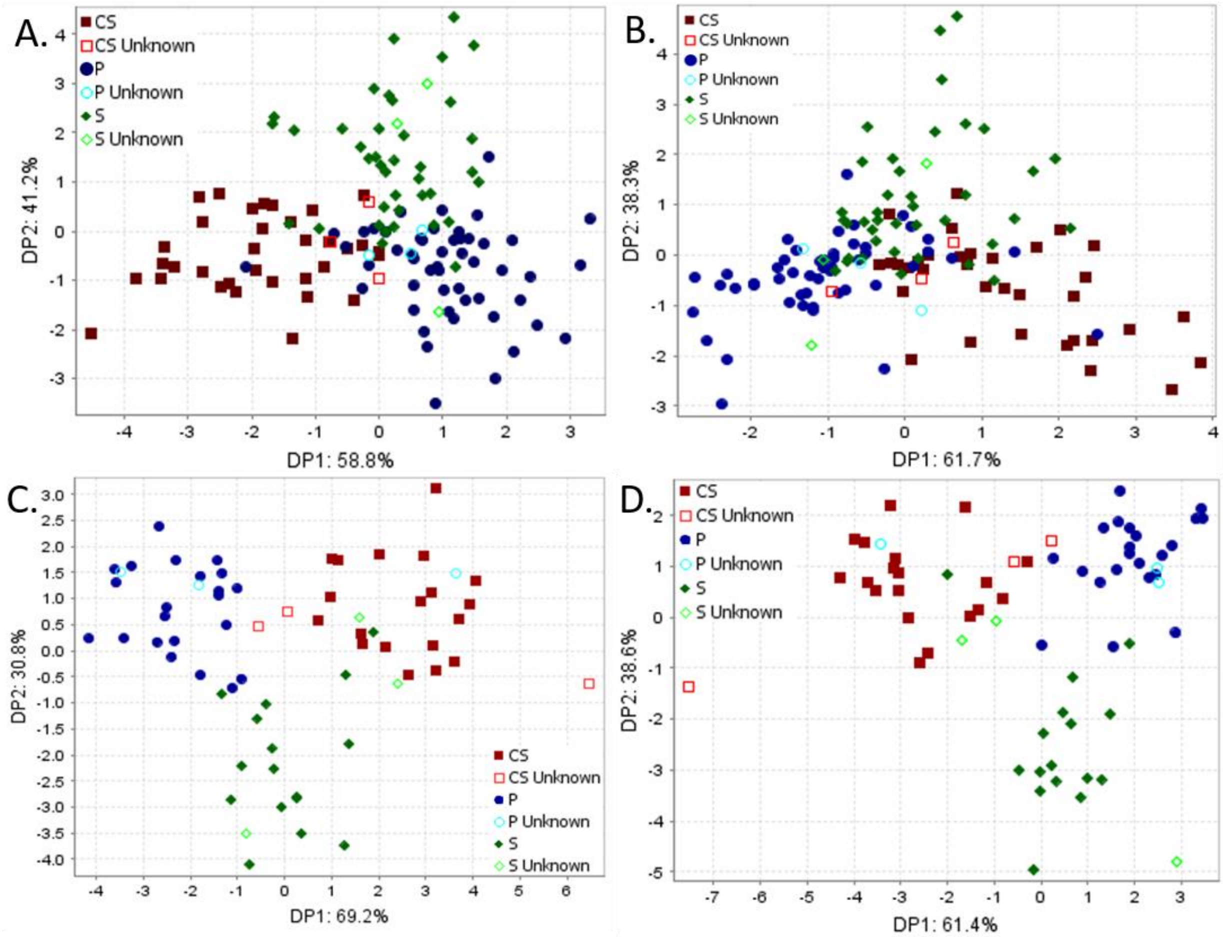

Fig. 3. Comparison between pXRF LDAs with plotted unknowns in reduced discriminant space, solid samples were used to construct LDA model hollow samples are withheld unknowns. (A) *in situ* pXRF data with Transformation 1 LOD replaced by half (B) *in situ* pXRF data elements with Transformation 2 returning >50% LOD removed (C) powdered sample 120 s run with Transformation 2 (D) powdered sample 240 s run with Transformation 2.

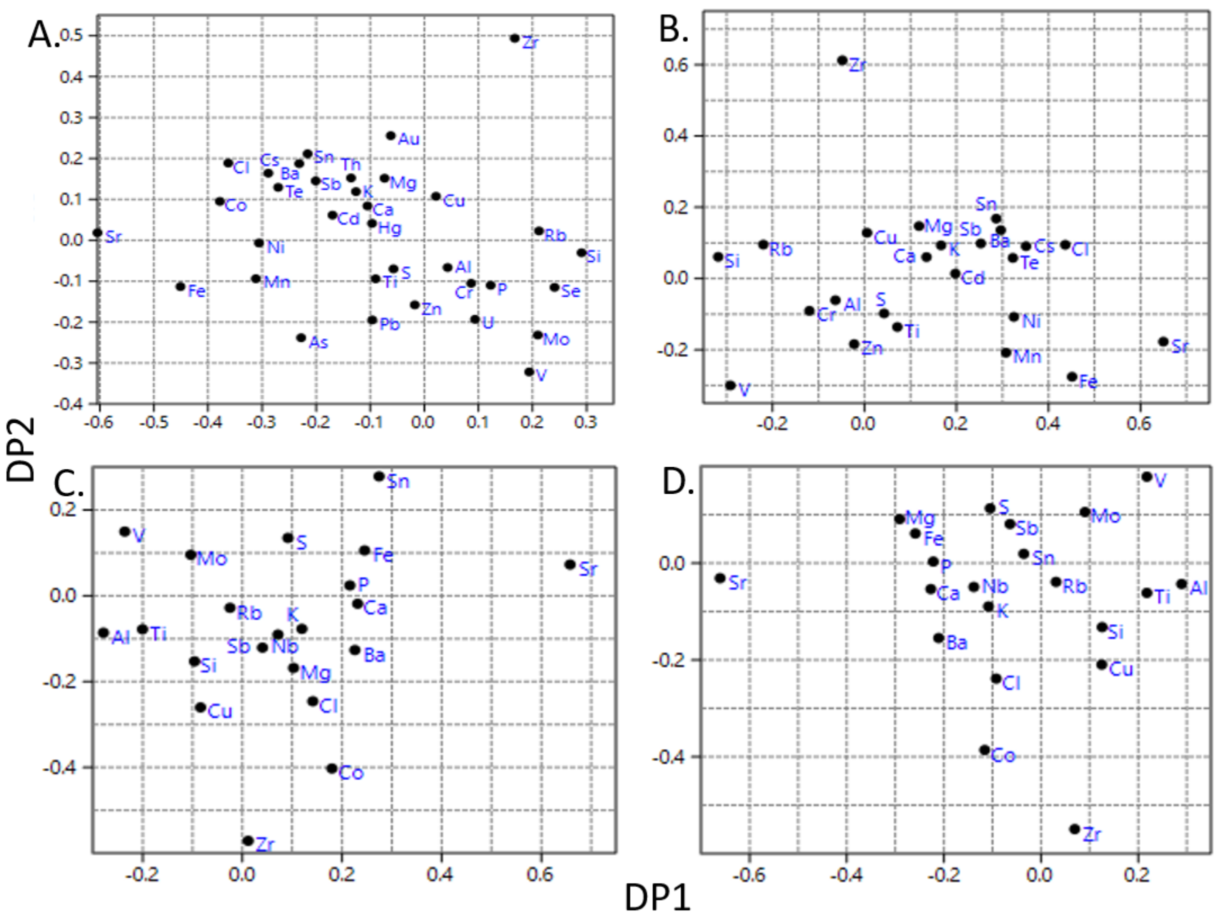

Fig. 4. Scatter plots of variable loadings for pXRF LDAs (A) *in situ* pXRF data with Transformation 1 LOD replaced by half (B) *in situ* pXRF data elements with Transformation 2 returning >50% LOD removed (C) powdered sample 120 s run with Transformation 2 (D) powdered sample 240 s run with Transformation 2.

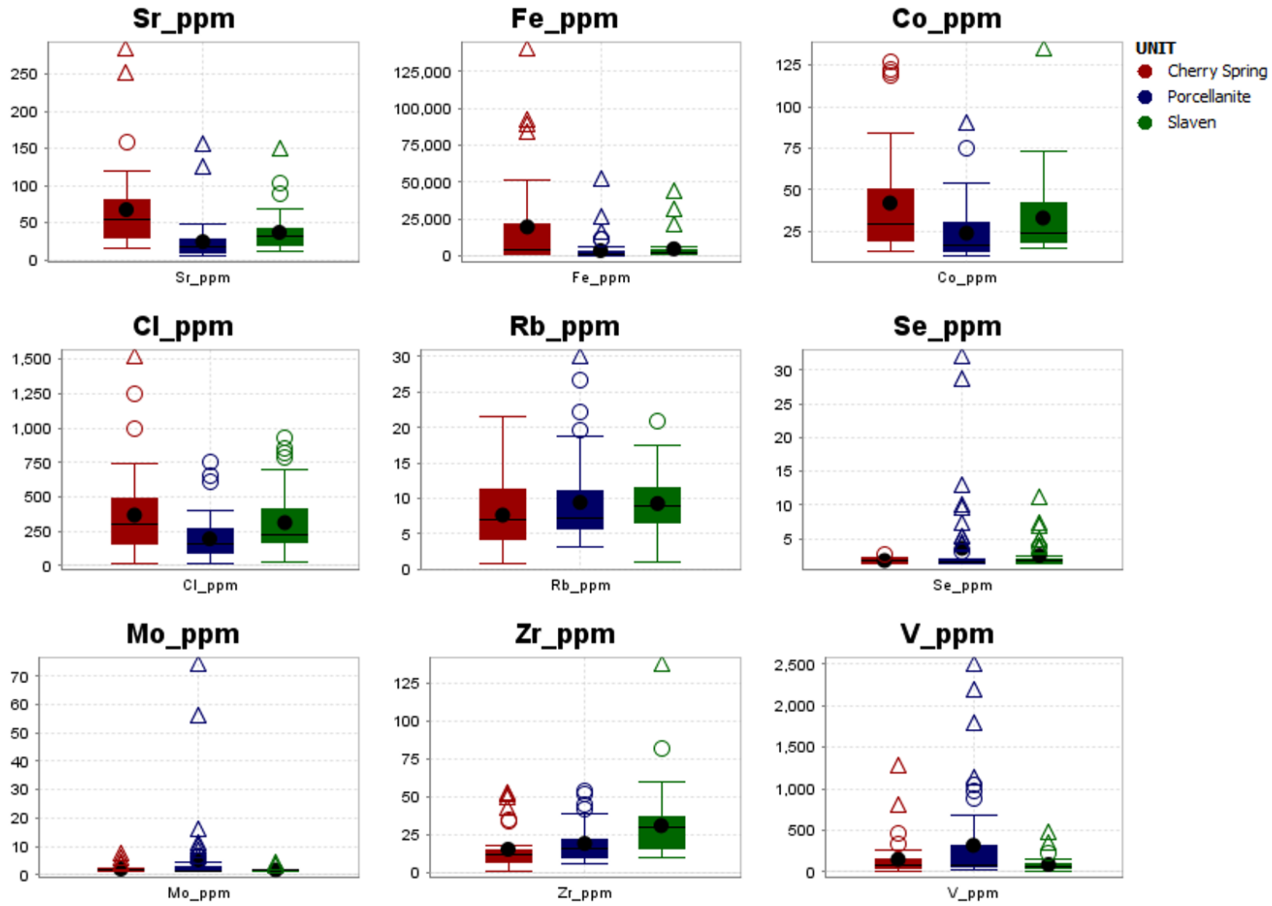

Figure 5. Box plots of selected elements for *in situ* pXRF with Transformation 1 LOD values replaced by half. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

Table 2 summarizes the results of the three model predictability tests on the *in situ* pXRF data; the predict function in R, the more rigorous Leave One Out Cross Validation (LOOCV) method, and the unknowns method. Looking specifically at the results of the T1 data, there is an expected decrease in predictability between the less rigorous predict function in R, and the LOOCV methods, but not a drop between the LOOCV (64.8) and unknown (66.7%) methods. Cherry Spring was misclassified two times and the Slaven was misclassified once (Table 2, Fig. 3A).

Table 2. *Classification matrices for in situ pXRF data showing the results of the 3 prediction methods for the 3 chert units. LOOCV = Leave One Out Cross Validation, CS = Cherry spring chert, P = Vinini Porcellanite, and S = Slaven*

	Data transformation 1: Predicted groups for LOD replaced by half											
	Predict function				LOOCV				Unknowns			
Observed groups	CS	P	S	% correct	CS	P	S	% correct	CS	P	S	% correct
CS	**30**	3	2	85.7	**23**	8	4	65.7	**1**	1	1	33.3
P	4	**46**	7	80.7	7	**36**	8	70.6	0	**3**	0	100
S	1	2	**30**	90.9	4	13	**22**	56.4	0	1	**2**	66.7
Total				84.8				64.8				66.7
	Data transformation 2: Predicted groups with >50% LOD elements removed											
	Predict function				LOOCV				Unknowns			
Observed groups	CS	P	S	% correct	CS	P	S	% correct	CS	P	S	% correct
CS	**23**	3	4	76.7	**18**	10	7	51.4	**0**	2	1	0
P	8	**43**	11	69.4	5	**39**	7	76.5	0	**3**	0	100
S	4	5	**24**	72.7	5	14	**20**	51.3	0	2	**1**	33.3
Total				72				61.6				44.4

Summary statistics for *in situ* pXRF T2 data, the smaller elemental suite where the elements that returned greater than 50% LOD values were removed, are found in Appendix 4. MANOVA analysis (Table 1.) gives a low *p*-value ($p < 0.000$) indicating that the groups defined by the LDA are statistically different from one another. LDA results on T2 data (Fig. 3B, Table 1) show increased overlap between all three units with element removal, as compared to T1 data, and decreased ability to predict units for all three prediction methods. DP1 explains 61.7% of variance and roughly separates Cherry Spring from porcellanite, while DP2 explains the rest of the variance at 38.3% and crudely breaks the Slaven out from the other two units (Fig. 3B). Similar the previous evaluation using T1 data, structure coefficients (Fig. 4B) of Sr and Zr indicate these elements have the most effect on the LDA; Sr effects the x-axis while Zr effects the y-axis. Examination of the summary statistics (Appendix 4) showed variation in mean values between units for the elements with larger variable loadings; Sr, Fe, Mn, Si, Rb, V, and Zr, box plots of these elements are presented in Figure 6. The mean value for Sr, (Fig, 6) is higher in the Cherry Spring (67.39ppm) than in the porcellanite (24.36ppm) and the Slaven (36.85ppm). This higher mean explains why Sr is having the largest effect in the variable loadings (Fig. 4A), for breaking out the Cherry Spring unit. Zr has a higher mean value in the Slaven chert (30.97ppm) explaining its strong effect on breaking out the Slaven from the Cherry Spring (15.34ppm) and porcellanite (19.23ppm), (Fig. 6). Predicting the unit for samples used in calculating LDA, gives 72% accuracy, cross validation drops in accuracy to 61.6%, and the most robust test of unknowns results in 44.4% accuracy (Table 2).

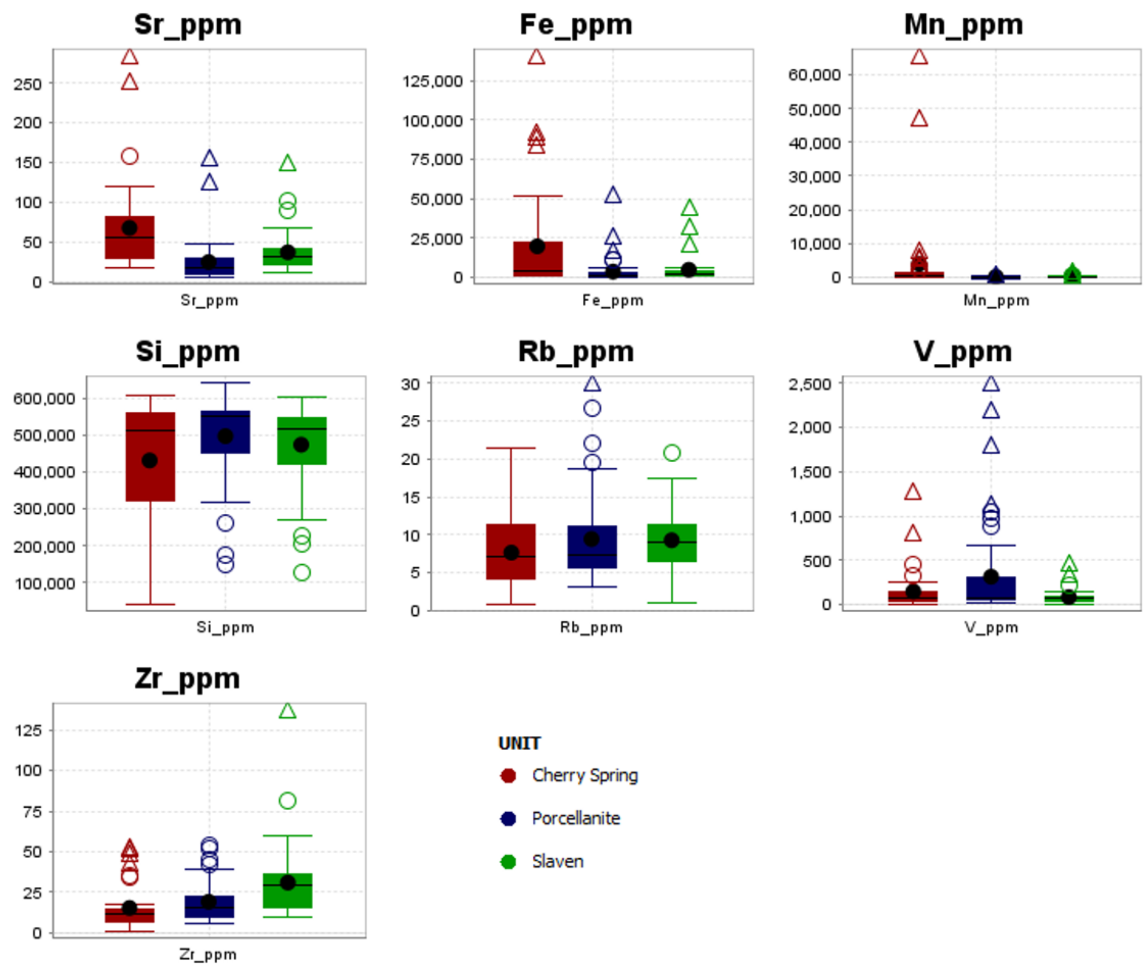

Figure 6. Box plots of selected elements for *in situ* pXRF with >50% LOD returned elements removed. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

pXRF powdered sample data

A total of 57 samples were used for LDA while the same 9 samples were withheld for use as unknowns (Appendix 5 & 6). Summary statistic data for both time runs are included in Appendices 6 and 7. MANOVA analyses give $p < 0.000$ for both the 120 second and the 240 second time runs, indicating that statistical differences between the three units defined by the LDA are significant (Table 1). Results using Transformation 2 are shown in Table 3 for both the 120 second and the longer 240 second runs. LDA on the 120 second run was able to break the cherts out by unit with minimal overlap (Fig. 3C). DP1 comprises 69.2% of the variance at 120 seconds and 61.4% of variance for 240 seconds and separates the Cherry Spring from the porcellanite. DP2 explains 30.8% of variance for the 120 second run and 38.6% of the variance for the 240 second run separating Slaven from the others (Table 1, Fig. 3C & 3D). Predicting the unit for samples used in calculating LDA, gives 94.7% accuracy at 120s and 93.0% at 240s (Table 3). LOOCV drops to 75.4% at 120 s and 71.9% at 240s (Table 3). The test of 9 withheld unknowns results in 44.4% accuracy at 120s and 55.6% for 240s (Table 3). Variable loading from both LDA indicate Sr largely effects DP1, while Zr and to a lesser degree Co affect DP2 (Fig. 4C & 4D). Examination of the 120 second summary statistics in Appendix 7 reveals that mean values for Sr, Al, V, Ti, Zr, Co vary between the units. Sr is highest in the Cherry Spring (66.51ppm), and lower in the porcellanite (21.53ppm) and Slaven (39.11ppm), which allows discrimination of the Cherry Spring (Fig. 7). Zr has the largest effect on differentiating the Slaven (28.11ppm) from the Cherry Spring (14.81ppm), and porcellanite (15.69ppm) (Fig. 7). Examination of the 240 second summary statistics (Appendix 8) reveals the same elements have variable mean values as the 120 second run. Sr is highest in the Cherry Spring (66.22ppm), and lower in the porcellanite (21.74ppm) and Slaven (38.94ppm) this larger mean value is the reason Sr is breaking out the Cherry Spring from the other two units (Fig. 8). Likewise Zr is breaking out the Slaven (28.11ppm), from the Cherry Spring (14.81ppm) and the porcellanite (15.69ppm) (Fig. 8).

Comparisons of the 120 second run to the 240 second run indicate increased detection for all elements with the longer run time (Table 4, Fig 9) for a total of 91.3% rate of detection at 240 seconds compared to 85.1% at 120 seconds. Elements showing the largest variation in mean value and difference in total detection between run times are Sb and Sn (Fig. 10, Table 4).

Table 3. *Classification matrices for pXRF powdered sample data showing the results of the 3 prediction methods for the 3 chert units. LOOCV = Leave One Out Cross Validation, CS = Cherry spring chert, P = Vinini porcellanite, and S = Slaven*

	Data transformation 1: Predicted groups for 120s run											
	Predict function				LOOCV				Unknowns			
Observed groups	CS	P	S	% correct	CS	P	S	% correct	CS	P	S	% correct
CS	**19**	0	2	90.5	**14**	3	2	73.7	**1**	2	0	33.3
P	0	**22**	1	95.7	0	**19**	3	86.4	1	**2**	0	66.7
S	0	0	**13**	100.0	3	3	**10**	62.5	2	0	**1**	33.3
Total				94.7				75.4				44.4
	Data transformation 2: Predicted groups for 240s run											
	Predict function				LOOCV				Unknowns			
Observed groups	CS	P	S	% correct	CS	P	S	% correct	CS	P	S	% correct
CS	**18**	0	1	94.7	**12**	4	3	63.2	**2**	1	0	66.7
P	1	**21**	1	91.3	1	**18**	3	81.8	1	**2**	0	66.7
S	0	1	**14**	93.3	2	3	**11**	68.8	2	0	**1**	33.3
Total				93.0				71.9				55.6

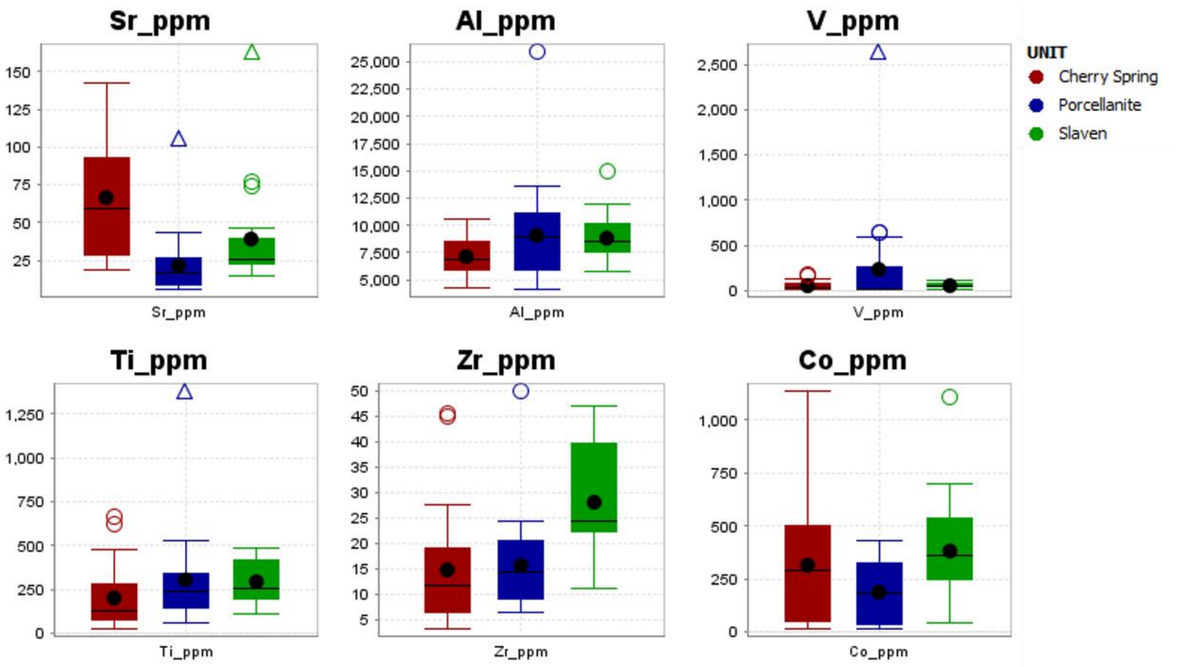

Figure 7. Box plots of selected elements for 120s powdered pXRF analysis. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

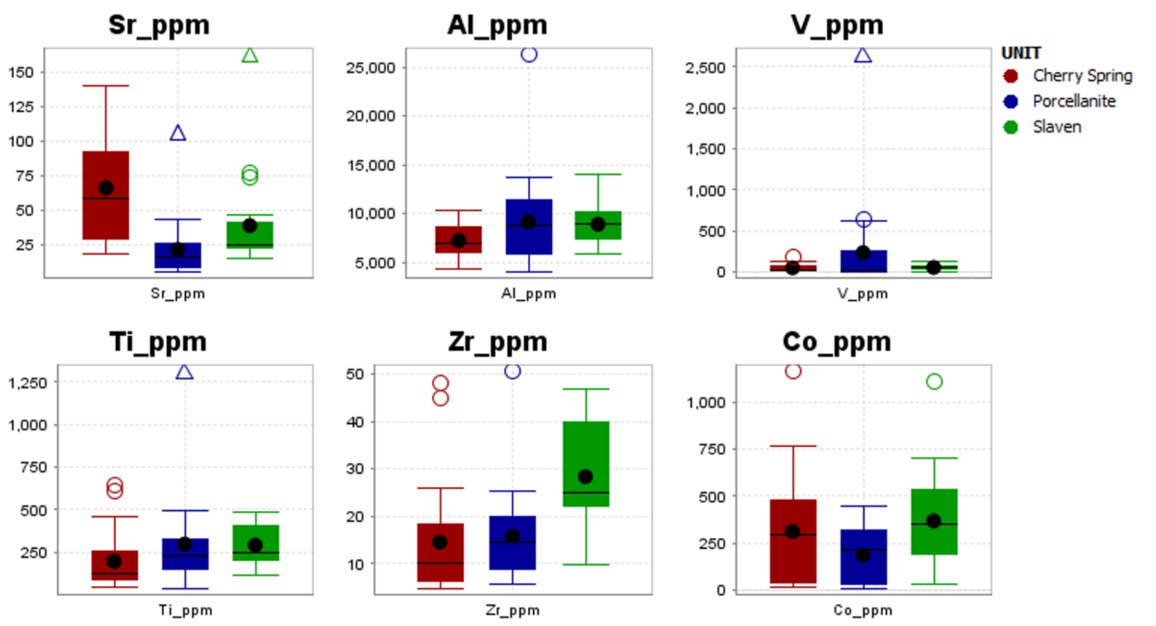

Figure 8. Box plots of selected elements for 240s powdered pXRF analysis. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

Table 4. *Detection comparison for pXRF powdered data.*

	120 second run		240 second run	
ppm	# of readings	% detected	# of readings	% detected
Mo	52	78.8	59	89.4
Zr	66	100.0	66	100.0
Sr	66	100.0	66	100.0
Rb	60	90.9	60	90.9
Cu	66	100.0	66	100.0
Co	44	66.7	45	68.2
Fe	66	100.0	66	100.0
V	36	54.5	48	72.7
Ti	65	98.5	66	100.0
Ca	66	100.0	66	100.0
K	60	90.9	62	93.9
S	66	100.0	66	100.0
Ba	64	97.0	66	100.0
Sb	28	42.4	45	68.2
Sn	29	43.9	57	86.4
Nb	37	56.1	50	75.8
Al	66	100.0	66	100.0
P	46	69.7	47	71.2
Si	66	100.0	66	100.0
Cl	65	98.5	66	100.0
Mg	66	100.0	66	100.0
Total	1180	85.1	1265	91.3

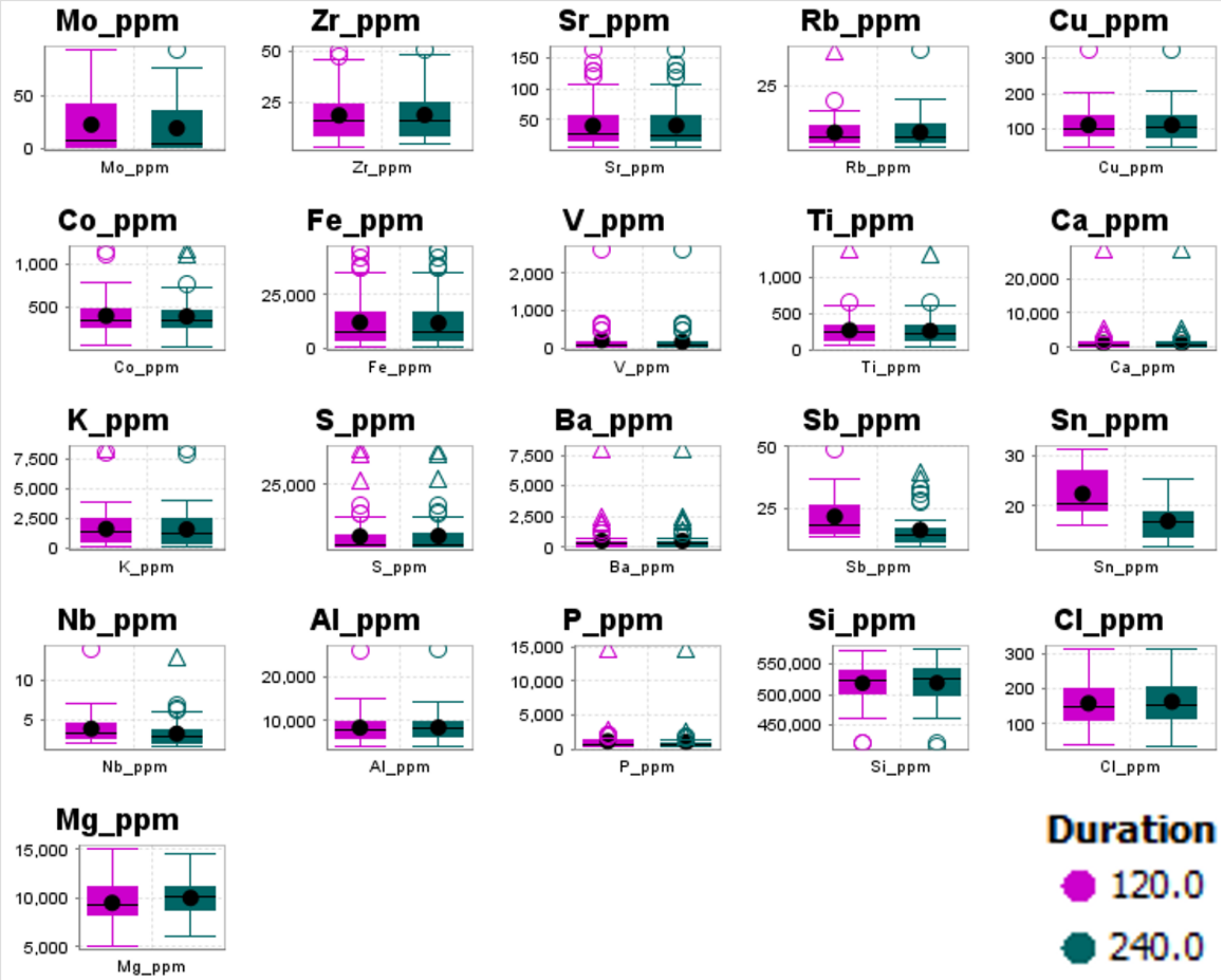

Fig. 9. Tukey box plots of pXRF powdered sample analysis. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren’t outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

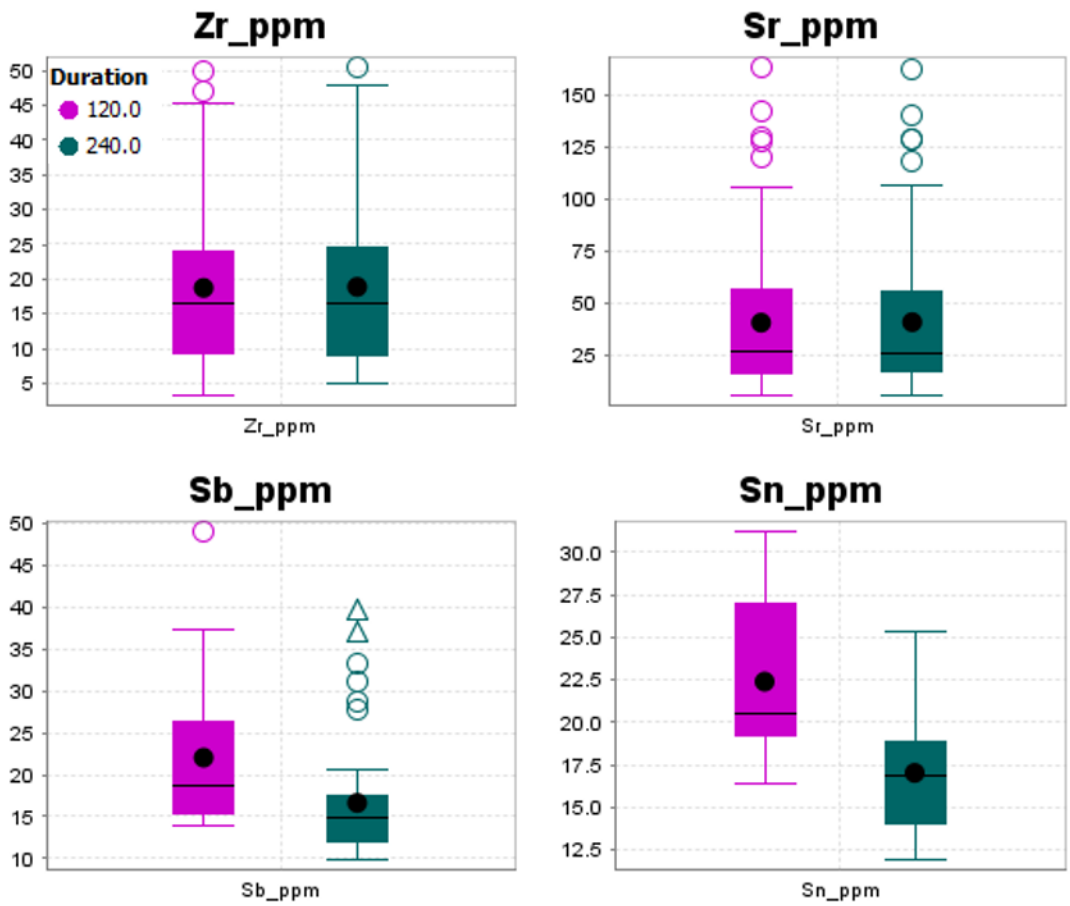

Fig. 10. Close up of box plots, Zr and Sr have similar mean values, while Sb and Sn have mean values with the largest difference between time runs, from pXRF powdered samples. The central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

ICP-MS analysis

MANOVA analysis (Table 5) gives p <0.000 indicating the units analyzed by ICP-MS are statistically different. LDA was able to break the cherts out by unit (Fig. 11A), with DP1 comprising most of the variance, 64.7%, and DP2 accounting for 35.3%. Samples from the Cherry Spring and porcellanite units are distributed in two discrete groups along the LD1 axis with the Slaven unit broken out along the LD2 axis (Fig. 11A). Variable loadings (Fig. 11B) indicate Sr and Ce, have the largest effect on DP1, with lesser influence from Sm and Eu. Li and Hf, and to a lesser extent Zr and Co, have the greatest effect on DP2 (Fig. 11B). Summary statistics located in Appendix 10 and box plots of mean element values in Figure 12 indicate higher mean values in the Cherry Spring for Sr (75.89ppm) and Ce (17.52ppm), compared to porcellanite Sr (23.52ppm) and Ce (6.19ppm), and Slaven Sr (46.51ppm) and Ce (8.62ppm). These higher mean values explain why Sr and Ce are having the largest variable loading (Fig. 11B) effect on the Cherry Spring chert. However, the correlation coefficient matrix for the Cherry Spring chert (Appendix 11), does not show any of the strong variable loading elements correlating with one another. Porcellanite has weaker variable loading elements; however, mean values for V (181.00 ppm) and Cr (42.69ppm) are higher than for the Cherry Spring; (35.87 ppm for and 19.61 ppm for Cr), and Slaven chert (41.45 ppm for V and 35.52 ppm for Cr) (Fig. 12). These higher mean values for V and Cr in the porcellanite explain why these two elements break it out. The porcellanite correlation coefficient matrix (Appendix 11), shows V and Ni correlating at 0.97 and both of these elements have higher variable loadings in the LDA. Cr, however, did not correlate significantly with any other elements. The mean values ofr Li, Hg and Zr for the Slaven are 16.59 ppm 0.74 ppm, and 27.92 ppm, respectively (Appendix 10 and Fig. 12). Cherry Spring displays lower mean values for these elements (Li, 10.07ppm; Hf, 0.46 ppm; Zr, 18.04 ppm). Porcellanite also displays lower mean values Li, 9.44 ppm; Hf, 0.45 ppm; Zr, 18.22 ppm). The Slaven correlation coefficient matrix (Appendix 11) shows that Zr and Hf are well correlated at 0.93, however, Li does not correlate with other elements. Predictability of the samples used in the model is 100%, LOOCV correctly predicts 78.9% of the time, and the nine unknowns had 66.7% accuracy. Raw data for the sixty-six samples used in analysis are located in Appendix 9.

Table 5. *Tests of multivariate statistics and LDA*

	ICP-MS
No. of variables	31
Wilks' lambda	0.02071
p-level	$p<0.000$
Eigen value	
DP1	6.593
DP2	3.04
Eigen (%)	
DP1	64.7
DP2	35.3

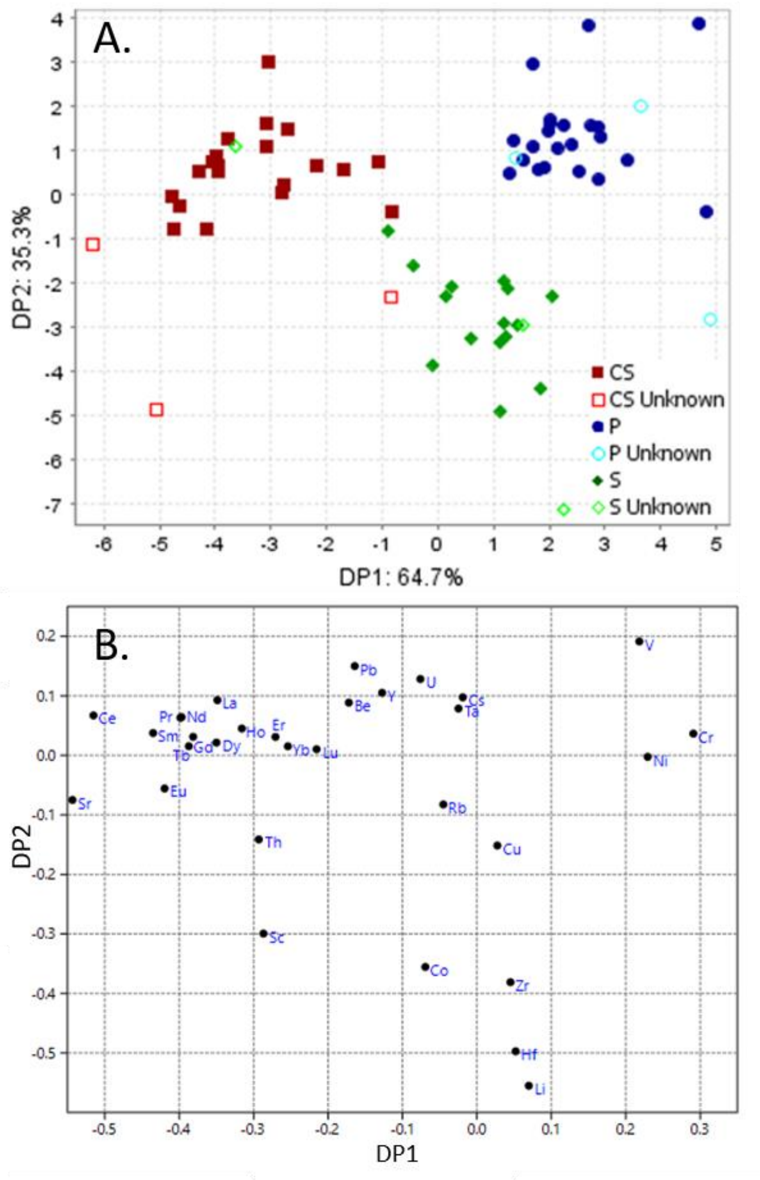

Fig. 11. (A) ICP-MS LDA plotted in reduced discriminant space, solid samples were used to construct LDA model hollow samples are withheld unknowns. (B) Scatter plot of variable loadings for ICP-MS LDA.

Table 6. *ICP-MS classification matrices*

	Predicted groups											
	Predict function				Cross validation				Unknowns			
Observed groups	CS	P	S	% correct	CS	P	S	% correct	CS	P	S	% correct
CS	**20**	0	0	100.0	**14**	4	2	70.0	**2**	0	1	66.7
P	0	**21**	0	100.0	1	**19**	1	90.5	0	**2**	1	66.7
S	0	0	**16**	100.0	3	1	**12**	75.00	1	0	**2**	66.7
Total				100.0				78.9				66.7

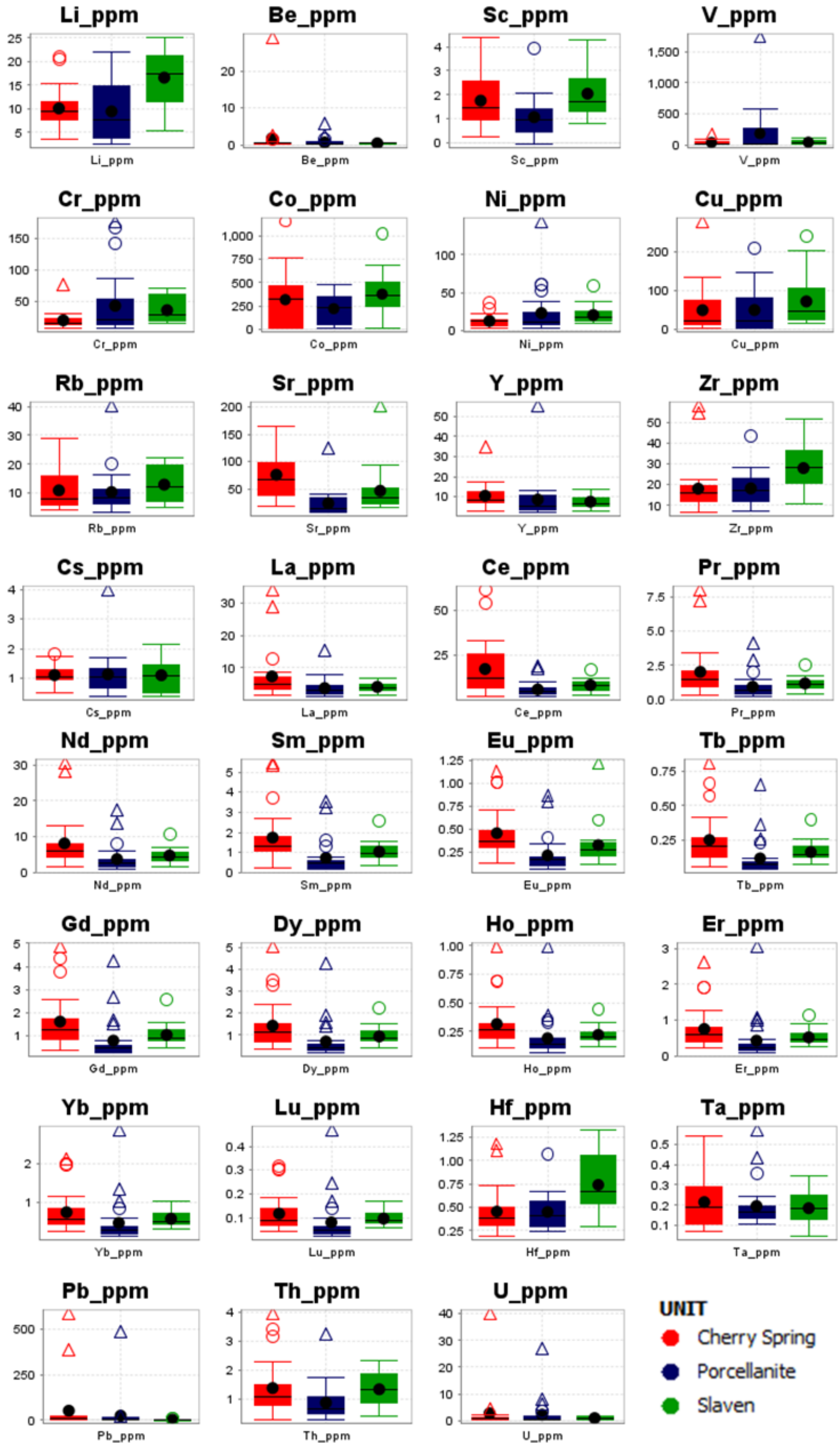

Fig 12. ICP-MS box plots, the central box represents 50% of data from the first to the third quartile, the black circle is the mean, and black line is the median. Whiskers are the extreme values that aren't outliers. Open circles are outliers farther than 1.5 * (Q3- Q1), and far outliers are open triangles with values 3.0 * (Q3-Q1) away from the main box.

ICP-ES analysis

The same sixty-six samples used for ICP-MS analysis were also analysed by ICP-ES (Appendix 12), and summary statistics are provided in Appendix 13. LDA analysis of the ICP-ES data did not result in any significant ability to model and predict units. Only CaO showed significant variation in mean value between the units (Appendix 13). CaO was 0.05 wt% in the porcellanite but higher in the Cherry Spring (0.27 wt%) and Slaven (0.19 wt%). However, the potential utility of this data lies more in its ability to indicate tectonic provenance for the different units, such as proximity to a mid ocean ridge versus continental margin (Murray et al. 1990; Tanner et al. 2013). Figure 13 displays major element plots with overlays of ridge, pelagic, and continental margin zones as defined by Murray (1994). Al_2O_3 and TiO_2 are indicative of terrigenous inputs, Fe_2O_2 represents metalliferous ridge proximal inputs (Murray, 1994). The majority of data plots in the continental margin region, exceptions from each unit do plot in the ridge region except for Fig. 13D, which has no samples plotted in the ridge field. The three samples that were run with the cleanest shards as well as a duplicate of altered material show variability in depositional environment. Sample 7030906A plots as margin in all four diagrams in Figure 13. Sample 07030921A.plots as ridge in 8A B and C, 07021448A plots as pelagic in 13A, margin in 13B, and just outside pelagic in 13D; samples 07030906B, 07030921B, and 07021448B plot as ridge in Figure 13A, B, and C. Only sample 07030906A and B show a distinct partitioning of the less oxidized 07030906A into margin and the more oxidized 07030906B into the ridge environment.

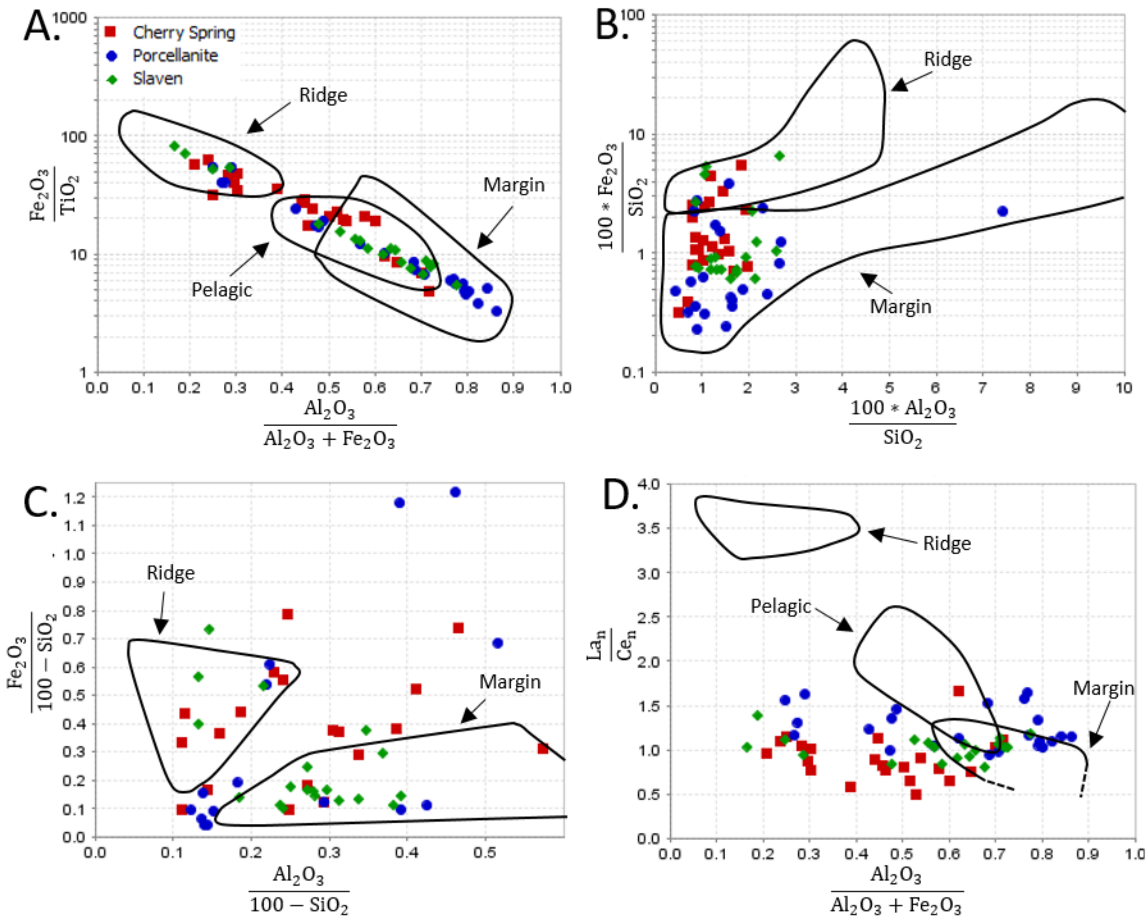

Fig 13. Scatter plots of selected major element ratios in the units; ridge, pelagic, and margin zones defined by Murray (1994). (A) Plot with terrigenous influence indicated by Al_2O_3 and TiO_2 and metalliferous input indicated by Fe_2O_3. (B) Minimization of diagenetic dilution by normalizing Al_2O_3 and Fe_2O_3 to SiO_2 breaks the majority of the samples out as margin. (C) Normalization of Al_2O_3 and Fe_2O_3 to 100-SiO_2 is done to evaluate the total non-siliceous component of the units. The plot displays a large amount of scatter with samples plotting as margin, ridge, and well outside both zones. (D) Plot of major oxides to La_n/Ce_n indicating that as iron increases the expected decrease in Ce_n is not seen.

Figure 13D plots major oxides against La_n/Ce_n, (La_n/Ce_n is discussed in the REE analysis section below) show values in the continental margin zone with more values to the left, but well below the ridge field (Murray 1994). Figure 13D show steady values for the La_n/Ce_n values, the variation in the plot is due to increased Fe_2O_3.

REE analysis

Profiles of the rare earth element plus yttrium data (Fig. 14) most closely resemble that of the terrigenous REE profile found in Tanner et al. (2013) because the shape of the spider diagram is fairly flat across the entire suite of REEs. Also, there is no pronounced dip in cerium that is expected if sediment is being sourced from an open ocean cerium depleted mid-ocean environment. High overall values for Ce/Ce* near or greater than 1 point to terrigenous input (Fig. 15A), which indicate that there is no real anomaly represented by this data (Murray et al. 1994). In comparison, cherts with an oceanic provenance show a dip in Ce/Ce* with typical values less than 0.5 (Murray et al. 1994). Figure 14 shows the data from each location combined by stratigraphic unit. Europium, as opposed to cerium in these cherts displays anomalous behaviour. While the other REE remain steady europium sees a slight uptick in all three units (Fig. 14).

All the europium data have means higher than 1.05 indicating enrichment with respect to surrounding REEs (Fig. 15B).

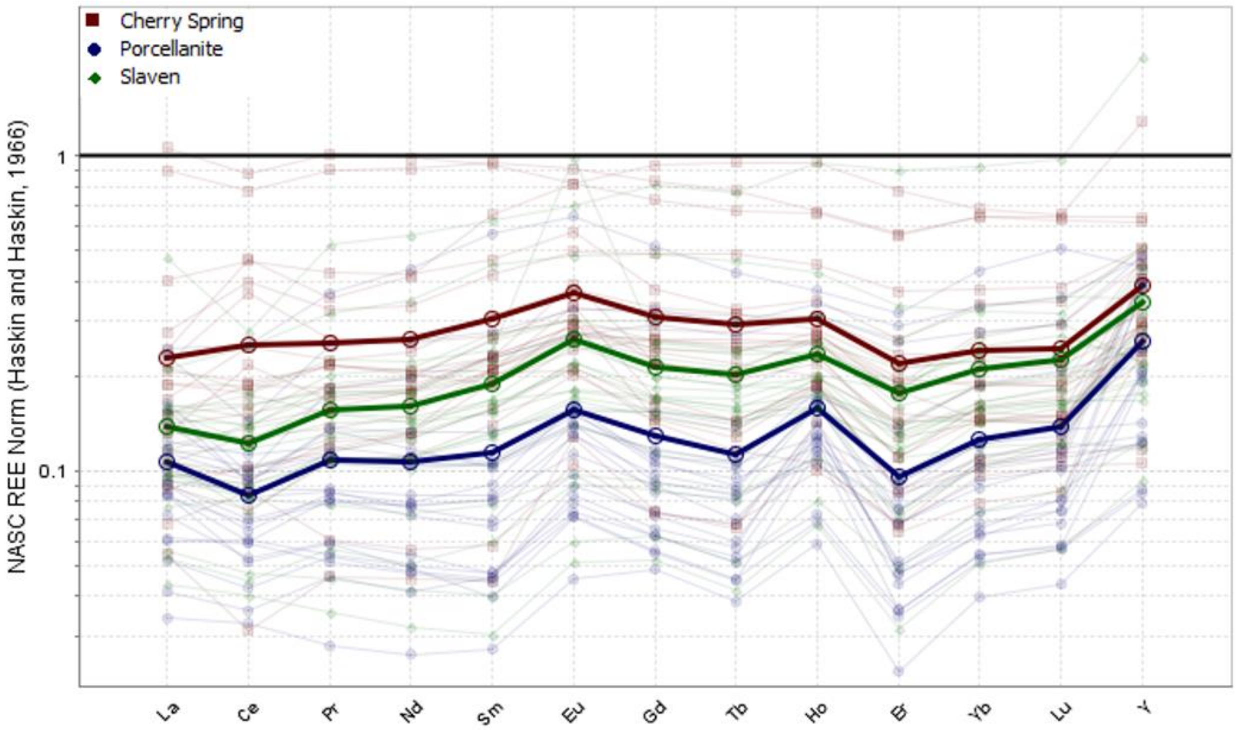

Fig. 14. Spider diagram of REE normalized to NASC, bold lines are unit averages thin lines are individual samples.

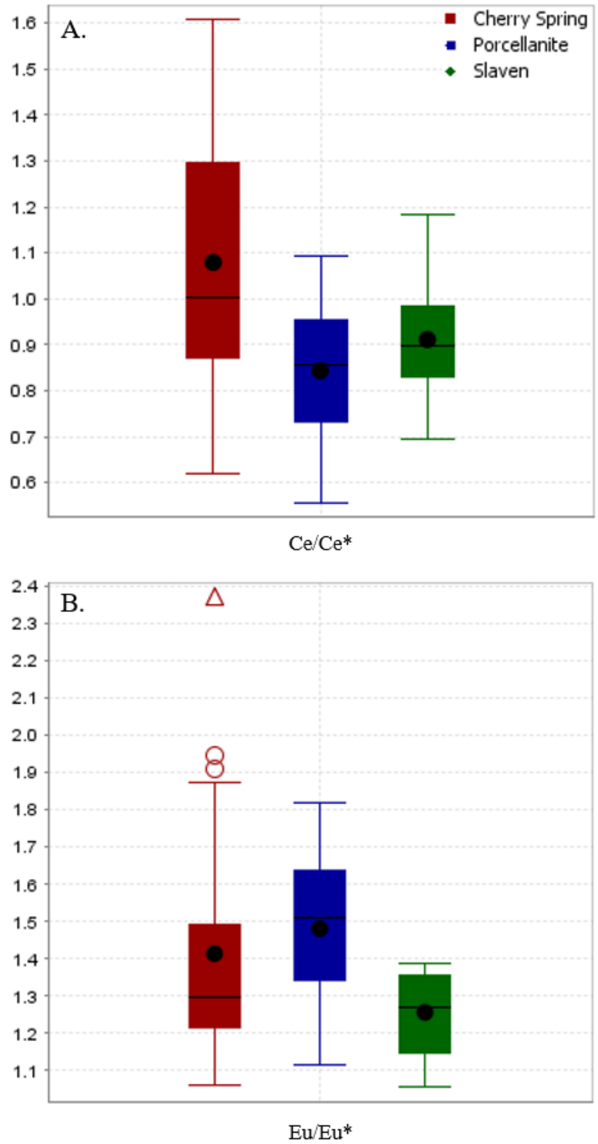

Fig.15. Box plots of cerium and europium anomalies normalized to NASC.

Additional REE analysis in Fig. 16 displays clustering of $La_n/Ce_n \approx 1$ consistent with continental margin input, and lack of depletion of Ce that would cause values greater than one and are typical of open ocean spreading ridge environments (Murray 1994).

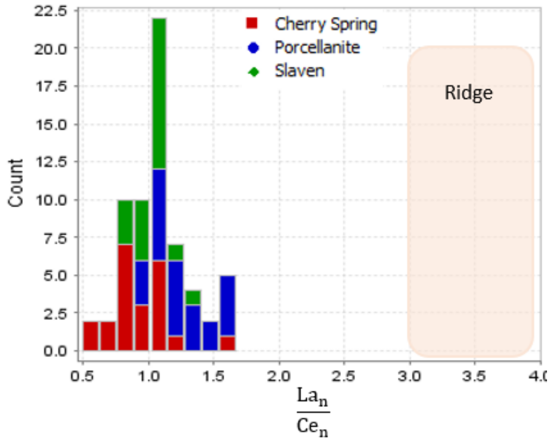

Fig 16. Histogram displaying clustering of units around $La_n/Ce_n \approx 1$. Shaded area represents ridge-proximal environment with typical $La_n/Ce_n \approx 3.5$ (Murray, 1994).

Thin sections transmitted light

All the cherts are variably recrystallized. Figure 17A is porcellanite from Vinini Creek and displays cryptocrystalline siliceous mud with no obvious recrystallization of quartz with larger white grains likely silt content, and very little biogenic content. Figure 17B is porcellanite, also from the Vinini Creek area, and, likewise, shows very little biogenic material. Figure 17B displays and intermediate level of recrystallization of silica content to poly-crystalline quartz. Recrystallization to coarser poly-crystalline quartz in the porcellanite is not as pronounced as can be found in the other two more siliceous units. Recrystallization of quartz is more difficult in less silica rich sediment due to greater amount of impurities preventing the quartz from concentrating and growing.

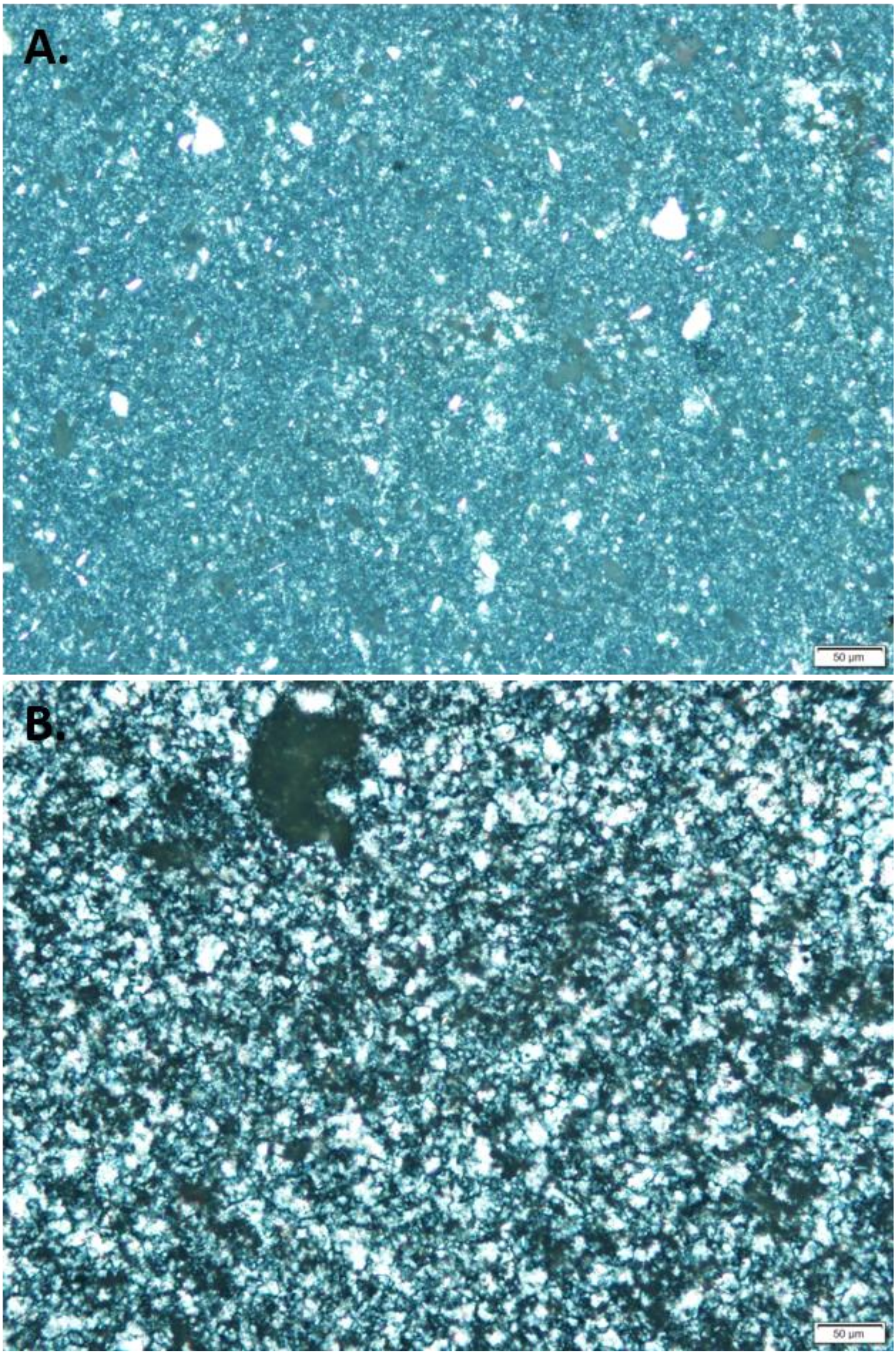

Figure 17. Select cross polar images displaying matrix variation in porcellanite. (A) Sample 7021448, cryptocrystalline matrix with no obvious recrystallization of quartz. (B) Sample 7021455, intermediate recrystallization of quartz in matrix.

Figure 18A & B are from the Cherry Spring chert in the Adobe Range. Figure 18A is an example of a ghost radiolarian, while still visible it lacks the distinct edge separating the matrix from the fossil. Figure 18B is the same area under polarized light, the radiolarian is almost completely lost in the coarsely recrystallized poly-crystalline quartz matrix material and only distinguishable by feathery chalcedony present in the fossil. This sample represents a high degree of recrystallization of the matrix from cryptocrystalline to coarse polycrystalline quartz.

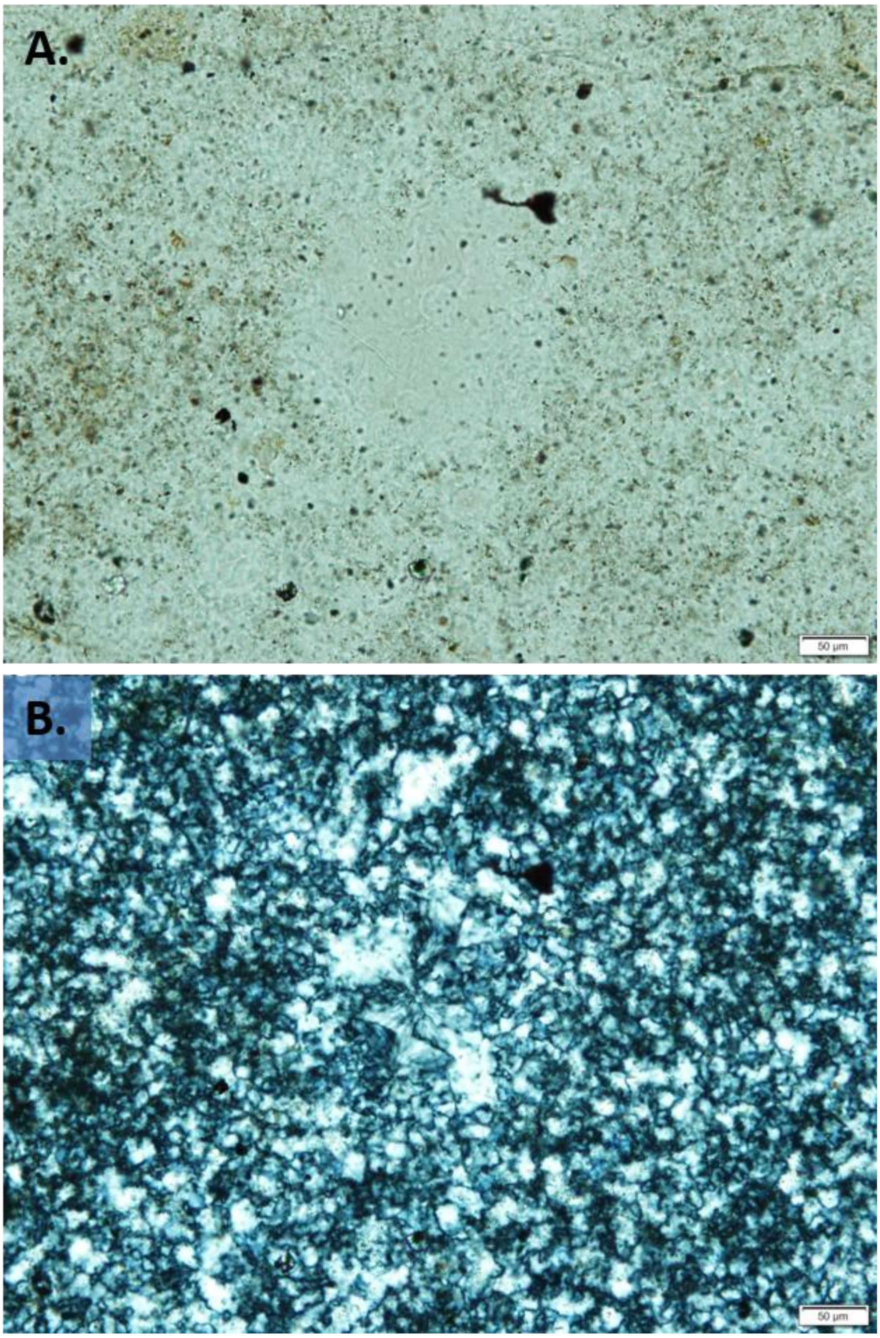

Figure 18. Sample 7030912. (A) Regular light, slightly resorbed radiolarian in Cherry Spring chert. (B) Polarized light image of same radiolarian with coarser chalcedonic quartz surrounded by highly recrystallized quartz matrix.

The thin section from the barite pit in Slaven Canyon (Figure 19A) displays abundant well preserved radiolarians and detrital radiolarian fragments. The matrix is cryptocrystalline with slight coarser recrystallization near veins but an overall unaltered matrix. Figure 19B is Slaven chert from Vinini Creek, displaying medium to coarsely recrystallized matrix into polycrystalline quartz.

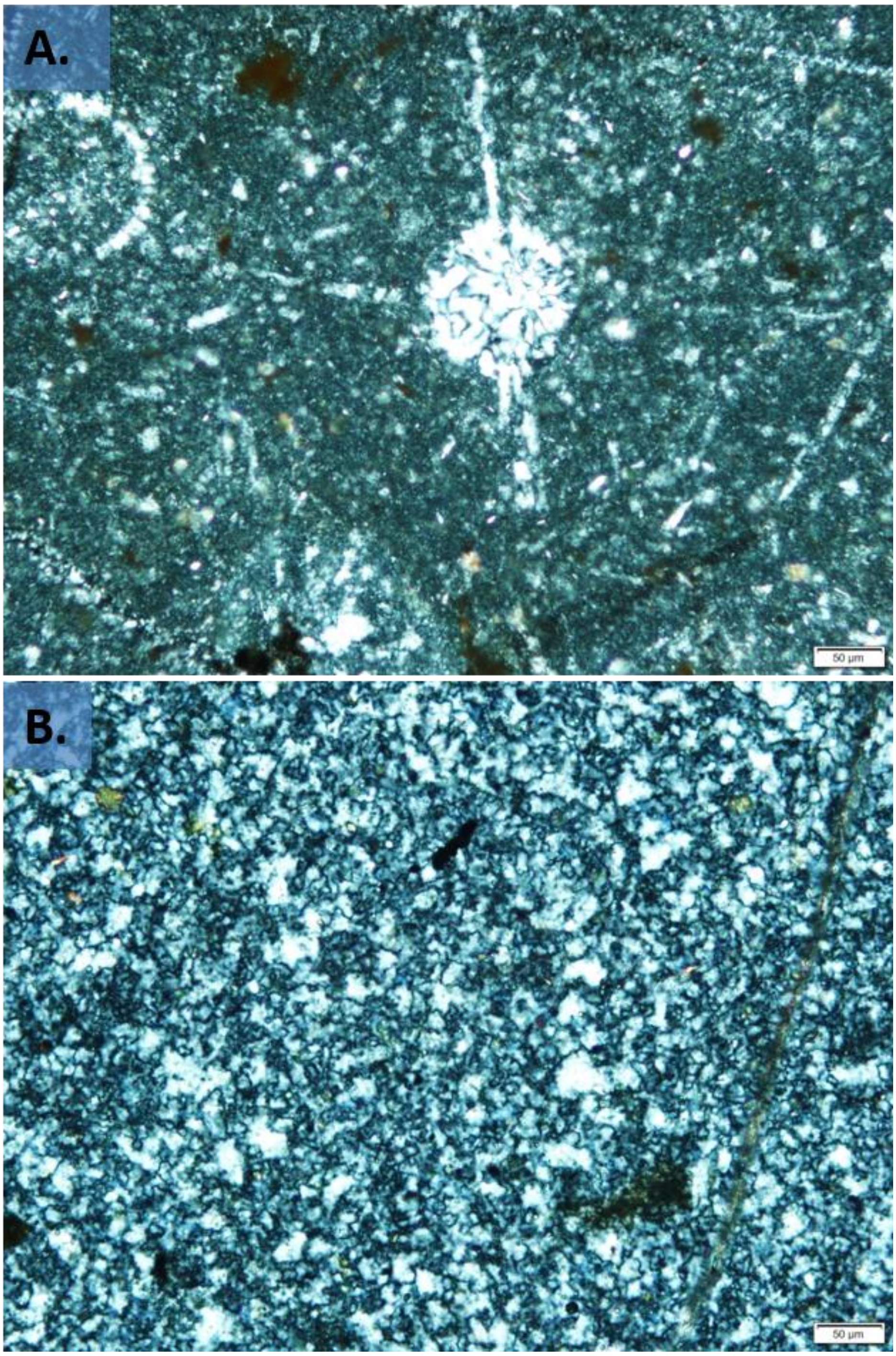

Figure 19. (A) Sample 7020957, well preserved radiolarian under crossed poles with cryptocrystalline matrix and abundant biogenic debris. (B) Sample 7030912, crossed polar image of medium to coarsely recrystallized quartz matrix.

Thin section SEM

SEM analysis of porcellanite from the Mary's Mountain locality showed the least elemental variability on the EDS. As expected, quartz is the most abundant mineral (Fig 20A & B), with iron sulphides (likely pyrite) being the only accessory mineral found (Fig 20 C-F). Slaven chert from the barite pit near Slaven Canyon displayed additional minerals; besides pyrite (Fig 21 E & F). There was hematite (Fig 21 A & B), as well as barite as expected (Fig 21 C & D). The Cherry Spring chert at Garden Pass also displayed variable minerology (Fig. 22).

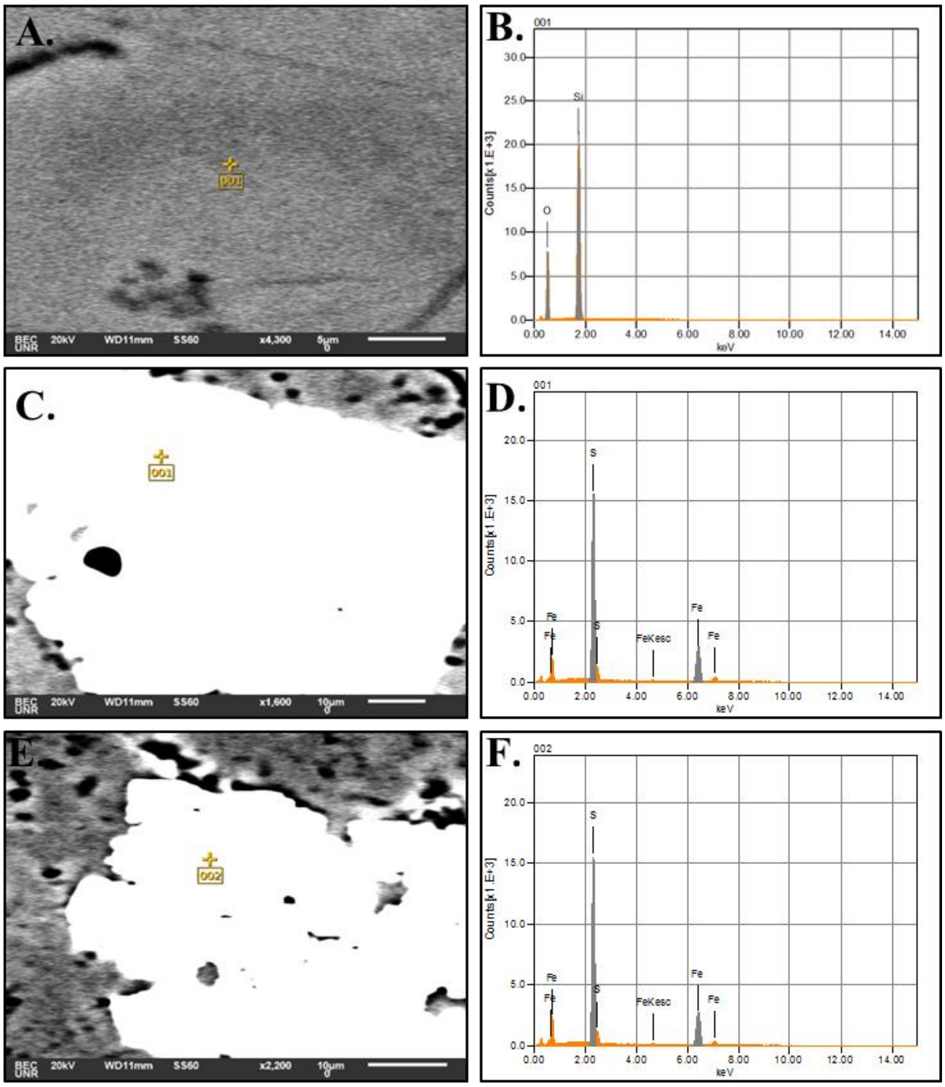

Fig 20A-F. Selected SEM backscatter images from porcellanite with corresponding EDS.

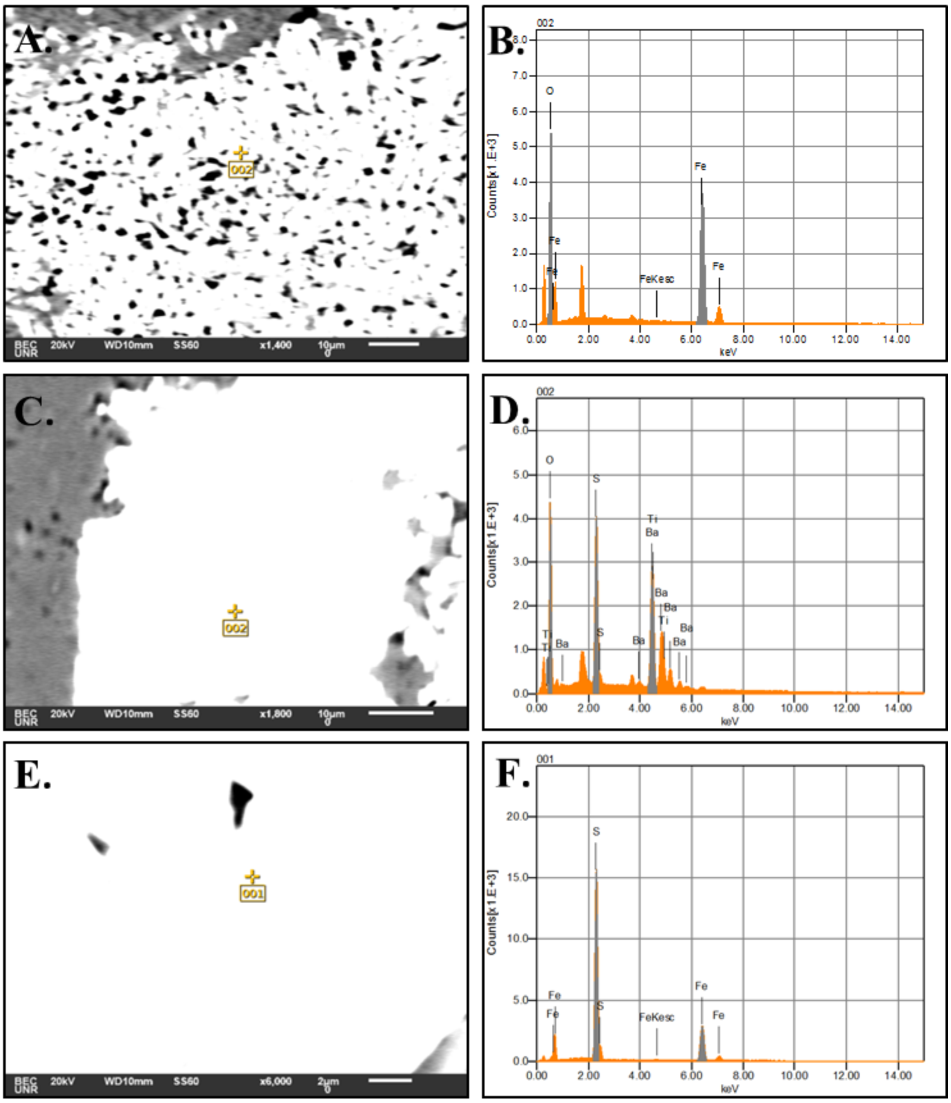

Fig 21A-F. Selected SEM backscatter images from the Slaven chert with corresponding EDS plots.

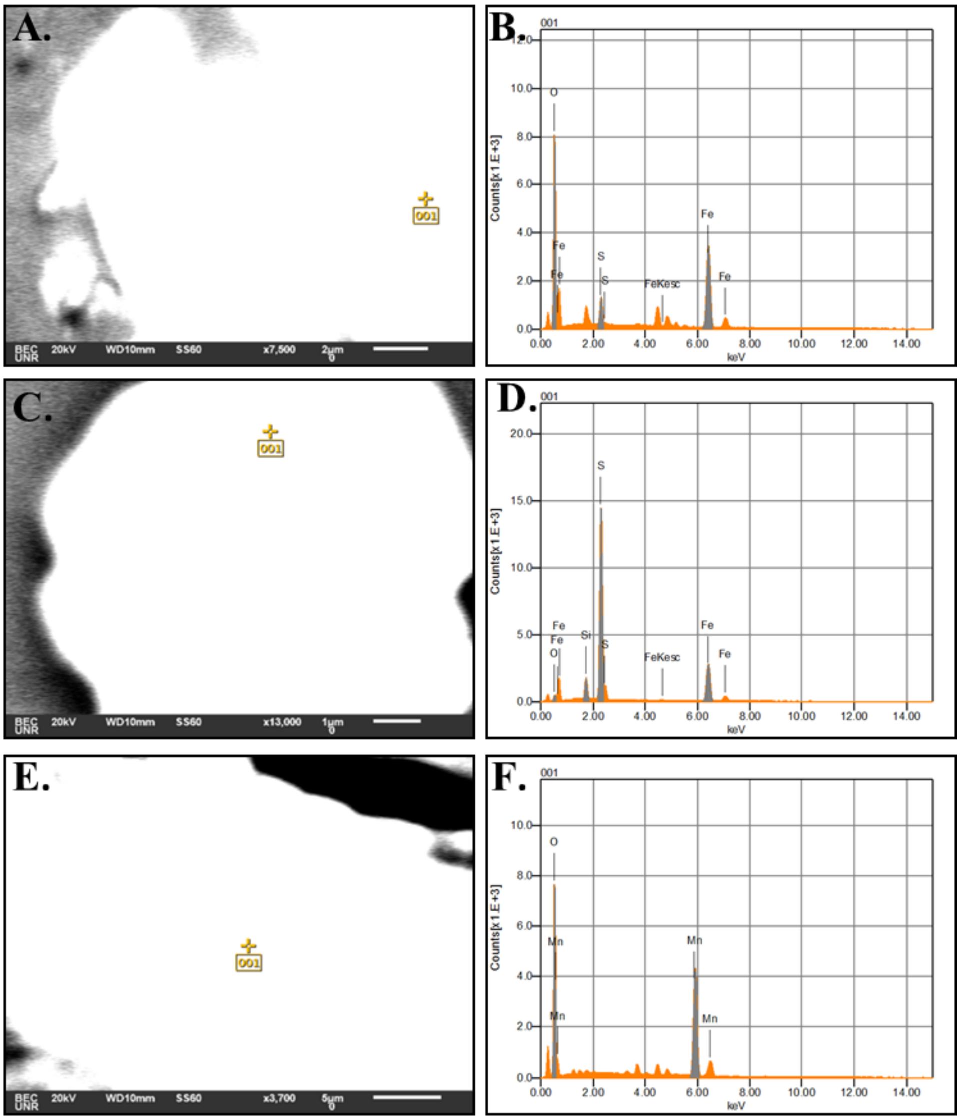

Fig 22A-F. Selected SEM backscatter images from the Cherry Spring chert with corresponding EDS plots. A-D plots pyrite. Hematite is found in A & B which would be expected due to the highly leached nature of the Cherry Spring chert. Additionally, F, displays magnesium and oxygen in the area examined in Figure 22 E, which was not found in the previous two examples examined.

Discussion

Evaluating model performance

LDA and MANOVA analysis demonstrates that all three analysis methods show variation between units, and indicates the potential to be discriminated geochemically. LDA works to force data into their known groups, which is why MANOVA analysis is vital to determine that the geochemical differences between the groups are statistically significant, as is the case for all analysis types in this study.

The various pXRF methods and ICP-MS analysis show good predictability when using the predict method with the sample being predicted left in the model; however, this is expected due to an exact match of the sample being used as an unknown existing within the data set (Maindonald and Braun, 2010). LOOCV decreases predictability but more rigorously tests the model (Maindonald and Braun, 2010). Partitioning of the data set to use a group of samples as unknowns presents several potential problems; the first being that it is reducing the size of the training data set and even with samples randomly withheld for use as unknowns the ability to predict could vary significantly depending on how the data is partitioned (Maindonald and Braun, 2010). Classification decreases for the *in situ* pXRF on T2 data with elements that return >50% LOD are removed from the analysis show a drop from 84.8% to 72.0%, between predict and LOOCV methods a large drop from 66.7% to 44.4%; however, predictability remains similar with LOOCV at 64.8% with all data and 61.6% with elements removed. The larger number of elements utilized appears to increased ability of the model to predict using the predict function and 9 unknowns. While *in situ* pXRF is the quickest method, it is also the least reliable unit predictor.

Owing to the high silica content of the samples, powdering pf samples for pXRF for homogeneity and increasing the analysis time for each filter was expected to produce fewer less than detection analyses. There was a roughly 10% increase in predictability for the predict function and LOOCV going from the *in situ* pXRF to the powdered samples for both time runs indicating that pulverization does increase predictability. Variable loadings from LDA of both times indicate that Sb and Sn show the largest change in value but have little effect on the model, while Sr and Zr, which have the largest effect on the model (Fig. 4), do not have significantly different means (Fig. 6). A larger percent predictability for the LOOCV for the 120s run 75.4%, compared to 71.9% for the 240s run indicates that a longer run time does not increase model predictability, and time could be saved by using the shorter run time. Pulverizing is more time consuming than *in situ* pXRF, and in this case care was taken to use the cleanest material, but it is still a relatively inexpensive method of analysis.

ICP-MS gave the greatest predictability of the three analytical methods utilized owing to complete and more precise measurement of elements. The predict function gave 100% identification of samples included in LDA, LOOCV increased over powdered pXRF by 3.5% to 78.9% predictability. This is not a greatly improved predictability over the powdered pXRF and is a more costly method.

Partitioning the data into the training set and testing set by removing 9 samples to use as unknowns gave varied results. ICP-MS and *in situ* pXRF with LOD replaced both gave 66.7% predictability, *in situ* pXRF with LOD removed and the powdered 120s run both gave 44.4% predictability, and powdered pXRF at 240s gave 55.6% predictability. The other two methods show an increase as the analysis type gets more precise while the 9 unknowns stay variable. A number of steps could be taken to try and improve the unknown test results. Removal of 9 samples for unknowns decreased the training set size by 13.6%; a larger sample set could help better train the model and increase predictability. Another approach that could increase predictability would be to focus on smaller regional areas such as a single mountain range within the Roberts Mountains allochthon, as lateral variability in the units on the larger allochthon-wide scale may be affecting unit classification.

Provenance

Major element data provided inconclusive results in interpreting provenance. Three plots that use Fe in the element ratios were not successful in conclusively identifying the depositional setting as continental margin due to samples plotting in margin and ridge regions of the graphs (Fig. 8A, B, and C), most likely due to the wide variability of Fe in the samples. It was observed in thin section that the distribution of Fe in the cherts was heterogeneous. Fe was in larger amounts on oxidized veins and fractures. In thin section, the Cherry Springs chert showed coarse distributions of Fe-bearing opaque minerals. There was also an increase in total Fe returned by ICP-ES for the Cherry Spring compared to the other units. Thin section examination shows that analysing completely unaltered material is nearly impossible due to the small scale vein and fracture fill that was present in all thin sections. Examination of the ICP-ES data reveals that the three samples run as a duplicate with unclean chert shards all plot in the ridge zone. This is likely due to the increased amount of iron oxide present on the surfaces and veins. Moree samples run as clean vs. unclean could help determine if the only reason some samples plot as ridge is due to formation of iron oxides during weathering. Fig. 8D comparing major oxides to normalized La over Ce does point to continental margin and doesn't show the correlation of increasing iron oxide content typically associated with decreased Ce values. Lack of a Ce anomaly is the strongest evidence for continental margin deposition of all three units, because there is no depletion of cerium in any of the units that would suggest open ocean deposition (Murray, 1994). The europium anomaly present in the data is an interesting feature. Tanner et al. (2013) argues high Eu/Eu* values result from hydrothermal alteration. It is possible to interpret that this may be the case for the extremely high value found in the Slaven barite pit locality, however it is unlikely that hydrothermal alteration is the driving force for the europium anomaly in all of the samples. Eu/Eu* values greater than 1.05 indicate enrichment of europium compared to the closest neighbouring REE (Taylor and McClennan, 1985). Furthermore, Taylor and McClennan (1985) noted that the vast majority of sedimentary rocks deposited after the Archean are dominated by a depleted Eu/Eu* signature, and interpret positive Eu/Eu* values, such as those seen in the RMA cherts sediments, with first cycle volcanogenic material, with mainly andesitic input, and a depositional environment of a fore-arc basin. This interpretation is significant because one of the long-standing points of interest relating to the tectonic setting of the RMA has been the notable scarcity of volcanic arc material in the stratigraphic sequence (Burchfiel and Royden, 1991). SEM EDS analysis did help in identifying opaque minerals within the samples examined however none of the samples contained any detrital grains large enough to show high europium content.

Conclusions

A comparison of the three methods, pXRF *in situ* measurements on hand sample, pXRF on powdered samples, and ICP-MS were used determine geochemical data's ability to differentiate between porcellanite, Cherry Springs, and Slaven cherts in the Roberts Mountains allochthon, Nevada. Results of a LDA and MANOVA of these data indicated that there were sufficient geochemical differences to successfully distinguish the three units and that the differences shown by the LDA were statically significant. Tests were then performed to determine whether the LDA models could successfully predict unknown samples, thereby using geochemistry as a tool for assigning new outcrops of chert to one of these stratigraphic units. Of the 3 tests used to evaluate the models, LOOCV was the most appropriate method for applicability to smaller datasets. The unknown test was not a good test for model performance owing to the size of the dataset. It was shown that:

in situ pXRF data performs better with the maximum number of elements used, even if the majority of returns were <LOD, with those values replaced by half. This is the fastest and cheapest form of analysis if a company already owns a pXRF, which is becoming increasingly more common. However, it is the least reliable prediction method, compared to pulverized pXRF and ICP-MS methods.

Use of homogenized pulverized sample for pXRF analysis did increase the predictability for analysis, when compared with the *in situ* pXRF data. The LOOCV model evaluation method showed a increase from 64.8% (*in situ)* 75.4% (pulverized) data using the second transformation method and for the same run time (120 seconds), Pulverizing the sample is therefore recommended over *in situ* analysis.

Increased run time on each filter from 30s to 60s with the pXRF did result in increased detection for all elements, however there was no significant increase in the model's ability to predict unknowns between the two runs for all samples left in and LOOCV. There was a 10% increase in the nine unknown classifications but at 55.6% being the higher prediction value it isn't great for determining unknowns.

ICP-MS did not show an increased ability to predict the 9 unknowns compared to the pXRF methods, however LOOCV prediction was 78.9% indicating the model should have the ability to better predict unknowns. ICP-MS shows the greatest probability of predicting the three studied chert units, however with the low predictability values for unknowns at 66.7%, and LOOCV only indicating predictability of 78.9%. Biostratigraphic work to date the cherts would still be necessary to validate results from chemostratigraphic classification.

Both ICP-ES and REE analysis ruled out an open ocean provenance. ICP-ES was a less conclusive tool, classifying the majority of samples as being deposited in a continental margin setting, with a sub-set that classified at ridge. REE analysis was more definitive, showing that there is no Ce anomaly to indicate an open ocean deposition of the units, but that there is a Eu anomaly that is indicative of a continental margin depositional environment. While weight percent oxide did not prove useful in LDA, the large difference in mean value for CaO between porcellanite and the other two units suggests that this is an element that would be work adding to ICP-MS analysis to determine if it could improve model predictability.

Thin section examination shows that all three units display varying degrees of recrystallization of quartz in the matrix; unaltered cryptocrystalline quartz to highly altered coarsely grained polycrystalline quartz. The ability of the LDA to break out the units indicates that even with varying degrees of matrix recrystallization, geochemical makeup of the units has not been altered enough to prevent classification.

SEM analysis indicates that alteration of iron sulfides occurs in samples down to the 1-30 µm scale and therefore picking of unaltered samples for use in provenance study may not be feasible.

Future Work

Future work to compliment this study is as follows.

- Sample submittal to a commercial laboratory to compare typical data received by mining companies to the data produced in a research laboratory setting.
- Systematic sampling of a single outcrop through the stratigraphic section to compare chemical variation within a stratigraphic unit to variation between different units studied.
- Use of known samples from areas of economic mineralization and alteration to ensure that cherts can still be differentiated from one another in locations of higher alteration.
- Additional petrography and SEM analysis to determine if alteration is a potential problem for some locations.

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Appendix 1: Outcrop Locations

Unit	Locality	Easting	Northing
Cherry Spring	Mary's Mtn	559456.16	5407397.96
Cherry Spring	Garden Pass	574018.66	4404563.31
Cherry Spring	Adobe Range	611569.69	4562025.59
Porcellanite	Mary's Mtn	559757.33	4506827.93
Porcellanite	Vinini Cr	564566.05	4414844.35
PK Chert	Ren	550949.12	4541375.33
Slaven	Mary's Mtn	560237.15	4506637.70
Slaven	Slaven Canyon	521683.62	4482430.23
Slaven	Barite Pit	522450.39	4487247.72
Slaven	Vinini Cr	564514.08	4414725.83

Appendix 2: Raw *in situ* pXRF data

* after sample number indicates use as unknown in LDA

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	703904	703904	703906	703906	703910	703910	703912*
Mo	5.89	7.65	< LOD : 3.08	< LOD : 3.04	< LOD : 2.80	< LOD : 2.88	< LOD : 3.14
Zr	6.73	6.71	52.73	52.23	13.36	13.74	11.02
Sr	75.07	69.74	70.56	57.99	16.76	21.36	54.96
U	4.58	< LOD : 4.17	< LOD : 4.85	< LOD : 4.59	< LOD : 3.61	< LOD : 3.89	< LOD : 4.68
Rb	2.7	2.5	13.67	11.47	4.7	4.32	10.27
Th	< LOD : 3.02	< LOD : 2.93	7.85	5.06	< LOD : 2.91	< LOD : 2.90	3.45
Pb	4.64	< LOD : 4.15	427.42	203.86	22.15	17.62	7.56
Au	< LOD : 4.33	< LOD : 4.26	< LOD : 4.92	< LOD : 4.59	< LOD : 3.96	< LOD : 4.32	< LOD : 4.62
Se	< LOD : 3.18	< LOD : 3.12	< LOD : 3.52	< LOD : 3.29	< LOD : 2.84	< LOD : 3.15	< LOD : 3.36
As	< LOD : 3.59	< LOD : 3.41	< LOD : 14.08	< LOD : 10.01	< LOD : 4.16	< LOD : 4.22	12.43
Hg	< LOD : 6.25	< LOD : 6.10	9.81	< LOD : 6.60	< LOD : 5.90	< LOD : 6.28	< LOD : 6.85
Zn	< LOD : 6.86	< LOD : 6.70	11.99	< LOD : 7.03	< LOD : 6.26	< LOD : 6.69	< LOD : 7.17
Cu	43.72	29.43	17.8	< LOD : 13.74	< LOD : 12.33	< LOD : 13.21	< LOD : 14.81
Ni	25.62	20.67	84.1	22.23	< LOD : 16.63	53.32	60.62
Co	< LOD : 27.73	< LOD : 27.17	< LOD : 44.73	< LOD : 37.78	< LOD : 25.75	< LOD : 28.25	< LOD : 100.13
Fe	703.26	703.87	3036.13	1959.19	597.58	767.47	25819.56
Mn	< LOD : 42.56	51.63	125.36	66.09	< LOD : 38.46	80.4	< LOD : 50.27
Cr	21.32	35.09	< LOD : 10.90	34.43	< LOD : 9.22	< LOD : 8.67	< LOD : 10.89
V	125.65	109.94	150.19	76.2	44.21	52.14	88.67
Ti	< LOD : 56.27	< LOD : 57.23	1554.77	780.45	102.5	192.77	196.13
Sc	< LOD : 7.99	< LOD : 8.25	< LOD : 9.38	< LOD : 7.10	< LOD : 6.19	< LOD : 6.32	< LOD : 8.56
Ca	829.12	883.4	619.52	329.51	265.04	326.12	123.15
K	1092.88	1046.95	5229.78	4078.51	1282.04	1404.33	7303.72
S	2134.16	2278.42	5741.18	3583.54	1379.85	1779.88	33183.32
Ba	690.3	874.85	1183.23	669.6	335.7	634.45	571.13
Sb	23.06	27.39	28.5	< LOD : 9.92	< LOD : 9.24	29.44	17.14
Sn	21.76	23.03	23.82	10	< LOD : 9.05	22.86	14.49
Cd	12.56	12.16	< LOD : 8.42	< LOD : 8.97	< LOD : 8.57	12.07	< LOD : 9.79
Cs	45.17	39.76	63.48	19.25	< LOD : 7.56	56.59	23.32
Te	92.37	82.79	100.98	29.78	< LOD : 23.45	101.07	41.46
Al	3221.18	2891.75	12489.74	10261.02	4882.64	4748.39	9711.91
P	< LOD : 419.41	< LOD : 405.37	< LOD : 512.19	< LOD : 428.42	< LOD : 430.19	< LOD : 421.47	739.14
Si	550645.06	525432.25	589962.94	548208.75	587227.06	569177.63	510754.16
Cl	245.85	305.97	< LOD : 33.48	177.46	568.61	359.69	184.29
Mg	4766.49	3050.56	4503.81	2770.6	< LOD : 2086.75	2913.46	3579.18

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	703912	703921	703921	703927	703927	703930	703930
Mo	< LOD : 3.17	< LOD : 3.13	< LOD : 3.05	< LOD : 3.26	< LOD : 2.99	< LOD : 3.13	3.67
Zr	6.13	34.02	43.05	49.47	34.92	12.35	11.17
Sr	117.35	251.81	115.35	67.33	66.24	119.36	80.25
U	< LOD : 5.37	5.78	5.05	5.57	< LOD : 4.46	6.04	< LOD : 4.24
Rb	21.53	11.55	10.31	10.78	11.51	5.78	3.99
Th	< LOD : 3.53	5.47	5.4	< LOD : 3.34	< LOD : 3.22	3.69	< LOD : 3.14
Pb	24.64	21.42	7	21.65	16.03	15.09	18.05
Au	< LOD : 4.81	< LOD : 4.60	< LOD : 4.39	< LOD : 4.60	< LOD : 4.47	< LOD : 4.61	< LOD : 4.44
Se	< LOD : 3.44	< LOD : 3.33	< LOD : 3.21	< LOD : 3.45	< LOD : 3.22	< LOD : 3.48	< LOD : 3.24
As	26.14	5.11	4.75	6.7	7.64	11.86	13.75
Hg	< LOD : 6.89	9	< LOD : 6.46	< LOD : 7.11	< LOD : 6.35	< LOD : 6.63	< LOD : 6.15
Zn	< LOD : 7.33	11.16	7.74	< LOD : 7.05	< LOD : 6.44	< LOD : 7.21	< LOD : 6.58
Cu	< LOD : 14.31	18.54	48.11	< LOD : 14.96	< LOD : 13.21	< LOD : 14.12	< LOD : 13.63
Ni	70.82	61.76	60.3	42.15	45.82	53.03	34.53
Co	< LOD : 146.07	50.01	41.36	< LOD : 50.63	< LOD : 59.63	< LOD : 64.28	< LOD : 78.41
Fe	50800.27	2826.04	2370.17	3931.9	10908.71	11231.56	20586.62
Mn	120.87	118.05	92.5	57.49	72.56	132.3	63.37
Cr	< LOD : 18.75	47.42	< LOD : 9.40	24.41	17.92	26.05	40.66
V	124.2	51.85	76.8	79.78	104.61	149.86	189.02
Ti	124.88	368.69	707.07	771.5	763.27	220.6	276.87
Sc	< LOD : 17.05	< LOD : 13.48	< LOD : 9.99	< LOD : 8.36	< LOD : 11.69	< LOD : 9.53	< LOD : 23.93
Ca	< LOD : 231.81	2082.2	1085.99	435.86	753.72	391.68	3570.93
K	11282.05	4503.68	4410.63	2910.33	9330.56	4758.84	12787.35
S	74855.97	14382.17	8225.46	5639.16	27867.05	20071.31	101963.98
Ba	886.82	2694.61	1453.64	705.85	1146.08	1973.69	1770.81
Sb	33.84	20.07	18.78	< LOD : 10.08	13.02	26.97	< LOD : 10.34
Sn	32.66	< LOD : 10.53	16.45	< LOD : 10.09	< LOD : 9.97	22.1	< LOD : 10.36
Cd	20.59	< LOD : 9.20	10.05	< LOD : 9.24	< LOD : 8.93	< LOD : 9.53	< LOD : 9.33
Cs	62.12	40.97	42.18	< LOD : 8.42	25.29	54.99	18.21
Te	105.13	52.08	56.88	< LOD : 25.72	33.26	86.57	< LOD : 25.96
Al	3088.72	10703.03	11842.63	9292.94	11249.03	6605.81	6254.08
P	2162.62	< LOD : 433.72	< LOD : 438.36	844.28	651.32	< LOD : 434.66	4508.61
Si	354445.66	532125.69	573256.5	608662.13	493691.97	529107.5	294853.28
Cl	46.3	352.4	488.25	1243.71	116.61	269.11	479.55
Mg	< LOD : 4626.71	< LOD : 4012.00	4911.33	4946.13	4167.89	2560.01	< LOD : 3380.74

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass
SAMPLE	703935	703935	7021318	7021318	7021320	7021320	7021327*
Mo	< LOD : 2.81	< LOD : 2.95	< LOD : 2.76	< LOD : 2.93	< LOD : 2.90	< LOD : 2.77	< LOD : 2.81
Zr	9.32	7.79	< LOD : 2.17	8.31	4.25	6.66	6.63
Sr	27.43	157.47	16.16	24.55	31.24	28.11	32.3
U	< LOD : 3.95	4.89	< LOD : 3.72	< LOD : 4.26	< LOD : 3.90	< LOD : 3.83	< LOD : 4.04
Rb	4.32	3.38	< LOD : 1.74	6.99	3.08	3.94	6.9
Th	< LOD : 3.05	< LOD : 3.26	< LOD : 2.96	< LOD : 3.09	< LOD : 2.92	< LOD : 2.92	3.25
Pb	9.84	17.2	< LOD : 4.07	5.93	11.54	< LOD : 4.01	9.44
Au	< LOD : 4.18	5.79	< LOD : 4.11	< LOD : 4.45	< LOD : 4.16	< LOD : 3.99	< LOD : 4.42
Se	< LOD : 3.08	< LOD : 3.38	< LOD : 2.95	< LOD : 3.26	< LOD : 3.07	< LOD : 2.88	< LOD : 3.08
As	< LOD : 3.77	5.71	< LOD : 3.29	< LOD : 3.62	< LOD : 3.99	< LOD : 3.19	< LOD : 3.68
Hg	< LOD : 6.17	< LOD : 6.58	< LOD : 6.21	< LOD : 6.65	< LOD : 6.21	< LOD : 6.05	< LOD : 6.23
Zn	< LOD : 6.68	7.58	< LOD : 6.58	< LOD : 6.94	12.62	< LOD : 6.41	< LOD : 6.54
Cu	< LOD : 12.98	< LOD : 13.74	< LOD : 12.60	< LOD : 13.65	< LOD : 13.46	13.46	< LOD : 13.27
Ni	42.33	85.57	39.28	66.15	57.42	26.58	63.4
Co	40.35	< LOD : 53.53	39.49	< LOD : 33.22	< LOD : 45.16	< LOD : 34.32	< LOD : 38.43
Fe	765.06	4837.9	1444.68	1319.32	3472.73	1641.47	2194.98
Mn	79.4	103.98	73.47	665.03	679.47	492.34	122.94
Cr	10.71	< LOD : 10.96	< LOD : 8.43	23.41	< LOD : 9.36	13.3	< LOD : 8.23
V	34.79	70.8	40.59	37.6	68.69	40.98	41.32
Ti	89.14	< LOD : 90.08	< LOD : 40.41	113.21	< LOD : 55.13	60.73	153.41
Sc	< LOD : 5.87	< LOD : 8.62	< LOD : 5.71	< LOD : 7.29	< LOD : 8.65	< LOD : 7.19	< LOD : 6.44
Ca	268.06	292.47	257.95	558.24	720.61	495.53	362.89
K	1496.53	1771.13	572.17	1555.26	927.84	1313.47	2098.35
S	1811.54	5457.01	657.68	479.47	559.65	885.2	3210.3
Ba	607.31	1875.29	364.8	711.95	553.83	427.9	859.24
Sb	29.2	31.62	24.86	43.07	19.86	19.6	50.42
Sn	18.54	27.43	24.29	31.13	24.36	22.49	44.66
Cd	12.79	11.65	< LOD : 8.85	12.18	< LOD : 9.05	< LOD : 8.75	26.31
Cs	47.29	78.16	36.48	81.9	39.88	30.39	90.66
Te	77.87	119.43	72.69	140.12	65.73	56.03	161.64
Al	4754.79	4606.22	3077.05	4144.97	4432.38	3292.57	5890.38
P	< LOD : 423.55	< LOD : 440.06	< LOD : 412.46	< LOD : 380.29	< LOD : 409.59	< LOD : 425.99	< LOD : 367.39
Si	561177	592125.56	566187.25	514443.31	564415.31	556289.19	510955.59
Cl	482.33	647.83	399.18	429.7	494.78	994.1	275.28
Mg	2492.55	2880.87	2930.95	< LOD : 1935.52	4401.48	2481.58	2290.34

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Mary's Mtn	Mary's Mtn
SAMPLE	7021327	7021330	7021330	14GP-HS001	14GP-HS001	14MM-CH001	14MM-CH001
Mo	< LOD : 2.87	< LOD : 2.83	< LOD : 2.78	4.65	< LOD : 3.47	< LOD : 3.23	< LOD : 3.61
Zr	8.43	10.06	4.78	13.17	12.6	11.39	17.19
Sr	34.64	30.21	19.8	57.98	91.68	42.05	55.3
U	< LOD : 3.85	< LOD : 3.93	< LOD : 3.68	< LOD : 6.25	< LOD : 5.72	< LOD : 5.17	< LOD : 5.68
Rb	4.75	5.89	2.7	11.58	9.53	11.41	11.35
Th	< LOD : 2.98	< LOD : 3.07	< LOD : 2.86	< LOD : 4.06	< LOD : 4.11	4.76	< LOD : 3.92
Pb	19.49	10.5	< LOD : 4.14	33.54	48.71	7.63	23.44
Au	< LOD : 3.99	< LOD : 4.27	< LOD : 4.03	< LOD : 7.73	< LOD : 6.89	< LOD : 6.16	< LOD : 7.14
Se	< LOD : 2.83	< LOD : 3.05	< LOD : 2.90	< LOD : 4.52	< LOD : 4.02	< LOD : 3.56	< LOD : 4.05
As	5.54	< LOD : 3.75	< LOD : 3.31	42.45	11.61	< LOD : 4.70	7.85
Hg	< LOD : 5.91	< LOD : 6.07	< LOD : 5.89	< LOD : 8.99	< LOD : 7.86	< LOD : 7.47	< LOD : 8.48
Zn	< LOD : 6.52	< LOD : 6.61	< LOD : 6.45	51.76	< LOD : 9.25	17.3	20.68
Cu	< LOD : 12.93	< LOD : 12.89	< LOD : 12.85	41.96	< LOD : 16.10	32.83	< LOD : 17.49
Ni	< LOD : 17.14	52	30.08	145.71	70.95	66.43	45.23
Co	< LOD : 45.28	< LOD : 37.69	< LOD : 29.30	< LOD : 237.91	< LOD : 155.91	< LOD : 61.72	< LOD : 64.71
Fe	4062.62	2245.98	1170.77	89590.68	51525.14	6531.17	6033.52
Mn	314.3	75.48	483.48	5453.1	217.5	491.53	2346.04
Cr	34.37	< LOD : 10.06	< LOD : 8.50	215.53	< LOD : 22.61	< LOD : 10.62	< LOD : 7.83
V	55.76	65.4	43.94	325.13	168.06	31.36	< LOD : 35.35
Ti	562.18	343.47	< LOD : 48.53	1924.76	917.17	2195.87	421.66
Sc	< LOD : 12.44	< LOD : 8.18	< LOD : 6.01	< LOD : 51.19	< LOD : 26.42	< LOD : 8.94	< LOD : 5.89
Ca	2151.05	552.96	258.64	7148.77	1725.06	409.12	281.81
K	5126.94	3972.05	939.57	13035.66	17113.43	5564.91	2657.04
S	2734.72	2785.79	1215.4	5158.01	44370.85	314.2	480.31
Ba	363.25	580.59	371.33	1278.52	851.07	719.71	907.73
Sb	< LOD : 9.24	18.91	9.62	60.07	63.77	65.97	87.91
Sn	< LOD : 8.99	27.07	12.47	46.34	51.7	52.61	69.24
Cd	< LOD : 7.55	< LOD : 8.50	< LOD : 8.66	29.43	20.34	22.02	36.23
Cs	< LOD : 7.57	42.67	22.74	116.33	110.46	115.02	142.82
Te	< LOD : 23.34	66.43	42.74	158.3	189.58	188.64	272.9
Al	47534.54	12434.86	3259.51	61102.33	28458.48	10552.43	4240.75
P	5850.57	< LOD : 417.56	< LOD : 430.30	7296.89	1328.04	< LOD : 735.71	635.5
Si	406510.44	549193.44	561418.75	214631.92	267371.28	381895.53	232014.97
Cl	741.78	1521.1	288.49	< LOD : 57.99	< LOD : 60.49	191.61	74.06
Mg	4333.06	2474.15	2981.78	10597.31	< LOD : 7177.38	< LOD : 4147.51	< LOD : 4268.09

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	14MM-CH002	14MM-CH002	14MM-CH002	14MM-CH003	14MM-CH003*	14MM-CH004	14MM-CH004
Mo	< LOD : 3.76	< LOD : 2.62	< LOD : 3.46	< LOD : 4.18	< LOD : 3.38	< LOD : 3.55	< LOD : 3.25
Zr	13.08	8.27	15.23	< LOD : 3.80	6.26	11.79	13.05
Sr	42.79	82.39	37.89	87.8	21.39	32.44	37.72
U	< LOD : 5.61	< LOD : 7.21	< LOD : 5.19	< LOD : 6.46	< LOD : 4.74	< LOD : 5.41	14.7
Rb	9.99	7.09	8.37	4.13	5.16	12.16	5.16
Th	< LOD : 3.85	< LOD : 4.64	< LOD : 3.47	< LOD : 4.92	< LOD : 3.35	< LOD : 3.78	3.62
Pb	16.57	22.73	< LOD : 5.96	62.35	6.48	8.25	6.56
Au	< LOD : 7.54	< LOD : 15.61	< LOD : 6.51	< LOD : 8.93	8.18	< LOD : 7.03	< LOD : 6.22
Se	< LOD : 4.33	< LOD : 4.40	< LOD : 3.78	< LOD : 5.27	< LOD : 3.76	< LOD : 4.15	< LOD : 3.52
As	17.73	87.06	< LOD : 4.91	38.85	< LOD : 4.88	7.03	< LOD : 4.75
Hg	< LOD : 9.71	< LOD : 12.23	< LOD : 7.84	< LOD : 11.12	< LOD : 7.73	< LOD : 8.54	< LOD : 7.31
Zn	435.93	657.03	< LOD : 9.84	408.61	68.22	49.35	24.71
Cu	73.18	171.85	18.87	31.84	25.07	29.68	19.63
Ni	211.34	118.43	34.28	427.84	50.15	72.54	59.14
Co	< LOD : 244.03	< LOD : 240.29	< LOD : 40.90	< LOD : 253.58	< LOD : 70.20	< LOD : 59.56	< LOD : 45.90
Fe	92419.91	140657.31	1910.51	84287.69	12564.01	4747.11	3364.04
Mn	7734.31	3131.29	164.27	65618.38	3864.86	6006.86	228.71
Cr	< LOD : 28.07	174.03	< LOD : 7.83	118.89	< LOD : 12.64	< LOD : 9.86	< LOD : 10.91
V	806.33	1284.98	< LOD : 23.09	456.14	< LOD : 29.43	39	62.46
Ti	168	302.63	2820.6	756.25	91.95	843.63	493.08
Sc	< LOD : 27.01	< LOD : 38.10	< LOD : 6.09	< LOD : 63.57	< LOD : 9.62	< LOD : 8.67	< LOD : 45.49
Ca	446.85	1734.37	242.44	2388.7	342.03	645.77	30545.88
K	1272.71	3174.49	2055.18	6083.84	1597.64	3220.34	4890.68
S	99.13	887.99	306.1	1861.78	268.87	248.65	321.39
Ba	939.7	781.96	744.01	1781.55	673.71	898.22	741.56
Sb	107.47	< LOD : 23.47	75.17	104.5	65.84	79.53	62.77
Sn	81.48	< LOD : 32.21	67.13	109.04	58.73	64.31	62.52
Cd	47.47	< LOD : 11.10	25.36	53.43	29.65	23.53	28.25
Cs	174.93	266.58	119.34	216.23	122.94	138.73	126.39
Te	338.38	495.88	195.28	359.65	211.67	243.43	205.58
Al	952.17	11984.93	6417.51	3380.84	4163.76	11163.27	10363.92
P	845.9	1209.12	< LOD : 1614.89	431.47	715.43	< LOD : 1152.89	17263.11
Si	87833.05	159018.84	497239.66	42482.62	360540.84	332545.16	291048.38
Cl	393.49	524.11	198.13	369.85	337.34	97.6	195.03
Mg	< LOD : 3280.48	< LOD : 4945.37	< LOD : 8580.75	< LOD : 4538.81	< LOD : 4141.02	< LOD : 7303.06	< LOD : 6652.57

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	14MM-CH005	14MM-CHOC003	14MM-CHOC006	7020921	7020921	7020923	7020923
Mo	< LOD : 3.88	< LOD : 3.68	< LOD : 3.03	4.87	4.44	< LOD : 2.95	< LOD : 2.82
Zr	14.3	17.79	11.98	12.92	10.99	5.4	7.19
Sr	75.32	284.22	25.8	22.41	15.5	12.97	9.34
U	< LOD : 6.40	< LOD : 7.11	< LOD : 4.41	< LOD : 3.98	< LOD : 3.79	< LOD : 3.97	< LOD : 3.79
Rb	7.32	12.44	7.64	11.26	4.55	4.03	3.82
Th	< LOD : 4.30	< LOD : 4.29	< LOD : 3.18	< LOD : 2.75	< LOD : 2.84	< LOD : 2.84	< LOD : 2.67
Pb	20.44	26.34	9.33	< LOD : 4.07	< LOD : 4.12	< LOD : 4.21	< LOD : 3.85
Au	10.54	7.97	< LOD : 6.01	< LOD : 4.25	< LOD : 4.04	< LOD : 4.31	< LOD : 4.04
Se	< LOD : 4.63	< LOD : 4.48	< LOD : 3.57	5.42	4.35	5.34	3.17
As	21.65	13.66	5.28	6.32	4.76	7.01	7.38
Hg	< LOD : 9.58	< LOD : 9.05	< LOD : 7.15	< LOD : 5.95	< LOD : 5.82	< LOD : 6.21	< LOD : 5.79
Zn	373.54	144.51	42.67	23.67	37.4	8.24	< LOD : 6.22
Cu	28.77	66.15	29	24.74	25.46	< LOD : 13.24	15.07
Ni	203.53	119.79	61.05	44.49	29.93	36.5	26.12
Co	< LOD : 167.99	< LOD : 151.84	< LOD : 52.23	< LOD : 28.53	36.68	< LOD : 53.35	< LOD : 39.82
Fe	46830.47	43649.34	5481.93	1076.92	568.01	6281.24	2952.3
Mn	47456.61	1115.39	375.75	44.52	< LOD : 40.26	< LOD : 42.11	< LOD : 40.01
Cr	< LOD : 24.62	< LOD : 19.50	< LOD : 13.06	79.01	11.65	< LOD : 11.43	< LOD : 10.27
V	151.98	258.68	109.65	1142.61	264.4	1044.95	322.94
Ti	818.15	391.31	1091.78	390.51	< LOD : 49.22	< LOD : 69.44	135.84
Sc	< LOD : 29.41	< LOD : 20.08	< LOD : 18.11	< LOD : 7.64	< LOD : 7.27	< LOD : 7.63	< LOD : 6.53
Ca	2885.79	948.59	3185.12	439.38	671.8	304.49	282.46
K	9414.67	5996.81	9096.54	2489.06	1026.55	2015.36	830.65
S	242.76	1777.48	1341.17	8886.79	6148.01	15008.17	4216.49
Ba	1009.47	1654.82	704.32	331.28	297.97	156.08	161.77
Sb	93.42	94.75	57.08	19.82	16.64	12.26	16.3
Sn	80.3	80.68	50.6	14.44	19.43	< LOD : 10.04	15.68
Cd	46.08	32.78	26.31	8.62	12.48	11.87	< LOD : 8.41
Cs	189.19	166.93	107.77	33.87	35.77	24.12	24.1
Te	337.56	279.32	156.34	60.05	77.42	49.23	40.76
Al	15912.13	18990.1	46327.97	8021.46	6193.85	10375.73	8731.65
P	767.77	1428.28	2535.92	2164.93	1306.31	46302.74	22748.93
Si	107943.3	434964	339366.31	521579.41	548658.81	351938.81	518431.56
Cl	109.83	208.25	58.59	240.88	182.69	104.06	175.62
Mg	< LOD : 5656.06	< LOD : 5348.03	9079.27	2474.79	3551.81	< LOD : 2658.54	2450.17

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	7020925	7020925	7020927	7020927*	7020930	7020930	14MM-CH010
Mo	3.12	< LOD : 2.91	16.4	3.11	6.48	< LOD : 2.86	74.36
Zr	15.71	16.13	51.6	29.04	31.41	19.23	45.06
Sr	24.77	19.75	34.65	28.81	47.02	22.66	40.27
U	< LOD : 3.98	< LOD : 3.97	12.41	16.44	11.55	5.18	27.77
Rb	5.65	6.05	22.12	15.6	18.67	9.34	30.04
Th	< LOD : 2.90	< LOD : 2.86	< LOD : 3.51	3.56	< LOD : 2.79	< LOD : 2.86	8.06
Pb	< LOD : 3.99	6.66	14.5	15.78	< LOD : 4.10	< LOD : 3.97	511.52
Au	< LOD : 4.07	< LOD : 4.34	< LOD : 4.37	< LOD : 4.49	< LOD : 3.81	< LOD : 3.91	< LOD : 8.23
Se	< LOD : 3.02	< LOD : 3.17	10.01	9.68	< LOD : 3.03	< LOD : 2.87	28.66
As	5.97	5.77	18.31	18.03	12.06	< LOD : 3.24	67.74
Hg	< LOD : 6.09	< LOD : 6.17	< LOD : 7.22	< LOD : 6.31	< LOD : 5.84	< LOD : 5.78	< LOD : 9.67
Zn	80.26	80.41	66.53	39.4	20.85	29.68	1440.88
Cu	< LOD : 13.01	< LOD : 13.12	101.07	66.16	55.31	40.14	137.51
Ni	19.6	63.82	< LOD : 19.61	70.88	< LOD : 16.85	36.54	118.11
Co	< LOD : 35.76	46.84	< LOD : 51.28	< LOD : 45.35	< LOD : 44.38	< LOD : 32.47	90.72
Fe	1826.49	2145.9	3925.23	3477.64	3847.42	1650.85	5911.64
Mn	< LOD : 37.50	57.99	< LOD : 42.15	68.32	< LOD : 36.78	< LOD : 38.51	87.73
Cr	37.22	26.34	263.36	186.14	132.78	82.01	141.71
V	200.33	206.96	881.96	677.53	594.43	357.25	2205.12
Ti	150.24	174.51	1238.11	868.82	747.84	561.26	1583.73
Sc	< LOD : 6.38	< LOD : 7.19	< LOD : 8.83	< LOD : 10.19	< LOD : 8.49	< LOD : 8.24	< LOD : 21.20
Ca	365.82	469.91	846.49	946.28	557.2	767.52	4726.29
K	1286.57	1522.28	5909.69	5079.43	5245.4	3290.01	11167.03
S	7991.29	6982.29	56506.15	17999.41	14671.01	10460.75	28936.8
Ba	177.9	503.96	< LOD : 25.91	551.63	242.11	284.8	703.74
Sb	< LOD : 9.07	46.17	< LOD : 7.42	26.35	< LOD : 8.43	< LOD : 9.25	58.54
Sn	< LOD : 8.80	33.04	< LOD : 6.93	27.16	< LOD : 8.16	< LOD : 8.97	29.86
Cd	< LOD : 8.21	21.85	< LOD : 6.89	10.95	< LOD : 7.99	< LOD : 8.25	22.29
Cs	< LOD : 7.48	76.59	< LOD : 6.60	54.3	< LOD : 7.06	8.78	71.71
Te	< LOD : 22.76	133.9	< LOD : 18.87	86.51	< LOD : 21.40	< LOD : 23.13	126.37
Al	7604.1	7264.9	29368.64	13686.54	15410.97	10843.71	21313.79
P	< LOD : 691.69	443.95	2832.91	1180.63	1268.78	580.33	2084.28
Si	601652.25	570413.94	613153.44	485961.81	521575.69	516447.25	316740.5
Cl	318.76	390.97	364.5	120.47	49.68	78.62	145.45
Mg	< LOD : 2289.77	2197.99	5170.87	3477.65	< LOD : 2417.78	2249.03	6528.74

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Ren Property	Ren Property
SAMPLE	14MM-CH010	14MM-CH011	14MM-CH011	14MM-CH012	14MM-CH012	7011002	7011002
Mo	56.28	11.24	4.79	8.46	6.8	< LOD : 2.85	< LOD : 2.82
Zr	41.92	36.38	14.86	6.7	18.23	19.32	21.67
Sr	37.78	24.59	25.53	10.32	14.69	16.94	16.13
U	31.32	6.22	< LOD : 4.77	< LOD : 4.98	< LOD : 4.59	< LOD : 4.11	< LOD : 3.94
Rb	26.74	19.57	7.68	3.09	7	13.48	15
Th	< LOD : 6.09	4.38	< LOD : 3.33	< LOD : 3.66	< LOD : 3.37	< LOD : 2.88	< LOD : 2.91
Pb	480.06	6.26	< LOD : 5.62	8.99	9.95	5.14	< LOD : 3.72
Au	< LOD : 8.08	< LOD : 6.57	< LOD : 6.34	< LOD : 7.13	< LOD : 6.52	< LOD : 4.34	< LOD : 3.80
Se	32.04	13.03	< LOD : 3.80	< LOD : 4.17	4.56	< LOD : 3.14	< LOD : 2.88
As	52.23	17.1	11.04	< LOD : 5.40	10.38	< LOD : 3.30	< LOD : 2.94
Hg	< LOD : 8.93	< LOD : 7.30	< LOD : 7.75	< LOD : 8.08	< LOD : 7.10	< LOD : 6.20	< LOD : 5.84
Zn	917.39	73.03	422.44	< LOD : 9.27	11.59	< LOD : 6.67	< LOD : 6.30
Cu	161.2	75.95	61.87	19.21	31.08	< LOD : 12.93	13.04
Ni	117.28	77.73	93.95	< LOD : 24.64	57.1	55.06	< LOD : 16.40
Co	< LOD : 68.00	53.6	< LOD : 94.11	< LOD : 33.57	< LOD : 34.51	27.46	< LOD : 25.03
Fe	10877.27	3916.65	26282.33	720.12	1244.6	408.99	607.92
Mn	108.81	94.37	997.9	87.74	70.23	76.59	< LOD : 37.73
Cr	134.75	372.01	< LOD : 23.33	137.09	< LOD : 10.36	15.43	< LOD : 9.04
V	2502.85	1798.42	612.28	145.51	513.6	53.35	76.18
Ti	1454.52	1400.89	131.28	143.75	276.14	432.19	598.52
Sc	< LOD : 13.16	< LOD : 11.59	< LOD : 53.82	< LOD : 4.51	< LOD : 6.92	< LOD : 7.35	< LOD : 8.53
Ca	780.21	987.47	13441.44	193.26	487.12	606.89	736.11
K	9951.12	9292.76	3641.45	1199.96	2266.48	3471.66	3942.21
S	27857.02	17977.54	3000.12	2173.66	4233.95	1271.01	2055.06
Ba	644.57	636.37	554.09	542.7	587.96	663.31	253.92
Sb	49.54	48.79	66.92	71.38	63.83	25.03	< LOD : 8.99
Sn	23.51	36.57	53.59	62.71	42.92	22.22	< LOD : 8.87
Cd	22.35	12.49	33.31	32.19	22.3	< LOD : 8.70	< LOD : 8.26
Cs	62.6	79.4	103.49	120.7	103.95	52.16	< LOD : 7.45
Te	80.58	118.29	170.89	207.41	167.73	90.23	< LOD : 22.92
Al	17945.29	20043.33	13840.91	3827.26	22243.44	10204.43	15918.4
P	8639.88	1287.16	8956.05	1881.23	16045.98	< LOD : 409.91	< LOD : 432.51
Si	330590.81	369141.78	175228.36	373055.63	389489.53	554614.13	573916.38
Cl	166.86	68.38	751.23	310.93	208.09	174.99	84.65
Mg	< LOD : 8808.97	< LOD : 4826.70	< LOD : 6302.81	< LOD : 5360.35	< LOD : 4699.90	3261.25	3985.11

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property
SAMPLE	7011009	7011009	7011012	7011012	7011014	7011014	7011016
Mo	< LOD : 2.91	< LOD : 2.85	< LOD : 2.87	< LOD : 2.82	< LOD : 2.80	< LOD : 2.76	< LOD : 2.83
Zr	15.99	12.64	31.99	30.65	8.39	7.61	13.09
Sr	13.68	9.51	18.34	27.26	9.59	7.99	8.81
U	< LOD : 4.21	< LOD : 3.77	4.76	< LOD : 4.12	< LOD : 3.78	< LOD : 3.73	< LOD : 4.06
Rb	8.92	4.71	13.42	9.86	5.71	4.69	9.09
Th	< LOD : 2.96	< LOD : 2.95	< LOD : 3.04	< LOD : 2.79	< LOD : 2.80	< LOD : 2.88	3.19
Pb	4.99	7.57	< LOD : 4.17	< LOD : 3.73	< LOD : 3.82	< LOD : 3.80	< LOD : 4.09
Au	< LOD : 4.32	< LOD : 4.22	< LOD : 4.24	< LOD : 3.86	< LOD : 3.95	< LOD : 4.06	5.28
Se	< LOD : 3.17	< LOD : 3.02	< LOD : 2.97	< LOD : 2.84	< LOD : 2.85	< LOD : 2.86	< LOD : 3.18
As	< LOD : 3.41	< LOD : 3.57	< LOD : 3.24	< LOD : 3.03	< LOD : 3.07	< LOD : 3.12	< LOD : 3.19
Hg	< LOD : 6.51	7.02	< LOD : 6.10	< LOD : 5.88	< LOD : 5.84	< LOD : 6.00	< LOD : 6.30
Zn	7.78	< LOD : 6.48	7.07	< LOD : 6.11	< LOD : 6.02	< LOD : 6.43	14.93
Cu	18.64	< LOD : 12.69	< LOD : 12.95	< LOD : 12.37	< LOD : 12.38	< LOD : 12.22	< LOD : 12.96
Ni	55.37	53.86	41.51	17.51	17.01	31.41	70.07
Co	42.89	< LOD : 29.04	< LOD : 27.41	< LOD : 24.88	< LOD : 22.71	< LOD : 22.73	< LOD : 27.57
Fe	550.03	933.35	771.97	557.9	317.02	243.08	646.92
Mn	51.5	115.08	65.4	< LOD : 39.22	39.9	54.67	75.83
Cr	31.51	10.92	18.59	13.63	10.17	< LOD : 8.73	< LOD : 8.56
V	42.85	23.58	52.99	73.02	28.33	49.34	62.5
Ti	533.17	1690.25	758.75	1277.67	130.33	147.1	326
Sc	< LOD : 11.90	< LOD : 6.51	< LOD : 7.14	< LOD : 9.55	< LOD : 6.22	< LOD : 5.37	< LOD : 6.03
Ca	2814.08	330.01	385.2	782.04	390.39	152.5	310.04
K	4936.3	1016.51	5385.66	6247.91	2519.44	1158.79	2333.95
S	1235.4	1638.92	1025.13	4869.61	4309.57	853.86	814.21
Ba	554.22	408.8	595.85	400.38	210.58	293.83	662.08
Sb	30.9	30.2	18.49	< LOD : 9.50	< LOD : 9.42	21.69	31.42
Sn	30.21	26.48	17.11	< LOD : 9.51	< LOD : 9.28	14.37	28.87
Cd	10.66	12.93	< LOD : 8.61	< LOD : 8.72	< LOD : 8.54	< LOD : 8.52	12.22
Cs	62.24	53.77	38.23	< LOD : 7.83	8.5	29.46	74
Te	108.89	108.57	61.23	< LOD : 24.24	< LOD : 23.60	59.13	120.83
Al	28391.77	6661.16	16545.86	20949.03	7359.38	5065.3	9227.1
P	7409.07	< LOD : 409.45	< LOD : 413.21	663.88	< LOD : 420.64	< LOD : 417.39	< LOD : 414.16
Si	489695.47	548744.56	537993.75	532941.19	553073.56	569673.75	562467.56
Cl	< LOD : 36.94	140.72	95.45	131.75	658.26	164.57	143.54
Mg	< LOD : 2081.72	2061.69	4307.45	2909.88	3278.27	2521.22	3846.33

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property
SAMPLE	7011016	7011017	7011017	7011019*	7011019	7011021	7011021
Mo	< LOD : 2.93	< LOD : 2.83	< LOD : 2.78	< LOD : 2.65	< LOD : 2.91	< LOD : 2.91	< LOD : 2.78
Zr	8.04	7.8	8.35	9.72	20.78	14.21	9.96
Sr	9.77	11.69	8.12	5.53	9.39	8.56	7.64
U	< LOD : 4.13	< LOD : 3.87	< LOD : 3.87	< LOD : 3.58	< LOD : 4.20	< LOD : 4.19	< LOD : 3.88
Rb	5.71	5.19	5.03	6.09	10.76	7.87	5.97
Th	3.66	< LOD : 2.87	< LOD : 2.90	< LOD : 2.85	< LOD : 3.14	< LOD : 2.98	< LOD : 2.92
Pb	< LOD : 4.08	< LOD : 4.08	< LOD : 3.80	< LOD : 3.81	< LOD : 4.36	< LOD : 4.27	< LOD : 3.83
Au	< LOD : 4.46	< LOD : 4.21	< LOD : 4.05	< LOD : 3.86	< LOD : 4.45	6.13	< LOD : 4.28
Se	< LOD : 3.16	< LOD : 3.01	< LOD : 2.92	< LOD : 2.74	< LOD : 3.23	< LOD : 3.28	< LOD : 3.05
As	11.22	4.46	< LOD : 3.01	< LOD : 2.87	< LOD : 3.52	< LOD : 3.46	< LOD : 3.10
Hg	< LOD : 6.44	7.42	< LOD : 5.86	< LOD : 5.63	< LOD : 6.54	< LOD : 6.49	< LOD : 6.10
Zn	35.7	18.91	< LOD : 6.40	< LOD : 5.90	< LOD : 7.01	< LOD : 6.76	< LOD : 6.35
Cu	15.8	19.51	< LOD : 12.41	< LOD : 11.44	20.94	< LOD : 13.45	< LOD : 12.69
Ni	67.43	39.56	35.89	20.27	58.08	64.03	30.54
Co	< LOD : 60.71	< LOD : 30.05	< LOD : 22.83	< LOD : 20.91	34.41	26.96	< LOD : 24.39
Fe	10898.68	1125.5	181.96	188.31	483.3	323.89	352.36
Mn	89.56	41.73	< LOD : 40.57	< LOD : 37.46	60.38	84.97	< LOD : 40.83
Cr	< LOD : 8.94	11.02	< LOD : 8.64	< LOD : 9.05	< LOD : 8.75	< LOD : 8.77	< LOD : 8.92
V	61.48	19.11	45.93	37.96	77.33	57.03	44.66
Ti	152.91	81.62	163.13	58.03	620.59	279.12	270.64
Sc	< LOD : 5.69	< LOD : 26.50	< LOD : 5.22	< LOD : 5.05	< LOD : 5.16	< LOD : 5.96	< LOD : 6.02
Ca	165.01	13728.69	117.51	90.46	102.84	305.84	281.21
K	1289.71	1239.51	1184.48	773.49	3529.5	1850.58	2015.95
S	442.18	52443.28	< LOD : 114.23	1148.12	699.29	865.78	737.52
Ba	740.07	463.59	308.89	163.33	497.93	600.97	395.96
Sb	37.71	24.96	20.96	< LOD : 9.02	30.53	35.26	23.26
Sn	30.43	18.49	14.54	< LOD : 8.90	35.16	33.04	20.54
Cd	13.95	11.16	10.84	< LOD : 8.38	15.91	14.2	< LOD : 8.76
Cs	77.77	44.56	37.55	< LOD : 7.46	68.03	73.11	39.28
Te	127.36	95.91	79.72	< LOD : 23.08	120.31	122.62	70.2
Al	5113.11	6331.48	5155.57	4236.87	10264.07	6366.38	7922
P	< LOD : 390.58	597.33	< LOD : 413.71	< LOD : 427.87	< LOD : 394.49	< LOD : 419.20	< LOD : 414.74
Si	543987.56	441740.38	570940	576325.63	554175.44	576588.81	560813.25
Cl	113.34	243.5	188.06	291.96	340.44	< LOD : 33.88	131.09
Mg	< LOD : 3034.23	< LOD : 2712.76	2448.48	2523.59	2792.14	2951.43	3624.27

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property	Ren Property
SAMPLE	7011023	7011023	7011027	7011027	7011030	7011030	7011034
Mo	< LOD : 2.79	< LOD : 2.93	< LOD : 2.77	< LOD : 2.83	< LOD : 2.85	< LOD : 3.00	< LOD : 2.90
Zr	11.53	9.11	11.66	9.22	10.24	9.88	21.79
Sr	6.92	5.53	13.08	10.93	6.84	10.24	12.2
U	< LOD : 3.87	< LOD : 4.02	< LOD : 3.76	< LOD : 4.02	< LOD : 3.81	< LOD : 4.00	5.88
Rb	7.21	4.07	6.59	6.88	5.42	4.78	13.83
Th	< LOD : 2.94	< LOD : 3.04	< LOD : 2.71	< LOD : 2.95	< LOD : 2.94	< LOD : 2.98	3.94
Pb	< LOD : 4.03	4.65	< LOD : 3.40	< LOD : 3.92	< LOD : 3.92	< LOD : 3.86	< LOD : 4.30
Au	< LOD : 4.09	6.42	< LOD : 3.75	< LOD : 4.25	< LOD : 4.18	< LOD : 4.31	7.63
Se	< LOD : 2.91	< LOD : 3.35	< LOD : 2.74	< LOD : 3.06	< LOD : 2.93	< LOD : 3.12	< LOD : 3.19
As	< LOD : 3.14	< LOD : 3.47	< LOD : 2.73	< LOD : 3.13	< LOD : 3.07	< LOD : 3.07	< LOD : 3.36
Hg	6.39	< LOD : 6.42	< LOD : 5.77	6.71	< LOD : 6.10	< LOD : 6.37	< LOD : 6.41
Zn	12.28	9.17	< LOD : 6.11	< LOD : 6.52	7.82	< LOD : 6.71	7.14
Cu	< LOD : 12.44	< LOD : 13.34	< LOD : 11.63	15.54	< LOD : 12.64	< LOD : 13.70	< LOD : 12.94
Ni	31.19	63.13	< LOD : 16.36	58.51	40.19	< LOD : 18.41	54.44
Co	< LOD : 28.34	< LOD : 26.60	< LOD : 22.05	< LOD : 27.08	< LOD : 26.47	< LOD : 32.87	45.27
Fe	901.97	424.81	302.94	704.76	557.5	1218.57	759.87
Mn	52.43	92.53	< LOD : 36.96	80.87	59.3	< LOD : 40.86	105.3
Cr	13.14	< LOD : 8.51	< LOD : 8.71	< LOD : 9.41	13.2	< LOD : 8.04	9.55
V	33.27	58.73	51.11	59.49	23.67	52.72	71.75
Ti	234.43	214.26	255.04	274.43	162.95	192.4	696.86
Sc	< LOD : 5.51	< LOD : 5.84	< LOD : 5.50	< LOD : 7.49	< LOD : 4.61	< LOD : 4.71	< LOD : 6.17
Ca	134.48	287.52	236.65	533.97	78.88	95.11	197.85
K	1920.08	1213.76	1676.64	2247.06	1259.04	1214.07	5029.32
S	< LOD : 134.36	533.87	933.14	3454.2	479.32	1088.05	822.54
Ba	362.19	489.04	206.84	543.72	372.69	207.52	819.18
Sb	22.99	39.53	< LOD : 9.07	38.6	28.46	< LOD : 9.79	45.78
Sn	15.52	35.56	< LOD : 8.81	33.96	23.9	< LOD : 9.53	42.57
Cd	< LOD : 8.71	19.74	< LOD : 7.12	17.82	12.22	< LOD : 8.63	20.2
Cs	35.53	77.76	< LOD : 7.37	76.82	51.23	< LOD : 8.07	91.42
Te	65.7	136.7	< LOD : 22.76	153.84	97.26	< LOD : 24.75	164.4
Al	5983.57	6886.98	7856.91	10274.26	4669.23	6411.1	12412.48
P	< LOD : 410.32	< LOD : 413.05	< LOD : 430.57	< LOD : 405.58	< LOD : 428.72	< LOD : 515.11	< LOD : 411.21
Si	564263.56	573795.38	583229.13	556079.56	565307.38	640636.81	556251.5
Cl	154.58	< LOD : 32.94	343.05	92.21	178.7	223.53	609.85
Mg	< LOD : 1988.68	2696.58	5812.04	2819.92	2512.95	< LOD : 3553.83	4037.97

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren Property	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7011034	7021448	7021448	7021452	7021452	7021455	7021455
Mo	< LOD : 2.83	< LOD : 2.79	< LOD : 2.80	< LOD : 2.87	< LOD : 2.83	< LOD : 3.01	< LOD : 2.88
Zr	32.58	31.63	11.85	17.11	11.41	53.5	39
Sr	13.98	26.31	26.74	35.78	25.63	36.46	41.16
U	< LOD : 4.38	< LOD : 3.80	< LOD : 3.98	< LOD : 4.06	< LOD : 4.15	< LOD : 4.19	5.39
Rb	17.84	8.25	5.95	9.19	7.38	7.36	10.57
Th	< LOD : 2.98	< LOD : 2.70	< LOD : 2.91	< LOD : 2.98	< LOD : 3.05	< LOD : 3.08	3.58
Pb	< LOD : 3.82	< LOD : 3.55	9.8	< LOD : 3.88	< LOD : 4.20	< LOD : 4.33	< LOD : 4.07
Au	< LOD : 3.85	< LOD : 3.87	< LOD : 4.18	< LOD : 4.11	< LOD : 4.42	6.92	< LOD : 4.21
Se	< LOD : 2.84	< LOD : 2.84	< LOD : 2.98	< LOD : 2.90	< LOD : 3.07	< LOD : 3.34	< LOD : 3.11
As	< LOD : 3.15	< LOD : 2.82	< LOD : 3.56	< LOD : 3.12	< LOD : 3.24	< LOD : 3.40	< LOD : 3.33
Hg	7.86	< LOD : 5.82	< LOD : 6.19	< LOD : 5.90	6.89	< LOD : 6.71	< LOD : 6.19
Zn	< LOD : 6.46	< LOD : 5.92	< LOD : 6.68	< LOD : 6.35	10.26	< LOD : 7.03	< LOD : 6.62
Cu	< LOD : 12.64	< LOD : 12.16	< LOD : 12.65	< LOD : 12.45	14.13	19.36	< LOD : 13.10
Ni	39.03	< LOD : 16.47	51.49	35.28	67.71	58.11	74.87
Co	< LOD : 33.23	< LOD : 22.41	< LOD : 26.28	< LOD : 29.48	< LOD : 29.75	32.3	< LOD : 31.36
Fe	1499.43	319.73	620.61	1134.3	923.97	571.03	1203.89
Mn	45.98	< LOD : 37.34	67.2	51.02	74.41	97.25	77.97
Cr	18.48	< LOD : 8.76	< LOD : 8.88	< LOD : 9.03	< LOD : 8.45	< LOD : 8.78	< LOD : 9.12
V	58.96	53.16	67.14	74.49	45.83	57.56	114.1
Ti	860.96	228.91	424.57	553.63	368.49	259	816.45
Sc	< LOD : 6.26	< LOD : 6.09	< LOD : 7.76	< LOD : 10.84	< LOD : 6.65	< LOD : 6.74	< LOD : 8.08
Ca	196.65	310.08	675.25	1786.57	378.55	426.79	652.13
K	5636.17	2077.57	2505.46	2832.45	2609.52	2192.2	5138.88
S	1010.77	1298.13	6989.73	4637.53	9331.58	1327.91	4234.48
Ba	475.2	100.75	331.63	471.73	606.49	591.13	501.6
Sb	20.81	< LOD : 9.16	16.26	18.4	42.81	35.74	27.8
Sn	11.8	< LOD : 9.03	19.81	14.72	38.03	35.09	31.32
Cd	< LOD : 8.80	8.91	9.54	< LOD : 8.76	20.24	13.18	11.66
Cs	31.46	< LOD : 7.51	40.98	24.42	79.27	75.32	57.02
Te	41.51	< LOD : 23.39	71.29	52.3	146.49	125.96	89.22
Al	16172.27	9665.13	14174.24	12635.41	9100.12	9030.52	18166.85
P	< LOD : 421.37	< LOD : 414.13	< LOD : 420.29	859.06	< LOD : 396.82	< LOD : 398.19	< LOD : 401.47
Si	559380.75	570446.19	553137.13	549517.63	521506.5	557023.56	533502.38
Cl	269.82	150.06	84.56	175.03	159.83	276.71	98.06
Mg	4952.28	< LOD : 3210.69	3631.9	3420.18	< LOD : 2891.10	2949.63	4418.53

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Slaven
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Barite Pit
SAMPLE	7021459*	7021459	14VC-HS001	14VC-HS001	14VC-OC001	14VC-OC004	6301234
Mo	< LOD : 2.91	< LOD : 2.86	< LOD : 3.28	< LOD : 3.41	10.44	< LOD : 3.35	< LOD : 2.92
Zr	17.84	19.13	19.46	20.94	16.84	22.36	9.43
Sr	125.45	155.39	29.14	47.4	20.89	36.8	29.79
U	< LOD : 4.49	< LOD : 4.54	< LOD : 4.80	< LOD : 5.46	10.63	< LOD : 5.21	< LOD : 4.18
Rb	7.3	5.96	11.95	10.32	7.02	7.17	7.38
Th	4.31	3.77	< LOD : 3.33	< LOD : 3.58	< LOD : 3.66	5.12	3.29
Pb	< LOD : 4.37	< LOD : 4.10	< LOD : 5.33	12.91	42	< LOD : 5.64	5.05
Au	< LOD : 4.25	< LOD : 4.35	< LOD : 6.05	< LOD : 6.44	< LOD : 6.60	9.22	< LOD : 4.54
Se	< LOD : 3.16	< LOD : 3.13	< LOD : 3.60	< LOD : 3.66	7.39	< LOD : 3.99	< LOD : 3.29
As	< LOD : 3.48	< LOD : 3.29	< LOD : 4.35	< LOD : 5.45	19.44	5.73	< LOD : 3.48
Hg	< LOD : 6.29	< LOD : 6.11	< LOD : 7.01	< LOD : 7.60	< LOD : 7.47	< LOD : 7.92	7.93
Zn	< LOD : 6.48	< LOD : 6.56	< LOD : 8.30	< LOD : 9.20	11.56	< LOD : 9.03	12.44
Cu	< LOD : 13.26	< LOD : 12.63	< LOD : 14.61	30.44	69.05	24.58	15.91
Ni	59.1	42.06	41.15	85.96	66.89	69.51	52.95
Co	< LOD : 44.02	< LOD : 26.80	< LOD : 30.62	< LOD : 149.84	< LOD : 78.46	< LOD : 57.49	< LOD : 35.47
Fe	3761.1	605.7	787.17	52196.58	16898.18	5462.72	1756.34
Mn	81.83	80.1	113.53	158.3	133.38	136.93	128.39
Cr	30.68	14.99	< LOD : 9.69	< LOD : 26.25	194.87	< LOD : 11.79	16.56
V	81.13	85.76	< LOD : 31.79	166.6	973.47	73.19	27.65
Ti	583.18	622.05	454.92	982.91	792.76	634.88	146.71
Sc	< LOD : 31.00	< LOD : 9.95	< LOD : 9.65	< LOD : 29.11	< LOD : 11.17	< LOD : 11.53	< LOD : 12.17
Ca	14419.27	534.24	963.08	958.83	1116.6	933.66	2326.95
K	8148.91	3396.62	2950.36	19439.71	4527.88	10490.47	1813.38
S	27465.94	2416.51	2906.62	73145.08	8364.68	10724.32	1220.99
Ba	1132.76	1213.42	898.22	1101.59	832.34	1171.59	824.38
Sb	29.73	23.1	63.78	74.46	79.95	65.08	35.1
Sn	31.17	21.62	37.43	68.09	76.28	56.32	25.64
Cd	12.05	< LOD : 8.56	24.34	33.29	23.47	34.99	15.98
Cs	61.98	49.36	105.56	139.74	130.07	134.77	64.34
Te	106.86	75.37	183.98	233.59	251.07	215.43	119.22
Al	23210.96	18903.77	13483.15	24926.5	7775.75	54035.13	6712.51
P	4019.02	4337.51	< LOD : 779.60	< LOD : 1021.52	7626.36	< LOD : 1007.59	925.61
Si	375643.81	550787.25	349667.63	147619.91	259686.47	342608.56	537717.5
Cl	< LOD : 41.43	401.75	118.85	< LOD : 60.17	79.44	< LOD : 59.15	204
Mg	2638.62	5434.54	< LOD : 5249.36	< LOD : 7211.45	< LOD : 4476.96	9454.3	< LOD : 3247.49

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Barite Pit	Barite Pit	Barite Pit	Barite Pit	Barite Pit	Mary's Mtn	Mary's Mtn
SAMPLE	6301234	6301237*	6301237	6301250	6301250	7020949	7020949
Mo	< LOD : 2.95	< LOD : 2.96	< LOD : 2.87	< LOD : 3.38	< LOD : 2.87	< LOD : 2.98	< LOD : 2.93
Zr	17.2	12.16	15.38	23.25	11.38	31.03	17.71
Sr	89.63	62.63	40.59	149.58	33.09	28.63	68.33
U	< LOD : 4.28	< LOD : 4.60	< LOD : 4.45	10.09	< LOD : 4.16	< LOD : 4.04	< LOD : 4.04
Rb	6.95	12.27	15.08	8.14	10.1	10.31	3.36
Th	< LOD : 2.86	< LOD : 3.18	< LOD : 3.13	6.71	< LOD : 3.03	< LOD : 2.73	< LOD : 2.69
Pb	< LOD : 4.09	< LOD : 4.43	< LOD : 4.16	9.17	< LOD : 4.26	< LOD : 3.60	< LOD : 3.60
Au	< LOD : 3.83	< LOD : 4.46	< LOD : 4.34	10.78	< LOD : 4.34	< LOD : 3.83	< LOD : 3.86
Se	< LOD : 2.78	< LOD : 3.17	< LOD : 3.12	< LOD : 3.99	< LOD : 3.12	< LOD : 2.82	< LOD : 2.86
As	< LOD : 3.22	3.9	< LOD : 3.32	< LOD : 4.40	< LOD : 3.23	3.53	4.53
Hg	< LOD : 6.04	< LOD : 6.68	< LOD : 6.46	8.59	< LOD : 6.32	< LOD : 5.98	< LOD : 6.22
Zn	7.58	25.11	8.89	18.71	< LOD : 6.70	< LOD : 6.61	< LOD : 6.58
Cu	< LOD : 13.23	17.33	< LOD : 13.28	37.05	< LOD : 13.20	13.49	< LOD : 13.43
Ni	< LOD : 17.01	77.72	31.83	147.43	44.77	< LOD : 16.81	< LOD : 17.42
Co	< LOD : 37.68	< LOD : 53.92	< LOD : 39.36	63.68	< LOD : 40.79	< LOD : 33.45	< LOD : 50.00
Fe	2232.09	5622.39	2587.62	1953.08	2632.47	1928.58	4530.83
Mn	66.96	485.29	69.62	349.28	360.02	< LOD : 36.47	199.62
Cr	15.6	28.36	25.79	69.3	21.45	15.82	< LOD : 9.70
V	68.54	87.76	48.75	65.42	42.83	32.88	32.33
Ti	334.37	968.22	391.55	< LOD : 147.84	334.67	227.05	61.77
Sc	< LOD : 11.98	< LOD : 14.23	< LOD : 8.85	< LOD : 15.75	< LOD : 15.45	< LOD : 10.51	< LOD : 39.61
Ca	2131.61	1918.05	940.72	2736.13	3382.76	1782.13	28101.9
K	2449.22	7770.1	3186.31	2460.46	2651.03	3254.14	1564.6
S	1394.64	5345.42	788.46	5666.61	2399.67	2701.55	12116.69
Ba	730.02	996.14	618.54	11039.51	534.94	163.18	< LOD : 30.24
Sb	< LOD : 8.85	31.87	23.67	29.3	28.56	< LOD : 8.97	< LOD : 9.47
Sn	< LOD : 8.53	38.89	16.46	15.49	21.07	< LOD : 8.71	< LOD : 9.12
Cd	< LOD : 8.05	20.4	< LOD : 9.02	< LOD : 10.53	13.51	< LOD : 8.33	< LOD : 8.46
Cs	< LOD : 7.35	85.4	37.65	104.4	47.29	< LOD : 7.44	< LOD : 7.71
Te	< LOD : 22.49	163.3	70.87	111.83	69.12	< LOD : 22.92	< LOD : 23.55
Al	9614	28816.13	10564.91	9223.45	9022.58	7922.97	5181.42
P	< LOD : 512.79	850.05	< LOD : 394.52	1267.72	< LOD : 405.12	< LOD : 460.25	< LOD : 445.20
Si	605067.25	414404.78	517731.25	540380.25	527464	582040.31	517184.91
Cl	400.47	159.31	206.51	173.78	213.29	485.47	299.42
Mg	4874.99	3317.74	3394.97	3300.92	3172.6	< LOD : 2351.45	5943.31

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	7020953	7020953	7020957	7020957	14MM-CH006	14MM-CH007	14MM-CH007*
Mo	< LOD : 2.84	< LOD : 2.88	< LOD : 2.91	< LOD : 2.96	< LOD : 3.24	< LOD : 3.46	< LOD : 3.27
Zr	27.18	12.54	37.93	42.94	12.9	81.35	36.66
Sr	15.89	11.08	23.42	18.36	12.03	33.42	19.74
U	< LOD : 3.87	< LOD : 3.97	< LOD : 4.28	< LOD : 4.27	< LOD : 4.43	< LOD : 6.03	< LOD : 4.93
Rb	9.37	7.1	11.03	11.12	5.7	20.84	13.76
Th	< LOD : 2.80	< LOD : 2.88	< LOD : 3.01	3.54	< LOD : 3.21	5.82	< LOD : 3.38
Pb	< LOD : 3.94	< LOD : 3.97	7.19	< LOD : 4.33	9.62	< LOD : 5.84	10.04
Au	< LOD : 4.03	< LOD : 4.20	< LOD : 4.23	4.8	6.75	< LOD : 6.56	7.07
Se	< LOD : 3.01	< LOD : 3.21	< LOD : 3.10	< LOD : 3.24	< LOD : 3.61	< LOD : 3.74	3.94
As	< LOD : 3.08	< LOD : 3.22	< LOD : 3.67	< LOD : 3.36	< LOD : 4.65	< LOD : 4.81	< LOD : 4.83
Hg	< LOD : 6.00	< LOD : 6.24	< LOD : 6.17	< LOD : 6.26	< LOD : 7.16	10.94	< LOD : 7.29
Zn	6.93	< LOD : 6.66	42.78	23.19	18.56	32.53	13.69
Cu	< LOD : 13.11	24.71	35.49	37.83	27.38	60.56	58.63
Ni	18.93	40.98	61.24	50.07	49.34	81.82	81.95
Co	< LOD : 30.06	44.03	< LOD : 46.12	< LOD : 33.10	55.33	< LOD : 48.74	< LOD : 57.50
Fe	1210.24	3169	3937.66	1442.75	1186.47	3374.02	6062.16
Mn	< LOD : 37.70	51.29	82.47	72.78	125.66	133.36	98.36
Cr	< LOD : 8.30	16.79	29.26	22.34	< LOD : 8.84	< LOD : 11.59	< LOD : 13.21
V	88.22	44.03	104.56	83.46	< LOD : 15.69	144.19	108.49
Ti	261.97	145.31	1039.15	569.62	102.96	1015.73	335.71
Sc	< LOD : 5.67	< LOD : 5.82	< LOD : 8.50	< LOD : 6.53	< LOD : 7.71	< LOD : 10.06	< LOD : 10.82
Ca	325.1	185.69	352	312.42	810.45	671.15	691.65
K	2794.73	1694.37	4261.18	4679.12	1670.36	14073.34	3678.6
S	3444.04	7337.79	1245.48	700.61	2320.76	965.94	4570.08
Ba	141.9	238.63	742.74	517.67	488.02	892.85	548.01
Sb	< LOD : 9.38	19.81	12.62	33.44	57.84	58.67	54.34
Sn	< LOD : 17.05	19.51	9.85	27.77	64.23	66.88	48.37
Cd	< LOD : 8.58	13.29	< LOD : 8.58	8.91	19.36	23.38	21.07
Cs	< LOD : 7.71	44.19	36.52	64.72	105.58	116.15	92.66
Te	< LOD : 23.70	84.12	46.38	109.98	178.08	166.4	156.37
Al	10000.52	5058.52	9713.74	10741.66	2575.44	20614.1	4411.38
P	484.89	< LOD : 650.25	6439.46	742.58	< LOD : 993.57	< LOD : 837.78	2493.32
Si	599552.94	561429.25	533460.31	563693.25	517777.94	487501.91	415440.19
Cl	853.28	329.31	275.24	209.29	445.74	788.47	315.97
Mg	< LOD : 3052.49	2800.73	2942.19	3229.25	< LOD : 6149.58	5094.85	< LOD : 4424.88

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	14MM-CH008	14MM-CH008	14MM-CH009	14MM-CH009	14MM-CHOC008	14MM-CHOC009	14MM-CHOC010
Mo	< LOD : 3.23	< LOD : 3.38	< LOD : 3.21	< LOD : 3.24	< LOD : 3.42	< LOD : 3.30	< LOD : 3.59
Zr	31.61	43.98	14.51	15.83	13.19	37.85	31.44
Sr	26.12	20.33	13.82	14.41	59.46	22.71	19.94
U	< LOD : 4.65	< LOD : 5.18	< LOD : 4.54	< LOD : 4.53	< LOD : 4.99	< LOD : 5.00	< LOD : 5.24
Rb	9.46	8.43	5.63	8.59	6.7	12.98	11.23
Th	< LOD : 3.30	< LOD : 3.50	< LOD : 3.28	< LOD : 3.41	< LOD : 3.51	< LOD : 3.43	4.31
Pb	6.45	< LOD : 5.92	5.79	5.82	< LOD : 5.77	< LOD : 5.25	9.86
Au	< LOD : 6.12	< LOD : 6.51	8.07	< LOD : 6.35	7.39	7.72	< LOD : 6.81
Se	< LOD : 3.54	< LOD : 3.84	< LOD : 3.65	< LOD : 3.62	< LOD : 3.94	< LOD : 3.65	< LOD : 4.01
As	< LOD : 4.50	5.39	6.62	11.1	5.66	4.52	< LOD : 5.40
Hg	< LOD : 7.18	< LOD : 8.18	< LOD : 7.46	< LOD : 7.24	< LOD : 7.89	< LOD : 7.08	< LOD : 8.16
Zn	18.57	327.73	19.03	30.79	29.45	28.58	94.66
Cu	18.98	200.39	27.47	32.8	42.32	49.25	110.06
Ni	53.31	252.49	44.98	62.88	59.92	61.66	58.6
Co	< LOD : 36.19	134.94	< LOD : 48.61	< LOD : 85.19	< LOD : 111.99	< LOD : 55.72	< LOD : 60.70
Fe	1505.42	3736.5	3443.34	21214.58	32323.73	5594.08	5242.13
Mn	143.28	1993.77	132.01	160.09	216.18	124.36	279.16
Cr	< LOD : 9.62	< LOD : 12.72	< LOD : 10.48	< LOD : 17.58	< LOD : 17.68	< LOD : 12.78	146.48
V	34.07	76.65	< LOD : 22.98	43.96	131.07	48.55	< LOD : 31.27
Ti	235.41	586.14	197.2	199.27	392.83	360.74	500.5
Sc	< LOD : 11.54	24.67	< LOD : 8.21	< LOD : 15.91	< LOD : 18.63	< LOD : 10.01	< LOD : 9.00
Ca	1842.48	3662.64	556.05	268.16	1055.27	371.73	1238.24
K	5359.2	5039.99	2836.84	14145.52	15619.56	5880.89	4885.3
S	2534.89	2058.79	4498.77	63900.55	36000.03	1513.03	1456.44
Ba	669.28	641.79	534.94	595.37	628.46	877.49	596.26
Sb	52.94	54.53	62.23	67.32	64.05	83.93	66.06
Sn	53.39	57.3	52.14	56.91	59.72	82.1	56.48
Cd	19.43	22.78	15.04	22.12	28.58	27.17	31.22
Cs	104.53	103.17	112.59	122.82	129.46	148.98	105.19
Te	172.28	173.77	195.87	211.13	224.58	252.84	194.97
Al	18258.77	11621.01	6391.08	6999.35	11368.14	12300.54	23092.39
P	< LOD : 803.41	2425.22	955.49	7223.33	7790.69	5965.17	3062.07
Si	456578.91	387505.03	448908.34	207727.56	127489.3	269286.22	343456.47
Cl	281.1	136.77	384.24	702.83	95.04	441.38	102.9
Mg	6655.03	< LOD : 6754.67	< LOD : 6589.48	< LOD : 6240.13	< LOD : 5818.13	< LOD : 3757.49	< LOD : 7067.29

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Slaven Canyon	Slaven Canyon	Slaven Canyon	Slaven Canyon	Slaven Canyon	Slaven Canyon	Vinini Creek
SAMPLE	6301134	6301134	6301138	6301138	6301150	6301150	7021426
Mo	< LOD : 3.00	< LOD : 2.89	< LOD : 2.92	< LOD : 2.90	< LOD : 2.88	< LOD : 2.89	< LOD : 3.04
Zr	34.65	40.93	32.02	28.82	30.39	16.68	42.61
Sr	25.74	25.31	24.08	32.22	31.79	23.44	102.22
U	< LOD : 4.53	< LOD : 4.46	4.88	< LOD : 4.20	< LOD : 3.90	< LOD : 4.08	< LOD : 4.39
Rb	14.29	17.55	12.21	14.9	8.57	12.1	7.92
Th	4.87	4.48	< LOD : 3.08	< LOD : 3.09	< LOD : 2.87	< LOD : 2.96	< LOD : 3.03
Pb	< LOD : 4.07	< LOD : 4.27	< LOD : 4.25	< LOD : 4.23	5.58	< LOD : 4.01	< LOD : 3.88
Au	< LOD : 4.54	< LOD : 4.10	< LOD : 4.35	5.81	< LOD : 4.23	< LOD : 4.25	< LOD : 3.95
Se	< LOD : 3.25	< LOD : 2.96	< LOD : 3.20	< LOD : 3.15	< LOD : 3.03	< LOD : 2.97	3.69
As	5.68	< LOD : 3.36	< LOD : 3.45	< LOD : 3.20	7.81	< LOD : 3.21	< LOD : 3.05
Hg	< LOD : 6.65	< LOD : 6.25	< LOD : 6.31	< LOD : 6.33	< LOD : 6.23	< LOD : 6.22	< LOD : 6.01
Zn	35.34	23.56	22.9	14	43.78	13.69	12.47
Cu	23.6	28	23.24	18.64	21	< LOD : 13.04	31.76
Ni	51.65	45.06	50.01	45.26	29.34	28.7	< LOD : 17.52
Co	< LOD : 44.63	65.33	< LOD : 36.13	< LOD : 32.85	< LOD : 38.24	< LOD : 35.32	< LOD : 36.28
Fe	3431.19	1336.78	1919.54	1409.98	2469.36	1893.96	2020.17
Mn	119.21	973.84	93.06	72.48	199.63	60.52	< LOD : 38.96
Cr	14.48	24.38	22.45	< LOD : 9.16	22.84	23.98	28.55
V	58.98	49.76	48.94	61.58	68.63	28.62	69.05
Ti	847.74	903.13	741.19	597.81	586	420.84	468.8
Sc	< LOD : 10.79	< LOD : 12.24	< LOD : 9.06	< LOD : 10.39	< LOD : 12.23	< LOD : 8.64	< LOD : 7.91
Ca	932.97	1864.48	1004.69	1529.85	2097.66	823.69	514.33
K	6668.33	6745.7	4513.44	4404.54	3817.73	3503.75	3030.11
S	3089.14	827.97	356.84	571.38	2014.11	1367.56	3030.96
Ba	532.18	474.36	607.97	639.17	378.56	387.5	608.89
Sb	32.58	23.8	28.27	21.53	10.31	17.31	< LOD : 9.04
Sn	32.34	23.43	25.88	18.4	12.45	17.89	< LOD : 8.78
Cd	12.55	10.3	12.67	< LOD : 8.64	< LOD : 8.59	11.82	< LOD : 8.40
Cs	67.37	50.66	57.51	36.1	28.87	30.77	< LOD : 7.51
Te	108.45	79.03	93.3	62.8	44.56	74.13	< LOD : 22.69
Al	14332.6	16148.58	11689.12	11859.67	13416.37	11667.01	10365.71
P	< LOD : 373.00	< LOD : 373.00	< LOD : 399.03	< LOD : 402.90	< LOD : 393.81	< LOD : 389.93	< LOD : 474.48
Si	516042.81	484505.72	531116.81	544334.88	510551.34	529535	585016.06
Cl	78	192.54	157.99	180.06	223.65	217.71	819.87
Mg	2812.99	3415.02	3196.27	2396.13	3874.47	4663.17	3399.75

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7021426	7021430	7021430	7021435	7021435*	14VC-HS002	14VC-HS002
Mo	< LOD : 2.92	< LOD : 2.93	< LOD : 2.93	3.36	< LOD : 2.92	< LOD : 3.49	< LOD : 3.50
Zr	25.29	26.55	31.8	28.84	14.14	10.06	137.29
Sr	37.41	21.98	32.73	31.62	18.44	18.85	60.09
U	< LOD : 4.01	5.2	< LOD : 4.26	< LOD : 4.07	< LOD : 4.02	< LOD : 4.89	< LOD : 5.31
Rb	6	3.48	6.07	7.36	5.1	< LOD : 2.22	10.55
Th	< LOD : 2.91	< LOD : 3.06	4.68	< LOD : 2.99	4.58	< LOD : 3.48	< LOD : 3.34
Pb	< LOD : 4.10	< LOD : 4.40	< LOD : 4.38	< LOD : 4.19	< LOD : 4.41	9.28	9.5
Au	< LOD : 4.28	5.8	4.92	< LOD : 4.35	< LOD : 4.45	< LOD : 6.88	< LOD : 6.37
Se	< LOD : 3.21	< LOD : 3.37	< LOD : 3.30	11.26	6.89	7.42	< LOD : 3.74
As	< LOD : 3.28	< LOD : 3.43	< LOD : 3.36	3.63	< LOD : 3.44	6.42	< LOD : 4.66
Hg	< LOD : 6.32	< LOD : 6.55	< LOD : 6.32	< LOD : 6.14	< LOD : 6.18	< LOD : 7.71	< LOD : 7.23
Zn	< LOD : 6.87	< LOD : 6.68	< LOD : 6.69	7.23	< LOD : 6.65	< LOD : 9.06	< LOD : 8.58
Cu	16.52	21.24	13.92	21.53	17.52	< LOD : 16.40	20.71
Ni	72.46	49.61	81.31	35.46	61.86	38.31	49.12
Co	34.58	42.38	< LOD : 36.68	< LOD : 38.69	42.27	< LOD : 56.03	< LOD : 35.71
Fe	869.11	1009.12	1918.45	2357.33	1836.79	4856.73	1559.51
Mn	93.12	107.7	80.3	< LOD : 40.04	94.77	85.06	128.27
Cr	< LOD : 7.62	< LOD : 9.75	< LOD : 10.27	23.23	< LOD : 9.05	< LOD : 11.63	< LOD : 10.16
V	77.11	77.41	110.91	217.88	86.24	354.54	155.56
Ti	202.48	140.46	391.2	428.57	89.26	215.62	988.48
Sc	< LOD : 8.45	< LOD : 8.55	< LOD : 10.73	< LOD : 10.12	< LOD : 8.26	< LOD : 10.21	< LOD : 10.53
Ca	1244.48	812.2	1249.73	1623.36	846.51	596.03	1299.42
K	1842.82	1236.82	4271.26	3194.99	1317.94	5050.96	4008.41
S	4595.91	2928.43	10505.53	5275.27	4511.53	19150.79	1332.24
Ba	628.12	657.49	857.05	341.97	423.46	756.96	1010.44
Sb	29.14	37.12	33.31	< LOD : 9.89	36.16	63.16	51.2
Sn	17.64	35.02	30.35	13.28	29.2	54.27	43.15
Cd	< LOD : 9.55	17.54	9.67	< LOD : 9.10	16.37	23.91	20.5
Cs	40.9	76.69	65.73	9.86	60.12	111.52	107.01
Te	81.31	120.09	113.73	< LOD : 24.55	103.02	192.3	166.36
Al	9970.28	4962.42	10799.57	9847.18	4769.43	7490.92	21179.34
P	< LOD : 483.57	< LOD : 410.17	1227.24	< LOD : 631.93	< LOD : 426.15	3588.86	< LOD : 941.99
Si	548828.44	562887.56	566801	534609.13	565038.5	377332.69	463567.59
Cl	926.25	285.86	450.21	297.48	154.79	220.89	487.52
Mg	< LOD : 2061.53	4016.22	4685.34	2951.34	2531	< LOD : 5952.01	7109.04

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14VC-HS003	14VC-HS003	14VC-HS004	14VC-HS004	14VC-OC005	14VC-OC007
Mo	< LOD : 3.14	< LOD : 3.24	< LOD : 3.59	< LOD : 3.78	4.49	< LOD : 3.62
Zr	36.73	35.14	33.88	24.5	33.58	59.45
Sr	33.58	32.32	40.22	53.47	42.13	47.1
U	< LOD : 4.53	< LOD : 4.65	< LOD : 5.41	5.99	< LOD : 5.97	< LOD : 5.76
Rb	8.32	9.56	5.39	4.84	10.14	9.62
Th	< LOD : 3.24	3.55	< LOD : 3.73	4.43	5.62	< LOD : 3.62
Pb	< LOD : 5.43	6.8	11.76	< LOD : 6.58	< LOD : 7.09	< LOD : 6.01
Au	7.88	< LOD : 6.11	< LOD : 6.99	< LOD : 7.59	< LOD : 7.87	< LOD : 6.92
Se	3.77	3.86	5.02	4.92	< LOD : 4.81	< LOD : 3.87
As	6.25	< LOD : 4.70	< LOD : 5.37	7.59	< LOD : 5.92	< LOD : 4.67
Hg	< LOD : 7.07	< LOD : 7.00	< LOD : 7.68	< LOD : 8.39	< LOD : 9.49	< LOD : 8.22
Zn	< LOD : 8.49	< LOD : 8.31	< LOD : 9.46	13.59	< LOD : 14.56	< LOD : 9.23
Cu	22.21	17.04	< LOD : 16.41	40.54	40.37	< LOD : 16.46
Ni	66.17	53.07	34.27	93.83	< LOD : 28.70	58.12
Co	< LOD : 36.47	52.97	< LOD : 40.91	< LOD : 146.77	57.19	36.93
Fe	1831.69	2155.02	1819.32	44393.5	2685.24	593.82
Mn	128.66	123.78	130.18	164.53	133.12	135.42
Cr	< LOD : 9.68	< LOD : 11.02	< LOD : 8.71	184.94	179.32	< LOD : 7.20
V	101.93	124.99	30.3	479.35	60.4	16.9
Ti	579.67	317.89	429.09	2112.14	157.15	244.96
Sc	< LOD : 8.74	< LOD : 8.91	< LOD : 7.29	< LOD : 27.72	< LOD : 8.58	< LOD : 4.54
Ca	745.59	599.59	528.92	2069.5	1193.53	139.39
K	3920.3	2192.81	2415.86	18803.05	1984.18	1667.26
S	2596.72	1567.3	1259.42	45535.26	12064.87	< LOD : 109.73
Ba	1022.4	896.69	991.8	1383.56	1102.42	1001.97
Sb	58.53	47.63	62.24	70.43	76.08	59.62
Sn	46.34	47.04	54.37	66.47	59.92	55.44
Cd	17.38	20.36	20.28	27.63	34.79	15.38
Cs	114.72	108.42	117.38	135.04	136.22	106.32
Te	183.19	174.19	200.81	222.94	268.86	157.93
Al	17891.41	13749.02	8628.15	33637.71	6636.61	8404.5
P	1066.53	< LOD : 1112.17	< LOD : 895.31	6887.77	4746.98	< LOD : 923.28
Si	447015.75	509868.97	423144.41	225540.41	332285.31	481537.13
Cl	< LOD : 60.91	156.1	194.12	< LOD : 70.28	310.9	188.48
Mg	< LOD : 4843.43	5143.62	< LOD : 4930.19	8054.95	< LOD : 6220.90	< LOD : 8441.03

Appendix 3: Summary Statistics *in situ* pXRF with <LOD Replaced by Half

	Cherry Spring						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	38	1.31	7.65	1.99	1.57	1.73	1.32
Zr_ppm	38	1.09	52.73	15.34	11.59	186.53	13.66
Sr_ppm	38	16.16	284.22	67.39	55.13	3412.31	58.41
U_ppm	38	1.81	14.70	3.21	2.51	5.07	2.25
Rb_ppm	38	0.87	21.53	7.66	7.04	17.66	4.20
Th_ppm	38	1.43	7.85	2.44	1.75	2.20	1.48
Pb_ppm	38	2.01	427.42	31.44	15.56	5439.66	73.75
Au_ppb	38	1.98	10.54	3.31	2.30	4.21	2.05
Se_ppm	38	1.42	2.64	1.77	1.69	0.08	0.29
As_ppm	38	1.60	87.06	10.43	5.20	257.27	16.04
Hg_ppm	38	2.95	9.81	3.95	3.38	2.26	1.50
Zn_ppm	38	3.13	657.03	63.66	4.15	21860.80	147.85
Cu_ppm	38	6.17	171.85	23.11	8.40	909.27	30.15
Ni_ppm	38	8.32	427.84	73.71	58.28	5466.49	73.94
Co_ppm	38	12.88	126.79	42.06	29.80	1112.10	33.35
Fe_ppm	38	597.58	140657.31	19710.28	3997.26	1075197652.23	32790.21
Mn_ppm	38	19.23	65618.38	3903.70	148.29	165894081.22	12879.99
Cr_ppm	38	3.92	215.53	25.87	9.56	2079.51	45.60
V_ppm	38	11.55	1284.98	148.97	73.50	56870.30	238.47
Ti_ppm	38	20.21	2820.60	547.17	323.05	414824.76	644.07
Sc_ppm	38	2.86	31.79	7.67	4.40	47.78	6.91
Ca_ppm	38	115.91	30545.88	1859.50	555.60	24665915.69	4966.48
K_ppm	38	572.17	17113.43	4641.29	3596.20	15929039.49	3991.12
S_ppm	38	99.13	101963.98	10014.76	1836.66	456851181.31	21374.08
Ba_ppm	38	335.70	2694.61	947.17	762.99	275441.55	524.83
Sb_ppm	38	4.62	107.47	40.52	28.85	958.19	30.95
Sn_ppm	38	4.50	109.04	35.26	24.33	715.02	26.74
Cd_ppm	38	3.78	53.43	16.41	12.12	193.64	13.92
Cs_ppm	38	3.78	266.58	81.24	59.36	4039.04	63.55
Te_ppm	38	11.67	495.88	138.60	101.03	13010.28	114.06
Al_ppm	38	952.17	61102.33	11438.97	6511.66	174275888.10	13201.36
P_ppm	38	183.70	17263.11	1441.61	399.66	9438886.21	3072.28
Si_ppm	38	42482.62	608662.13	431556.90	510854.88	25982989427.26	161192.40
Cl_ppm	38	16.74	1521.10	367.01	297.23	105506.53	324.82
Mg_ppm	38	967.76	10597.31	3319.82	2854.45	3502131.38	1871.40

	Porcellanite						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	52	1.33	74.36	5.14	1.45	159.92	12.65
Zr_ppm	52	5.40	53.50	19.23	16.06	140.49	11.85
Sr_ppm	52	5.53	155.39	24.36	16.54	690.36	26.27
U_ppm	52	1.79	31.32	4.28	2.06	35.30	5.94
Rb_ppm	52	3.09	30.04	9.46	7.33	33.52	5.79
Th_ppm	52	1.34	8.06	2.08	1.49	1.67	1.29
Pb_ppm	52	1.70	511.52	23.40	2.07	9150.42	95.66
Au_ppb	52	1.88	9.22	2.87	2.15	2.67	1.64
Se_ppm	52	1.37	32.04	3.61	1.58	35.24	5.94
As_ppm	52	1.37	67.74	6.58	1.73	142.80	11.95
Hg_ppm	52	2.82	7.86	3.70	3.15	1.68	1.30
Zn_ppm	52	2.95	1440.88	67.04	4.62	56725.90	238.17
Cu_ppm	52	5.72	161.20	24.13	6.79	1100.85	33.18
Ni_ppm	52	8.18	118.11	47.17	43.28	695.90	26.38
Co_ppm	52	10.46	90.72	24.01	16.53	269.29	16.41
Fe_ppm	52	181.96	52196.58	3579.82	912.97	68373635.37	8268.84
Mn_ppm	52	18.39	997.90	80.30	62.89	18131.64	134.65
Cr_ppm	52	4.02	372.01	41.26	10.55	5619.23	74.96
V_ppm	52	15.90	2502.85	317.21	72.38	299125.21	546.92
Ti_ppm	52	24.61	1690.25	508.65	379.50	179255.93	423.39
Sc_ppm	52	2.26	26.91	4.93	3.62	17.84	4.22
Ca_ppm	52	78.88	14419.27	1393.89	454.65	10262642.55	3203.54
K_ppm	52	773.49	19439.71	3761.84	2512.45	11632992.62	3410.72
S_ppm	52	57.12	73145.08	9014.37	3227.16	222823244.11	14927.27
Ba_ppm	52	12.96	1213.42	500.64	493.49	75737.52	275.20
Sb_ppm	52	3.71	79.95	29.80	25.69	439.46	20.96
Sn_ppm	52	3.47	76.28	24.94	22.87	305.20	17.47
Cd_ppm	52	3.45	34.99	12.57	11.41	77.99	8.83
Cs_ppm	52	3.30	139.74	52.96	51.69	1396.08	37.36
Te_ppm	52	9.44	251.07	92.70	87.87	3985.31	63.13
Al_ppm	52	3827.26	54035.13	12850.03	10234.25	75620074.83	8695.98
P_ppm	52	195.29	46302.74	2892.48	301.70	55249203.88	7432.98
Si_ppm	52	147619.91	640636.81	497343.12	549131.10	12421157556.63	111450.25
Cl_ppm	52	16.47	751.23	194.77	157.21	24579.92	156.78
Mg_ppm	52	994.34	9454.30	3082.30	2744.36	2357499.14	1535.41

	Slaven						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	42	1.42	4.49	1.68	1.51	0.29	0.54
Zr_ppm	42	9.43	137.29	30.97	29.62	483.04	21.98
Sr_ppm	42	11.08	149.58	36.85	30.71	709.77	26.64
U_ppm	42	1.94	10.09	2.70	2.27	2.09	1.45
Rb_ppm	42	1.11	20.84	9.30	8.98	15.39	3.92
Th_ppm	42	1.35	6.71	2.46	1.66	2.26	1.50
Pb_ppm	42	1.80	11.76	4.22	2.67	8.87	2.98
Au_ppb	42	1.92	10.78	3.75	3.12	4.85	2.20
Se_ppm	42	1.39	11.26	2.54	1.79	3.95	1.99
As_ppm	42	1.53	11.10	3.28	2.33	4.94	2.22
Hg_ppm	42	2.99	10.94	3.85	3.33	2.50	1.58
Zn_ppm	42	3.29	327.73	23.96	13.03	2589.10	50.88
Cu_ppm	42	6.52	200.39	29.80	21.38	1096.33	33.11
Ni_ppm	42	8.41	252.49	55.36	50.04	1650.67	40.63
Co_ppm	42	15.03	134.94	33.08	24.34	511.44	22.61
Fe_ppm	42	593.82	44393.50	4739.34	2193.56	69790866.61	8354.09
Mn_ppm	42	18.24	1993.77	196.96	125.01	106174.16	325.84
Cr_ppm	42	3.60	184.94	25.01	8.82	1832.26	42.80
V_ppm	42	7.85	479.35	86.37	66.98	7603.25	87.20
Ti_ppm	42	61.77	2112.14	460.55	375.97	144566.01	380.22
Sc_ppm	42	2.27	24.67	6.07	5.05	17.54	4.19
Ca_ppm	42	139.39	28101.90	1842.36	972.71	17922798.11	4233.53
K_ppm	42	1236.82	18803.05	4675.20	3591.18	15767643.39	3970.85
S_ppm	42	54.87	63900.55	6828.98	2565.81	160679717.65	12675.95
Ba_ppm	42	15.12	11039.51	898.53	628.29	2645961.67	1626.64
Sb_ppm	42	4.43	83.93	38.63	34.27	523.33	22.88
Sn_ppm	42	4.27	82.10	35.27	31.35	453.31	21.29
Cd_ppm	42	4.03	34.79	14.91	15.21	75.01	8.66
Cs_ppm	42	3.68	148.98	73.95	72.03	1858.88	43.11
Te_ppm	42	11.25	268.86	124.24	116.48	5234.43	72.35
Al_ppm	42	2575.44	33637.71	11610.72	10183.12	41314832.32	6427.66
P_ppm	42	186.50	7790.69	1552.61	466.32	4949897.05	2224.84
Si_ppm	42	127489.30	605067.25	473841.84	516613.86	12272841613.90	110782.86
Cl_ppm	42	30.46	926.25	312.19	222.27	49160.58	221.72
Mg_ppm	42	1030.77	8054.95	3498.26	3212.76	2224756.45	1491.56

Appendix 4: Summary Statistics for *in situ* pXRF with > 50% LOD Elements Removed

	Cherry Spring						
Element	Count	Min	Max	Mean	Median	Variance	SD
Zr_ppm	38	1.09	52.73	15.34	11.59	186.53	13.66
Sr_ppm	38	16.16	284.22	67.39	55.13	3412.31	58.41
Rb_ppm	38	0.87	21.53	7.66	7.04	17.66	4.20
Zn_ppm	38	3.13	657.03	63.66	4.15	21860.80	147.85
Cu_ppm	38	6.17	171.85	23.11	8.40	909.27	30.15
Ni_ppm	38	8.32	427.84	73.71	58.28	5466.49	73.94
Fe_ppm	38	597.58	140657.31	19710.28	3997.26	1075197652.23	32790.21
Mn_ppm	38	19.23	65618.38	3903.70	148.29	165894081.22	12879.99
Cr_ppm	38	3.92	215.53	25.87	9.56	2079.51	45.60
V_ppm	38	11.55	1284.98	148.97	73.50	56870.30	238.47
Ti_ppm	38	20.21	2820.60	547.17	323.05	414824.76	644.07
Ca_ppm	38	115.91	30545.88	1859.50	555.60	24665915.69	4966.48
K_ppm	38	572.17	17113.43	4641.29	3596.20	15929039.49	3991.12
S_ppm	38	99.13	101963.98	10014.76	1836.66	456851181.31	21374.08
Ba_ppm	38	335.70	2694.61	947.17	762.99	275441.55	524.83
Sb_ppm	38	4.62	107.47	40.52	28.85	958.19	30.95
Sn_ppm	38	4.50	109.04	35.26	24.33	715.02	26.74
Cd_ppm	38	3.78	53.43	16.41	12.12	193.64	13.92
Cs_ppm	38	3.78	266.58	81.24	59.36	4039.04	63.55
Te_ppm	38	11.67	495.88	138.60	101.03	13010.28	114.06
Al_ppm	38	952.17	61102.33	11438.97	6511.66	174275888.10	13201.36
Si_ppm	38	42482.62	608662.13	431556.90	510854.88	25982989427.26	161192.40
Cl_ppm	38	16.74	1521.10	367.01	297.23	105506.53	324.82
Mg_ppm	38	967.76	10597.31	3319.82	2854.45	3502131.38	1871.40

	Porcellanite						
Element	Count	Min	Max	Mean	Median	Variance	SD
Zr_ppm	52.00	5.40	53.50	19.23	16.06	140.49	11.85
Sr_ppm	52.00	5.53	155.39	24.36	16.54	690.36	26.27
Rb_ppm	52.00	3.09	30.04	9.46	7.33	33.52	5.79
Zn_ppm	52.00	2.95	1440.88	67.04	4.62	56725.90	238.17
Cu_ppm	52.00	5.72	161.20	24.13	6.79	1100.85	33.18
Ni_ppm	52.00	8.18	118.11	47.17	43.28	695.90	26.38
Fe_ppm	52.00	181.96	52196.58	3579.82	912.97	68373635.67	8268.84
Mn_ppm	52.00	18.39	997.90	80.30	62.89	18131.64	134.65
Cr_ppm	52.00	4.02	372.01	41.26	10.55	5619.23	74.96
V_ppm	52.00	15.90	2502.85	317.21	72.38	299125.21	546.92
Ti_ppm	52.00	24.61	1690.25	508.65	379.50	179255.93	423.39
Ca_ppm	52.00	78.88	14419.27	1393.89	454.65	10262642.55	3203.54
K_ppm	52.00	773.49	19439.71	3761.84	2512.45	11632992.62	3410.72
S_ppm	52.00	57.12	73145.08	9014.37	3227.16	222823244.11	14927.27
Ba_ppm	52.00	12.96	1213.42	500.64	493.49	75737.52	275.20
Sb_ppm	52.00	3.71	79.95	29.80	25.69	439.46	20.96
Sn_ppm	52.00	3.47	76.28	24.94	22.87	305.20	17.47
Cd_ppm	52.00	3.45	34.99	12.57	11.41	77.99	8.83
Cs_ppm	52.00	3.30	139.74	52.96	51.69	1396.08	37.36
Te_ppm	52.00	9.44	251.07	92.70	87.87	3985.31	63.13
Al_ppm	52.00	3827.26	54035.13	12850.03	10234.25	75620074.83	8695.98
Si_ppm	52.00	147619.91	640636.81	497343.12	549131.10	12421157556.63	111450.25
Cl_ppm	52.00	16.47	751.23	194.77	157.21	24579.92	156.78
Mg_ppm	52.00	994.34	9454.30	3082.30	2744.36	2357499.14	1535.41

	Slaven						
Element	Count	Min	Max	Mean	Median	Variance	SD
Zr_ppm	42.00	9.43	137.29	30.97	29.62	483.04	21.98
Sr_ppm	42.00	11.08	149.58	36.85	30.71	709.77	26.64
Rb_ppm	42.00	1.11	20.84	9.30	8.98	15.39	3.92
Zn_ppm	42.00	3.29	327.73	23.96	13.03	2589.10	50.88
Cu_ppm	42.00	6.52	200.39	29.80	21.38	1096.33	33.11
Ni_ppm	42.00	8.41	252.49	55.36	50.04	1650.67	40.63
Fe_ppm	42.00	593.82	44393.50	4739.34	2193.56	69790866.61	8354.09
Mn_ppm	42.00	18.24	1993.77	196.96	125.01	106174.16	325.84
Cr_ppm	42.00	3.60	184.94	25.01	8.82	1832.26	42.80
V_ppm	42.00	7.85	479.35	86.37	66.98	7603.25	87.20
Ti_ppm	42.00	61.77	2112.14	460.55	375.97	144566.01	380.22
Ca_ppm	42.00	139.39	28101.90	1842.36	972.71	17922798.11	4233.53
K_ppm	42.00	1236.82	18803.05	4675.20	3591.18	15767643.39	3970.85
S_ppm	42.00	54.87	63900.55	6828.98	2565.81	160679717.65	12675.95
Ba_ppm	42.00	15.12	11039.51	898.53	628.29	2645961.67	1626.64
Sb_ppm	42.00	4.43	83.93	38.63	34.27	523.33	22.88
Sn_ppm	42.00	4.27	82.10	35.27	31.35	453.31	21.29
Cd_ppm	42.00	4.03	34.79	14.91	15.21	75.01	8.66
Cs_ppm	42.00	3.68	148.98	73.95	72.03	1858.88	43.11
Te_ppm	42.00	11.25	268.86	124.24	116.48	5234.43	72.35
Al_ppm	42.00	2575.44	33637.71	11610.72	10183.12	41314832.32	6427.66
Si_ppm	42.00	127489.30	605067.25	473841.84	516613.86	12272841613.90	110782.86
Cl_ppm	42.00	30.46	926.25	312.19	222.27	49160.58	221.72
Mg_ppm	42.00	1030.77	8054.95	3498.26	3212.76	2224756.45	1491.56

Appendix 5: Raw Data for pXRF 120s Powdered Sample Run

* after sample number indicates use as unknown in LDA

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	7030904	7030910	7030912*	7030927	7030935	07030906a	07030906b	07030921a	07030921b
Mo	7.35	< LOD : 2.36	16.56	3.67	75.45	< LOD : 2.53	4.68	2.64	63.89
Zr	4.75	9.46	11.38	26.34	15.71	45.47	44.96	27.57	22.1
Sr	76.25	23.23	58.01	129.49	59.38	77.31	99.16	127.53	142.35
Rb	2.53	2.01	5.89	9.76	5.1	10.69	19.39	8.3	7.03
Cu	101.86	72.58	84.57	86.72	174.76	56.72	82.41	70.84	148.93
Co	< LOD : 33.28	275.61	< LOD : 65.87	133.5	< LOD : 107.26	< LOD : 61.27	< LOD : 112.41	< LOD : 44.98	< LOD : 108.49
Fe	1783.53	2368.76	13320.61	18337.46	38561.59	5744.28	42477.55	4674.78	37473.22
V	175.68	< LOD : 35.12	< LOD : 35.70	< LOD : 57.52	< LOD : 69.69	91.22	165.05	< LOD : 46.07	65.99
Ti	55.44	111.74	131.9	477.38	239.16	620.16	662.98	329.56	267.26
Ca	997.26	260.32	377.52	631.31	739.51	1507.51	1380.82	1039.45	1143.3
K	< LOD : 81.01	98.71	1388.17	3556.76	766.53	2425.29	8082.71	1705.88	2340.23
S	3057.12	2482.39	10076.25	12477.15	4038.22	6199.84	38412.48	7240.36	11989.03
Ba	671.91	509.98	628.28	2114.7	513.35	747.57	1080.51	1954.88	2530.8
Sb	< LOD : 18.94	< LOD : 19.41	19	< LOD : 20.38	< LOD : 20.36	15.36	21.25	< LOD : 15.65	< LOD : 18.05
Sn	< LOD : 25.48	26.97	< LOD : 25.52	< LOD : 26.00	24.53	27.19	< LOD : 19.71	< LOD : 23.55	< LOD : 20.50
Nb	< LOD : 1.96	< LOD : 1.95	< LOD : 1.96	2.15	2.83	5.27	6.02	< LOD : 2.01	2.88
Al	4755.54	4301.94	5897.01	9878.12	6150.72	9605.21	9233.83	7686.09	7631.14
P	670.86	572.3	588.66	1243.81	457.34	1117.56	2064.38	642.38	681.19
Si	514254.88	506579.94	490161.28	478475.38	510080.53	497608.75	422122.22	488774.19	463662.72
Cl	149.09	207.7	112.74	80.95	151.21	95.29	66.14	88.21	100.53
Mg	8178.14	9561.33	7714.03	9727.82	9264.84	9531.67	13327.6	5408.99	7985.05

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass
SAMPLE	07030930a	07030930b	7021320	7021327	14gphs002	14gphs004	14gphs005*	14gphs006	14gphs007
Mo	48.8	54.62	< LOD : 2.57	24.49	5.04	< LOD : 2.28	3.69	3.24	2.51
Zr	13.03	18.08	8.56	5.21	7.47	4.21	6.7	3.23	6.38
Sr	90.52	120.05	60.73	29.21	31.78	18.75	22.55	27.71	26.68
Rb	10.66	14.5	2.7	2.38	< LOD : 1.50	< LOD : 1.50	4.29	2.78	< LOD : 1.50
Cu	172.12	158.94	73.96	107.59	94.27	87.53	78.99	80.79	94.25
Co	< LOD : 115.12	< LOD : 104.73	313.36	304.62	707.37	747.67	359.99	488.35	555.8
Fe	45391.51	35643.05	8468.44	13676.19	10054.35	5500.63	7644.35	6299.04	7995.73
V	134.78	111.69	< LOD : 32.94	< LOD : 32.21	< LOD : 49.75	< LOD : 41.38	31.83	< LOD : 51.56	< LOD : 39.76
Ti	317.95	197.29	96.45	77.83	101.75	58.56	115.51	69.32	78.69
Ca	602.64	538.59	733.2	527.98	1609.05	483.6	679.52	1096.3	466.26
K	3136.87	2687.99	458.34	< LOD : 101.04	172.6	< LOD : 98.62	885.99	343.47	123.85
S	14276.91	16929.16	3504.2	1509.57	1810.23	1537.27	1610.84	1850.7	1521.91
Ba	444.86	1347.42	441.4	514.05	440.01	274.6	266.21	349.44	242.77
Sb	36.87	18.75	14.72	< LOD : 13.57	18.58	14.06	14.31	< LOD : 20.66	15.31
Sn	19.67	< LOD : 18.42	30.6	28.49	20.1	< LOD : 25.49	20.1	19.38	< LOD : 16.75
Nb	6.93	< LOD : 2.11	< LOD : 1.95	< LOD : 2.21	2.26	< LOD : 1.50	< LOD : 2.07	< LOD : 1.93	2.09
Al	10605.74	7278.33	5894.83	5182.77	7031.28	6176.89	8270.38	7273.35	6630.54
P	507.85	849.75	525.57	< LOD : 413.17	700.41	< LOD : 465.88	< LOD : 703.45	< LOD : 720.90	< LOD : 456.90
Si	556086.63	488354.47	524663.56	519459.19	540166.06	551950.25	536312	548435.75	553006.81
Cl	85.59	115.7	239.68	164.73	222.82	228.24	213.2	229.22	243.33
Mg	7548.67	13299.31	8244.35	7938.77	12340.28	12355.82	7746.37	9515.39	8217.98

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Ren	Ren	Ren	Ren	Ren
SAMPLE	14mmch001	14mmch002	14mmch003*	14mmch004	7011002	7011009	7011012	7011014	7011016
Mo	3.31	4.25	3.51	5.99	2.33	2.38	< LOD : 2.26	< LOD : 2.25	41.11
Zr	12.31	12.46	6.3	14.09	17.84	6.59	18.74	17.16	11.68
Sr	58.52	55.57	47.69	80.68	12.73	9.05	11.18	22.16	7.25
Rb	9.61	4.51	< LOD : 1.50	9.86	6.57	2.3	5.64	6.48	4.94
Cu	76.43	98.23	119.68	102.87	70.07	81.24	72.35	71	127.63
Co	377.52	779.27	1137.54	372.99	186.05	359.52	335.56	252.46	< LOD : 74.28
Fe	9544.63	8162.4	11022.21	8809	2642.37	1650.33	1750.52	3007.7	17251.63
V	< LOD : 30.30	44.32	< LOD : 47.38	61.69	< LOD : 28.03	< LOD : 23.51	< LOD : 34.73	< LOD : 30.28	29.9
Ti	124.65	138.6	< LOD : 50.59	142.42	319.83	109.98	324.2	325.86	237.46
Ca	355.84	958.57	417.26	28495.34	381.25	159.48	193.75	447.11	241.21
K	2588.82	1552.62	174.75	1448.13	1405.91	< LOD : 122.57	1307.15	1646.26	742.15
S	1367.99	2307.04	1530.88	1499.74	1824.1	1886.04	1488.86	1996.83	1605.77
Ba	93.86	109.17	222.44	212.3	292.48	178.77	321.14	339.41	233.31
Sb	< LOD : 13.48	20.39	< LOD : 14.78	< LOD : 14.26	< LOD : 20.44	< LOD : 12.80	< LOD : 17.93	18.17	22.46
Sn	17.46	27.57	< LOD : 27.57	31.2	< LOD : 16.50	< LOD : 16.63	17.72	18.52	< LOD : 16.81
Nb	3.26	3.89	< LOD : 2.23	6.39	2.36	< LOD : 1.67	1.98	< LOD : 1.95	< LOD : 2.00
Al	6623.08	9051.46	5302.17	6802.4	9197.83	4758.22	9000.11	10812.42	7645.29
P	489.87	673.6	773.23	14686.4	< LOD : 542.78	< LOD : 530.81	742.13	< LOD : 423.23	< LOD : 522.19
Si	529550.75	546678.13	520372.19	496109.19	520913.47	538534.38	531309.38	538361.38	527359.69
Cl	166.99	200.44	310.31	176.47	108.13	168.34	104.68	135.78	128.3
Mg	6778	12009.96	12035.5	11563.32	5241.13	6145.06	8649.06	10091.77	7822.52

DURATION	120	120	120	120	120	120	120	120	120
UNIT	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	Porcellanite	Porcellanite
LOCATION	Ren	Ren	Ren	Ren	Ren	Ren	Ren	Mary's Mtn	Mary's Mtn
SAMPLE	7011017	7011019*	7011021	7011023	7011027	7011030	7011034	7020921	7020923
Mo	< LOD : 2.08	31.48	37.34	< LOD : 2.66	< LOD : 2.25	53.31	92.66	56.98	2.85
Zr	7.46	6.98	8.7	6.38	9.61	9.38	23.96	9.71	6.43
Sr	10.68	5.74	7.02	5.61	12.12	8.4	16.51	17.7	8.92
Rb	2.48	2.7	1.95	2.03	3.66	2.7	13.43	4.58	< LOD : 1.50
Cu	50.74	112.67	107.56	79.89	65.72	196.22	323.59	123.63	83.15
Co	< LOD : 27.88	< LOD : 61.22	334.38	429.73	278.6	< LOD : 85.70	< LOD : 116.64	< LOD : 77.57	285.2
Fe	733.02	11738.53	12994.97	1662.51	1679.94	25074.38	46042.96	19482.55	3023.76
V	22.75	< LOD : 37.25	< LOD : 39.55	< LOD : 24.20	< LOD : 29.44	< LOD : 31.34	50.05	473.38	70.81
Ti	127.42	137.35	152.43	122.32	185.5	148.4	480.4	144.77	63.35
Ca	218.53	239.86	201.22	67.88	265.81	578.96	1148.84	715.53	218.02
K	176.72	176.39	199.29	113.86	455.76	265.33	2489.75	187.79	< LOD : 74.35
S	1627.84	1574.73	1523.47	1448.05	1871.47	1950.49	1983.57	5698.39	4582.85
Ba	217.5	194.21	249.7	176.89	249.07	124.56	570.07	207.82	121.98
Sb	< LOD : 13.33	< LOD : 13.43	< LOD : 15.68	< LOD : 15.77	< LOD : 18.06	30.38	< LOD : 24.82	< LOD : 20.81	< LOD : 20.63
Sn	< LOD : 16.53	< LOD : 16.57	18.78	< LOD : 18.65	< LOD : 16.95	20.43	< LOD : 31.02	28.48	20.07
Nb	< LOD : 2.04	< LOD : 1.50	< LOD : 2.00	< LOD : 2.04	< LOD : 1.50	3.39	5.33	< LOD : 2.00	< LOD : 1.50
Al	5744.65	5284.73	5480.34	5418.5	6604.21	6916.83	11393.35	5978.74	4116.26
P	1052.78	< LOD : 472.53	1027.94	1068.22	528.33	< LOD : 467.22	< LOD : 371.97	< LOD : 411.36	694.86
Si	511966.09	515340.47	527706.06	527579.19	513555.53	544631.75	460127.84	504480.13	535515.13
Cl	124.53	129.63	98.56	103.39	103.19	96.88	41.05	256.94	286.4
Mg	7837.84	5043.48	9046.11	8750.32	9284.32	8525.63	11081.23	7439.04	8601.79

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7020925	7020927*	7020930	14mmch010	14mmch011	7021452	7021455	7021459*	07021448a
Mo	7.32	9.27	16.79	61.15	7.29	< LOD : 2.24	< LOD : 2.22	2.25	21.21
Zr	18.43	22.59	22.63	49.94	14.56	11.15	23.42	14.42	12.62
Sr	22.89	22.92	30.84	43.21	16.13	31.06	31.86	105.87	26.41
Rb	11.05	12.84	13.35	38.17	4.26	4.23	5.7	3.62	4.83
Cu	114.78	122.7	104.54	201.42	143.1	80.63	71.09	65.52	87.07
Co	104.99	62.06	< LOD : 64.48	< LOD : 65.85	345.35	316.57	< LOD : 29.98	275.1	222.88
Fe	17302.88	5166.35	7944.46	13555.87	4285.37	2037.63	1040.84	1509.68	7912.22
V	446.73	642.6	597.21	2642.57	647.65	< LOD : 28.35	36.91	< LOD : 38.44	< LOD : 29.24
Ti	442.17	497.48	527.21	1381.68	231.51	300.88	273.89	223.18	358.74
Ca	311.68	622.85	794.71	1114.25	506.39	470.61	468.2	456.88	364.1
K	2415.6	2332.25	2614.64	8380.46	442.78	734.67	933.23	409.69	705
S	26610.87	13921.35	12075.26	36311.49	7808.95	1688.85	1862.95	1806.16	2301.38
Ba	323.1	235.6	233.84	190.29	50.67	396.69	279.57	610.07	230.97
Sb	< LOD : 14.10	< LOD : 12.94	< LOD : 13.04	37.22	33.27	< LOD : 14.97	< LOD : 12.66	< LOD : 19.78	< LOD : 13.76
Sn	< LOD : 17.74	16.35	20.53	< LOD : 15.94	19.36	< LOD : 23.46	< LOD : 15.61	< LOD : 16.30	24.93
Nb	2.63	4.7	3.66	13.9	2.2	< LOD : 1.96	< LOD : 1.93	2.38	< LOD : 1.99
Al	12438.71	12214.52	12117.12	25970.59	7025.45	9185.66	10111.9	6320.23	9217.34
P	494.01	914.47	1132.74	1244.8	523.3	516.11	< LOD : 583.88	899.66	< LOD : 695.54
Si	479862.06	490077.09	482690.94	420538.81	561585.88	527807.38	539010.56	534843.25	539935.44
Cl	177.79	151.95	150.65	94.8	285.76	131.87	124.13	165.22	114.8
Mg	8457.74	11417.36	12468.18	12520.89	9619.66	11533.65	8737.49	9797.77	11610.81

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Porcellanite	Porcellanite	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Barite Pit	Barite Pit	Barite Pit	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	07021448b	14vchs001	6301234	6301237*	6301250	7020949	7020953	07020957a	07020957b
Mo	64.33	4.21	< LOD : 2.27	2.61	4.44	40.3	< LOD : 2.31	31.41	22.94
Zr	24.52	17.45	11.54	11.33	20.67	13.08	22.36	39.72	45.33
Sr	26.54	25.46	76.72	74.28	163.28	26.14	15.8	24.63	27.3
Rb	5.72	6.02	4.45	8.4	15.49	2.56	6.03	11.71	13.59
Cu	118.77	68.62	79.62	89.15	99.6	148.31	114.28	138.46	183.78
Co	175.07	427.38	310.93	246.91	281.2	458.27	395.5	< LOD : 90.70	246.74
Fe	25819.45	2873.89	4633.58	4063.72	7493.64	18264.21	6112.82	17153.48	17029.23
V	< LOD : 29.94	32.63	< LOD : 35.61	39.63	< LOD : 93.80	38.5	62.68	67.14	103.74
Ti	227.59	307.46	130.58	256.97	234.49	143.71	260.5	406.09	486.26
Ca	583.09	453.39	2280	923.87	3998.92	5581.79	699.41	442.46	585.41
K	912.73	1216.64	519.7	1225.24	2729.91	722.68	1295.99	2962.13	3493.53
S	1704.18	1900.75	3190.63	2725.92	10020.42	3218.87	7820.02	1949.01	2052.47
Ba	134.48	243.53	684.87	646.87	7984.09	100.33	128.23	363.08	374
Sb	< LOD : 19.56	14.26	20.52	16.86	< LOD : 19.46	15.18	< LOD : 15.26	< LOD : 18.32	< LOD : 19.83
Sn	20.8	< LOD : 23.87	29.06	< LOD : 17.42	< LOD : 21.00	< LOD : 27.14	< LOD : 16.95	< LOD : 17.70	< LOD : 17.99
Nb	2.59	3.35	< LOD : 2.16	2.39	4.24	< LOD : 2.18	2.85	< LOD : 2.01	2.96
Al	10347.54	13647.14	6861.29	8915.6	14940	5818.73	7882.33	9548.1	9903.01
P	< LOD : 444.17	< LOD : 705.54	1826.4	862.36	2729.32	< LOD : 427.27	895.69	396.31	916.53
Si	538576.19	550139.63	513301.53	509653.84	490225.41	523969.34	523651.78	481713.69	496179.25
Cl	125.71	97.77	157.44	131.16	< LOD : 45.38	304.66	222.23	133.42	151.12
Mg	9742.18	9566.31	9097.83	8759.39	9514.97	10547.22	11394.63	9135.1	11148.14

DURATION	120	120	120	120	120	120	120	120	120
UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Slaven Canyon	Slaven Canyon	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14mmch006	14mmch007*	14mmch008	14mmch009	6301134	6301150	14vchs002	14vchs003	14vchs004
Mo	5.88	2.41	3.56	4.55	66.82	< LOD : 2.32	3.2	5.22	4.8
Zr	22.21	47.1	45.03	26.02	30.16	23.02	24.22	38.52	40.64
Sr	14.28	25.99	24.66	16.67	22.72	39.82	22.78	37.45	37.32
Rb	5.28	11.37	9.41	4.39	14.8	7.56	< LOD : 1.50	4.95	5.91
Cu	107.35	139.85	159.76	144.91	188.08	93.46	100.1	128.78	97.37
Co	698.01	363.38	468.74	1105.93	< LOD : 100.25	322.99	552.17	623.7	450.93
Fe	5133.83	9208.22	6645.18	6990.07	33073.71	4596.47	5361.08	5213.32	4744.76
V	< LOD : 37.74	74.2	56.16	44.53	40.87	45.19	43.77	117.92	81.82
Ti	241.85	440.16	472.98	328.34	455.97	313.26	108.59	294.64	419.64
Ca	645.61	953.77	3742.69	387.72	916.27	733.97	649.79	647.61	746.79
K	1480.96	3924.23	3200.36	1879.42	3342.39	1777.37	< LOD : 112.73	904.11	1512.82
S	5470.64	6354.57	4226.91	8052.79	1540.19	2134.44	4465.39	4146.38	3343.25
Ba	< LOD : 47.71	150.67	104.12	< LOD : 47.98	391.59	378.39	204.66	343.97	350.47
Sb	13.96	< LOD : 13.59	15.77	19.26	< LOD : 20.74	< LOD : 16.85	17.19	21.12	18.61
Sn	< LOD : 16.74	< LOD : 16.78	< LOD : 25.19	< LOD : 16.90	22.43	< LOD : 17.50	< LOD : 16.67	17.85	16.89
Nb	2.78	3.61	5.67	4.66	2.79	3.19	< LOD : 1.95	4.42	3.55
Al	7882.08	10622.99	10457.56	7567.57	12006.96	8700.14	5954.2	8296.28	10222.95
P	608.66	794.47	2087.56	811.74	525.5	513.47	502.33	573.13	579.59
Si	550666.38	516535	537873.38	558166.94	466381.06	514401.78	550490.56	545127.44	544686.75
Cl	266.36	153.67	229.61	311.63	55.06	164.31	176.18	200.94	163.07
Mg	9410.9	9551.63	11436.76	9404.49	10026.8	9262.61	8578.63	7091.9	11734.93

DURATION	120	120	120
UNIT	Slaven EQ	Slaven EQ	Slaven EQ
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7021426	7021430	7021435*
Mo	2.83	42.38	63.32
Zr	25.27	23.65	24.28
Sr	46.35	20.91	25.93
Rb	1.71	3.44	3.75
Cu	154.23	120.61	167.31
Co	538.5	< LOD : 84.99	< LOD : 104.30
Fe	5479.16	24220.43	37442.77
V	< LOD : 29.29	45.91	107.06
Ti	172.5	247.69	197.25
Ca	464.82	918.15	951.49
K	356.17	632.95	649.1
S	6034.3	3099.57	4297.03
Ba	398.03	108.19	124.81
Sb	< LOD : 20.29	36.51	30.24
Sn	< LOD : 17.50	19.55	20.75
Nb	< LOD : 2.00	4.41	5.88
Al	6136.78	8470.98	7831.29
P	549.56	< LOD : 695.05	< LOD : 704.68
Si	528085.06	571293.75	557645.63
Cl	133.33	156.83	149.04
Mg	8532.36	13505.57	15081.73

Appendix 6: Raw Data for pXRF 240s Powdered Sample Run

* after sample number indicates use as unknown in LDA

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	7030904	7030910	7030912*	7030927	7030935	07030906a	07030906b	07030921a	07030921b
Mo	7.29	1.93	16.36	4.14	76.3	< LOD : 1.60	5.2	3	64.62
Zr	4.95	8.74	10.66	25.51	17.07	47.99	44.88	25.98	22.09
Sr	75.9	22.81	57.9	129.18	56.18	76.59	103.05	128.53	139.82
Rb	2	1.76	5.77	11.7	5.19	11.39	20.09	6.99	6.84
Cu	115.01	68.6	85.11	82.14	157.55	62.59	71.73	79.68	143
Co	< LOD : 26.50	281.93	< LOD : 45.63	119.06	< LOD : 109.40	< LOD : 33.00	< LOD : 78.60	< LOD : 31.06	< LOD : 74.62
Fe	1757	2415.71	13319.1	18347.54	38713.96	5758.67	42541.48	4656.86	37678.23
V	177.15	< LOD : 24.32	26.02	62.51	< LOD : 30.17	98.72	126.52	< LOD : 31.22	59.82
Ti	54.2	99.36	159.04	462.31	236.65	646.15	612.44	301.57	238.62
Ca	965.34	246.11	403.98	660.15	731.88	1482.24	1229.5	1020.43	1142.3
K	< LOD : 56.07	108.01	1419.05	3600.93	696.89	2445.97	8007.61	1770.9	2367.98
S	3113.23	2401.69	9960.41	12623.34	4151.88	6234.68	37676.3	7335.04	11752.85
Ba	680.44	474.05	619.87	2145.45	525.03	798.25	1090.14	2009.97	2484.27
Sb	14.26	< LOD : 11.54	< LOD : 13.47	10.8	18.95	11.77	< LOD : 10.77	19.61	< LOD : 10.96
Sn	16.16	12.04	12.49	13.78	18.58	18.83	16.82	20	24.35
Nb	1.98	< LOD : 1.50	< LOD : 1.50	3.07	4.67	6.77	6.19	2.02	2.76
Al	4371.79	4364.03	6026.9	9964.64	6975.27	9864.05	8651.76	7629.73	8034.76
P	763.84	< LOD : 283.19	590.84	704.82	502.77	1237.06	1730.53	530.17	643.54
Si	515713.09	507736.56	487245.56	480583.75	511852.5	498393.38	415030.97	489054.56	461271.41
Cl	172.43	213.97	127.95	79.91	168.84	116.06	45.37	109.12	107.41
Mg	9143.08	8489.04	8918.75	10269.87	12030.34	11194.06	10779.25	8170.3	11756.45

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass
SAMPLE	07030930a	07030930b	7021320	7021327	14gphs002	14gphs004	14gphs005*	14gphs006	14gphs007
Mo	47.91	53.98	1.87	23.37	4.85	2.78	3.72	3.03	2.93
Zr	12.45	16.15	7.17	4.9	6.4	4.86	6.36	5.9	6.36
Sr	88.86	118.4	59.71	29.35	33.17	18.39	22.65	27.48	25.94
Rb	10.89	13.21	2.71	2.09	< LOD : 1.50	< LOD : 1.50	4.55	2.58	< LOD : 1.50
Cu	172.8	144.47	75.94	108.43	96.36	95	88.4	92.9	79.06
Co	< LOD : 80.36	< LOD : 71.00	349.06	300.71	678.77	719.7	430.66	458.11	544.83
Fe	45342.62	35453.7	8281.91	13745.72	10135.26	5602.43	7548.41	6319.8	8025.13
V	134.01	112	< LOD : 23.10	24.23	< LOD : 36.80	< LOD : 28.01	< LOD : 21.20	< LOD : 27.73	25.93
Ti	317.23	140.15	92.51	100.21	89.86	46.05	95.68	72.85	98.7
Ca	620.3	570.56	728.97	506.67	1601.5	478.17	652.7	1124.62	460.12
K	3018.45	2696.03	479.92	72.16	173.46	< LOD : 67.30	816.1	356.68	108.35
S	14297.75	16942.16	3508.06	1538.66	1850.92	1504.57	1662.09	1863.54	1504.21
Ba	430.67	1339.48	430.29	538.4	451.46	261.03	245.76	377.42	245.77
Sb	39.69	16.03	9.87	< LOD : 15.28	11.52	14.99	13.59	10.31	12.18
Sn	< LOD : 11.48	18.17	14.81	< LOD : 19.90	24.57	13.91	19.67	20.97	14.77
Nb	5.95	2.29	< LOD : 1.50	< LOD : 1.50	2.41	1.68	< LOD : 1.50	1.57	< LOD : 1.50
Al	10255.25	7012.78	6419.4	5494.03	6678.75	5659.69	8634.91	6876.71	6205.12
P	< LOD : 350.58	821.67	551.64	510.79	818.83	< LOD : 474.50	360.46	< LOD : 403.60	< LOD : 317.13
Si	554487.56	488870.53	523258.44	522525.59	541812.81	551927.5	540390.88	545028.63	556844.69
Cl	96.55	108.79	246.94	168.77	203.2	218.43	252	227.01	253.46
Mg	10858.84	10209.37	9473.38	10581.44	9859.69	11134.95	12084.27	11186.57	10639.46

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Ren	Ren	Ren	Ren	Ren
SAMPLE	14mmch001	14mmch002	14mmch003*	14mmch004	7011002	7011009	7011012	7011014	7011016
Mo	3.07	3.24	3.96	5.54	< LOD : 1.55	2.86	2.25	3.35	41.24
Zr	9.87	12.64	6.53	12.87	18.36	7.8	17.89	16.81	11.23
Sr	60.06	55.12	46.84	80.87	12.47	7.63	12.32	23.69	7.82
Rb	10.35	4.45	< LOD : 1.50	9.39	6.6	1.63	6.02	7.1	4.8
Cu	75.72	109.35	120.91	112.12	69.23	74.75	75.65	71.94	136.6
Co	377.84	768.03	1164.11	382.89	193.11	351.08	343.47	247.98	< LOD : 50.66
Fe	9516.93	8322.28	11018.46	8913.09	2608.4	1639.22	1778.06	3020.4	17223.48
V	< LOD : 20.67	47.07	< LOD : 37.47	65.58	22.48	18.68	< LOD : 25.22	32.55	36
Ti	121.27	123.44	45.86	162.09	327.05	114.6	318.35	328.52	230.36
Ca	393.9	982.58	438.9	28493.1	389.43	153.23	224.02	474.98	246.64
K	2565.19	1565.31	174.7	1502.64	1472.15	115.93	1376.42	1606.42	761.76
S	1388.49	2317.71	1457.63	1449.62	1827.18	1921.57	1511.74	1985.64	1590.32
Ba	129.11	132.56	228.61	219.45	327.13	160.62	338.38	340.58	227.94
Sb	17.44	15.71	15.12	17.45	10.63	< LOD : 11.61	13.27	14.84	13.57
Sn	16.31	11.93	17.18	16.31	18.69	14.02	16.82	< LOD : 11.37	19.94
Nb	3.31	3.59	1.61	6.44	2.17	< LOD : 1.50	1.79	2.11	1.99
Al	6673.43	9578.94	5110.25	8356.43	8797.59	5404.67	9127.29	10920.18	7751.24
P	525.9	539.63	637.86	14671.65	< LOD : 386.49	389.56	< LOD : 292.20	< LOD : 393.47	< LOD : 291.83
Si	526986	548289.5	516858.34	497385.91	516872.53	539826.5	531052.38	541114.5	530668.44
Cl	172.87	200.43	313.45	198.44	139.45	176.07	117.6	137.58	104.42
Mg	11249.1	14552.31	9480.97	11262.61	7607.62	11767.37	11801.79	11346.17	10262.79

DURATION	240	240	240	240	240	240	240	240	240
UNIT	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	PK Chert	Porcellanite	Porcellanite
LOCATION	Ren	Ren	Ren	Ren	Ren	Ren	Ren	Mary's Mtn	Mary's Mtn
SAMPLE	7011017	7011019*	7011021	7011023	7011027	7011030	7011034	7020921	7020923
Mo	1.62	31.57	36.07	< LOD : 1.56	< LOD : 1.53	54.98	92.19	56.26	2.97
Zr	6.45	7.86	8.76	6.91	9.45	9.15	22.68	9.7	5.67
Sr	10.66	6.32	7.39	5.89	11.91	8.05	14.7	19.33	9.22
Rb	2.6	3.36	2.84	1.69	3.04	3.18	13.53	4.6	< LOD : 1.50
Cu	57.92	106.32	101.23	70.52	75.98	202.13	320.98	125.64	91.59
Co	< LOD : 19.54	< LOD : 42.35	294.97	406.41	277.58	< LOD : 59.68	< LOD : 81.19	< LOD : 53.14	309.61
Fe	689.44	11606.9	12939.77	1683.5	1708.58	25117.33	46102.99	19549.59	3016.8
V	< LOD : 15.73	19.6	< LOD : 18.70	< LOD : 17.69	< LOD : 24.49	28.52	36.84	465.15	66.32
Ti	123.7	150.4	166.45	128.85	168.7	158.9	472.49	127.84	39.49
Ca	223.91	247.59	211.01	58.34	245.52	557.1	1210.06	718.12	196.89
K	145.51	170.77	251.86	75.75	483.57	283.25	2492.79	140.16	< LOD : 50.37
S	1699.98	1584.91	1543.61	1478.63	1901.65	1962.78	1978.48	5701.59	4579.63
Ba	222.93	166.24	214.9	213.87	251.19	102.19	601.38	226.96	98.81
Sb	14.21	12.14	< LOD : 9.81	< LOD : 11.37	< LOD : 9.29	27.72	20	11.3	< LOD : 10.53
Sn	14.09	< LOD : 11.50	17.58	12.02	22.69	14	23.74	19.51	13.68
Nb	< LOD : 1.50	< LOD : 1.50	1.98	< LOD : 1.50	< LOD : 1.50	2.87	3.45	1.74	< LOD : 1.50
Al	5470.46	5219.75	5648.5	5287.53	6147.58	6836.19	11823.48	6105.34	4070.48
P	862.7	< LOD : 277.96	769.19	1133.59	548.19	< LOD : 315.16	414.97	< LOD : 279.67	372.91
Si	509363.28	514350.34	528168.19	529079.63	512956.31	545059.13	462514.91	505106.81	536823.38
Cl	119.15	142.97	134.48	103.84	82.43	133.64	35.44	253.29	292.08
Mg	6119.91	9798.67	8035.43	9117.51	8756	11169.47	10189.98	9918.94	11294.48

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7020925	7020927*	7020930	14mmch010	14mmch011	7021452	7021455	7021459*	07021448a
Mo	6.75	9.31	16.48	61.2	7.35	< LOD : 1.56	2.06	< LOD : 1.55	22.17
Zr	18.18	25.16	21.62	50.5	14.61	12.83	23.04	15.14	13.41
Sr	23.81	22.57	30.09	43.74	16.41	30.06	34.04	106.48	27.33
Rb	10.83	12.47	13.28	38.72	3.91	4.79	5.62	3.54	4.45
Cu	118.64	127.15	115.39	209.47	147.55	68.06	48.66	64.26	94.07
Co	77.79	56.79	40.45	< LOD : 58.45	341.43	327.41	< LOD : 20.38	274.47	235.68
Fe	17382.26	5097.66	7913.66	13589.13	4233.54	2052.35	1044.52	1610.82	7957.37
V	458.73	639.89	605.94	2643.36	628.26	< LOD : 19.50	36.2	< LOD : 33.50	20.51
Ti	486.75	491.26	490.4	1311.31	197.58	289.87	273.72	223	326.5
Ca	323.97	642.46	782.02	1093.09	486.96	427.78	526.26	446.65	368.17
K	2423.93	2356.14	2640.35	8319.88	426.02	728.44	915.54	462.93	677.35
S	26968.85	13900.39	12183.58	36507.05	7789.6	1708.04	1836.93	1762.89	2296.54
Ba	312.18	214.19	248.37	206.05	43.3	410.14	287.54	592.49	258.52
Sb	10.37	10.84	17.02	31.09	28.71	< LOD : 9.51	12.14	15.07	10.06
Sn	12.59	18.12	19.06	17.92	13.75	13.03	20.67	14.47	16.29
Nb	1.81	3.54	4.24	12.75	3.65	< LOD : 1.50	1.88	2.72	1.71
Al	12747.82	11780.37	12373.71	26273.52	7165.8	9601.37	9841.79	7354.07	9047.27
P	489.92	884.57	789.47	1142.86	< LOD : 452.88	555.65	349.54	968.7	< LOD : 305.64
Si	482681.59	490031.16	486441.66	421730.81	563817.5	529665.94	539019.06	538446.63	541224.38
Cl	207.08	165.02	126.74	89.83	298.66	139.73	160.47	148.37	112.81
Mg	11220.59	7634.61	7059.6	9896.71	10798.62	8485.67	11226.74	8533.49	10331.97

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Porcellanite	Porcellanite	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Barite Pit	Barite Pit	Barite Pit	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	07021448b	14vchs001	6301234	6301237*	6301250	7020949	7020953	07020957a	07020957b
Mo	64.37	3.56	< LOD : 1.57	2.01	3.8	42.1	3.43	32.1	21.4
Zr	23.76	17.54	9.88	10.9	20.87	12.86	22.57	40.66	45.94
Sr	25.76	25.8	77.22	74.22	162.21	25.58	16.52	24.07	27.44
Rb	4.98	5.94	4.74	8.53	14.39	2.53	6.53	12.52	13.31
Cu	122.02	65.79	85.98	86.13	110.33	135.99	119.64	148.27	171.32
Co	218.77	444.44	335.68	257.46	306.75	413.47	365.74	< LOD : 57.37	194.73
Fe	25581.67	2795.24	4645.49	4109.01	7443.37	18316.85	6205.55	17252.61	16865.99
V	23.1	23.09	25.49	40.16	69.61	31.51	55.5	68.77	84.16
Ti	214.51	314.18	188.66	244.43	207.46	120.05	247.24	405.93	487.16
Ca	537.39	452.11	2247.09	954.58	4018.23	5534.63	648.97	451.86	591.16
K	935.2	1192.97	517.96	1204.99	2758.5	696.91	1272.72	2997.92	3525.1
S	1690.17	1806.45	3119.79	2697.33	9967.7	3257.55	7833.59	1897.79	2030.04
Ba	144.53	248.4	642.15	627.87	7944.38	104.92	143.75	369.34	355.34
Sb	< LOD : 9.96	16.06	< LOD : 9.63	< LOD : 14.57	< LOD : 10.75	< LOD : 10.02	< LOD : 9.56	< LOD : 10.06	< LOD : 14.31
Sn	18.28	< LOD : 11.36	13.74	< LOD : 12.08	< LOD : 16.39	< LOD : 12.45	14.3	17.07	16.8
Nb	2	2.53	< LOD : 1.50	< LOD : 1.50	4.32	1.79	2	2.75	3.71
Al	10498.95	13684.91	7206.65	8108.49	14063.37	6764.51	7754.18	9381.25	10367.89
P	339.85	443.32	1523.7	497.68	2550.28	< LOD : 412.60	692.64	558.28	832.99
Si	540539.31	546428.06	512186.66	511394.63	489354.59	524695.81	525765.94	482466.44	496756.41
Cl	155.01	107.3	156.63	164.88	83.95	306.94	243.24	133.96	127.44
Mg	8743.76	8520.84	10972.5	10667.98	10680.16	12381.66	8607.97	7151.44	9780.34

DURATION	240	240	240	240	240	240	240	240	240
UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Slaven Canyon	Slaven Canyon	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14mmch006	14mmch007*	14mmch008	14mmch009	6301134	6301150	14vchs002	14vchs003	14vchs004
Mo	3.64	2.73	3.63	4.53	68.02	2.24	3.86	3.94	3.87
Zr	22.3	46.77	46.05	26.12	31.06	24.69	24.87	39.49	39.74
Sr	14.74	24.44	22.46	15.82	23.92	41.43	23	37.36	36.86
Rb	4.34	12.14	9.6	4.94	15.07	8.22	< LOD : 1.50	4.82	7.2
Cu	113.8	139.34	149.98	144.49	185.12	96.2	96.55	116.03	77.45
Co	700.57	349.82	414.67	1114.93	< LOD : 68.76	296.99	543.24	586.95	454.08
Fe	5111.12	9224.19	6664.89	6914	33016.39	4642.45	5343.15	5340.69	4921.85
V	< LOD : 18.82	90.17	47.02	35.34	36.82	30.65	47.04	122.13	76.06
Ti	250.93	407.05	489.84	313.85	455.03	292.31	118.18	311.5	397.4
Ca	665.83	980.72	3824.36	405.98	929.64	762.91	667.47	606.81	710.36
K	1529.84	4020.4	3196.38	1795.16	3401.4	1698.57	< LOD : 64.54	939.34	1449.5
S	5525.35	6416.12	4108.01	8267.07	1505.37	2094.98	4523.27	4204.41	3348.3
Ba	55.63	127.82	93.12	77.4	453.68	397.76	207.84	331.26	384.49
Sb	16.49	< LOD : 9.57	12.42	20.69	14.73	< LOD : 9.69	12.91	15.13	17.22
Sn	16.3	16.83	21.04	17.68	17.17	18.54	25.28	13.94	13.84
Nb	2.64	2.78	5.87	3.66	3.89	< LOD : 1.50	1.91	2.91	3.55
Al	7332.48	10783.71	9942.98	8931	12017.88	8902.04	5927.91	8864.38	10165.51
P	607.3	515.71	1920	637.23	365.25	339.38	< LOD : 313.57	442.17	< LOD : 313.35
Si	547018.06	520294.59	537103.19	559978.88	468938.38	514134.91	552400.19	548400.63	545470.75
Cl	287.66	161.38	247.36	306.27	56.32	138.09	193.87	203.39	159.49
Mg	11018.29	10089.22	11816.99	12603.79	7407.13	8567.05	9838.56	7491.27	10306.52

DURATION	240	240	240
UNIT	Slaven EQ	Slaven EQ	Slaven EQ
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7021426	7021430	7021435*
Mo	2.08	43.37	62.43
Zr	26.65	22.54	24.65
Sr	46.28	21.47	24.73
Rb	2.35	3.71	3.51
Cu	146.6	134.57	171.53
Co	537.27	< LOD : 58.64	< LOD : 71.51
Fe	5489.3	24394.11	37486.42
V	25.65	48.37	120.28
Ti	176.16	226.83	206.16
Ca	449.74	932.19	910.57
K	297.26	660.55	671.68
S	6106.29	3206.7	4265.35
Ba	380.06	122.24	107.75
Sb	10.75	37.03	33.14
Sn	14.99	18.32	< LOD : 11.26
Nb	1.65	3	4.75
Al	6447.06	8090.99	8088.66
P	803.33	< LOD : 337.60	< LOD : 411.31
Si	530113.13	574200.88	555891.81
Cl	136.51	143.43	178.86
Mg	7139.21	10436.22	12539.4

Appendix 7: Summary Statistics for Powdered pXRF 120s Run

	Cherry Spring						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	22	1.14	75.45	15.39	3.97	525.65	22.93
Zr_ppm	22	3.23	45.47	14.81	11.85	143.21	11.97
Sr_ppm	22	18.75	142.35	66.51	58.95	1468.25	38.32
Rb_ppm	22	0.75	19.39	6.14	4.81	24.85	4.98
Cu_ppm	22	56.72	174.76	101.14	90.89	1121.63	33.49
Co_ppm	22	16.64	1137.54	315.01	290.12	97083.37	311.58
Fe_ppm	22	1783.53	45391.51	15588.79	9176.81	198403419.85	14085.57
V_ppm	22	15.15	175.68	53.04	27.27	2520.64	50.21
Ti_ppm	22	25.30	662.98	201.81	128.28	32160.16	179.33
Ca_ppm	22	260.32	28495.34	2047.33	706.36	35041939.41	5919.62
K_ppm	22	40.51	8082.71	1549.00	1137.08	3402719.18	1844.65
S_ppm	22	1367.99	38412.48	6692.24	2769.76	73552184.78	8576.26
Ba_ppm	22	93.86	2530.80	714.11	477.42	461155.32	679.08
Sb_ppm	22	6.74	36.87	13.79	12.20	48.96	7.00
Sn_ppm	22	8.38	31.20	18.53	18.42	57.63	7.59
Nb_ppm	22	0.75	6.93	2.50	1.60	3.95	1.99
Al_ppm	22	4301.94	10605.74	7148.31	6916.84	2956151.85	1719.35
P_ppm	22	206.59	14686.40	1301.15	615.52	9102535.83	3017.04
Si_ppm	22	422122.22	556086.63	512857.49	516857.04	1110731374.22	33327.64
Cl_ppm	22	66.14	310.31	165.84	165.86	4451.33	66.72
Mg_ppm	22	5408.99	13327.60	9558.78	9390.12	5059457.84	2249.32

	Porcellanite						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	25.00	1.04	92.66	20.89	7.29	695.57	26.37
Zr_ppm	25.00	6.38	49.94	15.69	14.42	87.95	9.38
Sr_ppm	25.00	5.61	105.87	21.53	16.51	408.34	20.21
Rb_ppm	25.00	0.75	38.17	6.80	4.83	55.44	7.45
Cu_ppm	25.00	50.74	323.59	109.75	87.07	3431.67	58.58
Co_ppm	25.00	13.94	429.73	187.71	186.05	20808.33	144.25
Fe_ppm	25.00	733.02	46042.96	9527.35	4285.37	118195560.94	10871.78
V_ppm	25.00	11.76	2642.57	235.81	19.78	300843.92	548.49
Ti_ppm	25.00	63.35	1381.68	306.04	237.46	66665.28	258.20
Ca_ppm	25.00	67.88	1148.84	448.94	447.11	75225.60	274.27
K_ppm	25.00	37.18	8380.46	1214.50	734.67	2901297.46	1703.32
S_ppm	25.00	1448.05	36311.49	5562.19	1886.04	73547454.25	8575.98
Ba_ppm	25.00	50.67	610.07	256.23	233.84	15833.60	125.83
Sb_ppm	25.00	6.33	37.22	12.52	9.03	78.92	8.88
Sn_ppm	25.00	7.81	28.48	14.29	11.94	39.46	6.28
Nb_ppm	25.00	0.75	13.90	2.42	1.02	7.43	2.73
Al_ppm	25.00	4116.26	25970.59	9077.91	9000.11	19878641.21	4458.55
P_ppm	25.00	185.99	1244.80	557.00	494.01	122893.47	350.56
Si_ppm	25.00	420538.81	561585.88	518497.91	527706.06	980776791.35	31317.36
Cl_ppm	25.00	41.05	286.40	140.25	125.71	3470.30	58.91
Mg_ppm	25.00	5043.48	12520.89	9161.25	9046.11	3933007.14	1983.18

	Slaven						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	19.00	1.14	66.82	16.32	4.55	473.24	21.75
Zr_ppm	19.00	11.33	47.10	28.11	24.28	130.06	11.40
Sr_ppm	19.00	14.28	163.28	39.11	25.99	1207.25	34.75
Rb_ppm	19.00	0.75	15.49	7.13	5.91	19.89	4.46
Cu_ppm	19.00	79.62	188.08	129.21	128.78	1062.19	32.59
Co_ppm	19.00	42.50	1105.93	381.79	363.38	69844.64	264.28
Fe_ppm	19.00	4063.72	37442.77	11729.46	6645.18	102861607.99	10142.07
V_ppm	19.00	14.65	117.92	56.18	45.91	878.88	29.65
Ti_ppm	19.00	108.59	486.26	295.34	260.50	14730.71	121.37
Ca_ppm	19.00	387.72	5581.79	1382.66	746.79	2118367.81	1455.46
K_ppm	19.00	56.37	3924.23	1719.23	1480.96	1444502.84	1201.87
S_ppm	19.00	1540.19	10020.42	4428.57	4146.38	5425404.94	2329.25
Ba_ppm	19.00	23.86	7984.09	678.12	343.97	3166352.37	1779.42
Sb_ppm	19.00	6.80	36.51	15.65	15.18	60.75	7.79
Sn_ppm	19.00	8.34	29.06	13.12	9.00	38.24	6.18
Nb_ppm	19.00	0.98	5.88	3.08	2.96	2.46	1.57
Al_ppm	19.00	5818.73	14940.00	8843.10	8470.98	5010331.07	2238.38
P_ppm	19.00	213.64	2729.32	846.64	579.59	432022.84	657.28
Si_ppm	19.00	466381.06	571293.75	525265.71	523969.34	805167657.88	28375.48
Cl_ppm	19.00	22.69	311.63	172.78	157.44	5288.04	72.72
Mg_ppm	19.00	7091.90	15081.73	10169.24	9514.97	3534473.50	1880.02

Appendix 8: Summary Statistics for Powdered pXRF 240s Run

	Cherry Spring						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	22	0.80	76.30	15.45	4.05	524.41	22.90
Zr_ppm	22	4.86	47.99	14.56	10.27	148.08	12.17
Sr_ppm	22	18.39	139.82	66.22	58.81	1460.27	38.21
Rb_ppm	22	0.75	20.09	6.13	4.87	26.42	5.14
Cu_ppm	22	62.59	172.80	101.68	93.95	919.66	30.33
Co_ppm	22	13.25	1164.11	311.40	291.32	99422.46	315.31
Fe_ppm	22	1757.00	45342.62	15609.74	9215.01	198664661.48	14094.85
V_ppm	22	10.34	177.15	50.00	25.08	2411.22	49.10
Ti_ppm	22	45.86	646.15	196.19	122.35	30147.39	173.63
Ca_ppm	22	246.11	28493.10	2042.46	694.56	35036693.64	5919.18
K_ppm	22	28.04	8007.61	1545.82	1117.58	3358403.36	1832.59
S_ppm	22	1388.49	37676.30	6660.67	2757.46	71304430.70	8444.20
Ba_ppm	22	129.11	2484.27	720.79	462.76	461063.92	679.02
Sb_ppm	22	5.39	39.69	13.65	12.89	52.84	7.27
Sn_ppm	22	5.74	24.57	16.24	16.31	19.83	4.45
Nb_ppm	22	0.75	6.77	2.76	2.16	4.09	2.02
Al_ppm	22	4364.03	10255.25	7219.94	6925.99	3119844.40	1766.31
P_ppm	22	141.60	14671.65	1229.84	545.64	9146325.04	3024.29
Si_ppm	22	415030.97	556844.69	512797.64	516285.72	1193006851.67	34539.93
Cl_ppm	22	45.37	313.45	172.79	172.65	4547.19	67.43
Mg_ppm	22	8170.30	14552.31	10605.64	10709.36	1990041.24	1410.69

	Porcellanite						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	25	0.77	92.19	20.90	6.75	694.16	26.35
Zr_ppm	25	5.67	50.50	15.78	14.61	88.08	9.39
Sr_ppm	25	5.89	106.48	21.74	16.41	414.07	20.35
Rb_ppm	25	0.75	38.72	6.81	4.79	56.67	7.53
Cu_ppm	25	48.66	320.98	110.46	94.07	3625.29	60.21
Co_ppm	25	9.77	444.44	185.37	218.77	21767.90	147.54
Fe_ppm	25	689.44	46102.99	9517.71	4233.54	118191246.41	10871.58
V_ppm	25	7.87	2643.36	235.31	23.10	300630.83	548.30
Ti_ppm	25	39.49	1311.31	298.99	230.36	60914.80	246.81
Ca_ppm	25	58.34	1210.06	449.75	427.78	77210.98	277.87
K_ppm	25	25.19	8319.88	1219.21	728.44	2870080.49	1694.13
S_ppm	25	1478.63	36507.05	5588.73	1901.65	74707996.75	8643.38
Ba_ppm	25	43.30	601.38	258.35	227.94	17210.35	131.19
Sb_ppm	25	4.65	31.09	13.00	12.14	55.74	7.47
Sn_ppm	25	5.68	23.74	15.52	16.29	23.35	4.83
Nb_ppm	25	0.75	12.75	2.41	1.98	5.68	2.38
Al_ppm	25	4070.48	26273.52	9159.19	8797.59	20237632.51	4498.63
P_ppm	25	138.98	1142.86	478.11	389.56	106669.39	326.60
Si_ppm	25	421730.81	563817.50	519319.30	529665.94	967259055.53	31100.79
Cl_ppm	25	35.44	298.66	147.34	137.58	3719.80	60.99
Mg_ppm	25	6119.91	11801.79	9585.55	9896.71	2510513.97	1584.46

	Slaven						
Element	Count	Min	Max	Mean	Median	Variance	SD
Mo_ppm	19	0.79	68.02	16.31	3.86	486.07	22.05
Zr_ppm	19	9.88	46.77	28.35	24.87	137.06	11.71
Sr_ppm	19	14.74	162.21	38.94	24.73	1199.76	34.64
Rb_ppm	19	0.75	15.07	7.33	6.53	19.45	4.41
Cu_ppm	19	77.45	185.12	127.86	134.57	976.82	31.25
Co_ppm	19	28.69	1114.93	368.45	349.82	71744.61	267.85
Fe_ppm	19	4109.01	37486.42	11757.23	6664.89	102798971.02	10138.98
V_ppm	19	9.41	122.13	56.01	47.04	985.91	31.40
Ti_ppm	19	118.18	489.84	291.90	250.93	13921.34	117.99
Ca_ppm	19	405.98	5534.63	1383.85	762.91	2121599.50	1456.57
K_ppm	19	32.27	4020.40	1719.29	1449.50	1502466.13	1225.75
S_ppm	19	1505.37	9967.70	4440.79	4108.01	5558548.72	2357.66
Ba_ppm	19	55.63	7944.38	680.36	331.26	3127174.79	1768.38
Sb_ppm	19	4.78	37.03	12.61	10.75	89.06	9.44
Sn_ppm	19	5.63	25.28	14.84	16.30	26.98	5.19
Nb_ppm	19	0.75	5.87	2.81	2.78	1.96	1.40
Al_ppm	19	5927.91	14063.37	8902.15	8864.38	4055275.87	2013.77
P_ppm	19	156.68	2550.28	693.69	515.71	410819.38	640.95
Si_ppm	19	468938.38	574200.88	526135.05	525765.94	803298594.10	28342.52
Cl_ppm	19	56.32	306.94	180.51	161.38	4936.28	70.26
Mg_ppm	19	7139.21	12603.79	9973.46	10306.52	3264047.56	1806.67

Appendix 9: ICP-MS Data

* after sample number indicates use as unknown in LDA

Bold font indicates sample with incomplete digestion

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	7030904	7030910	7030927	7030935	07030906A	07030906B	07030921A	07030930A	07030930B
Li	3.64	7.23	9.54	6.47	6.04	7.72	6.85	7.69	7.73
Be	2.37	0.24	0.45	0.23	1.41	0.63	29.09	0.50	0.64
Sc	0.26	1.48	3.52	1.80	2.62	4.40	2.85	2.56	2.83
V	181.79	10.74	26.50	13.04	87.75	93.37	17.65	85.58	96.30
Cr	19.70	7.61	14.40	76.05	9.99	14.54	12.09	28.00	29.98
Co	38.08	347.09	134.31	9.50	16.48	22.46	17.95	10.20	10.26
Ni	6.64	6.68	3.76	36.66	3.75	4.30	7.30	13.33	13.97
Cu	52.63	4.03	13.68	278.77	7.07	6.30	21.59	109.11	134.79
Rb	4.10	4.55	21.42	7.83	15.85	29.13	12.21	18.92	23.07
Sr	92.31	25.19	160.56	65.58	91.20	125.01	161.49	136.01	163.98
Y	6.48	3.16	13.62	7.57	17.23	16.74	12.29	7.08	7.16
Zr	7.80	18.06	22.19	17.68	58.06	54.63	21.75	19.61	16.64
Cs	0.49	0.59	1.81	0.76	1.74	1.54	1.27	1.28	1.02
La	1.75	2.18	12.87	7.04	28.81	34.07	6.62	6.01	6.03
Ce	2.18	6.03	32.51	25.62	54.19	61.45	13.34	12.33	13.10
Pr	0.37	0.48	3.37	2.06	7.15	8.00	1.71	1.72	1.72
Nd	1.41	1.74	13.07	7.86	28.21	30.59	6.46	6.27	6.41
Sm	0.25	0.33	2.68	1.54	5.46	5.35	1.31	1.08	1.19
Eu	0.16	0.13	0.71	0.38	1.13	1.01	0.49	0.37	0.41
Tb	0.06	0.06	0.28	0.17	0.66	0.57	0.18	0.11	0.12
Gd	0.39	0.38	1.96	1.16	4.35	3.78	1.14	0.76	0.88
Dy	0.40	0.36	1.52	0.90	3.48	3.29	1.06	0.66	0.70
Ho	0.15	0.10	0.36	0.23	0.69	0.68	0.28	0.19	0.20
Er	0.22	0.23	0.89	0.48	1.93	1.91	0.65	0.38	0.38
Yb	0.25	0.33	1.05	0.58	2.00	1.99	0.85	0.50	0.45
Lu	0.04	0.06	0.17	0.09	0.31	0.30	0.14	0.08	0.07
Hf	0.19	0.42	0.69	0.46	1.18	1.11	0.74	0.50	0.40
Ta	0.29	0.13	0.18	0.19	0.42	0.35	0.50	0.23	0.27
Pb	3.14	16.07	19.53	13.49	384.81	587.31	18.05	23.36	25.09
Th	0.30	0.82	3.40	1.34	3.18	3.96	2.29	1.71	1.45
U	4.20	0.63	1.35	0.90	1.53	1.26	1.40	2.06	2.31

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass
SAMPLE	7030912*	7021318	7021320	7021327	7021330	14-GPHS-002	14-GPHS-004	14-GPHS-005*	14-GPHS-006
Li	8.23	10.66	11.76	9.80	9.56	20.47	8.28	10.57	9.42
Be	0.30	0.45	0.33	0.33	0.28	0.51	0.35	0.42	0.36
Sc	1.39	1.21	0.77	1.29	0.79	1.91	0.59	2.26	1.55
V	14.11	14.61	9.37	10.14	9.35	10.46	7.31	16.27	12.15
Cr	21.49	25.08	9.47	20.78	23.16	14.17	13.07	13.94	15.15
Co	22.79	15.16	338.50	266.56	323.78	727.37	742.69	451.88	459.58
Ni	14.14	20.23	5.81	13.96	14.18	28.52	10.07	8.67	4.82
Cu	74.33	90.10	5.07	59.49	88.59	20.46	12.17	17.17	13.34
Rb	11.57	7.58	7.50	5.61	6.24	5.74	5.15	8.72	6.53
Sr	74.32	48.32	74.89	38.26	43.12	41.94	18.60	23.67	33.98
Y	12.61	6.05	11.07	11.70	11.00	8.77	7.98	2.87	8.09
Zr	12.69	15.98	9.11	6.54	6.81	13.78	11.75	13.20	7.36
Cs	0.98	1.36	0.98	1.09	0.95	1.27	1.23	1.53	1.03
La	4.51	4.85	2.87	4.30	3.45	4.86	2.80	3.73	3.08
Ce	10.69	13.08	5.27	8.57	6.57	11.31	7.26	9.88	7.07
Pr	1.36	1.45	0.85	1.23	0.98	1.45	0.90	1.25	0.93
Nd	5.60	5.79	3.44	5.14	3.95	6.11	4.07	5.53	4.11
Sm	1.32	1.30	0.80	1.20	0.90	1.50	1.08	1.17	1.19
Eu	0.36	0.34	0.25	0.32	0.26	0.41	0.30	0.26	0.34
Tb	0.20	0.19	0.11	0.17	0.12	0.27	0.21	0.10	0.22
Gd	1.27	1.25	0.78	1.14	0.84	1.65	1.37	0.74	1.35
Dy	1.14	0.99	0.64	0.93	0.66	1.59	1.22	0.49	1.21
Ho	0.29	0.21	0.19	0.24	0.20	0.32	0.26	0.11	0.27
Er	0.59	0.48	0.30	0.43	0.29	0.80	0.61	0.23	0.52
Yb	0.64	0.48	0.34	0.44	0.31	0.73	0.45	0.30	0.45
Lu	0.10	0.07	0.06	0.07	0.05	0.11	0.07	0.05	0.07
Hf	0.37	0.38	0.31	0.23	0.24	0.36	0.31	0.34	0.21
Ta	0.29	0.23	0.07	0.07	0.07	0.11	0.13	0.10	0.09
Pb	13.65	8.69	7.00	11.12	7.22	10.36	6.94	9.18	5.94
Th	1.49	1.09	0.95	0.71	0.67	0.91	0.65	0.97	0.78
U	0.71	0.57	0.51	0.43	0.41	1.07	0.61	0.58	0.69

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	**Porcellanite**	**Porcellanite**	**Porcellanite**	**Porcellanite**
LOCATION	Garden Pass	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	**Mary's Mtn**	**Mary's Mtn**	**Mary's Mtn**	**Mary's Mtn**
SAMPLE	14-GPHS-007	14-MM-CH-001	14-MM-CH-002	14-MM-CH-003*	14-MM-CH-004	**7020923**	**7020925**	**7020930**	**14-MM-CH-010**
Li	10.31	15.30	20.94	11.41	11.89	**7.41**	**10.97**	**10.95**	**9.66**
Be	0.40	0.53	0.43	0.36	0.62	**0.28**	**0.75**	**0.81**	**1.54**
Sc	0.94	1.08	1.04	0.92	2.33	**-0.07**	**1.39**	**1.94**	**3.91**
V	8.58	7.81	26.12	13.14	52.98	**68.13**	**404.12**	**569.36**	**1730.59**
Cr	15.28	14.60	22.90	17.98	11.60	**15.97**	**176.58**	**142.03**	**75.48**
Co	574.09	402.53	767.36	1156.86	425.52	**318.58**	**93.45**	**81.05**	**40.08**
Ni	13.99	9.57	13.68	21.76	18.62	**17.24**	**53.18**	**60.37**	**144.19**
Cu	10.33	13.53	27.17	30.60	39.38	**19.77**	**65.80**	**67.13**	**115.52**
Rb	5.53	15.90	11.11	5.77	10.36	**3.18**	**16.36**	**19.93**	**40.39**
Sr	33.81	71.27	67.10	56.45	98.42	**8.66**	**22.78**	**37.79**	**40.39**
Y	6.44	7.76	13.78	8.00	34.76	**2.14**	**6.58**	**12.90**	**55.46**
Zr	12.51	16.69	19.08	12.91	20.12	**12.28**	**23.14**	**28.20**	**43.39**
Cs	1.08	0.95	0.88	0.73	1.01	**0.39**	**1.42**	**1.70**	**4.00**
La	3.36	5.43	8.82	4.20	7.75	**1.09**	**4.57**	**7.45**	**15.24**
Ce	9.07	17.30	27.90	15.20	33.02	**2.30**	**6.52**	**10.15**	**19.34**
Pr	1.08	1.77	2.56	1.33	2.81	**0.22**	**1.08**	**1.98**	**4.11**
Nd	4.68	7.43	10.33	5.47	12.84	**0.81**	**4.11**	**8.04**	**17.29**
Sm	1.20	1.78	2.39	1.33	3.71	**0.15**	**0.76**	**1.58**	**3.56**
Eu	0.33	0.47	0.62	0.36	1.01	**0.06**	**0.20**	**0.40**	**0.87**
Tb	0.22	0.27	0.41	0.24	0.81	**0.03**	**0.12**	**0.25**	**0.65**
Gd	1.36	1.73	2.55	1.45	4.87	**0.25**	**0.80**	**1.70**	**4.23**
Dy	1.30	1.47	2.37	1.35	5.06	**0.18**	**0.72**	**1.55**	**4.29**
Ho	0.26	0.29	0.47	0.28	1.00	**0.06**	**0.18**	**0.35**	**0.99**
Er	0.65	0.73	1.26	0.67	2.64	**0.08**	**0.46**	**0.99**	**3.07**
Yb	0.60	0.69	1.17	0.58	2.12	**0.12**	**0.59**	**1.04**	**2.88**
Lu	0.09	0.10	0.18	0.09	0.31	**0.02**	**0.10**	**0.17**	**0.47**
Hf	0.34	0.42	0.46	0.32	0.50	**0.26**	**0.57**	**0.67**	**1.07**
Ta	0.11	0.14	0.27	0.54	0.19	**0.11**	**0.18**	**0.24**	**0.36**
Pb	6.13	3.58	5.10	7.12	14.69	**1.41**	**26.02**	**7.52**	**486.85**
Th	0.83	1.23	1.10	0.76	1.33	**0.29**	**1.42**	**1.59**	**3.24**
U	0.40	0.17	0.36	0.55	40.18	**0.63**	**3.52**	**7.97**	**27.02**

UNIT	**Porcellanite**	**Porcellanite**	**Porcellanite**	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	**Mary's Mtn**	**Mary's Mtn**	**Mary's Mtn**	Ren	Ren	Ren	Ren	Ren	Ren
SAMPLE	**14-MM-CH-011**	**14-MM-CH-012**	**7020927***	7011002	7011009	7011012	7011014	7011016	7011017
Li	**7.63**	**7.73**	**9.15**	4.61	3.19	8.65	5.05	2.62	6.61
Be	**0.59**	**0.34**	**0.82**	0.25	0.19	0.25	0.18	0.20	5.86
Sc	**0.40**	**0.15**	**1.14**	2.04	0.54	1.69	1.00	0.83	0.32
V	**530.64**	**331.65**	**510.33**	17.80	5.13	14.66	11.54	10.34	5.84
Cr	**86.27**	**28.58**	**166.37**	14.66	11.74	13.16	12.84	21.26	6.52
Co	**343.10**	**478.88**	**79.58**	240.92	424.88	372.88	204.62	8.50	19.46
Ni	**37.83**	**20.88**	**60.13**	8.32	6.87	8.23	5.99	9.87	3.35
Cu	**69.37**	**25.86**	**68.29**	11.98	6.84	8.41	9.02	105.71	1.73
Rb	**8.04**	**4.90**	**15.31**	11.94	4.83	11.24	10.39	8.13	5.45
Sr	**14.93**	**11.56**	**19.56**	13.54	9.32	12.60	16.49	9.17	7.74
Y	**3.36**	**2.53**	**13.04**	3.47	2.36	3.84	10.67	5.58	10.22
Zr	**18.99**	**15.66**	**25.44**	22.44	14.51	23.17	10.55	13.46	7.08
Cs	**0.95**	**0.59**	**1.35**	1.63	1.06	1.51	1.23	1.11	0.96
La	**1.78**	**1.40**	**5.26**	3.98	1.92	3.76	2.88	2.91	1.32
Ce	**3.31**	**2.80**	**6.94**	7.87	4.24	7.19	4.51	4.94	2.52
Pr	**0.36**	**0.28**	**1.44**	0.94	0.43	0.89	0.67	0.64	0.36
Nd	**1.31**	**1.00**	**6.07**	3.45	1.55	3.25	2.47	2.25	1.28
Sm	**0.23**	**0.17**	**1.31**	0.61	0.27	0.60	0.52	0.38	0.26
Eu	**0.07**	**0.06**	**0.33**	0.19	0.09	0.18	0.20	0.12	0.11
Tb	**0.04**	**0.04**	**0.23**	0.08	0.04	0.09	0.08	0.05	0.06
Gd	**0.32**	**0.27**	**1.53**	0.54	0.32	0.58	0.56	0.38	0.39
Dy	**0.26**	**0.20**	**1.41**	0.47	0.25	0.53	0.45	0.35	0.36
Ho	**0.08**	**0.07**	**0.32**	0.12	0.08	0.13	0.17	0.13	0.15
Er	**0.17**	**0.11**	**0.87**	0.28	0.12	0.31	0.23	0.18	0.16
Yb	**0.23**	**0.16**	**0.86**	0.35	0.17	0.39	0.27	0.23	0.19
Lu	**0.04**	**0.03**	**0.14**	0.06	0.03	0.06	0.05	0.04	0.04
Hf	**0.39**	**0.30**	**0.55**	0.58	0.35	0.60	0.35	0.34	0.25
Ta	**0.17**	**0.14**	**0.17**	0.16	0.21	0.19	0.13	0.20	0.43
Pb	**7.20**	**7.31**	**15.64**	2.76	1.63	1.66	2.29	13.85	1.62
Th	**0.59**	**0.41**	**1.76**	1.17	0.48	1.05	0.67	0.66	0.38
U	**1.20**	**1.87**	**6.12**	0.44	0.26	0.37	0.26	0.24	0.19

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren	Ren	Ren	Ren	Ren	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	7011021	7011023	7011027	7011030	7011019*	7021452	7021455	07021448A	07021448B
Li	2.43	2.47	5.87	3.50	2.87	19.76	19.30	20.31	16.04
Be	0.15	0.18	0.16	0.18	0.27	0.29	2.56	0.26	0.20
Sc	0.39	0.32	0.91	0.58	0.73	1.19	1.42	1.36	0.74
V	7.35	6.85	9.92	7.06	7.73	17.60	24.69	10.38	9.01
Cr	30.07	12.03	14.50	27.18	24.20	17.06	11.55	24.25	60.94
Co	279.48	453.44	306.33	7.14	9.62	347.94	29.22	219.78	159.89
Ni	13.32	8.34	6.99	13.52	13.55	7.64	2.72	11.28	24.85
Cu	86.48	3.41	3.61	208.46	93.77	4.29	2.85	55.53	145.98
Rb	6.88	5.40	7.49	6.21	6.02	8.95	9.32	9.49	10.80
Sr	6.47	6.97	13.92	8.22	7.52	39.95	40.12	34.53	33.25
Y	10.24	2.30	5.61	5.20	5.43	3.34	6.57	10.71	10.97
Zr	9.04	13.77	11.16	9.47	11.50	19.00	25.50	12.99	22.37
Cs	1.12	0.86	1.27	1.13	1.03	0.66	0.68	0.58	0.73
La	1.66	1.95	2.66	2.69	2.32	3.00	3.68	2.71	5.00
Ce	2.98	4.13	4.79	3.60	3.69	6.09	6.67	4.17	6.41
Pr	0.42	0.41	0.62	0.46	0.47	0.69	0.88	0.65	1.07
Nd	1.48	1.47	2.43	1.53	1.68	2.60	3.27	2.40	3.65
Sm	0.26	0.25	0.46	0.23	0.27	0.48	0.59	0.46	0.58
Eu	0.10	0.09	0.14	0.09	0.10	0.17	0.19	0.16	0.17
Tb	0.05	0.04	0.06	0.04	0.05	0.07	0.09	0.07	0.09
Gd	0.34	0.29	0.47	0.29	0.32	0.48	0.59	0.51	0.61
Dy	0.32	0.22	0.37	0.27	0.32	0.41	0.55	0.47	0.56
Ho	0.15	0.07	0.13	0.12	0.13	0.11	0.17	0.17	0.19
Er	0.16	0.12	0.17	0.12	0.15	0.23	0.29	0.26	0.31
Yb	0.20	0.16	0.21	0.17	0.20	0.29	0.38	0.32	0.37
Lu	0.04	0.03	0.04	0.03	0.03	0.05	0.06	0.06	0.07
Hf	0.29	0.35	0.29	0.26	0.28	0.50	0.51	0.44	0.56
Ta	0.11	0.15	0.11	0.14	0.18	0.16	0.57	0.14	0.11
Pb	2.03	1.34	1.32	9.67	6.26	1.49	1.26	2.29	2.48
Th	0.49	0.53	0.58	0.44	0.53	0.72	0.69	0.80	0.77
U	0.19	0.17	0.21	0.22	0.22	0.28	0.34	0.26	0.25

UNIT	Porcellanite	Porcellanite	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Barite Pit	Barite Pit	Barite Pit	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	14-VCHS-001	7021459*	6301234	6301250	6301237*	7020949	7020953	07020957B	14-MM-CH-006
Li	21.89	17.82	5.20	8.17	9.64	15.31	21.35	21.62	16.20
Be	0.30	0.28	0.36	0.50	0.48	0.27	0.36	0.71	0.37
Sc	1.63	1.12	0.80	1.69	1.23	1.38	1.71	4.30	1.32
V	23.18	10.10	20.88	61.65	40.00	14.57	50.48	74.67	14.96
Cr	20.01	11.21	14.20	18.43	17.35	30.74	31.70	61.32	21.60
Co	431.36	317.47	365.15	290.60	274.72	362.02	362.85	245.55	682.07
Ni	8.38	6.95	13.47	13.07	12.30	21.70	20.29	25.70	17.39
Cu	5.81	5.22	17.87	24.39	22.78	106.61	44.77	133.97	33.69
Rb	10.60	6.90	9.09	21.07	13.84	7.00	10.58	21.71	10.44
Sr	23.65	125.25	92.75	202.64	86.91	32.71	18.24	35.56	14.98
Y	3.31	12.02	7.42	8.55	7.84	10.60	5.80	5.92	3.20
Zr	21.77	22.38	15.35	22.40	10.95	11.82	29.62	51.78	23.55
Cs	0.76	0.55	1.05	2.01	1.47	0.47	0.78	2.15	1.08
La	3.22	7.78	3.66	6.84	3.44	1.68	3.12	4.89	2.46
Ce	5.82	17.64	8.27	12.52	6.98	3.13	6.34	12.14	5.68
Pr	0.68	2.90	1.03	1.77	1.00	0.44	0.87	1.20	0.62
Nd	2.37	13.61	4.25	6.95	4.09	1.56	3.43	4.41	2.26
Sm	0.40	3.23	0.96	1.37	0.89	0.34	0.75	0.87	0.45
Eu	0.16	0.80	0.31	1.23	0.28	0.11	0.19	0.23	0.12
Tb	0.07	0.36	0.16	0.21	0.13	0.07	0.12	0.14	0.07
Gd	0.45	2.69	1.03	1.34	0.90	0.45	0.80	0.89	0.48
Dy	0.43	1.90	0.91	1.20	0.77	0.44	0.75	0.90	0.42
Ho	0.12	0.39	0.20	0.27	0.20	0.17	0.18	0.21	0.11
Er	0.26	1.08	0.49	0.71	0.37	0.24	0.48	0.61	0.25
Yb	0.33	1.33	0.45	0.70	0.37	0.32	0.58	0.83	0.35
Lu	0.05	0.24	0.07	0.11	0.06	0.06	0.10	0.14	0.06
Hf	0.57	0.49	0.39	0.65	0.29	0.41	0.70	1.33	0.72
Ta	0.18	0.15	0.06	0.15	0.05	0.12	0.19	0.12	0.25
Pb	1.57	2.12	3.45	4.76	9.16	2.81	3.83	5.61	2.49
Th	0.85	1.09	0.90	1.82	0.96	0.58	1.06	2.19	1.26
U	0.34	0.34	0.62	1.18	0.89	0.57	1.80	1.06	1.16

UNIT	**Slaven**	**Slaven**	**Slaven**	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	**Mary's Mtn**	**Mary's Mtn**	**Mary's Mtn**	Slaven Canyon	Slaven Canyon	Slaven Canyon	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	**14-MM-CH-007***	**14-MM-CH-008**	**14-MM-CH-009**	6301134	6301138	6301150	7021426	7021430	14-VCHS-002
Li	**17.49**	**21.52**	**16.89**	11.59	11.39	12.47	18.88	20.90	19.95
Be	**0.56**	**0.54**	**0.45**	0.62	0.55	0.43	0.38	0.35	0.25
Sc	**4.24**	**2.89**	**2.12**	2.09	2.35	1.81	1.22	1.72	1.08
V	**81.08**	**28.98**	**17.20**	14.24	13.11	27.55	16.99	21.07	31.60
Cr	**70.06**	**68.50**	**28.33**	65.06	16.08	21.62	16.54	64.40	19.35
Co	**354.29**	**456.34**	**1025.96**	7.70	247.53	334.71	509.11	12.24	558.15
Ni	**37.68**	**58.43**	**22.86**	25.87	9.05	14.66	9.40	33.33	12.16
Cu	**63.30**	**82.10**	**59.08**	239.71	16.03	30.21	66.92	203.15	32.13
Rb	**19.68**	**16.00**	**12.48**	22.10	20.12	13.69	7.26	6.93	4.81
Sr	**23.43**	**21.67**	**15.12**	24.43	36.52	51.84	55.95	25.80	23.45
Y	**9.52**	**13.95**	**4.55**	5.32	12.15	5.18	11.81	6.75	4.78
Zr	**44.14**	**37.15**	**28.33**	30.34	18.49	26.07	20.68	30.45	30.00
Cs	**1.68**	**1.35**	**1.36**	1.54	1.24	1.28	0.49	0.53	0.38
La	**5.23**	**6.74**	**3.86**	5.11	4.97	4.24	3.01	3.15	3.13
Ce	**10.30**	**17.42**	**9.58**	11.33	8.73	8.61	5.80	6.34	5.87
Pr	**1.59**	**2.51**	**1.20**	1.41	1.36	1.12	0.92	0.84	0.86
Nd	**6.52**	**10.74**	**4.59**	5.48	5.54	4.46	3.89	3.14	3.47
Sm	**1.56**	**2.58**	**0.96**	1.14	1.25	0.93	0.90	0.60	0.74
Eu	**0.37**	**0.60**	**0.22**	0.32	0.33	0.26	0.27	0.17	0.21
Tb	**0.25**	**0.40**	**0.13**	0.16	0.18	0.14	0.15	0.09	0.12
Gd	**1.56**	**2.54**	**0.87**	1.04	1.19	0.88	0.96	0.60	0.81
Dy	**1.52**	**2.24**	**0.72**	0.87	1.05	0.79	0.88	0.58	0.71
Ho	**0.32**	**0.44**	**0.16**	0.19	0.27	0.18	0.24	0.18	0.16
Er	**0.89**	**1.14**	**0.39**	0.45	0.55	0.44	0.45	0.32	0.40
Yb	**1.03**	**1.00**	**0.49**	0.49	0.58	0.48	0.51	0.44	0.47
Lu	**0.17**	**0.15**	**0.08**	0.08	0.10	0.08	0.09	0.08	0.08
Hf	**1.13**	**1.10**	**0.86**	0.77	0.58	0.62	0.67	0.65	0.54
Ta	**0.28**	**0.29**	**0.34**	0.27	0.23	0.14	0.19	0.22	0.13
Pb	**5.22**	**5.40**	**3.84**	10.05	3.46	2.51	3.82	2.30	1.95
Th	**1.93**	**2.31**	**1.50**	2.01	1.88	1.44	0.96	0.77	0.43
U	**1.69**	**1.52**	**0.72**	0.37	0.32	0.67	0.51	0.45	0.91

UNIT	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14-VCHS-003	14-VCHS-004	7021435*
Li	23.44	25.14	17.95
Be	0.43	0.39	0.33
Sc	2.89	2.65	1.37
V	115.77	63.31	79.39
Cr	29.87	25.96	53.73
Co	587.92	454.16	6.31
Ni	12.62	8.82	20.04
Cu	45.18	15.85	128.50
Rb	10.28	11.94	6.10
Sr	45.55	45.31	30.89
Y	6.65	6.01	7.39
Zr	37.19	36.36	25.78
Cs	0.81	0.90	0.46
La	4.67	4.99	3.42
Ce	9.79	9.74	5.16
Pr	1.40	1.49	0.87
Nd	5.66	6.20	3.40
Sm	1.28	1.48	0.73
Eu	0.34	0.38	0.21
Tb	0.20	0.21	0.11
Gd	1.28	1.35	0.77
Dy	1.16	1.18	0.72
Ho	0.25	0.24	0.21
Er	0.64	0.63	0.42
Yb	0.73	0.77	0.51
Lu	0.12	0.13	0.09
Hf	1.05	1.07	0.54
Ta	0.18	0.18	0.16
Pb	3.57	2.83	3.57
Th	1.35	1.43	0.82
U	1.19	0.90	1.23

Appendix 10: Summary Statistics for ICP-MS

	Cherry Spring							Porcellanite						
Element	Count	Min	Max	Mean	Median	Variance	SD	Count	Min	Max	Mean	Median	Variance	SD
Li_ppm	23	3.64	20.94	10.07	9.54	17.06	4.13	24	2.43	21.89	9.44	7.68	40.50	6.36
Be_ppm	23	0.23	29.09	1.79	0.43	35.62	5.97	24	0.15	5.86	0.71	0.28	1.50	1.23
Sc_ppm	23	0.26	4.40	1.76	1.48	1.05	1.02	24	-0.07	3.91	1.07	0.96	0.69	0.83
V_ppm	23	7.31	181.79	35.87	14.11	1946.60	44.12	24	5.13	1730.59	181.00	13.10	145900.69	381.97
Cr_ppm	23	7.61	76.05	19.61	15.15	186.63	13.66	24	6.52	176.58	42.69	20.63	2545.01	50.45
Co_ppm	23	9.50	1156.86	316.57	323.78	101071.83	317.92	24	7.14	478.88	219.49	230.35	25907.52	160.96
Ni_ppm	23	3.75	36.66	12.80	13.33	67.42	8.21	24	2.72	144.19	23.08	10.57	964.19	31.05
Cu_ppm	23	4.03	278.77	49.12	21.59	3883.52	62.32	24	1.73	208.46	49.62	22.81	3016.58	54.92
Rb_ppm	23	4.10	29.13	10.89	7.83	46.11	6.79	24	3.18	40.39	10.34	8.54	56.55	7.52
Sr_ppm	23	18.60	163.98	75.89	67.10	2108.74	45.92	24	6.47	125.25	23.52	14.42	614.13	24.78
Y_ppm	23	2.87	34.76	10.53	8.09	42.18	6.49	24	2.14	55.46	8.66	5.59	113.16	10.64
Zr_ppm	23	6.54	58.06	18.04	15.98	168.67	12.99	24	7.08	43.39	18.22	17.33	65.97	8.12
Cs_ppm	23	0.49	1.81	1.11	1.03	0.11	0.34	24	0.39	4.00	1.14	1.04	0.50	0.71
La_ppm	23	1.75	34.07	7.36	4.85	64.38	8.02	24	1.09	15.24	3.76	2.90	9.03	3.00
Ce_ppm	23	2.18	61.45	17.52	12.33	234.03	15.30	24	2.30	19.34	6.19	4.86	18.04	4.25
Pr_ppm	23	0.37	8.00	2.02	1.45	3.58	1.89	24	0.22	4.11	0.94	0.66	0.81	0.90
Nd_ppm	23	1.41	30.59	8.11	5.79	53.51	7.32	24	0.81	17.29	3.72	2.42	16.02	4.00
Sm_ppm	23	0.25	5.46	1.74	1.30	1.87	1.37	24	0.15	3.56	0.73	0.46	0.79	0.89
Eu_ppm	23	0.13	1.13	0.45	0.36	0.07	0.27	24	0.06	0.87	0.21	0.16	0.04	0.21
Tb_ppm	23	0.06	0.81	0.25	0.20	0.04	0.19	24	0.03	0.65	0.11	0.07	0.02	0.14
Gd_ppm	23	0.38	4.87	1.62	1.27	1.42	1.19	24	0.25	4.23	0.79	0.48	0.86	0.92
Dy_ppm	23	0.36	5.06	1.43	1.14	1.28	1.13	24	0.18	4.29	0.70	0.42	0.78	0.88
Ho_ppm	23	0.10	1.00	0.32	0.26	0.04	0.21	24	0.06	0.99	0.19	0.13	0.04	0.19
Er_ppm	23	0.22	2.64	0.75	0.59	0.39	0.62	24	0.08	3.07	0.42	0.23	0.39	0.63
Yb_ppm	23	0.25	2.12	0.75	0.58	0.31	0.56	24	0.12	2.88	0.48	0.28	0.35	0.59
Lu_ppm	23	0.04	0.31	0.12	0.09	0.01	0.08	24	0.02	0.47	0.08	0.05	0.01	0.10
Hf_ppm	23	0.19	1.18	0.46	0.38	0.06	0.25	24	0.25	1.07	0.45	0.41	0.03	0.18
Ta_ppm	23	0.07	0.54	0.22	0.19	0.02	0.13	24	0.11	0.57	0.20	0.17	0.01	0.11
Pb_ppm	23	3.14	587.31	52.50	10.36	19684.06	140.30	24	1.26	486.85	25.32	2.29	9700.27	98.49
Th_ppm	23	0.30	3.96	1.39	1.09	0.89	0.95	24	0.29	3.24	0.88	0.68	0.40	0.63
U_ppm	23	0.17	40.18	2.73	0.69	67.41	8.21	24	0.17	27.02	2.20	0.31	31.88	5.65

	Slaven						
Element	Count	Min	Max	Mean	Median	Variance	SD
Li_ppm	19	5.20	25.14	16.59	17.49	30.55	5.53
Be_ppm	19	0.25	0.71	0.44	0.43	0.01	0.12
Sc_ppm	19	0.80	4.30	2.05	1.72	0.97	0.98
V_ppm	19	13.11	115.77	41.45	28.98	891.38	29.86
Cr_ppm	19	14.20	70.06	35.52	28.33	425.61	20.63
Co_ppm	19	6.31	1025.96	375.65	362.02	60159.11	245.27
Ni_ppm	19	8.82	58.43	20.46	17.39	149.97	12.25
Cu_ppm	19	15.85	239.71	71.91	45.18	4116.30	64.16
Rb_ppm	19	4.81	22.10	12.90	11.94	32.56	5.71
Sr_ppm	19	14.98	202.64	46.51	32.71	1905.46	43.65
Y_ppm	19	3.20	13.95	7.55	6.75	8.36	2.89
Zr_ppm	19	10.95	51.78	27.92	28.33	111.02	10.54
Cs_ppm	19	0.38	2.15	1.11	1.08	0.28	0.53
La_ppm	19	1.68	6.84	4.14	3.86	1.83	1.35
Ce_ppm	19	3.13	17.42	8.62	8.61	11.01	3.32
Pr_ppm	19	0.44	2.51	1.18	1.12	0.22	0.47
Nd_ppm	19	1.56	10.74	4.74	4.41	4.10	2.02
Sm_ppm	19	0.34	2.58	1.04	0.93	0.25	0.50
Eu_ppm	19	0.11	1.23	0.32	0.27	0.06	0.24
Tb_ppm	19	0.07	0.40	0.16	0.14	0.01	0.07
Gd_ppm	19	0.45	2.54	1.04	0.90	0.22	0.47
Dy_ppm	19	0.42	2.24	0.94	0.87	0.17	0.42
Ho_ppm	19	0.11	0.44	0.22	0.20	0.01	0.07
Er_ppm	19	0.24	1.14	0.52	0.45	0.05	0.22
Yb_ppm	19	0.32	1.03	0.58	0.51	0.04	0.21
Lu_ppm	19	0.06	0.17	0.10	0.09	0.00	0.03
Hf_ppm	19	0.29	1.33	0.74	0.67	0.08	0.28
Ta_ppm	19	0.05	0.34	0.19	0.18	0.01	0.08
Pb_ppm	19	1.95	10.05	4.24	3.57	4.68	2.16
Th_ppm	19	0.43	2.31	1.35	1.35	0.31	0.56
U_ppm	19	0.32	1.80	0.94	0.90	0.19	0.44

Appendix 11: ICP-MS Correlation Coefficient Matrices

	Cherry Spring																													
	Li	Be	Sc	V	Cr	Co	Ni	Cu	Rb	Sr	Y	Zr	Cs	La	Ce	Pr	Nd	Sm	Eu	Tb	Gd	Dy	Ho	Er	Yb	Lu	Hf	Ta	Pb	Th	U
Li	1																														
Be	-0.2	1																													
Sc	-0.18	0.23	1																												
V	-0.45	-0.02	0.24	1																											
Cr	-0.17	-0.13	-0.02	0.01	1																										
Co	0.62	-0.23	-0.45	-0.45	-0.28	1																									
Ni	0.3	-0.17	-0.2	-0.27	0.7	0.2	1																								
Cu	-0.27	-0.1	-0	0.08	0.96	-0.4	0.68	1																							
Rb	-0.12	0.05	0.83	0.38	-0	-0.47	-0.31	0.02	1																						
Sr	-0.27	0.43	0.68	0.51	0.05	-0.56	-0.23	0.14	0.77	1																					
Y	0.11	0.07	0.34	0.14	-0.18	-0.06	-0.03	-0.14	0.27	0.33	1																				
Zr	-0.19	0.08	0.69	0.36	-0.12	-0.34	-0.28	-0.16	0.67	0.41	0.38	1																			
Cs	9.40E-04	0.1	0.67	-0.03	-0.26	-0.25	-0.3	-0.27	0.54	0.31	0.2	0.56	1																		
La	-0.15	-0	0.71	0.36	-0.09	-0.33	-0.28	-0.15	0.71	0.41	0.43	0.96	0.59	1																	
Ce	-0.023	-0.05	0.69	0.28	0.01	-0.23	-0.12	-0.07	0.68	0.41	0.58	0.91	0.53	0.95	1																
Pr	-0.1	-0.02	0.71	0.34	-0.08	-0.3	-0.24	-0.14	0.71	0.41	0.49	0.96	0.6	0.99	0.97	1															
Nd	-0.075	-0.03	0.7	0.32	-0.1	-0.27	-0.23	-0.16	0.69	0.39	0.53	0.95	0.61	0.99	0.97	1	1														
Sm	0.024	-0.06	0.64	0.25	-0.14	-0.17	-0.18	-0.2	0.61	0.34	0.67	0.89	0.58	0.93	0.97	0.96	0.98	1													
Eu	0.062	0.04	0.66	0.26	-0.16	-0.17	-0.16	-0.18	0.62	0.46	0.78	0.83	0.56	0.84	0.93	0.89	0.91	0.97	1												
Tb	0.2	-0.07	0.42	0.16	-0.22	0.05	-0.04	-0.25	0.36	0.2	0.86	0.67	0.37	0.68	0.81	0.74	0.78	0.89	0.93	1											
Gd	0.17	-0.08	0.46	0.17	-0.2	0.01	-0.07	-0.24	0.41	0.22	0.84	0.71	0.41	0.73	0.85	0.79	0.82	0.93	0.95	1	1										
Dy	0.21	-0.06	0.41	0.16	-0.22	0.07	-0.02	-0.24	0.34	0.2	0.88	0.62	0.32	0.63	0.77	0.7	0.74	0.86	0.91	1	0.99	1									
Ho	0.15	-0.02	0.44	0.2	-0.2	0	-0.05	-0.22	0.38	0.27	0.92	0.63	0.32	0.65	0.79	0.71	0.75	0.87	0.92	0.99	0.98	0.99	1								
Er	0.17	-0.02	0.47	0.2	-0.22	0.02	-0.05	-0.24	0.4	0.26	0.88	0.68	0.35	0.69	0.82	0.75	0.78	0.89	0.93	0.99	0.99	1	0.99	1							
Yb	0.084	0.05	0.6	0.25	-0.19	-0.12	-0.13	-0.22	0.53	0.38	0.82	0.8	0.45	0.81	0.9	0.85	0.88	0.95	0.98	0.96	0.97	0.95	0.96	0.98	1						
Lu	0.07	0.07	0.61	0.25	-0.19	-0.13	-0.14	-0.22	0.54	0.4	0.82	0.81	0.45	0.82	0.91	0.86	0.89	0.95	0.98	0.95	0.96	0.94	0.95	0.97	1	1					
Hf	-0.19	0.25	0.77	0.28	-0.12	-0.39	-0.3	-0.16	0.7	0.53	0.42	0.97	0.63	0.93	0.89	0.93	0.92	0.87	0.83	0.64	0.68	0.59	0.61	0.66	0.8	0.82	1				
Ta	-0.24	0.48	0.31	0.36	-0.01	-0.09	-0.04	-0.01	0.33	0.51	0.18	0.5	0.06	0.42	0.42	0.42	0.41	0.37	0.39	0.28	0.29	0.27	0.28	0.31	0.39	0.41	0.53	1			
Pb	-0.24	-0.03	0.61	0.39	-0.15	-0.31	-0.33	-0.2	0.61	0.27	0.31	0.91	0.48	0.95	0.83	0.92	0.91	0.83	0.7	0.57	0.62	0.53	0.54	0.58	0.69	0.7	0.83	0.38	1		
Th	-0.21	0.21	0.87	0.25	-0.09	-0.48	-0.34	-0.12	0.83	0.67	0.39	0.85	0.71	0.87	0.84	0.87	0.86	0.79	0.78	0.52	0.57	0.48	0.52	0.55	0.71	0.72	0.92	0.43	0.76	1	
U	0.043	-0.03	0.14	0.18	-0.12	0.02	0.13	-0.02	0.01	0.17	0.81	0.05	-0.07	0.02	0.22	0.1	0.15	0.31	0.45	0.63	0.58	0.69	0.7	0.66	0.53	0.52	0.05	-0	-0.05	0	1

Porcellanite

	Li	Be	Sc	V	Cr	Co	Ni	Cu	Rb	Sr	Y	Zr	Cs	La	Ce	Pr	Nd	Sm	Eu	Tb	Gd	Dy	Ho	Er	Yb	Lu	Hf	Ta	Pb	Th	U
Li	1																														
Be	0.066	1																													
Sc	0.32	0.038	1																												
V	0.0094	0.13	0.67	1																											
Cr	0.065	-0.014	0.27	0.55	1																										
Co	0.089	-0.43	-0.28	-0.25	-0.34	1																									
Ni	0.014	0.074	0.67	0.97	0.65	-0.33	1																								
Cu	-0.2	-0.18	0.08	0.28	0.33	-0.57	0.39	1																							
Rb	0.16	0.095	0.9	0.89	0.51	-0.37	0.91	0.27	1																						
Sr	0.62	-0.025	0.32	0.12	0.037	0.0081	0.12	-0.13	0.2	1																					
Y	0.084	0.22	0.74	0.85	0.27	-0.39	0.85	0.32	0.89	0.28	1																				
Zr	0.41	0.0097	0.83	0.76	0.49	-0.15	0.76	0.081	0.85	0.43	0.66	1																			
Cs	-0.22	0.1	0.81	0.83	0.34	-0.35	0.83	0.29	0.9	-0.028	0.84	0.66	1																		
La	0.25	0.047	0.86	0.79	0.39	-0.33	0.82	0.25	0.91	0.54	0.88	0.86	0.79	1																	
Ce	0.33	0.0019	0.78	0.61	0.22	-0.17	0.61	0.05	0.73	0.75	0.73	0.8	0.61	0.93	1																
Pr	0.27	0.063	0.79	0.73	0.34	-0.28	0.75	0.16	0.82	0.66	0.84	0.81	0.7	0.98	0.97	1															
Nd	0.27	0.059	0.75	0.7	0.32	-0.25	0.72	0.13	0.78	0.7	0.82	0.78	0.66	0.96	0.98	1	1														
Sm	0.27	0.06	0.7	0.66	0.29	-0.21	0.67	0.086	0.72	0.75	0.78	0.74	0.61	0.92	0.97	0.98	0.99	1													
Eu	0.3	0.068	0.71	0.64	0.25	-0.21	0.64	0.064	0.72	0.76	0.78	0.73	0.6	0.92	0.97	0.98	0.99	1	1												
Tb	0.22	0.12	0.78	0.81	0.36	-0.28	0.82	0.17	0.86	0.57	0.9	0.8	0.75	0.97	0.93	0.98	0.98	0.96	0.96	1											
Gd	0.22	0.1	0.75	0.78	0.34	-0.26	0.79	0.15	0.82	0.62	0.88	0.78	0.72	0.96	0.94	0.99	0.99	0.98	0.97	1	1										
Dy	0.19	0.13	0.8	0.85	0.36	-0.31	0.85	0.2	0.89	0.5	0.93	0.81	0.8	0.97	0.9	0.97	0.96	0.93	0.93	1	0.99	1									
Ho	0.16	0.17	0.79	0.85	0.34	-0.37	0.86	0.26	0.9	0.44	0.97	0.77	0.82	0.96	0.86	0.94	0.93	0.9	0.9	0.98	0.96	0.99	1								
Er	0.16	0.13	0.81	0.88	0.37	-0.3	0.88	0.22	0.91	0.44	0.94	0.81	0.83	0.97	0.87	0.95	0.93	0.91	0.9	0.98	0.97	1	0.99	1							
Yb	0.21	0.11	0.8	0.85	0.37	-0.29	0.85	0.19	0.89	0.52	0.92	0.82	0.79	0.98	0.91	0.97	0.96	0.94	0.93	0.99	0.99	1	0.99	0.99	1						
Lu	0.22	0.11	0.79	0.83	0.36	-0.28	0.83	0.18	0.87	0.56	0.91	0.81	0.77	0.97	0.92	0.98	0.97	0.95	0.95	1	0.99	1	0.98	0.99	1	1					
Hf	0.41	0.012	0.92	0.74	0.43	-0.17	0.76	0.1	0.91	0.38	0.73	0.96	0.74	0.89	0.8	0.82	0.78	0.73	0.73	0.81	0.78	0.82	0.8	0.83	0.83	0.82	1				
Ta	0.21	0.78	0.34	0.26	-0.014	-0.47	0.19	-0.16	0.3	0.096	0.32	0.35	0.26	0.27	0.23	0.25	0.23	0.21	0.22	0.27	0.25	0.3	0.32	0.3	0.29	0.28	0.29	1			
Pb	-0.002	0.14	0.73	0.88	0.19	-0.26	0.85	0.28	0.86	0.14	0.94	0.67	0.87	0.82	0.66	0.75	0.73	0.68	0.67	0.83	0.8	0.87	0.9	0.9	0.87	0.85	0.72	0.31	1		
Th	0.18	0.052	0.89	0.86	0.56	-0.32	0.89	0.2	0.96	0.33	0.85	0.88	0.86	0.93	0.81	0.88	0.85	0.81	0.8	0.91	0.88	0.92	0.91	0.93	0.92	0.91	0.92	0.24	0.81	1	
U	0.024	0.14	0.76	0.96	0.43	-0.31	0.95	0.28	0.94	0.16	0.93	0.77	0.89	0.87	0.69	0.81	0.78	0.73	0.72	0.88	0.85	0.92	0.93	0.95	0.91	0.89	0.79	0.31	0.95	0.9	1

	Slaven																												
	Li	Be	Sc	V	Cr	Co	Ni	Cu	Rb	Sr	Y	Zr	Cs	La	Ce	Pr	Nd	Sm	Eu	Tb	Gd	Dy	Ho	Er	Yb	Lu	Hf	Ta	Pb	Th	U
Li	1																													
Be	-0.11	1																												
Sc	0.44	0.73	1																											
V	0.41	0.19	0.54	1																										
Cr	0.38	0.45	0.6	0.24	1																									
Co	0.2	-0.19	-0.01	-0.08	-0.43	1																								
Ni	0.27	0.33	0.46	-0.02	0.83	-0.12	1																							
Cu	0.16	0.24	0.15	-0.11	0.75	-0.55	0.46	1																						
Rb	-0.28	0.93	0.63	0.12	0.31	-0.21	0.23	0.1	1																					
Sr	-0.57	0.08	-0.23	0.15	-0.41	-0.15	-0.35	-0.33	0.25	1																				
Y	-0.07	0.16	0.13	-0.1	0.12	-0.18	0.33	-0.06	0.15	0.15	1																			
Zr	0.66	0.49	0.84	0.56	0.66	0.023	0.46	0.26	0.35	-0.34	-0.17	1																		
Cs	-0.34	0.87	0.57	0.16	0.22	-0.044	0.22	-0.02	0.91	0.38	-0.009	0.34	1																	
La	-0.04	0.69	0.57	0.34	0.31	-0.12	0.34	-0.04	0.75	0.39	0.3	0.47	0.7	1																
Ce	0.049	0.73	0.61	0.22	0.41	0.03	0.53	0.042	0.71	0.19	0.26	0.54	0.7	0.9	1															
Pr	0.073	0.6	0.54	0.26	0.36	0.014	0.51	-0.07	0.62	0.22	0.43	0.45	0.6	0.9	0.9	1														
Nd	0.084	0.55	0.51	0.24	0.33	0.029	0.5	-0.11	0.56	0.2	0.47	0.41	0.5	0.9	0.9	1	1													
Sm	0.14	0.49	0.51	0.23	0.33	0.058	0.52	-0.14	0.49	0.12	0.52	0.4	0.4	0.9	0.9	1	1	1												
Eu	-0.29	0.31	0.12	0.23	-0.05	-0.075	0.07	-0.22	0.5	0.8	0.31	0.04	0.5	0.8	0.6	0.7	0.7	0.6	1											
Tb	0.15	0.47	0.52	0.26	0.34	0.056	0.55	-0.15	0.46	0.11	0.57	0.41	0.4	0.8	0.9	1	1	1	0.56	1										
Gd	0.14	0.45	0.49	0.24	0.33	0.057	0.54	-0.16	0.45	0.12	0.57	0.39	0.4	0.8	0.9	1	1	1	0.57	1	1									
Dy	0.17	0.47	0.55	0.3	0.37	0.028	0.57	-0.14	0.46	0.11	0.58	0.44	0.4	0.8	0.8	0.9	1	1	0.56	1	1	1								
Ho	0.14	0.44	0.51	0.28	0.38	-0.083	0.56	-0.1	0.41	0.14	0.76	0.33	0.3	0.8	0.7	0.9	0.9	0.9	0.54	1	1	1	1							
Er	0.21	0.52	0.65	0.41	0.42	0.0079	0.57	-0.13	0.51	0.14	0.52	0.55	0.5	0.8	0.9	0.9	0.9	0.9	0.58	1	1	1	0.9	1						
Yb	0.41	0.57	0.84	0.58	0.52	0.0092	0.52	-0.06	0.52	0.004	0.36	0.77	0.5	0.8	0.8	0.8	0.8	0.8	0.45	0.8	0.8	0.9	0.8	0.9	1					
Lu	0.46	0.56	0.87	0.6	0.53	-0.009	0.49	-0.03	0.51	-0.03	0.34	0.8	0.5	0.7	0.7	0.7	0.7	0.7	0.4	0.8	0.8	0.8	0.8	0.9	1	1				
Hf	0.64	0.58	0.89	0.5	0.56	0.2	0.45	0.15	0.45	-0.28	-0.016	0.93	0.4	0.6	0.7	0.6	0.5	0.5	0.13	0.5	0.5	0.6	0.5	0.6	0.8	0.8	1			
Ta	0.32	0.28	0.37	-0.15	0.44	0.32	0.51	0.25	0.26	-0.48	0.061	0.39	0.1	0.3	0.4	0.4	0.4	0.4	0.01	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	1		
Pb	-0.32	0.66	0.21	0.03	0.33	-0.33	0.22	0.36	0.61	0.15	0.097	0.03	0.6	0.4	0.4	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.07	0.01	1	
Th	0.002	0.9	0.74	0.18	0.43	-0.031	0.44	0.1	0.9	0.06	0.22	0.55	0.8	0.8	0.9	0.8	0.8	0.7	0.46	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.69	0.49	0.45	1	
U	0.37	0.07	0.38	0.61	0.29	0.15	0.39	-0.25	0.09	-0.03	-0.008	0.47	0.2	0.3	0.3	0.3	0.3	0.4	0.23	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.43	0.12	0.008	0.2	1

Appendix 12: ICP-ES Data

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range	Adobe Range
SAMPLE	7030904	7030910	7030912	7030927	7030935	07030906A	07030906B	07030921A	07030930A
P_2O_5_Wt%	0.05	0.04	0.04	0.09	0.06	0.08	0.12	0.04	0.08
SiO_2_Wt%	102.36	98.78	94.72	94.13	94.52	92.69	85.86	94.60	91.61
MnO_Wt%	0.00	0.00	0.03	0.02	0.04	0.00	0.00	0.02	0.02
Fe_2O_3_Wt%	0.32	0.38	2.33	2.18	4.83	0.72	4.74	0.67	3.06
MgO_Wt%	0.05	0.06	0.06	0.15	0.14	0.30	0.28	0.13	0.18
Al_2O_3_Wt%	0.53	0.70	0.99	1.84	1.58	1.82	1.58	1.58	1.34
TiO_2_Wt%	0.03	0.04	0.06	0.13	0.07	0.15	0.15	0.10	0.09
CaO_Wt%	0.13	0.04	0.05	0.08	0.10	0.18	0.15	0.13	0.06
Na_2O_Wt%	0.04	0.07	0.03	0.04	0.05	0.05	0.07	0.05	0.09
K_2O_Wt%	0.12	0.16	0.30	0.67	0.23	0.55	1.27	0.44	0.51
Ba_ppm	1296.69	812.23	1087.10	3426.84	1274.47	1405.82	1487.21	3343.38	2750.42
Sr_ppm	87.96	28.72	69.28	146.75	68.08	82.57	117.89	144.68	128.29

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring
LOCATION	Adobe Range	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass	Garden Pass
SAMPLE	07030930B	7021318	7021320	7021327	7021330	14-GPHS-002	14-GPHS-004	14-GPHS-005	14-GPHS-006
P_2O_5_Wt%	0.09	0.07	0.06	0.07	0.04	0.11	0.06	0.04	0.05
SiO_2_Wt%	90.73	95.40	97.26	96.70	96.91	97.58	97.99	97.98	97.11
MnO_Wt%	0.02	0.12	0.01	0.13	0.05	0.32	0.05	0.04	0.04
Fe_2O_3_Wt%	4.05	2.54	1.03	1.92	2.42	1.26	0.77	0.96	0.84
MgO_Wt%	0.14	0.15	0.08	0.06	0.07	0.13	0.09	0.15	0.13
Al_2O_3_Wt%	1.07	1.11	0.84	0.76	0.76	0.99	0.78	1.32	0.98
TiO_2_Wt%	0.07	0.05	0.04	0.04	0.04	0.05	0.04	0.05	0.04
CaO_Wt%	0.07	0.15	0.09	0.06	0.07	0.23	0.07	0.10	0.16
Na_2O_Wt%	0.07	0.05	0.04	0.03	0.03	0.04	0.01	0.03	0.03
K_2O_Wt%	0.51	0.19	0.22	0.14	0.15	0.16	0.06	0.22	0.19
Ba_ppm	2977.11	869.91	853.65	771.34	790.87	915.43	558.96	571.98	762.63
Sr_ppm	148.21	50.83	67.78	38.67	42.89	41.90	26.49	30.54	35.73

UNIT	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Cherry Spring	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Garden Pass	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn	Ren	Ren	Ren	Ren
SAMPLE	14-GPHS-007	14-MM-CH-001	14-MM-CH-002	14-MM-CH-003	14-MM-CH-004	7011002	7011009	7011012	7011014
P_2O_5_Wt%	0.05	0.06	0.05	0.05	1.40	0.04	0.05	0.04	0.04
SiO_2_Wt%	93.98	99.41	94.49	98.18	88.39	96.32	99.46	98.02	97.98
MnO_Wt%	0.12	0.04	0.05	0.41	0.52	0.00	0.00	0.00	0.02
Fe_2O_3_Wt%	1.00	1.14	0.99	1.34	1.15	0.41	0.32	0.35	0.48
MgO_Wt%	0.10	0.25	0.17	0.10	0.19	0.13	0.05	0.18	0.14
Al_2O_3_Wt%	0.87	1.23	1.50	0.85	1.30	1.57	0.71	1.62	1.83
TiO_2_Wt%	0.04	0.05	0.05	0.04	0.06	0.08	0.04	0.09	0.09
CaO_Wt%	0.07	0.05	0.13	0.06	4.02	0.05	0.02	0.03	0.06
Na_2O_Wt%	0.04	0.05	0.05	0.04	0.06	0.02	0.01	0.03	0.03
K_2O_Wt%	0.16	0.50	0.37	0.17	0.36	0.37	0.15	0.35	0.39
Ba_ppm	601.44	432.66	476.24	540.02	505.08	598.44	367.97	588.22	779.73
Sr_ppm	34.39	71.25	64.90	55.75	94.31	18.57	13.74	18.71	32.17

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Ren	Ren	Ren	Ren	Ren	Ren	Ren	Mary's Mtn	Mary's Mtn
SAMPLE	7011016	7011017	7011019	7011021	7011023	7011027	7011030	14-MM-CH-010	14-MM-CH-011
P_2O_5_Wt%	0.04	0.03	0.04	0.01	0.04	0.05	0.04	0.10	0.04
SiO_2_Wt%	97.56	99.64	98.21	96.43	97.17	99.69	97.73	65.92	93.60
MnO_Wt%	0.02	0.02	0.02	0.03	0.00	0.00	0.03	0.03	0.03
Fe_2O_3_Wt%	1.68	0.23	2.18	2.18	0.35	0.31	2.68	1.46	0.59
MgO_Wt%	0.15	0.06	0.11	0.06	0.10	0.08	0.13	0.47	0.12
Al_2O_3_Wt%	1.26	0.90	0.83	0.80	0.83	1.05	0.89	4.89	0.97
TiO_2_Wt%	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.24	0.06
CaO_Wt%	0.04	0.03	0.02	0.02	0.01	0.03	0.06	0.14	0.07
Na_2O_Wt%	0.07	0.02	0.03	0.03	0.04	0.01	0.06	0.07	0.05
K_2O_Wt%	0.25	0.16	0.13	0.17	0.13	0.23	0.14	1.20	0.18
Ba_ppm	525.43	367.11	357.54	379.30	382.77	459.89	386.89	736.47	217.08
Sr_ppm	15.13	17.73	12.19	12.47	11.84	17.13	13.90	50.82	21.60

UNIT	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite	Porcellanite
LOCATION	Mary's Mtn	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Vinini Creek	Mary's Mtn	Mary's Mtn
SAMPLE	14-MM-CH-012	7021452	7021455	7021459	07021448A	07021448B	14-VCHS-001	7020923	7020925
P_2O_5_Wt%	0.05	0.04	0.04	0.08	0.04	0.02	0.04	0.04	0.07
SiO_2_Wt%	94.17	95.97	98.05	97.91	98.03	93.35	96.76	97.01	88.80
MnO_Wt%	0.03	0.00	0.00	0.00	0.03	0.05	0.03	0.00	0.02
Fe_2O_3_Wt%	0.55	0.39	0.23	0.34	1.50	3.57	0.43	0.46	2.14
MgO_Wt%	0.09	0.14	0.12	0.12	0.07	0.14	0.16	0.03	0.12
Al_2O_3_Wt%	0.72	1.58	1.49	1.21	1.37	1.46	2.31	0.41	2.04
TiO_2_Wt%	0.04	0.08	0.07	0.07	0.09	0.07	0.09	0.03	0.11
CaO_Wt%	0.05	0.07	0.07	0.06	0.04	0.07	0.06	0.03	0.04
Na_2O_Wt%	0.05	0.12	0.07	0.07	0.05	0.05	0.06	0.03	0.04
K_2O_Wt%	0.11	0.25	0.29	0.19	0.23	0.25	0.32	0.07	0.46
Ba_ppm	209.58	727.32	605.05	1306.72	552.89	271.86	730.62	117.61	491.46
Sr_ppm	18.29	41.13	40.25	118.23	35.73	34.76	33.09	13.27	32.21

UNIT	Porcellanite	Porcellanite	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Barite Pit	Barite Pit	Barite Pit	Mary's Mtn	Mary's Mtn	Mary's Mtn	Mary's Mtn
SAMPLE	7020927	7020930	6301234	6301237	6301250	7020949	7020953	07020957B	14-MM-CH-006
P_2O_5_Wt%	0.08	0.12	0.14	0.06	0.32	0.01	0.07	0.11	0.05
SiO_2_Wt%	84.05	83.68	95.80	96.02	92.38	93.81	93.99	94.33	95.82
MnO_Wt%	0.00	0.02	0.02	0.00	0.04	0.05	0.00	0.03	0.04
Fe_2O_3_Wt%	0.69	1.04	0.69	0.58	0.97	2.48	0.84	2.14	0.70
MgO_Wt%	0.19	0.17	0.12	0.12	0.17	0.45	0.10	0.17	0.11
Al_2O_3_Wt%	2.22	2.24	1.25	1.56	2.38	0.82	1.11	1.96	1.13
TiO_2_Wt%	0.11	0.12	0.06	0.07	0.11	0.05	0.06	0.12	0.07
CaO_Wt%	0.08	0.10	0.31	0.14	0.53	0.67	0.08	0.08	0.09
Na_2O_Wt%	0.09	0.05	0.04	0.04	0.04	0.04	0.03	0.04	0.05
K_2O_Wt%	0.46	0.50	0.21	0.35	0.53	0.23	0.34	0.67	0.36
Ba_ppm	486.51	566.61	1375.04	1034.53	14416.64	166.49	250.88	579.80	187.04
Sr_ppm	30.85	38.78	90.23	84.44	182.74	34.64	22.20	37.09	20.79

UNIT	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven	Slaven
LOCATION	Mary's Mtn	Mary's Mtn	Mary's Mtn	Slaven Canyon	Slaven Canyon	Slaven Canyon	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14-MM-CH-007	14-MM-CH-008	14-MM-CH-009	6301134	6301138	6301150	7021426	7021430	7021435
P_2O_5_Wt%	0.07	0.19	0.05	0.04	0.03	0.05	0.06	0.05	0.05
SiO_2_Wt%	92.88	92.49	95.09	89.03	94.70	95.13	97.53	93.17	92.53
MnO_Wt%	0.03	0.03	0.03	0.06	0.02	0.00	0.00	0.04	0.04
Fe_2O_3_Wt%	1.16	0.85	0.88	5.86	0.58	0.64	0.73	5.02	4.24
MgO_Wt%	0.22	0.18	0.12	0.23	0.14	0.12	0.07	0.13	0.14
Al_2O_3_Wt%	1.99	1.79	1.23	2.37	2.02	1.64	0.91	1.00	0.99
TiO_2_Wt%	0.11	0.11	0.08	0.11	0.11	0.08	0.05	0.06	0.06
CaO_Wt%	0.14	0.51	0.06	0.12	0.15	0.10	0.07	0.11	0.10
Na_2O_Wt%	0.05	0.06	0.06	0.05	0.03	0.03	0.06	0.10	0.07
K_2O_Wt%	0.75	0.58	0.40	0.67	0.54	0.45	0.21	0.17	0.17
Ba_ppm	395.54	331.73	216.35	483.81	750.45	632.71	680.27	540.73	546.43
Sr_ppm	32.91	30.69	22.15	29.51	36.57	50.80	56.05	30.31	34.18

UNIT	Slaven	Slaven	Slaven
LOCATION	Vinini Creek	Vinini Creek	Vinini Creek
SAMPLE	14-VCHS-002	14-VCHS-003	14-VCHS-004
P_2O_5_Wt%	0.05	0.05	0.06
SiO_2_Wt%	96.95	95.27	93.31
MnO_Wt%	0.03	0.03	0.03
Fe_2O_3_Wt%	0.75	0.69	0.67
MgO_Wt%	0.11	0.13	0.17
Al_2O_3_Wt%	0.83	1.34	1.61
TiO_2_Wt%	0.05	0.08	0.10
CaO_Wt%	0.11	0.08	0.11
Na_2O_Wt%	0.06	0.07	0.07
K_2O_Wt%	0.13	0.26	0.36
Ba_ppm	515.58	888.64	949.68
Sr_ppm	30.78	45.93	47.43

Appendix 13: Summary Statistics for ICP-ES

	Cherry Spring							Porcellanite						
Elements	Count	Min	Max	Mean	Median	Variance	SD	Count	Min	Max	Mean	Median	Variance	SD
P_2O_5_Wt%	23	0.04	1.40	0.12	0.06	0.08	0.28	24	0.01	0.12	0.05	0.04	0.00	0.03
SiO_2_Wt%	23	85.86	102.36	95.28	95.40	13.72	3.70	24	65.92	99.69	94.40	97.09	55.55	7.45
MnO_Wt%	23	0.00	0.52	0.09	0.04	0.02	0.14	24	0.00	0.05	0.02	0.02	0.00	0.01
Fe_2O_3_Wt%	23	0.32	4.83	1.77	1.15	1.75	1.32	24	0.23	3.57	1.02	0.52	0.86	0.93
MgO_Wt%	23	0.05	0.30	0.14	0.13	0.00	0.07	24	0.03	0.47	0.13	0.12	0.01	0.08
Al_2O_3_Wt%	23	0.53	1.84	1.14	1.07	0.14	0.38	24	0.41	4.89	1.47	1.32	0.82	0.91
TiO_2_Wt%	23	0.03	0.15	0.06	0.05	0.00	0.03	24	0.03	0.24	0.08	0.07	0.00	0.04
CaO_Wt%	23	0.04	4.02	0.27	0.09	0.67	0.82	24	0.01	0.14	0.05	0.05	0.00	0.03
Na_2O_Wt%	23	0.01	0.09	0.05	0.04	0.00	0.02	24	0.01	0.12	0.05	0.05	0.00	0.03
K_2O_Wt%	23	0.06	1.27	0.33	0.22	0.07	0.26	24	0.07	1.20	0.29	0.24	0.05	0.23
Ba_ppm	23	432.66	3426.84	1239.63	853.65	883119.46	939.74	24	117.61	1306.72	508.88	488.98	60231.95	245.42
Sr_ppm	23	26.49	148.21	72.95	67.78	1584.40	39.80	24	11.84	118.23	28.86	20.16	492.53	22.19

	Slaven						
Elements	Count	Min	Max	Mean	Median	Variance	SD
P_2O_5_Wt%	19	0.01	0.32	0.08	0.05	0.00	0.07
SiO_2_Wt%	19	89.03	97.53	94.22	94.33	3.87	1.97
MnO_Wt%	19	0.00	0.06	0.03	0.03	0.00	0.02
Fe_2O_3_Wt%	19	0.58	5.86	1.60	0.84	2.67	1.63
MgO_Wt%	19	0.07	0.45	0.16	0.13	0.01	0.08
Al_2O_3_Wt%	19	0.82	2.38	1.47	1.34	0.25	0.50
TiO_2_Wt%	19	0.05	0.12	0.08	0.08	0.00	0.02
CaO_Wt%	19	0.06	0.67	0.19	0.11	0.03	0.18
Na_2O_Wt%	19	0.03	0.10	0.05	0.05	0.00	0.02
K_2O_Wt%	19	0.13	0.75	0.39	0.36	0.04	0.19
Ba_ppm	19	166.49	14416.64	1312.76	546.43	10168945.80	3188.88
Sr_ppm	19	20.79	182.74	48.39	34.64	1417.35	37.65