ANALYSIS OF TRACE ELEMENT DISTRIBUTIONS DISTAL TO PORPHYRY COPPER DEPOSITS

by

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TABLE OF CONTENTS

TABLE OF CONTENTS - *Continued*

LIST OF FIGURES

LIST OF FIGURES - *Continued*

LIST OF FIGURES - *Continued*

LIST OF FIGURES - *Continued*

LIST OF FIGURES - *Continued*

LIST OF TABLES

ABSTRACT

Enrichment and depletion of trace elements occurs in host rocks distal to porphyry copper deposits as a result of hydrothermal metasomatism. Subtle geochemical distributions in weakly propylitized host rocks are sufficient to indicate proximity to a mineralized system and can be applied to porphyry copper exploration.

Samples collected adjacent to four porphyry copper deposits - Morenci, Sierrita/Esperanza, and Ajo, Arizona, and Ann Mason, Nevada - were analyzed for a multi-element trace element suite, then normalized to the elemental concentrations of the fresh host rocks. The probability that an element has been enriched or depleted is determined by comparison of sample geochemisty with chemistry of the unaltered host and a calculated standard deviation. The anomalous probabilities have distinct zoning that is related to alteration around the deposits.

Contribution lateral to deposits was observed in Ag, As, Au, Bi, Cu, Hg, Mo, Sb, and Se. Proximal to the mineralized portion of the systems, elemental removal was observed in Ba, Mg, P, Ti, and Y. Variable contribution and removal lateral to the deposits was observed in Br, Ca, Mn, Pb, V, and Zn.

INTRODUCTION

It was the intent of this thesis to determine first if there is enrichment or depletion of trace elements in host rocks distal to porphyry copper deposits, and second if these elements could be used to determine the direction to the deposit from a distal position.

Porphyry copper deposits are a widely recognized class of ore deposit, consisting of large volumes of rock containing minor but anomalous amounts of iron, copper, and molybdenum sulfides. They occur within wide mineralogically zoned aureoles of hydrothermally altered rock. Mineralogy and geometry of the alteration zones vary among deposits, but the succession of alteration zones outward is generally the same. The innermost alteration assemblage is generally potassic and is characterized by orthoclase, biotite, sericite, and quartz. Next outward is the phyllic zone containing dominantly quartz, sericite, and pyrite. Further out and generally distal to the deposit is propylitic alteration, the primary focus of this study. Propylitic alteration is largely the result of development of new calcium and magnesium minerals by rearrangement of the original rock-forming components to form an assemblage of epidote, chlorite, and albite. A more detailed description of these systems can be found in Lowell and Guilbert (1970) and Titley (1982).

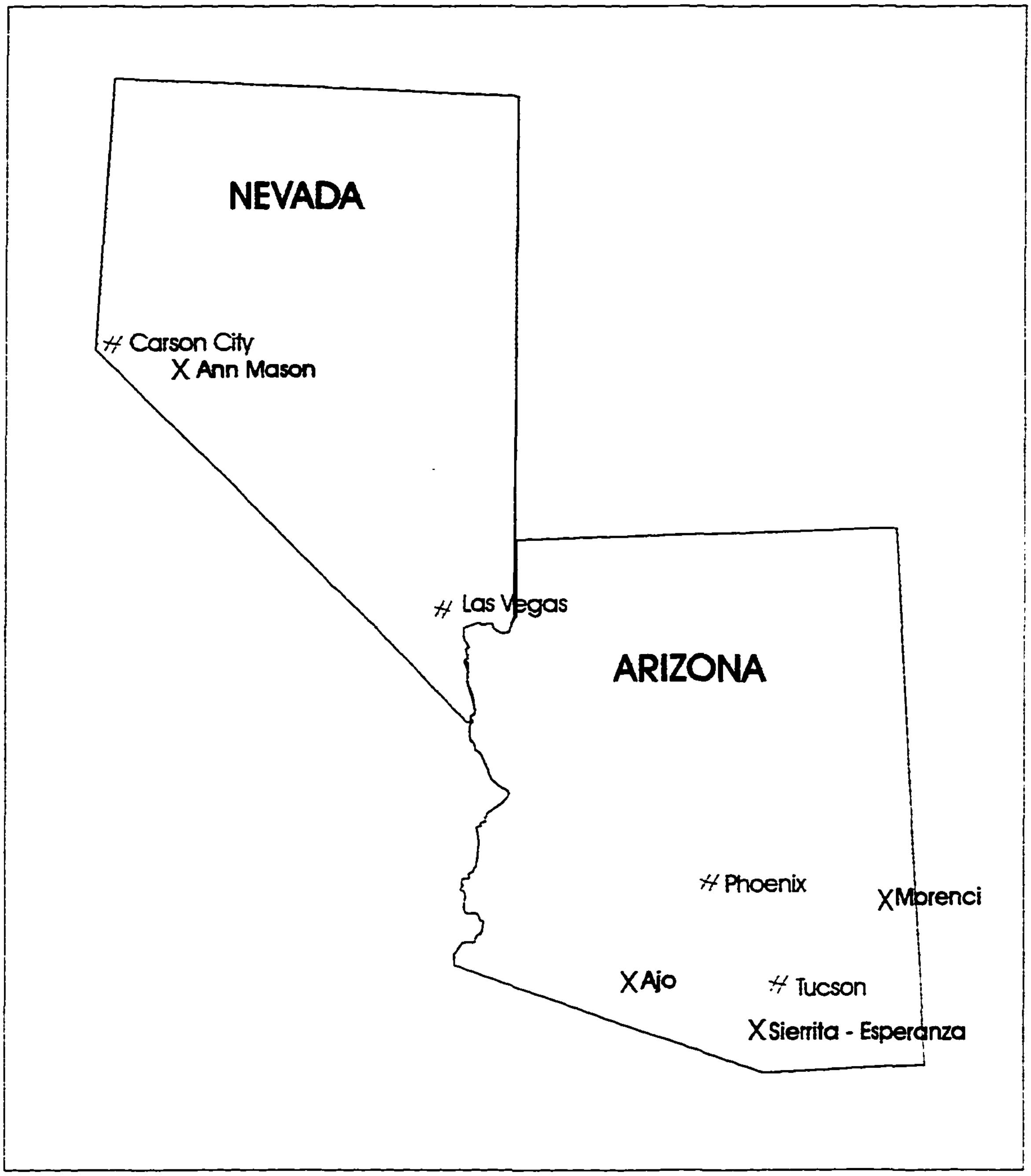


FIGURE 1: Locations of Porphyry Copper Deposits Studied

The mineralization and associated alteration are the result of impregnation by hot aqueous magmatic and/or meteoric solutions that introduce or remove, and therefore redistribute, chemical components in a large body of rock. Mobilization of elements in the host rocks caused by alteration and the introduction of elements creates detectable distributions of elemental enrichment and depletion.

Interpretation of these distributions is complicated by the fact that multiple overprinting alteration events have taken place, as indicated by Titley et al (1986). At Sierrita-Esperanza, Titley et al were able to differentiate different episodes of fracturing and alteration. The work at Sierrita-Esperanza illustrated that a porphyry copper system is not the result of a single mineralizing event resulting in uniformly zoned alteration around an ore zone, which makes it difficult to relate particular dispersion patterns to specific alteration types. A number of elemental distributions do have strong correlations to particular alteration zones - the focus of this study is on spatial elemental distributions within alteration zones - attempting to find universal patterns that correlate spatially to porphyry copper systems.

One hundred fifty-nine (159) samples were collected from four deposits - Morenci, AZ (16), Ann Mason, NV (69), Sierrita/Esperanza, AZ (34), and Ajo, AZ (40) (Figure 1). These systems were chosen because each, with the exception of Morenci, has already been evaluated extensively with respect to geology, alteration, and petrography. The previous work provides better geologic control and understanding of the hydrothermal environment being sampled.

Published works regarding Morenci are few. Langton (1973) suggested that a well-developed propylitic fringe exists around the Morenci-Metcalf deposits, although, field observation failed to support his conclusion. Effective sampling was hindered by poor documentation of the distribution of alteration around the deposit

The Ann Mason deposit has been rotated by post mineral tectonics, providing an opportunity to evaluate a system both laterally and vertically. Work by Dilles et al. (1992) provides useful information about alteration distribution and hydrothermal fluid flow directions.

Fracture densities within the Ruby Star granodiorite at Sierrita - Esperanza have been extensively studied by Manske (1980) and Haynes (1980). Fracture density distributions are very helpful in interpreting elemental enrichment and depletion.

The three systems studied have different ages of mineralization and different crystalline host rocks. Ajo, which is hosted by volcanics of variable composition, is used as a test case. Ajo illustrates that enrichment and depletion trends can be used for exploration purposes in fundamentally different porphyry copper system settings.

Samples were collected from proximal phyllic or potassic alteration zones to distal weak propylitic, but with greater sample density in propylitic alteration assemblages. Samples were analyzed at Skyline Laboratories in Tucson, Arizona, for fifty major and trace elements with an inductively coupled plasma spectrometer (ICP) and by neutron activation (INAA) analytical methods. The samples were then normalized against fresh rock determinations to account for mass balance influence related to alteration.

A probability of enrichment or depletion was determined by comparing concentrations in the normalized altered rocks to those of the 'fresh' unnormalized host. Plots for all fifty elements (Table 1 and Table 2) were created for all three deposits to evaluate possible patterns. Only the results for those elements that appear to have distinct spatial patterns are presented in this thesis.

STATEMENT OF PROBLEM

The SW United States is endowed with many world class porphyry copper deposits. The region has been extensively explored and is considered to be a 'mature' exploration terrain. New techniques of exploration are needed to aid in the discovery of new deposits. All outcropping porphyry copper systems have presumably been evaluated, so exploration generally involves pursuing targets under alluvial or volcanic cover.

The intent of this thesis is to aid in exploration for porphyry copper deposits by studying how trace elements are distributed around them. Application of these elemental distributions in systems where a distal edge is exposed, where outcrop is limited, or where it is intersected by drilling, may determine the direction the deposit lies from the sample locations. Similar work has been published by others, and this thesis is intended to augment what is already known about trace element distributions.

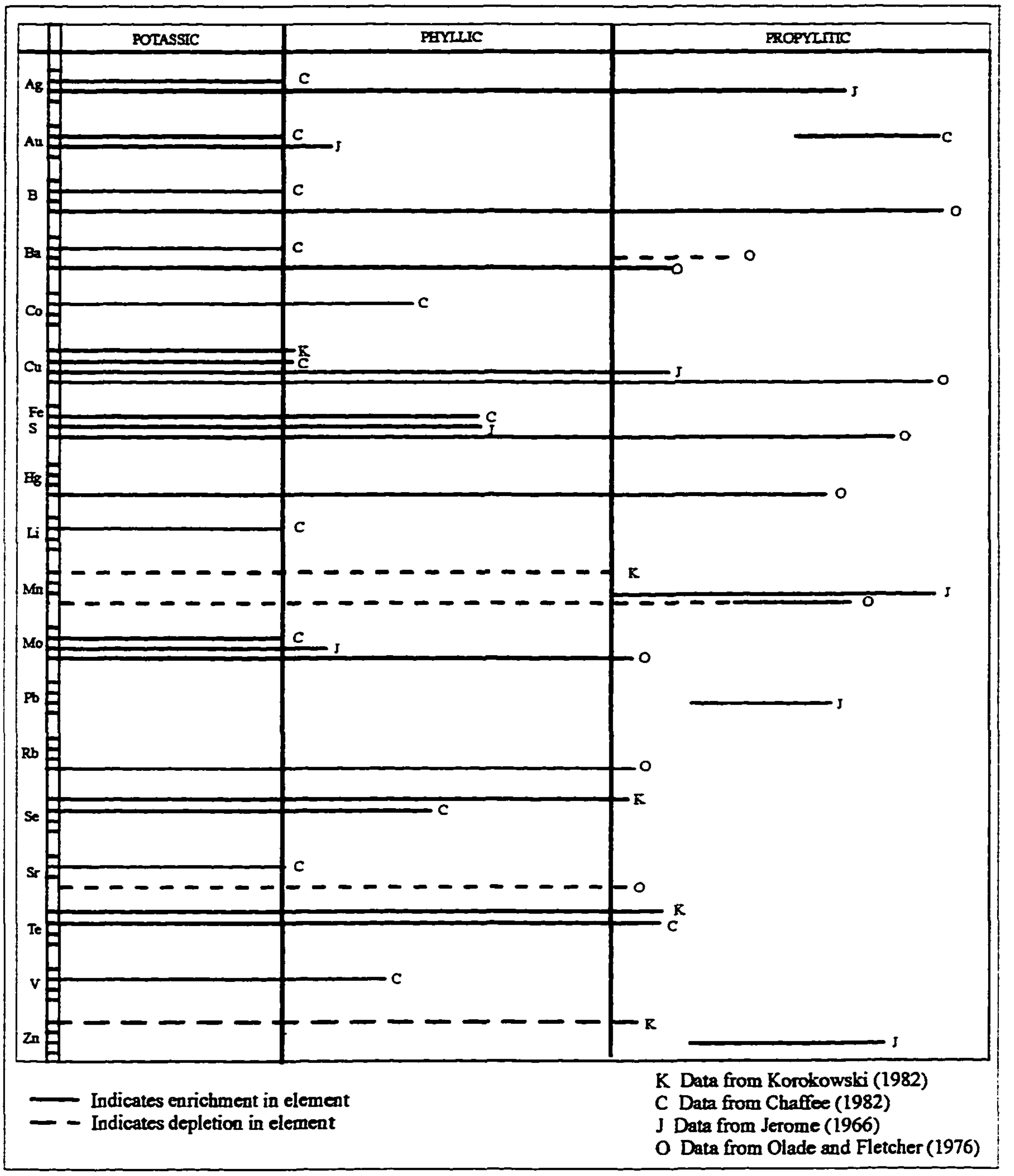
A uniform measure of trace element contribution or removal, the probability of enrichment or depletion, has been devised to aid in the evaluation of the porphyry copper systems. Three deposits are evaluated and their trace element patterns compared to create a trace element distribution model. This model was tested successfully at the Ajo deposit. Finally, suggestions as to how to apply these distributions to exploration are presented.

PREVIOUS WORK BY OTHERS

Geochemical dispersion relationships at San Manuel and North Silverbell were studied by Maurice Chaffee (1982) and John Korkowski (1982), respectively. Olade and Fletcher (1972) studied trace element dispersion around porphyry copper systems in British Columbia, and dispersion patterns have been generalized by Jerome (1966). Korkowski (1982) identified trends in Mn, Zn, Se, Te, and possibly Cd, and concluded that these elements serve as better pathfinders of copper mineralization than the major lithophile elements. Korkowski's study only included a limited suite of elements, which suggests that there could be additional useful unevaluated elemental patterns. The intent of this thesis is to study a large multi-element suite in the hope of finding unrecognized elemental patterns.

Chaffee (1982) did extensive geochemical analyses and observed similar results at San Manuel with the inclusion of the additional elements Fe, V, Rb, Sr, Co, Ag, B, Ba, and Li. Chaffee's work indicated that detectable patterns did not extend far beyond the phyllic zone, with negligible enrichment or depletion within the propylitic zone. His detection of patterns out into the propylitic zone may have been hindered both by relatively high analytical detection limits at the time of his study and low propylitic representation.

FIGURE 2: SUMMARY OF PREVIOUS WORK



Jerome summarized features associated with porphyry copper deposits, including geochemical halos and how they correlate to alteration. The patterns are supported by work done by Chaffee and Korkowski, except for peripheral lead, zinc, and manganese enrichment. A summary of previous work is presented in Figure 2.

This study shows that patterns documented by Korkowski, Chaffee, and Jerome are reproducible in other deposits, that improvement in geochemical analyses enables detection of enrichment or depletion distal to porphyry copper systems, and that there are additional elemental patterns that can be useful in exploration.

PROCEDURE

Sampling. A sampling technique was developed to optimize the determination of elemental addition to or removal from host rocks. Veinlets occur erratically in porphyry copper systems. Samples containing variable percentages of veinlets may distort geochemical values. To avoid complications in the interpretation of results, veins and veinlets were excluded from the samples. All samples were trimmed, using a rock hammer to remove surficial weathering, fracture coatings, and veinlets. Samples were then scrubbed with a plastic brush and washed in distilled water to remove any contamination by exotic material or soil. Samples were air dried and sealed in zip-lock bags for shipment to the analytical lab.

Analysis. Samples from each porphyry copper deposit were sent to the lab as a set to eliminate potential problems of comparing results from separate batches. Each set included blind duplicates (generally of the freshest sample) to provide control on the accuracy of the run. Preparation of samples included silica sand cleaning of crusher plates between each crushing to eliminate contamination between samples. Samples were analyzed by two different geochemical procedures, ICP and INAA.

TABLE 1: ELEMENTS BEST ANALYZED USING ICP

Ag	As	Cu	Hg	Mo	Pb	Sb
Tl	Zn	Bi	Cd	Ga	Se	Te

Au done by Atomic Absorption

TABLE 2: ELEMENTS BEST ANALYZED USING INAA

Al	Ba	Be	Br	Ca	Co	Cr	Cs	Fe
Hf	Ir	K	Mg	Mn	Na	Ni	P	Rb
Rb	Sc	Sn	Sr	Ta	Th	U	V	W
Y	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu

ICP is more accurate than INAA in determining the concentrations of the elements in Table 1, so ICP values for these elements were used in the spatial analyses. The results of geochemical analysis are reported in APPENDIX C.

Normalization. The intent of this study was to determine which elements have been enriched or depleted in porphyry copper host rocks. To determine gains and losses, an adaptation of Gresens Equation (Grant, 1986) was applied in conjunction with statistical analysis. The method does not provide a quantitative value for gain or loss, but instead states the probability that a particular element has been added or removed from a sample.

When studying metasomatically altered rocks, it is virtually essential to determine or reconstruct the composition of the unaltered host rock since fresh rock chemistry provides the baseline for normalization of the altered rocks. The freshest samples were identified petrographically. The composition of the fresh rock was determined by averaging analytical values for three samples of the petrographically identified fresh host. Homogeneity is determined by dividing the standard deviation of the sample set by the mean, referred to here as the 'percent of mean'. The lower the value for 'percent of mean' the more homogeneous the sample set (APPENDIX A). The composition of the host at each of the three deposits is relatively homogeneous with a 'percent of mean' for aluminum that varies from 5% for Ann Mason to 14% for Morenci. The 'percent of means' for the fresh sample set are less than the values for the entire data set, as would be expected.

Once the composition of the fresh rock is established, one must consider volume or density changes resulting from alteration in order to evaluate real gains and losses. In order to make the adjustment for this change, it is necessary to assume that some element or elements remained immobile during alteration. If an immobile element can be identified, an adjustment of the altered rock composition can be calculated to remove effects of volume change. It is then possible to accurately determine gains or losses of the elements (Grant, 1986).

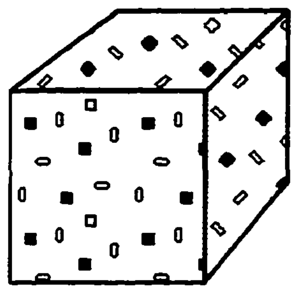
To illustrate the need for this correction, consider a hypothetical rock (Figure 3) in which alteration has removed albite (gray rectangles) leaving void spaces (white circles). The volume of the rock stays the same, but 5% is now empty space. Analysis shows that the unaltered rock contains 2.36% Fe and the altered rock contains 2.48% Fe. There is an apparent 5.26% increase in iron (refer to the 'no correction' box) when in fact iron was neither added or removed by the alteration. Two methods of correction may be used for the adjustment of this error. The density correction (ρ correction) uses the density of the altered and unaltered rocks, (specific gravity may be utilized in place of density). The second correction (Zr correction) assumes that Zr remains immobile during alteration. The volume change can be determined by comparing the concentration of zirconium in the fresh sample to its concentration in the altered sample.

The equations are:

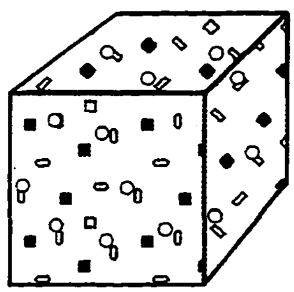
Density correction: $C_x(alt)_2=(\rho_a/\rho_f)*C_x(alt)_1$ (Grant,1986),

where $C_x(alt)_1$ is the concentration of an element in the altered rock, the densities of the fresh and altered

Figure 3: Alteration of albite leaving open voids



UNALTERED ROCK	%Volume	g/cm³
Quartz	30.00	0.795
Albite	38.00	0.996
Biotite	5.00	0.160
Orthoclase	25.00	0.643
Magnetite	1.00	0.052
Zircon	1.00	0.047
Pyrite	0.00	0.000
TOTAL	100.0	2.692



ALTERED ROCK	%Volume	g/cm³
Quartz	30.00	0.795
Albite	33.00	0.865
Biotite	5.00	0.160
Orthoclase	25.00	0.643
Magnetite	1.00	0.052
Zircon	1.00	0.047
Pyrite	0.00	0.000
TOTAL	95.00	2.561

UNALTERED ROCK - Concentration in one (1) gram sample

	Si	Al	Fe	Na	K	Zr
Grams	0.3478	0.0660	0.0236	0.0333	0.0389	0.0050

ALTERED ROCK - Concentration in one (1) gram sample

	Si	Al	Fe	Na	K	Zr
Grams	0.3492	0.0640	0.0248	0.0305	0.0410	0.0052

NO CORRECTION - Concentration change in sample

	Si	Al	Fe	Na	K	Zr
Grams	0.0014	-0.0019	0.0012	-0.0029	0.0021	0.0003
Percent	0.40%	-2.95%	5.26%	-8.59%	5.26%	5.26%

P CORRECTION - Concentration change in sample

	Si	Al	Fe	Na	K	Zr
Grams	-0.0156	-0.0051	0.00003	-0.0043	0.0001	0.00001
Percent	-4.49%	-7.67%	0.14%	-13.04%	0.14%	0.14%

Zr CORRECTION - Concentration change in sample

	Si	Al	Fe	Na	K	Zr
Grams	-0.0161	-0.0051	0.0000	-0.0044	0.0000	0.0000
Percent	-4.62%	-7.80%	0.00%	-13.16%	0.00%	0.00%

rocks are represented by ρ_f and ρ_a respectively, and $C_x(alt)_2$ represents the corrected concentration in the altered rock. When the adjusted altered value ($C_x(alt)_2$) is compared to the fresh value ($C_x(fr)$) it is possible to determine gains and losses of the mobile elements (Grant, 1986).

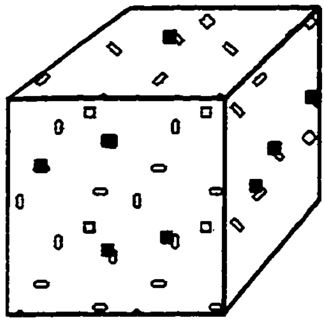
Immobile correction: $C_x(alt)_2 = (C_{Zr}(fr)/C_{Zr}(alt))*C_x(alt)_1$

Here $C_{Zr}(fr)$ and $C_{Zr}(alt)$ represents the concentration of zirconium in the fresh and altered rock (Grant, 1986).

The density correction (ρ corr) and zirconium correction (Zr corr) in Figure 2 both reflect the chemical changes in the rock. Both techniques accurately determine the removal of elements, while 'no correction' (no corr) indicates that some elements had been enriched. The density correction shows slight enrichment in iron, potassium, and zirconium, which indicates that it is not as accurate as the Zr correction. Another problem with the density correction is that it assumes the overall volume of the rock has not changed, (Figure 4.1).

In Figure 4.1 we have the same rock, but in this case it has been compacted to remove the 5% void space. Under these conditions the density correction is deceptive, indicating an addition of iron, potassium, and zirconium

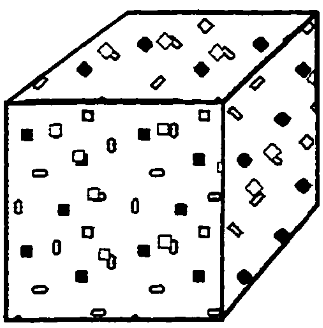
Figure 4.1: Open spaces created by removal of albite are eliminated by compression.



	%Volume	g/cm^3
Quartz	31.75	0.837
Albite	34.74	0.910
Biotite	5.26	0.168
Orthoclase	26.32	0.676
Magnetite	1.05	0.055
Zircon	1.05	0.049
Total	100.0	2.695

Element	altered rock (g)*	no corr**	p corr**	Zr corr**
Si	0.3492	0.40%	0.54%	-4.62%
Al	0.0640	-2.95%	-2.81%	-7.80%
Fe	0.0248	5.26%	5.41%	0.00%
Na	0.0305	-8.59%	-8.46%	-13.16%
K	0.0401	5.26%	5.41%	0.00%
Zr	0.0052	5.26%	5.41%	0.00%

Figure 4.2: Open spaces created by albite removal are filled by silicification.



	%Volume	g/cm^3
Quartz	35.00	0.928
Albite	33.00	0.865
Biotite	5.00	0.160
Orthoclase	25.00	0.643
Magnetite	1.00	0.052
Zircon	1.00	0.047
Total	100.0	2.693

Element	altered rock (g)*	no corr**	p corr**	Zr corr**
Si	0.3551	2.10%	2.16%	2.10%
Al	0.0608	-7.80%	-7.75%	-7.80%
Fe	0.0236	0.00%	0.06%	0.00%
Na	0.0289	-13.16%	-13.11%	-13.16%
K	0.0389	0.00%	0.06%	0.00%
Zr	0.0050	0.00%	0.06%	0.00%

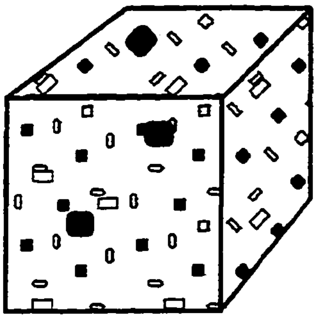
* Grams of each element contained in a one (1) gram sample.
** Percent increase/decrease in concentration in the altered rock.

when one did not occur (5.41% increase in ρ corr column). The data in the 'Zr corr' column are accurate. The void spaces are filled with quartz in Example 4.2; the rock has retained its volume and again the density correction is deceptive.

Figure 4.3 represents alteration of albite to orthoclase and mafics to pyrite and again the density correction provides erroneous results. In Example 4.4, an open space is formed by a crack (5% of the volume) that has been filled with quartz (80%) and pyrite (20%); magnetite and biotite are altered to pyrite. It would be difficult to determine whether or not such a sample has undergone volume change in hand sample. When the density correction is used, values are closer to the 'Zr corr' values than to the 'no corr' values. This is a function of the density changing from 2.692 (unaltered) to 2.755 (altered). No correction (no corr) or the density correction (ρ corr) would suggest that sodium and zirconium are leaving the system when in fact they are not. The correct result is provided by the Zr correction (Zr corr) with sodium and zirconium remaining immobile.

For the immobile element correction to work properly it is essential that the element be evenly distributed and that it remains immobile during alteration. The examples illustrate that the density correction is most effective

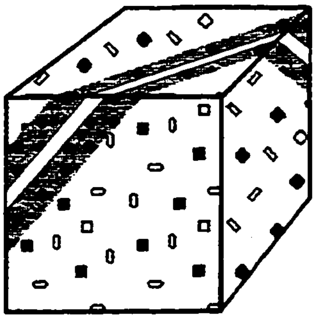
Figure 4.3: Albite (50%) converted to orthoclase, biotite (50%) and all magnetite altered to pyrite.



	%Volume	g/cm³
Quartz	30.00	0.795
Albite	19.00	0.498
Biotite	2.50	0.080
Orthoclase	44.00	1.131
Pyrite	3.50	0.176
Zircon	1.00	0.047
Total	100.0	2.726

Element	altered rock (g)*	no corr**	p corr**	Zr corr**
Si	0.3401	-2.20%	-0.95%	-2.20%
Al	0.0635	-3.71%	-2.48%	-3.71%
Fe	0.0245	3.71%	5.03%	3.71%
Na	0.0167	-50.00%	-49.36%	-50.00%
K	0.0637	63.64%	65.73%	63.64%
Zr	0.0049	0.00%	1.28%	0.00%

Figure 4.4: Open space (5%) crack filled with quartz (80%) and pyrite(20%), biotite(50%) and magnetite altered to pyrite.



	%Volume	g/cm³
Quartz	32.50	0.861
Albite	36.10	0.946
Biotite	2.38	0.076
Orthoclase	23.75	0.610
Pyrite	4.33	0.217
Zircon	0.95	0.044
Total	100.0	2.755

Element	altered rock (g)*	no corr**	p corr**	Zr corr**
Si	0.3452	-0.75%	1.59%	4.48%
Al	0.0614	-6.90%	-4.71%	-2.00%
Fe	0.0279	18.25%	21.03%	24.47%
Na	0.0317	-5.00%	-2.77%	0.00%
K	0.0352	-9.66%	-7.53%	-4.91%
Zr	0.0047	-5.00%	-2.77%	0.00%

* Grams of each element contained in a one (1) gram sample.
** Percent increase/decrease in concentration in the altered rock.

when alteration has simply removed components leaving void space.

The immobile element method was chosen for the normalization of values for the three deposits. Aluminum was selected as the immobile element based on petrographic as well as geochemical evaluation. Petrographic analysis of the samples indicated only mild alteration. Such alteration will not mobilize aluminum, because aluminum is immobile in all normal hydrothermal environments (Rose, Hawks, and Webb 1979). Titanium was considered, but its distribution was too erratic and not applicable to all three systems. Finally, aluminum was selected because it has a low standard deviation for the set of fresh rocks that were averaged in each system. All samples have been normalized using the immobile element correction formula. The calculations used and the normalized values are in APPENDIX C.

Multi-element concentrations in the 'fresh' host rocks are averages of the unnormalized values, since these rocks are unaltered with no volumetric change. The standard deviation for the fresh sample set reflects the natural heterogeneity of the host and analytical variability. Due to the small number of samples, standard deviation (S.D.) is calculated using this formula:

$$S.D. = SQRT[\{n*SUM(C_{fr}^2) - (SUM(C_{fr}))^2\}/\{n*(n-1)\}]$$

Where SQRT is the square root, n is the number of samples, SUM is the summation of the samples, and C_{fr}^2 is the averaged concentration in the fresh samples. The S.D. will be used in the calculation of the probability of enrichment or depletion.

Probability of Enrichment or Depletion. A method is needed to decide whether an apparent chemical transfer is the result of metasomatic processes, analytical variation, natural heterogeneity of the host, or some combination of these effects. This problem is dealt with by determining the probability of enrichment or depletion of each element calculated by subtracting the concentration of an element in the fresh normalized host (c_{fr}) from the concentration in the altered normalized rock (c_{alt}). The result, with appropriate sign, is divided by the standard deviation for that element in the fresh host.

$$k = (c_{alt} - c_{fr})/(\text{standard deviation})$$

The standard deviation is calculated either from duplicate samples or determined by averaging normalized fresh samples; the larger of the two values is used. The advantage of this method is that it incorporates analytical error and natural petrologic variations in the sample set.

The value for 'k' is used in Tchebysheff's Theorem (Schaeffer et al, 1986), which states that in a set of random values at least $(1 - 1/k^2)$ of the measurements must be within k standard deviations of their mean. In other words, if Cu in an altered sample is 50ppm and the fresh sample concentration is 30ppm with a standard deviation in the host set of 10ppm, (50ppm - 30ppm)/10ppm yields a k of 2. Cu(alt) is two standard deviations away from the mean Cu(fr), yielding a result of $(1-(1/2^2))$ or 75%. If the Cu(alt) value is the result of natural heterogeneity of the host at least 75% of the other fresh assays have a k of 2 or less. This percentage is considered the percent probability of enrichment (+) or depletion (-) or (PPE/D). So there is a 75% chance this sample has been enriched in copper. The formula used to calculate PPE/D is:

$$PPE/D=[1-[1/\{(C_x(alt)_2-C_x(fr))/S.D.\}^2]]*SIGN\{C_x(alt)_2-C_x(fr)\}$$

Where SIGN is the sign (- or +) of the associated function. A value of -75% would indicate a 75% chance that an element has been removed or depleted from an altered sample.

The values and calculations used to determine probabilities of elemental transfer in the porphyry copper systems studied are in APPENDIX D. Ann Mason samples are divided between the granodiorite host and the mineralizing porphyry, with separate calculations for each, the advantage of which is the ability to display enrichment or depletion probabilities for different rock types on the same map, regardless of rock type. A problem with this technique is that it provides a particularly heavy filter that may obscure more subtle anomalies and patterns. However, if an anomaly trend is detected it will be a legitimate interpretation of the data.

A similar technique is used by geochemists. A mean and standard deviation is determined for an entire data set and the number of standard deviations from the mean for an assay is plotted. This technique involves the averaging of enriched, depleted, and unaltered samples and provides relatively large standard deviations that may hide subtle anomalies.

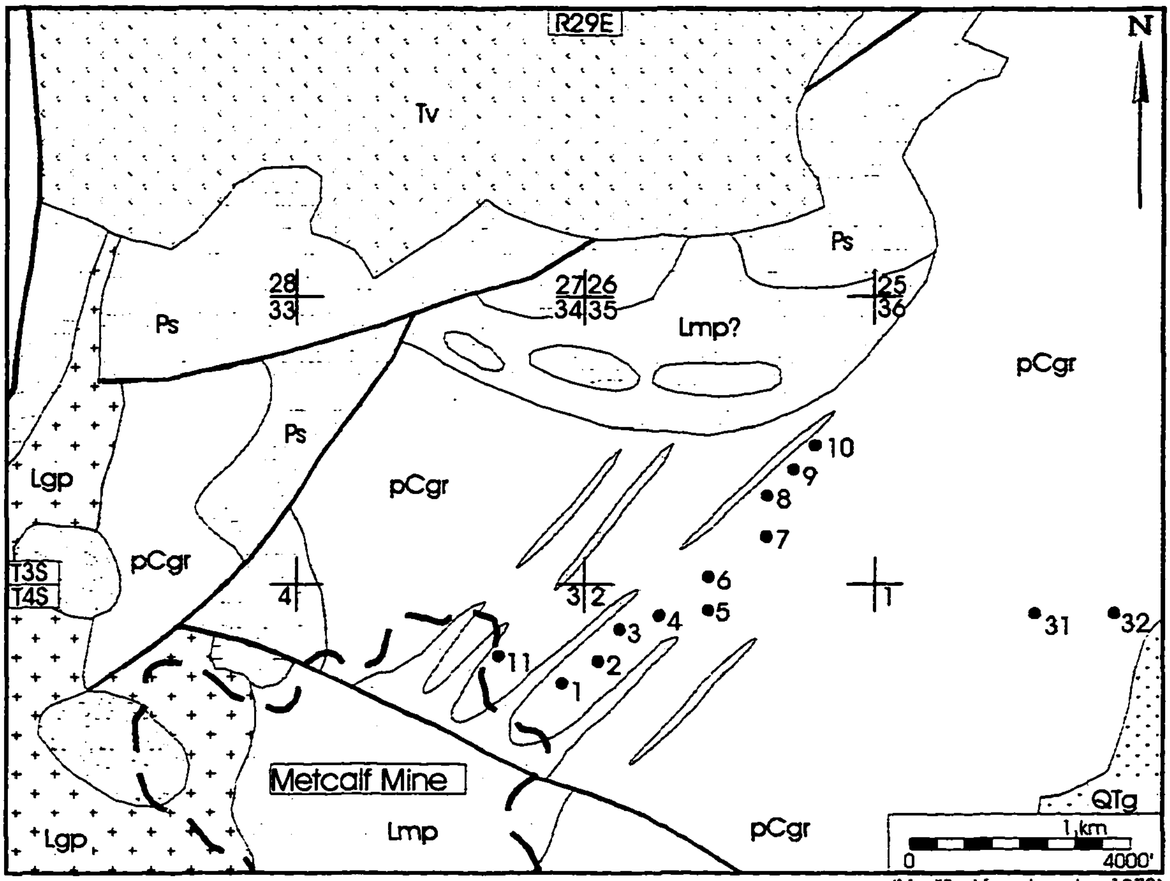
MORENCI, ARIZONA

Location. The Morenci district is located 6 kilometers northwest of Clifton, Arizona. The system is extensive, with mining occurring within Township 4S Range 29E, Sections 3,4,5,9,15, and 16. The sampling traverse for this study starts on the NE edge of the Metcalf pit and extends for 1.6 kilometers northeast, passing through T4S R29E S2 and T3S R29E S35, roughly following the ridge line of Copper King Mountain (Figure 5).

Geology. At Morenci, a Laramide stock oriented NE-SW intruded Precambrian basement complex and Paleozoic sedimentary rocks. The sedimentary rocks are exposed largely to the south with the underlying Precambrian rocks largely exposed to the north. The Precambrian host is granitic to granodioritic and equigranular or aplitic. The complex is intruded by a Laramide stock that is elongate NE-SW, with associated dikes parallel to the stock and extending NE of it.

Petrology. The principal rock type sampled is the Precambrian granite. The granite is reddish, coarse grained, and consists of orthoclase, albite, quartz, and biotite. Locally there are dikes and masses of red aplite and porphyritic granite (Moolick and Durek, 1966). Thirteen samples were taken. Using petrographic evaluation, sample alteration was divided into three groups; phyllic,

FIGURE 5: MORENCI-METCALF DISTRICT



(Modified from Langton 1973)

QTg: Quaternary Gravels

Breccia body

Tv: Tertiary Volcanics

Ps: Paleozoic Sediments

Lgp: Granite porphyry

pCgr: Precambrian Metcalf Granite

Lmp: Laramide QM porphyry

•32 Sample location

Metcalf mine outline

sericitic, and chloritic. The phyllic alteration is characterized by alteration of feldspars to quartz and sericite and pyrite occupying mafic sites. Sericitic alteration consists of quartz and sericite alteration of mafics and some feldspar. The chloritic alteration involves green sericite or chlorite after mafics. The chloritic alteration is weak and may be attributed to weathering.

Presentation of Results. Multiple elements were evaluated for patterns of enrichment and/or depletion. The elements, presented in the following figures, are those that show a systematic spatial relationship to the porphyry copper system, or that were effective in other systems and are shown here for purpose of comparison. Morenci proved to be the most difficult system to evaluate due to the presence of dikes sub-parallel to the traverse, and the lack of a large sample set. Values of >50% or <-50% are used on the plot to approximate the boundary between enrichment and depletion.

A measuring stick, divided into ten segments (250m increments), will be used to describe the proximity of enrichment and/or depletion to the deposit (Figure 6.1). The estimated edge of economic mineralization is located at zero. The sample furthest from mineralization is at 2500m. Phyllic alteration (quartz, pyrite, and sericite) is present from zero 0m to 500m. Sericitic alteration (sericite after biotite and feldspar) occurs from 500m to 1250m. Samples taken from beyond 1250m are characterized by weak chloritic alteration of the biotites.

Silver (Figure 6.1) - Silver is enriched out to 750m and distal enrichment occurs from 1750m to 2250m - possibly influenced by the presence of dikes.

Arsenic (Figure 6.2) - Arsenic has been removed between 500m and 1750m, with enrichment further from the deposit at 2500m. The probabilities are not high, suggesting a weak or non-existent trend.

Barium (Figure 6.3) - Barium is enriched at 250m within the phyllic zone and is depleted distally 1750m to 2500m. Low probabilities make this a questionable trend.

Bismuth (Figure 6.4) - Bismuth is erratic and interpretation is difficult. Possibly depletion within the phyllic zone at 250m with an adjacent area of enrichment from 500m to 750m.

FIGURE 6.1: SILVER (Ag) - PPE(+)/D(-); Morenci, AZ

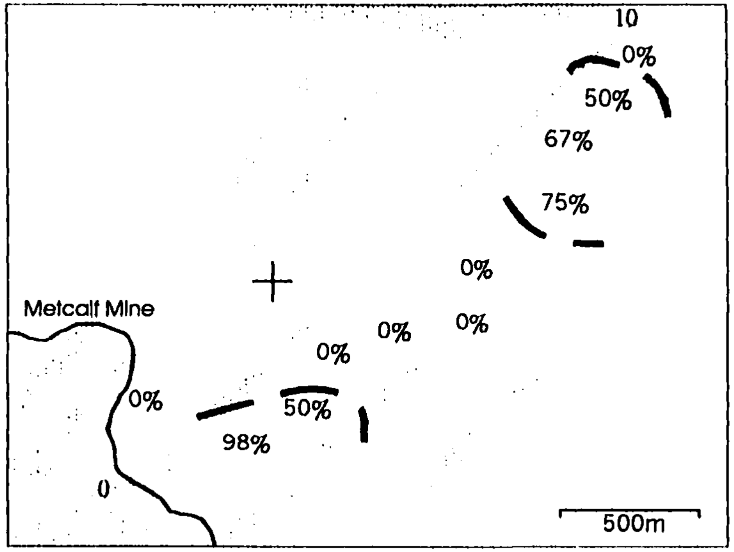


FIGURE 6.2: ARSENIC (As) - PPE(+)/D(-); Morenci, AZ

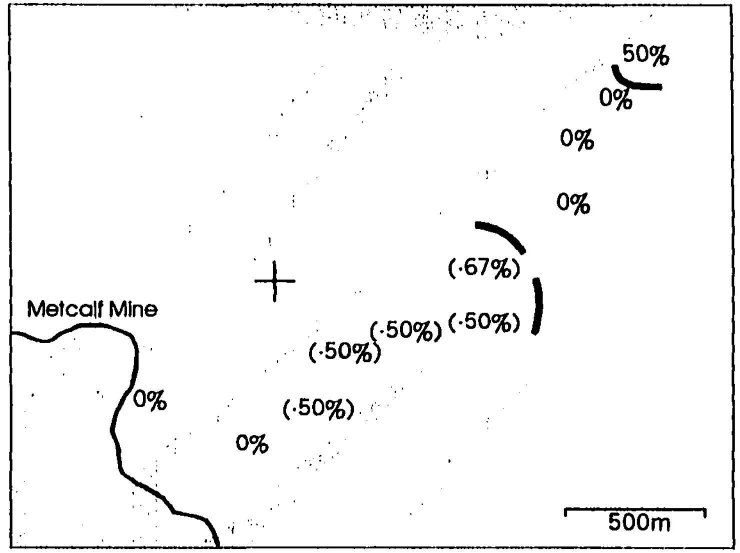


FIGURE 6.3: BARIUM (Ba) - PPE(+)/D(-); Morenci, AZ

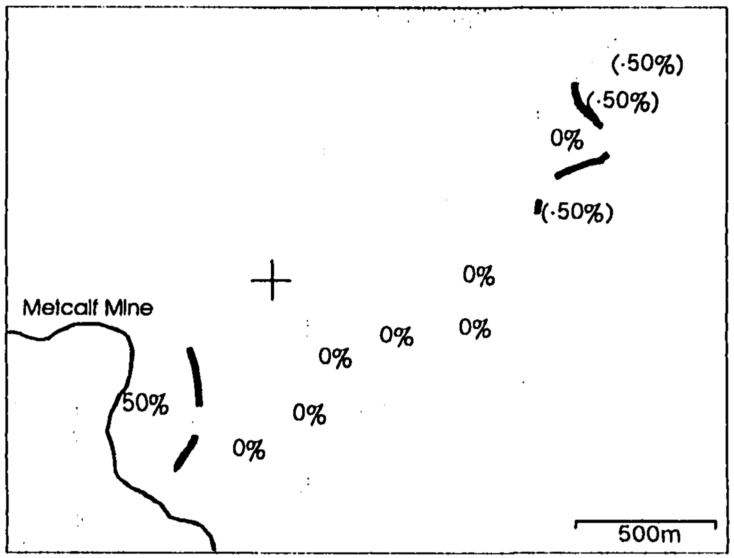
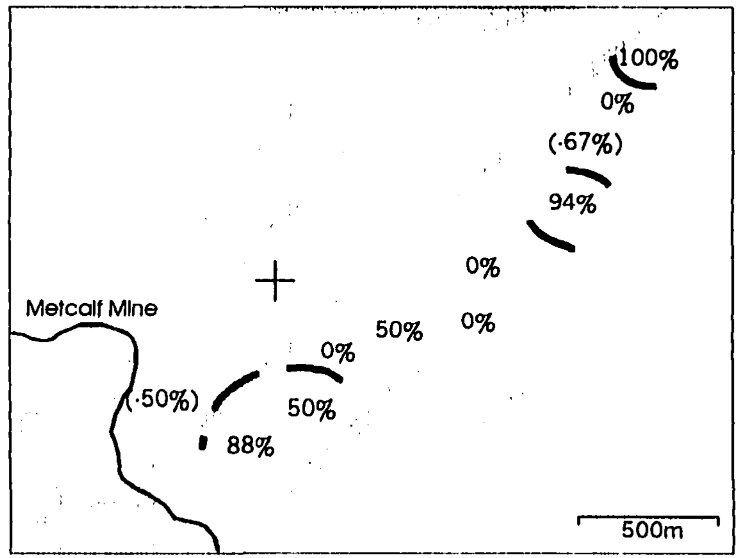


FIGURE 6.4: BISMUTH (Bi) - PPE(+)/D(-); Morenci, AZ



Bromine (Figure 7.1) - Bromine has been removed close to the deposit, from the deposit edge out to 750m.

Copper (Figure 7.2) - As would be expected, copper is enriched close to the deposit, out to 500m. There are low-probability contributions from 1250m to 2000m, probably related to the influence of the dikes.

Potassium (Figure 7.3) - Potassium has been enriched closer to the deposit at 250m as would be expected within the phyllic zone of a porphyry copper system.

Magnesium (Figure 7.4) - Magnesium has been enriched in two areas from 250m to 1000m and from 1250m to 2000m. The results suggest either a broad halo of enrichment or a problem with low 'fresh' rock magnesium values.

FIGURE 7.1: BROMINE (Br) - PPE(+)/D(-); Morenci, AZ

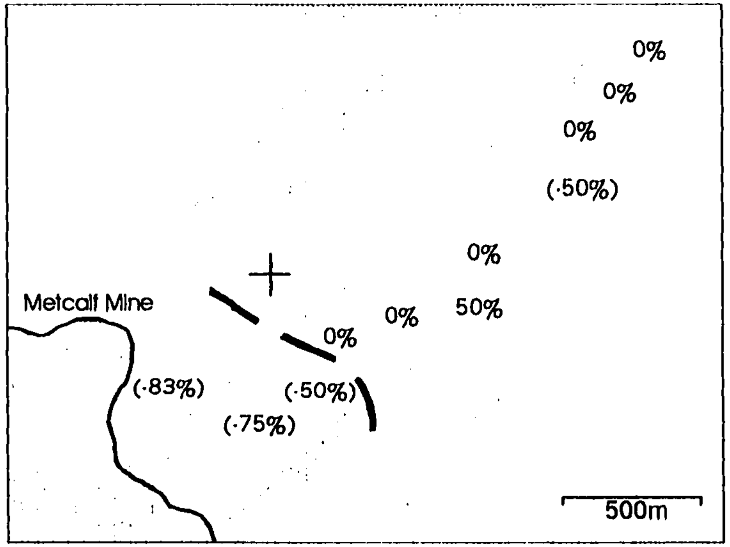


FIGURE 7.2: COPPER (Cu) - PPE(+)/D(-); Morenci, AZ

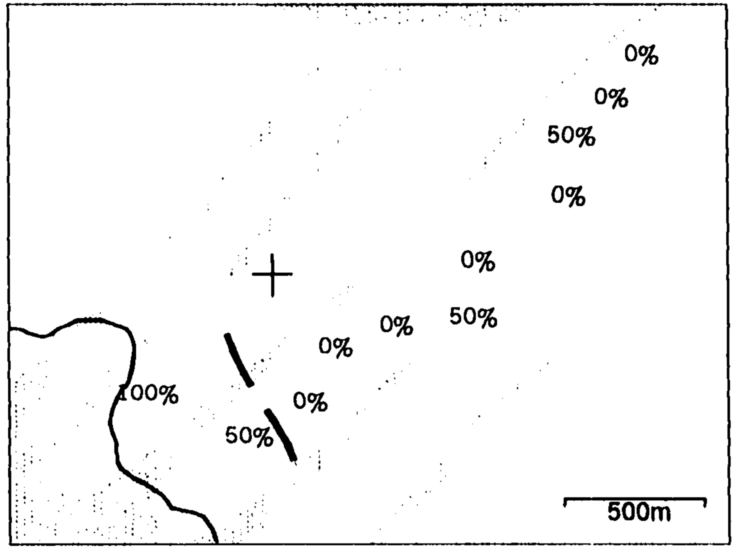


FIGURE 7.3: POTASSIUM (K) - PPE(+)/D(-); Morenci, AZ

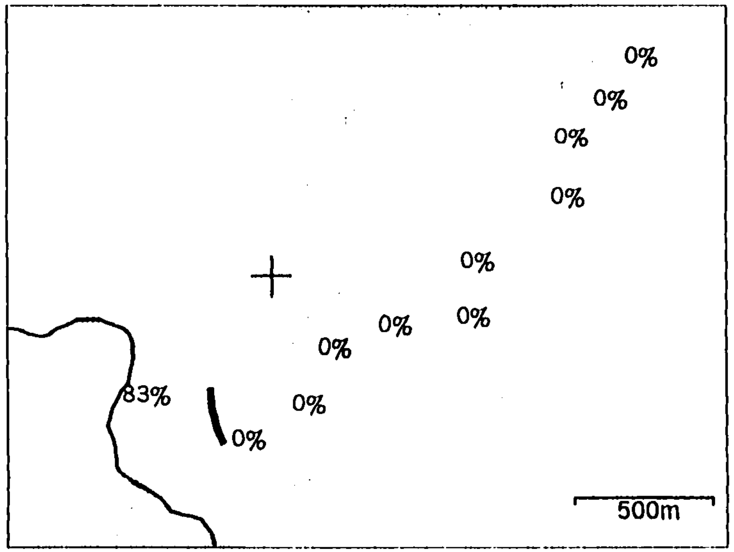
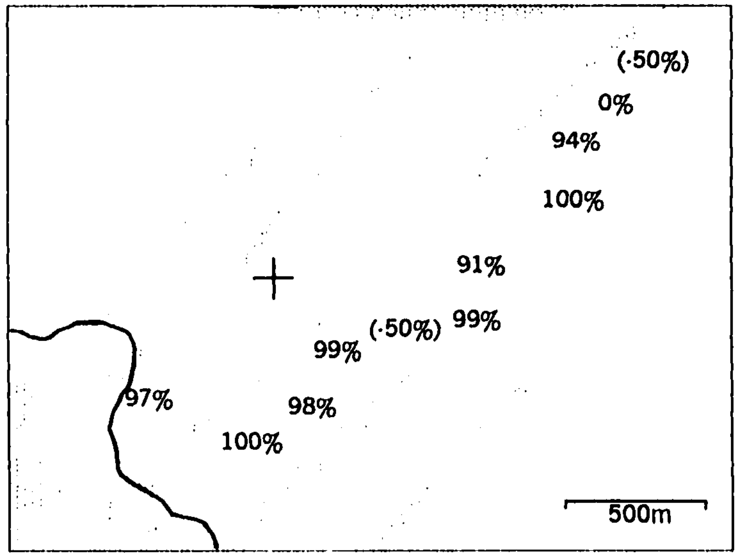


FIGURE 7.4: Magnesium (Mg) - PPEt(+)/D(-); Morenci, AZ



Manganese (Figure 8.1) - Manganese has been enriched away from the deposit only at 1250m.

Molybdenum (Figure 8.2) - The results for molybdenum are erratic and make interpretation difficult. There is enrichment evident from 250m to 500m.

Lead (Figure 8.3) - There is distal enrichment in lead at 1000m to 2000m, which corresponds to enrichment in zinc.

Selenium (Figure 8.4) - Selenium has been enriched distally to the deposit in a broad halo 1000m to 2250m.

FIGURE 8.1: MANGANESE (Mn) - PPE(+)/D(-); Morenci, AZ

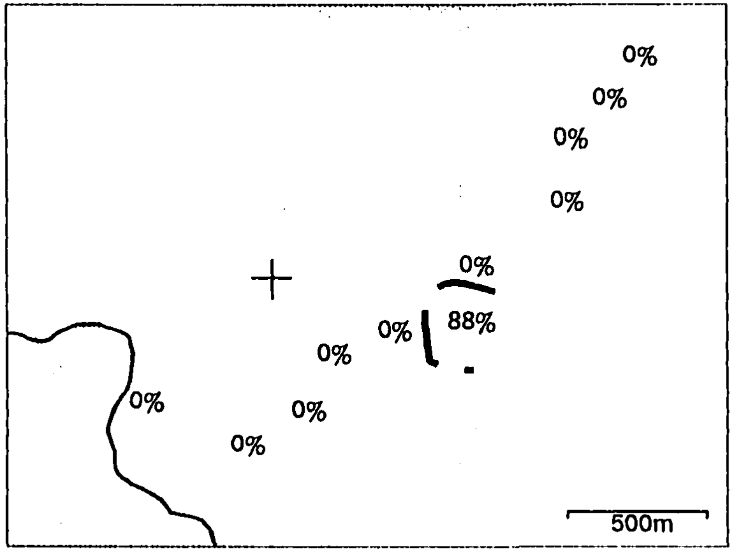


FIGURE 8.2: MOLYBDENUM (Mo) - PPE(+)/D(-); Morenci, AZ

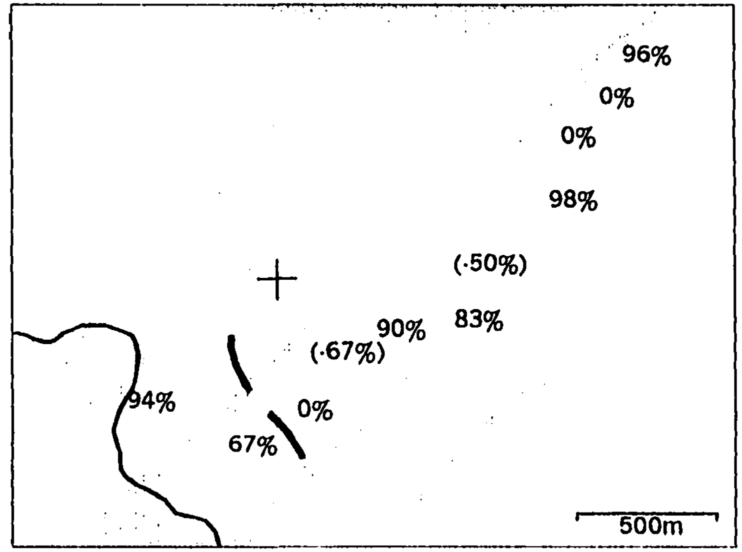


FIGURE 8.3: LEAD (Pb) - PPE(+)/D(-); Morenci, AZ

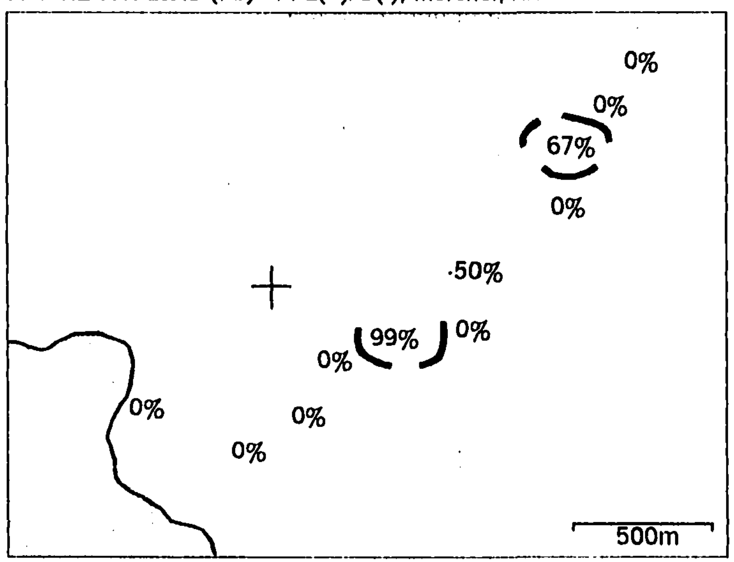
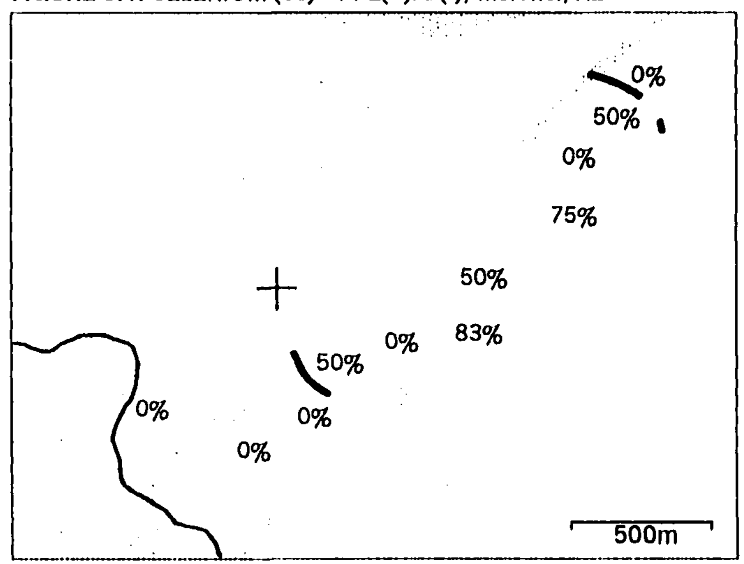


FIGURE 8.4: SELENIUM (Se) - PPE(+)/D(-); Morenci, AZ



Uranium (Figure 9.1) - Uranium has been removed close to the deposit between 250m and 500m. Further away, low probabilites make it unclear whether there has been any influence on uranium.

Vanadium (Figure 9.2) - Close to the deposit there has been enrichment in vanadium, between 250m and 500m, while low probabilities, from 500m to 2500m, suggest there may be weak depletion.

Zinc (Figure 9.3) - Zinc has been enriched between 500m and 750m and at 1250m. Zinc enrichment correlates to enrichment in lead, with lead enrichment occurring further away from the deposit. There is also evidence of depletion within 250m.

FIGURE 9.1: URANIUM (U) - PPE(+)/D(-); Morenci, AZ

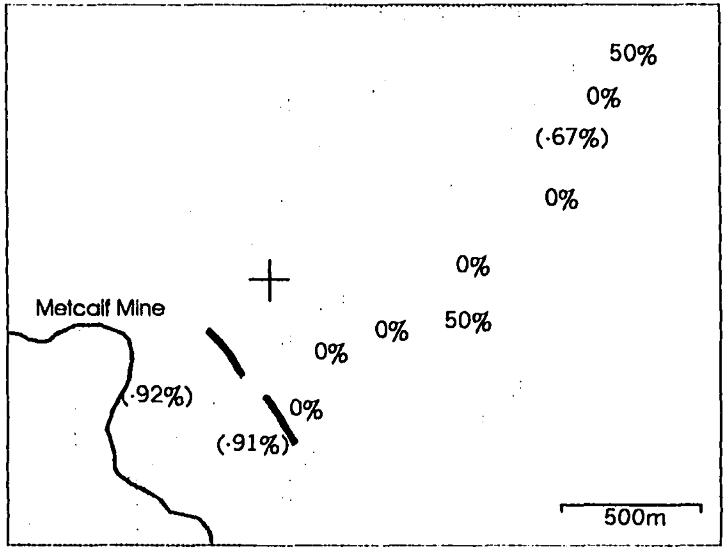


FIGURE 9.2: VANADIUM (V) - PPE(+)/D(-); Morenci, AZ

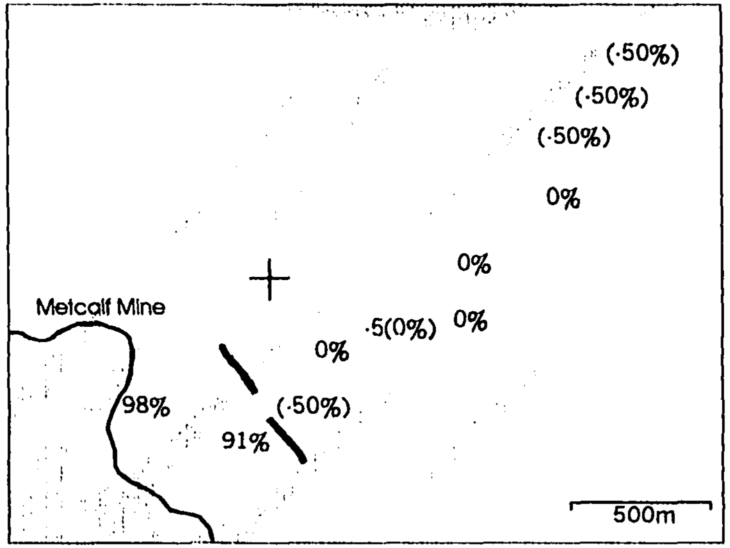


FIGURE 9.3: ZINC (Zn) - PPE(+)/D(-); Morenci, AZ

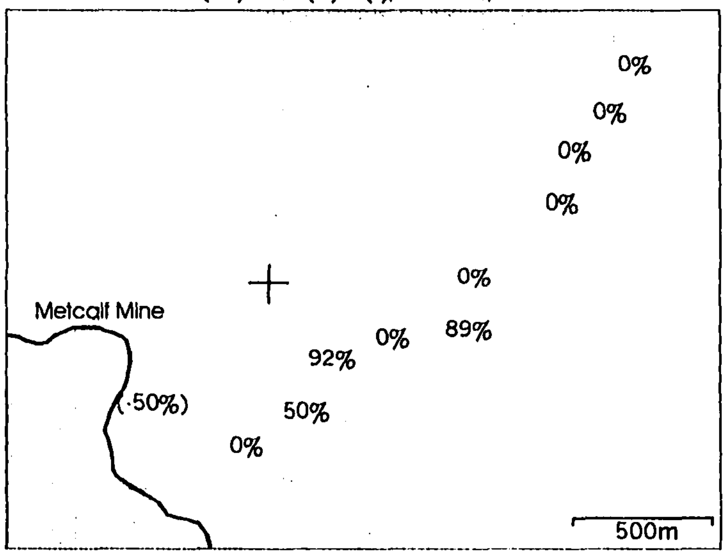
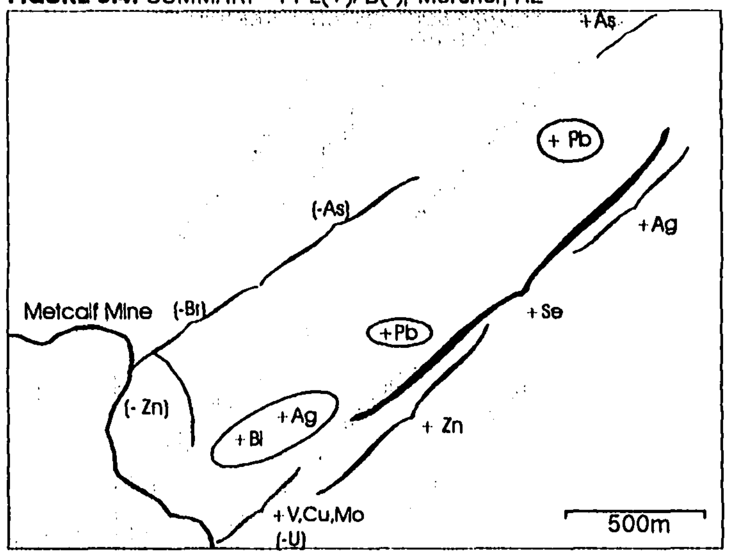
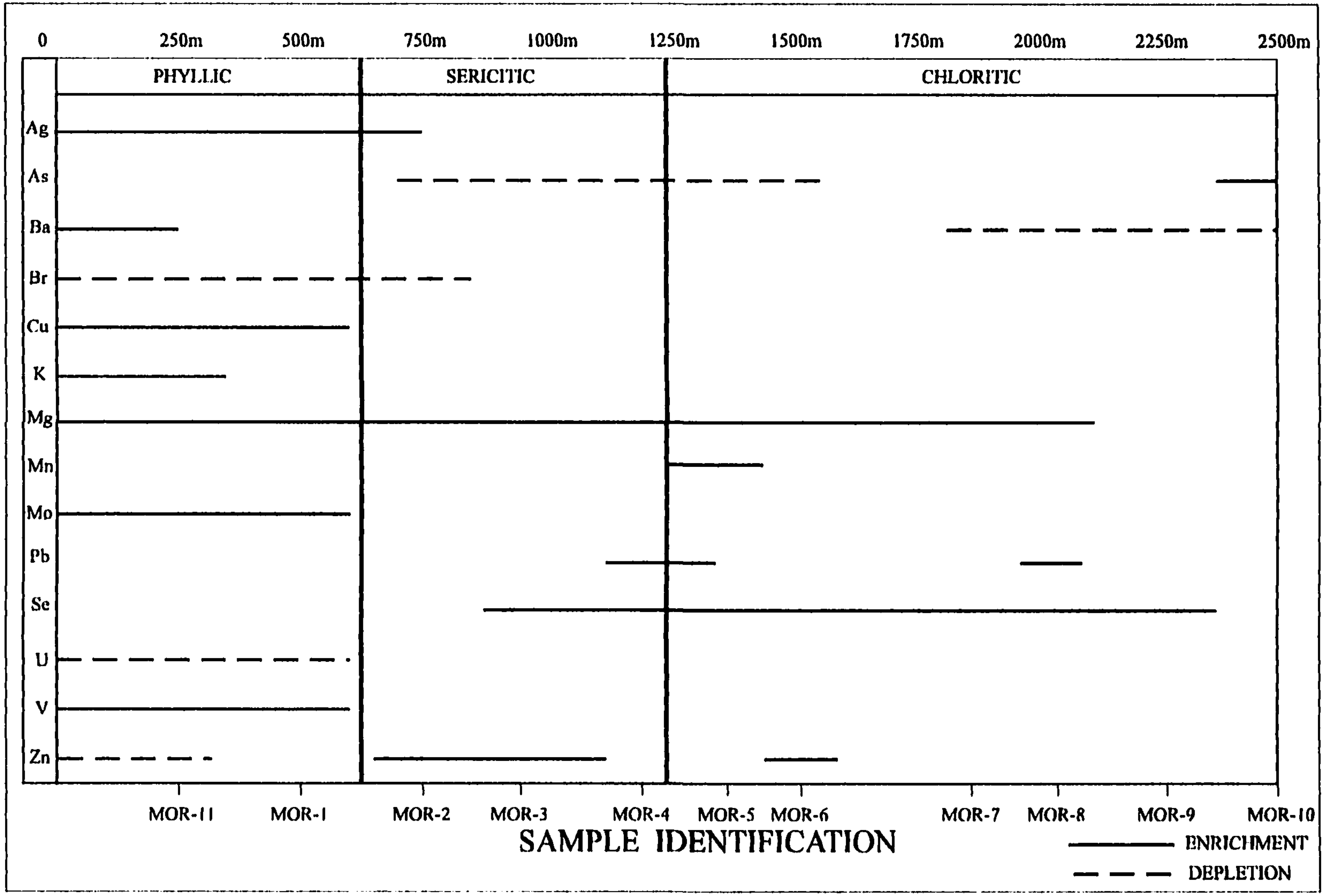


FIGURE 9.4: SUMMARY - PPE(+)/D(-); Morenci, AZ



Conclusions. Morenci was chosen as the initial test site for this study based on Langton's paper (Langton, 1973), which described the district as a classic well-zoned porphyry system with a well established distal epidote-chlorite propylitic zone. This proved not to be the case. In fact, distal alteration appeared to be largely dike controlled both to the NE along trend and to the SE. In the areas sampled and investigated, no epidote was seen in hand sample or thin section. The chloritic alteration that is present can be attributed to deuteric alteration. Samples taken near to dikes in some instances were found to be anomalous in metals, making interpretation of this system difficult, which is why more extensive sampling was not done. The trends in trace elements are summarized in Figures 9.4 and 10. Selenium, lead, and zinc have the best trends. It is premature to attribute significance to these trends without a larger data set or a clearer understanding of dike effects and other variables.

FIGURE 10: Morenci Trace Elements and Alteration

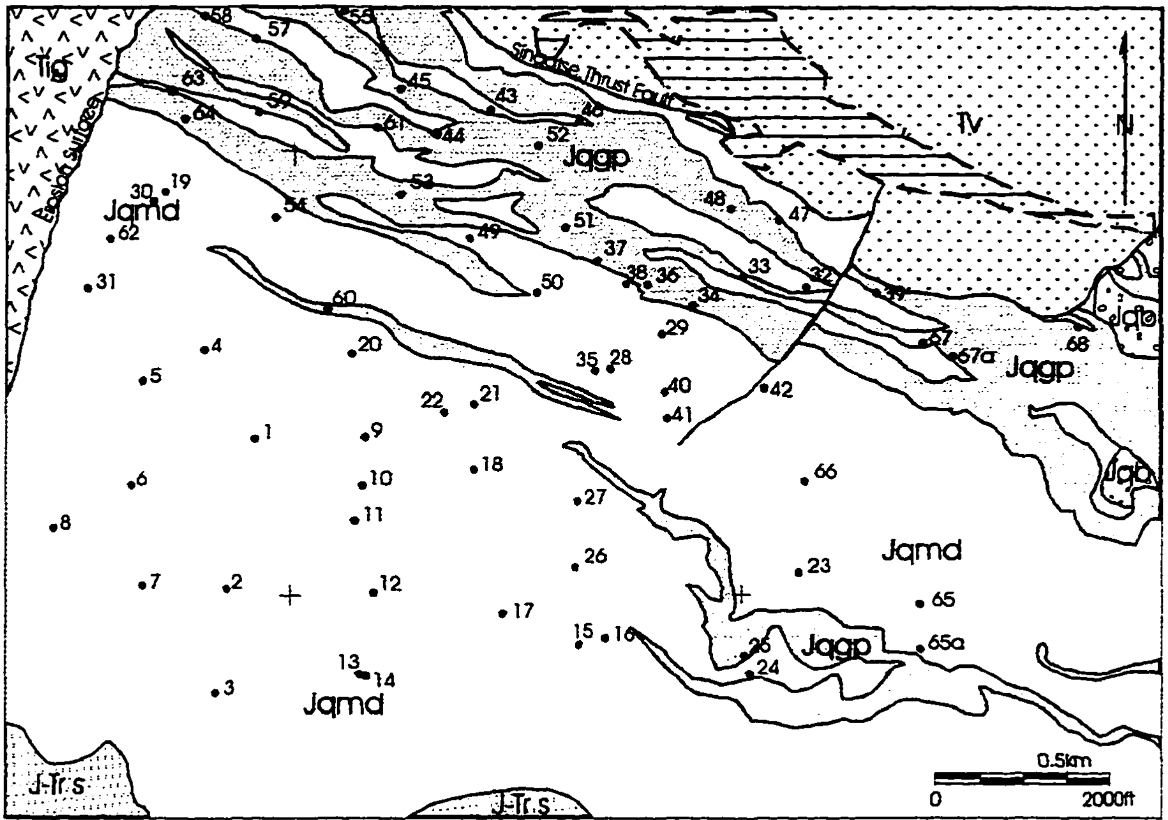


ANN MASON, NEVADA

Location. The Ann Mason porphyry copper deposit (Figure 11) is located eight kilometers west of Yerington, Nevada, and seven kilometers west of the Yerington mine. Copper mineralization lies primarily within T13N R24E S13,S14 and T13N R25E S18. Alteration related to the porphyry copper system is well exposed and was sampled in T13N R24E S22 thru S27.

Geology - Ann Mason was chosen for study because of its excellent exposure and the work done by Dilles, which provides a well - constrained fluid flow model (Dilles et al, 1992). The porphyry copper system at Ann Mason is related genetically to the better known Yerington deposit. Mesozoic rocks have been tilted 90^{o}W, providing a 5km vertical by 3km horizontal section (Figure 11.1). This provides an excellent cross-section of a porphyry copper system for the study of trace elements both vertically and laterally. A Tertiary erosion surface preserved in the section is believed to represent 1km of erosion, so the exposure comprises from 1km to 6km depth within the system. The host of mineralization ranges in age from approximately Middle Triassic to Middle Jurassic. Copper mineralization is associated with the Middle Jurassic Yerington Batholith that intrudes cogenetic andesite-dacite volcanic rocks of Artesia Lake (Dilles, 1987).

FIGURE 11.1: ANN MASON PORPHYRY COPPER SYSTEM

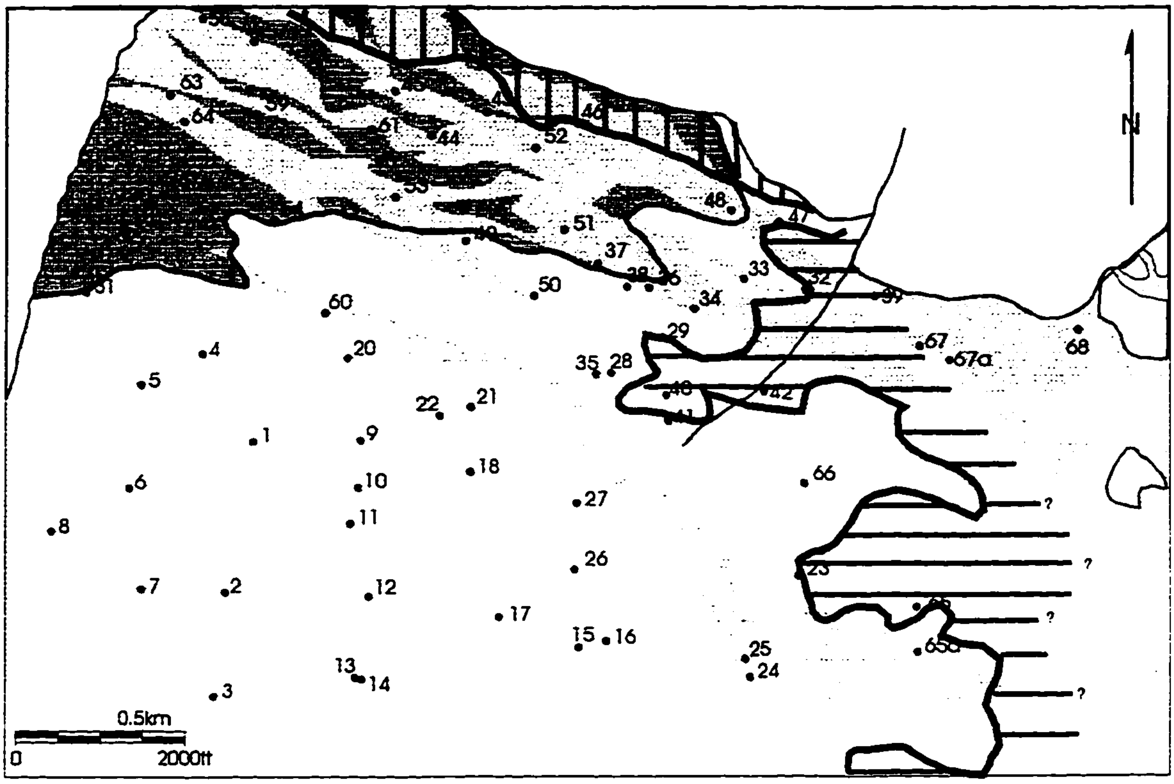


(Simplified from Dilles & Einaudi 1992)

Tv: Tertiary Volcanic Rocks	Jqb: Jurassic Border Phase
Tig: Tertiary Ignimbrites	Jqmd: Jurassic Quartz Monzodiorite
Jqgp: Jurassic Granite Porphyry	J-Trs: Jurassic-Triassic Sedimentary units

Copper >0.2% overlain by volcanics

FIGURE 11.2: ALTERATION AT ANN MASON



(Simplified from Dilles & Einaudi 1992)

Propylitiic Alteration

Sodic-Calcic Alteration

Sodic and Sericitic Alteration

Strong Potassic Alteration

*See figure 11.1 for explanation of lithologic units

The composite pluton ranges in composition from quartz monzodiorite (Jqmd) to granite (Jqgp). The earliest intrusion is a hornblende quartz monzonite. The monzonite is cut by the Bear pluton which is compositionally zoned from hornblende quartz monzonite to a border granite. This composite, the main phases of Dilles, is intruded by granite porphyry dikes that are associated with the porphyry copper mineralization and emplacement of a porphyritic granite (Jqb) in the area of Luhr Hill. This porphyritic granite represents a cupola lying 3.6km below the Tertiary erosion surface with dikes extending to it. To the north, the Ann Mason copper deposit is overlain by Tertiary volcanic flows (Tv) thrust over the mineralization along the Singatse thrust fault.

Alteration at Ann Mason is shown in Figure 11.2. Hypogene chalcopyrite mineralization is covered by Tertiary volcanic rocks. A portion of potassic alteration outcrops adjacent to the thrust fault. The upper portion of the system is characterized by phyllic and sodic alteration. The deeper parts of the system have undergone sodic and calcic alteration. Extending away from the system is an extensive zone of propylitic alteration.

Petrology. Petrographic examination was necessary to insure that the host rock is similar between samples to minimize variance due to compositional variation within the host rock. The set of samples was broken into two groups due to the significant composition difference between the main phases (the host) and granite porphyry in the dikes (the mineralizer). Composition variation in the main phase was minimized by hand sample comparison; mineralogical composition showed little variation between samples in thin section. The average composition of the main phase is granodiorite. The porphyry is granitic in composition.

Sampling was done in three zones of alteration: propylitic, sodic and sericitic, and potassic (Dilles et al, 1992), (Figure 11.2). The propylitic alteration is characterized by alteration to albite, epidote, chlorite, and minor specular hematite. Small veinlets are filled with epidote and albite. Sodic and sericite alteration is localized largely in the upper central portion of the system. Little to no epidote is present and alteration is dominated by sericitization and albitization. The potassic zone has minor chlorite, epidote, and chalcopyrite associated with potassium feldspar flooding. Refer to Appendix C for detailed petrographic descriptions of the samples.

Presentation of Results. The sample location map (Figure 11) shows that samples can be broken out as either porphyry or main phase. The data is presented using percent probability plots with no distinction made between rock types, because the difference in rock types has already been incorporated in the calculations. Ann Mason proved to be the most useful of all the systems evaluated. The plots are overlain on geology, but the PPE/D values are not shown. Lines are drawn using a value of >50% or <-50% as the cut off for enrichment or depletion.

Silver and Copper (Figure 12.1 and 12.2) - Silver and copper have been enriched in a similar manner (Figure 12.3). Enrichment appears to be centered on the granite porphyry dikes (Jqgp) regardless of depth. Copper enrichment forms a halo that is more extensive than that of silver around known mineralization and dikes, with copper enrichment detected up to two kilometers from mineralization (Figure 12.4).

FIGURE 12.1: SILVER (Ag) · PPE(+)/D(-); Ann Mason, NV

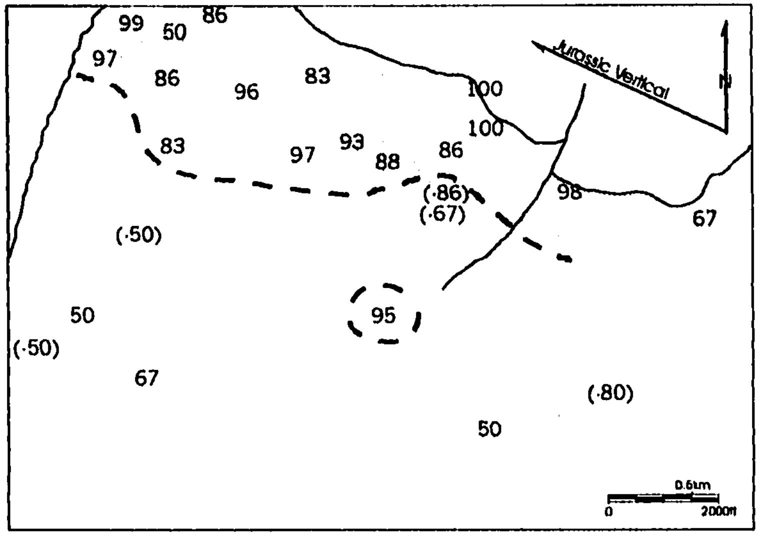


FIGURE 12.2: COPPER (Cu) · PPE(+)/D(-); Ann Mason, NV

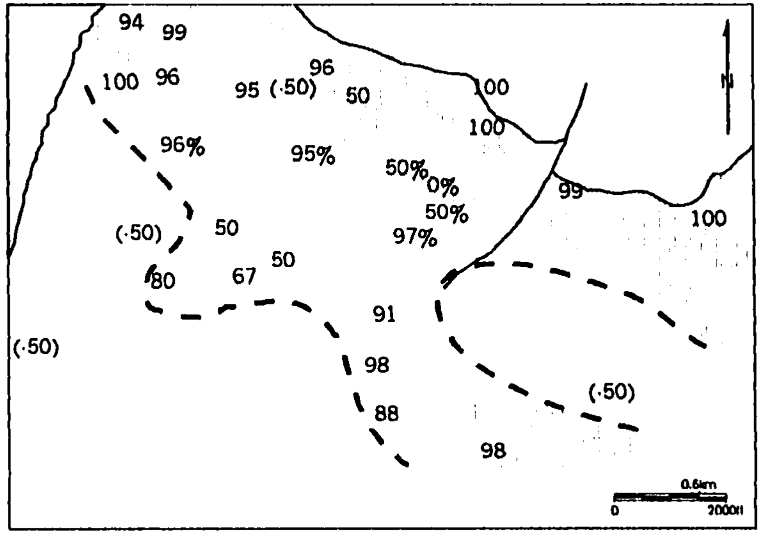


FIGURE 12.3: Correlation of Ag and Cu; Ann Mason, NV

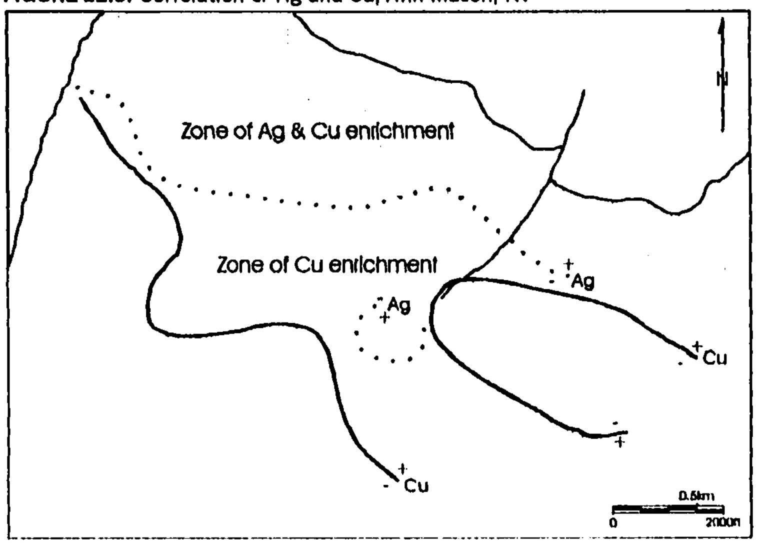
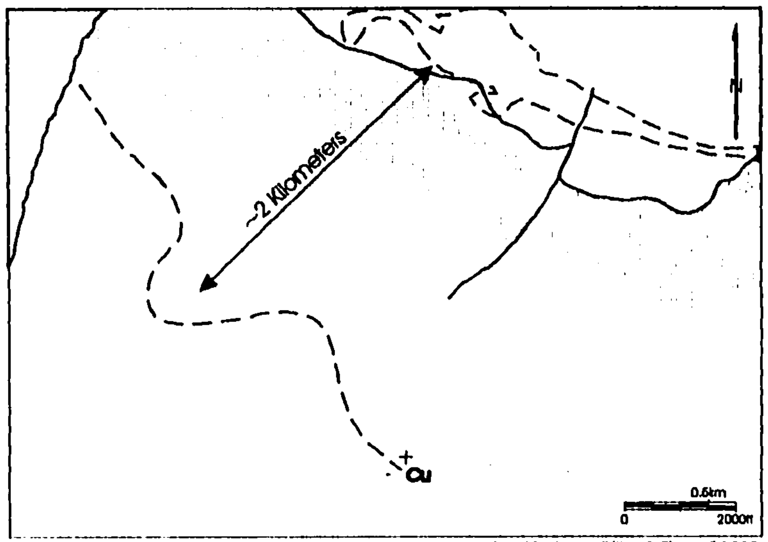


FIGURE 12.4: Distance of detectable Cu enrichment



(Simplified from Dilles & Einaudi 1992)

Lead, Zinc, and Manganese (Figure 13.1, 13.2, and 13.3) - Lead, zinc, and manganese enrichment occurs in a plume open to the SW (Figure 13.4). The plume is capped to the NW approximately by the contact with sodic and sericitic alteration. The contact to the east is poorly defined and may correlate with the area of sodic-calcic alteration. Outside the enrichment plume the rocks have been depleted in lead, zinc, and manganese possibly providing a source for the metals where they have been enriched. The correlation of lead, zinc, and manganese, suggests that they have been removed from their source and redistributed - enriched during the same mineralizing - alteration event.

FIGURE 13.1: LEAD (Pb) - PPE(+)/D(-); Ann Mason, NV

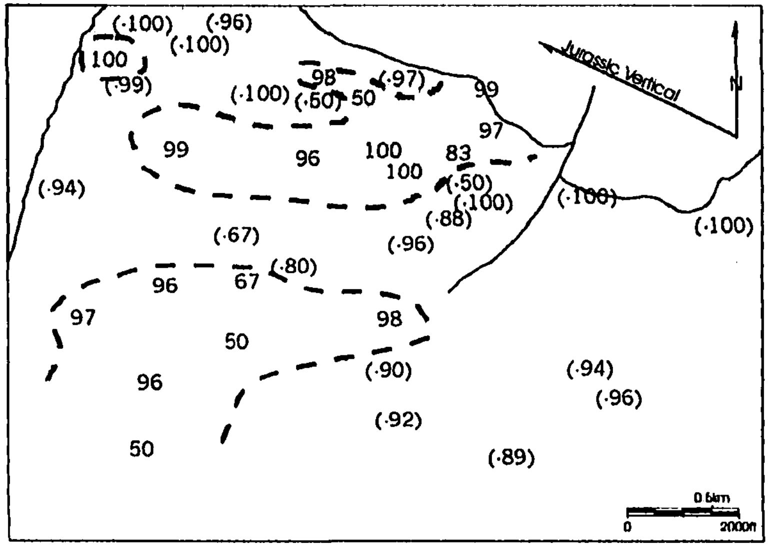


FIGURE 13.2: ZINC (Zn) - PPE(+)/D(-); Ann Mason, NV

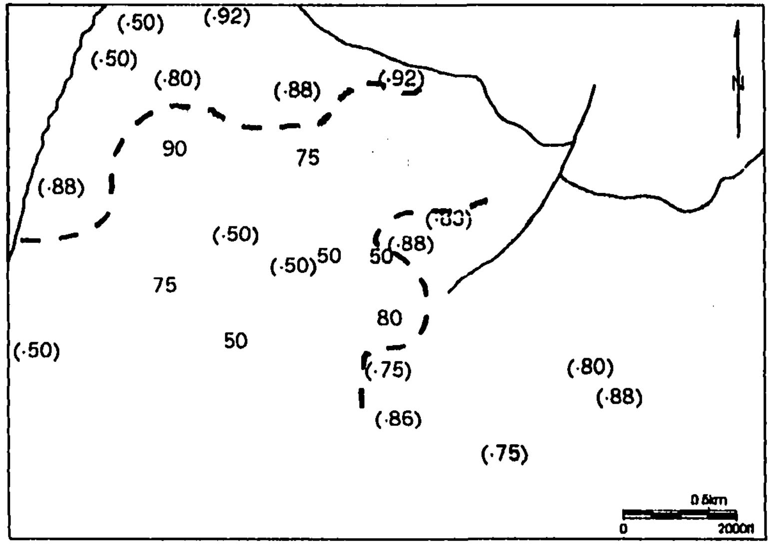


FIGURE 13.3: MANGANESE (Mn) - PPE(+)/D(-); Ann Mason, NV

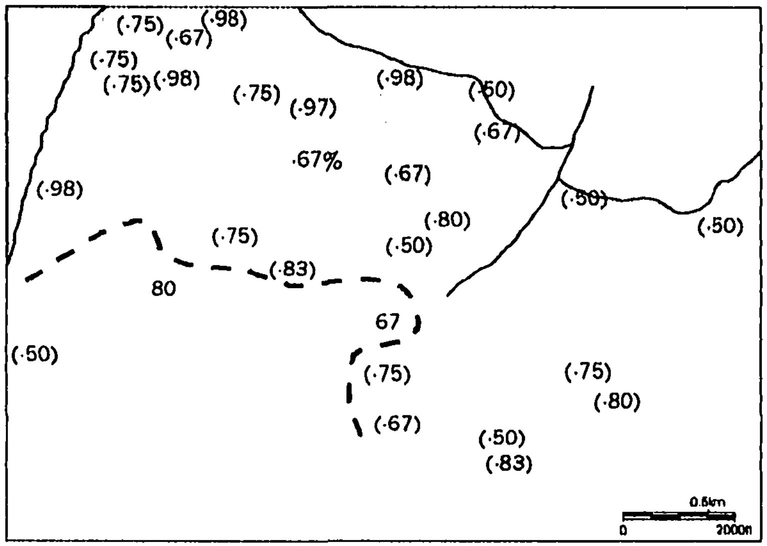
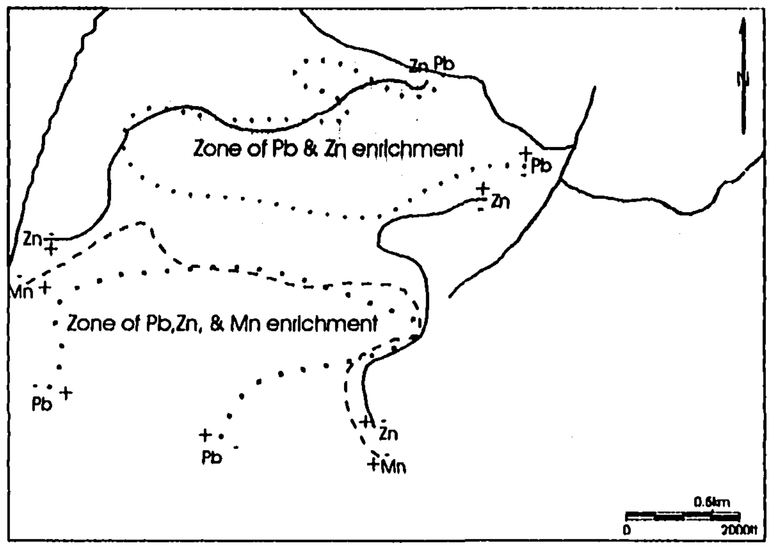


FIGURE 13.4: Correlation of Pb, Zn, and Mn



Titanium and Vanadium (Figure 14.1 and Figure 14.2) - Titanium has been depleted in the shallower inner portions of the system, and correlates with depletion in vanadium. Vanadium shows an inner zone of enrichment ringed by depletion. The zone of depletion correlates, approximately, to the area of strong sericitic alteration (Figure 14.4). Titanium and vanadium may have been removed through the destruction of biotite and rutile.

FIGURE 14.1: TITANIUM (Ti) - PPE(+)/D(-); Ann Mason, NV

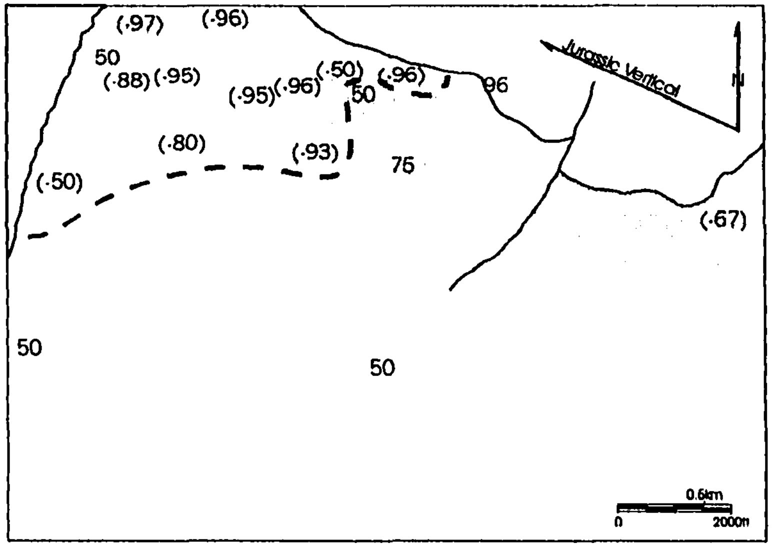


FIGURE 14.2: VANADIUM (V) - PPE(+)/D(-); Ann Mason, NV

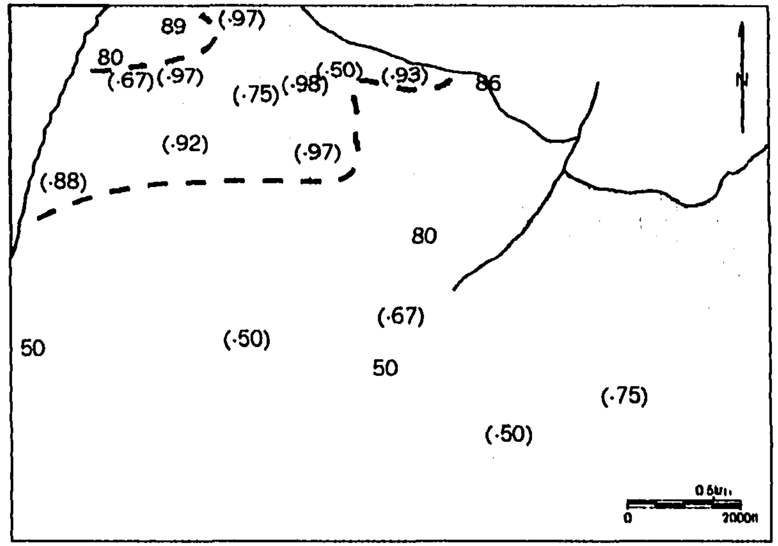


FIGURE 14.3: Correlation of Ti and V depletion

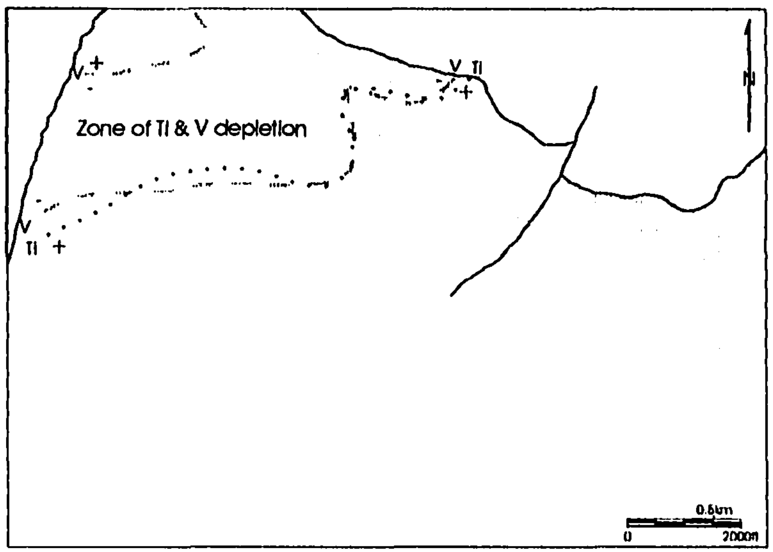
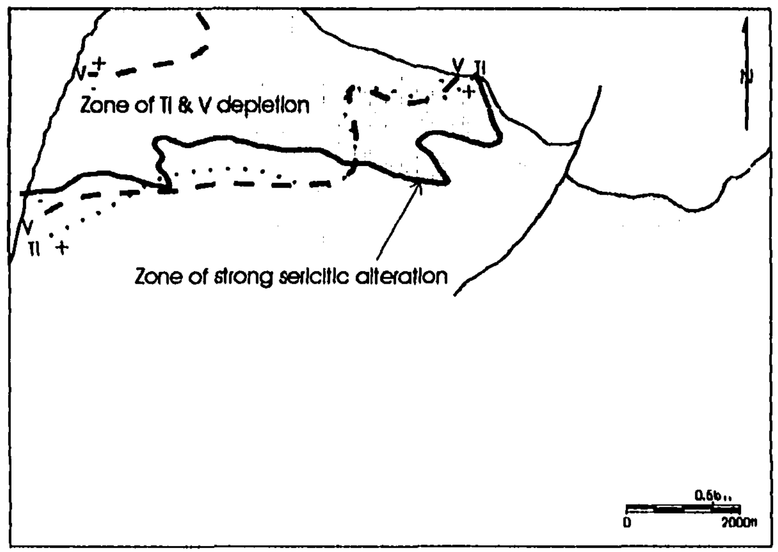


FIGURE 14.4: Correlation of Ti and V to strong sericitic alteration



Phosphorus and Magnesium (Figure 15.1 and 15.2) - Phosphorus and magnesium both display almost identical depletion distributions - an upward opening plume. The depletion plume correlates exactly with sericitic alteration (Figure 15.4). Phosphorus and magnesium may have been leached through the destruction of apatite and biotite.

FIGURE 15.1: PHOSPHORUS (P) ·PPE(+)/D(-); Ann Mason, NV

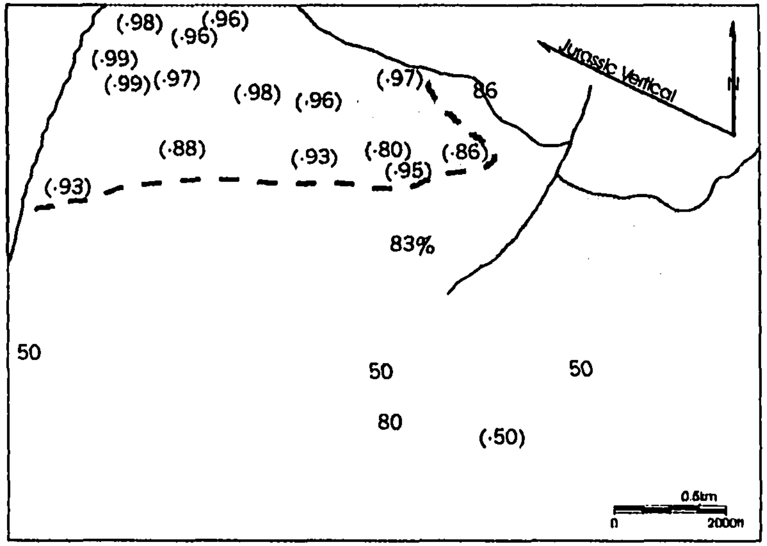


FIGURE 15.2: MAGNESIUM (Mg) · PPE(+)/D(-); Ann Mason, NV

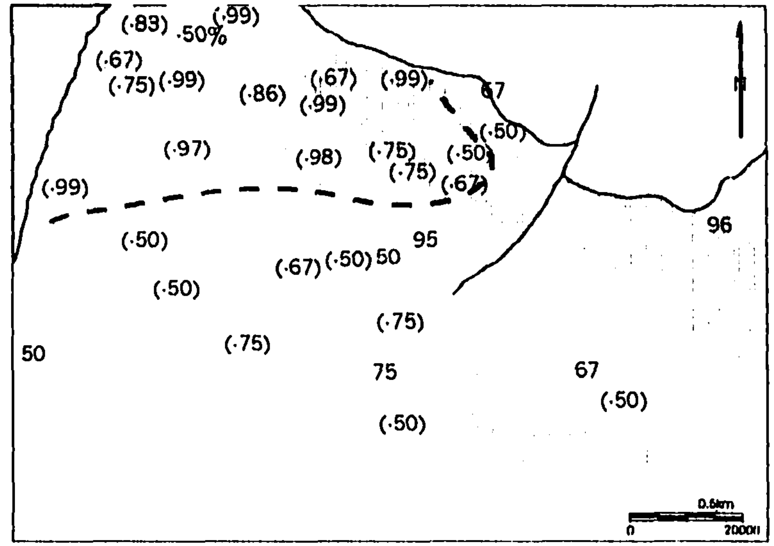


FIGURE 15.3: Correlation of P and Mg; Ann Mason, NV

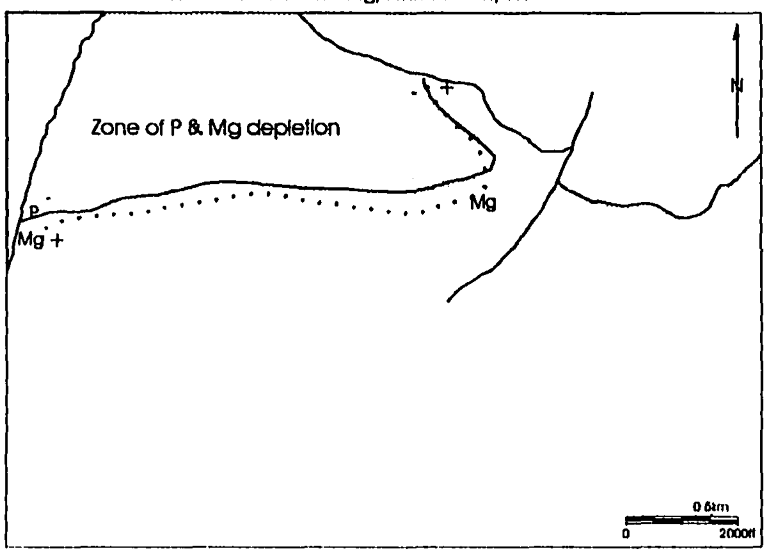
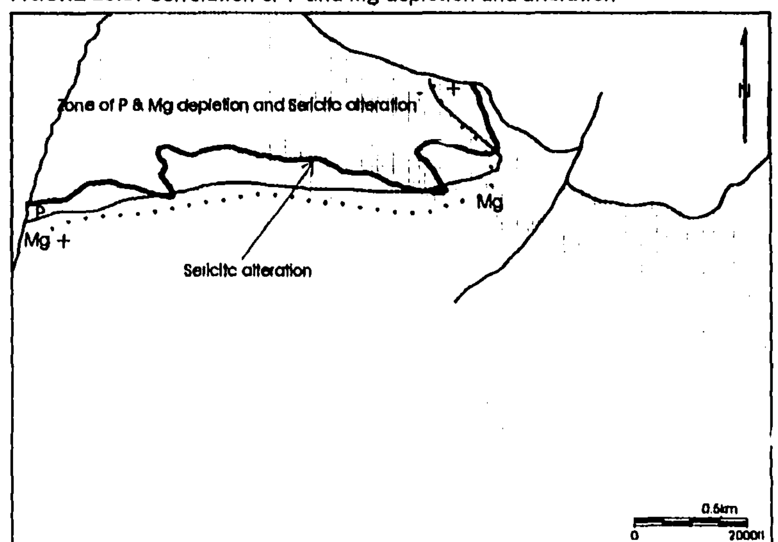


FIGURE 15.3: Correlation of P and Mg depletion and alteration



(Simplified from Dilles & Einaudi 1992)

Arsenic and Antimony (Figure 16.1 and Figure 16.2) - Arsenic and antimony have been enriched in the shallow portion of the system from 1000m to 1500m below the erosional surface. The deeper portion of arsenic enrichment toward the center of enrichment corresponds to the zone of strong sericitic alteration. The enrichment in these elements extends 2km - 3km away from the >0.2% copper body. The radiating zone of enrichment may not be accurate due to low to moderate probabilities.

FIGURE 16.1: ARSENIC (As) - PPE(+)/D(-); Ann Mason, NV

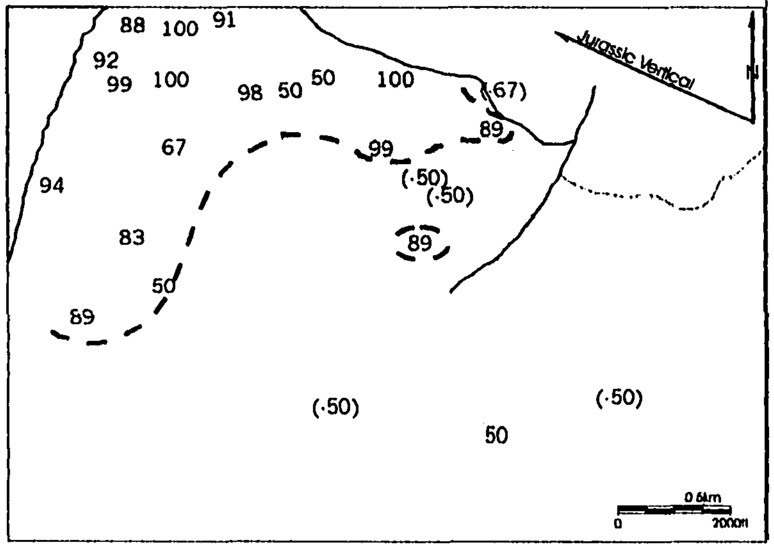


FIGURE 16.2: ANTIMONY (Sb) - PPE(+)/D(-); Ann Mason, NV

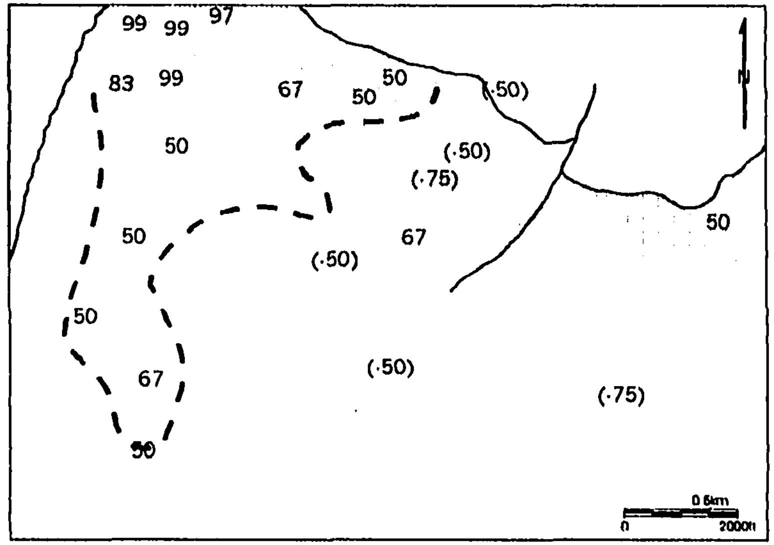


FIGURE 16.3: Correlation of As and Sb enrichment

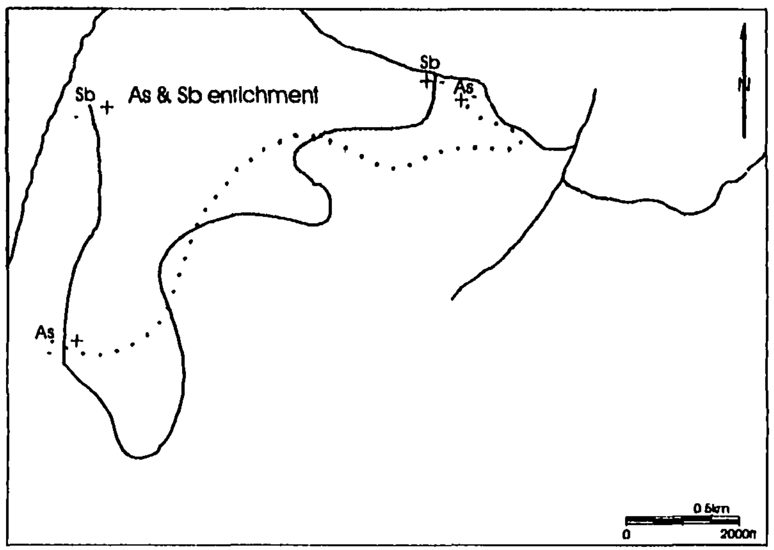
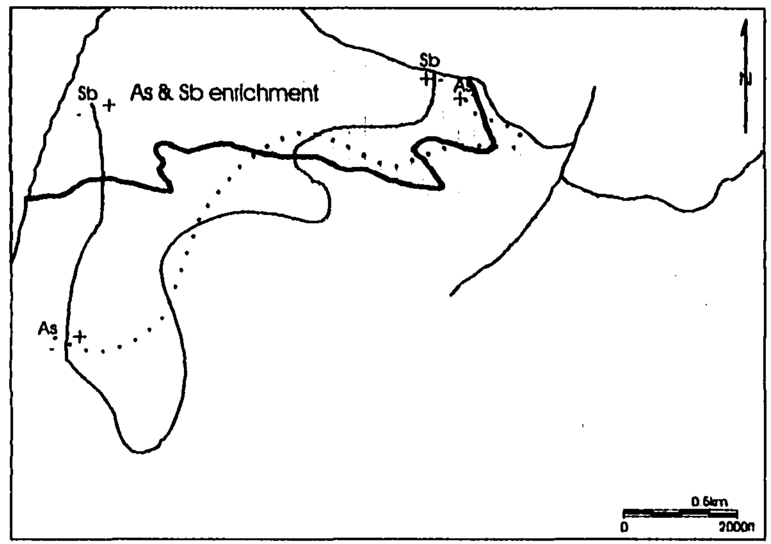


FIGURE 16.4: Correlation of As to sericitic alteration



Bromine and Mercury (Figure 17.1 and Figure 17.2) - Bromine has been depleted in the central portion of the system and has been enriched further away. Mercury has been enriched along a conduit which opens into a plume ending at the erosional surface. The areas of bromine depletion correlate to enrichment in mercury, suggesting that these events may have been related.

FIGURE 17.1: BROMINE (Br) - PPE(+)/D(-); Ann Mason, NV

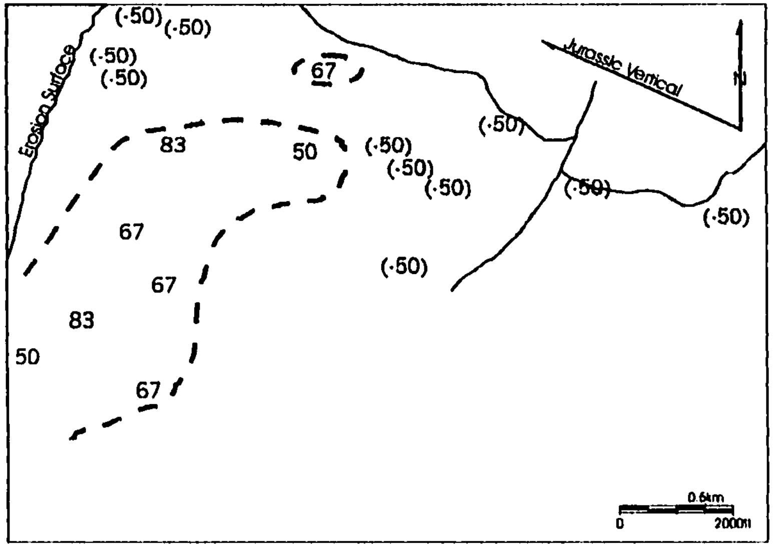


FIGURE 17.2: MERCURY (Hg) - PPE(+)/D(-); Ann Mason, NV

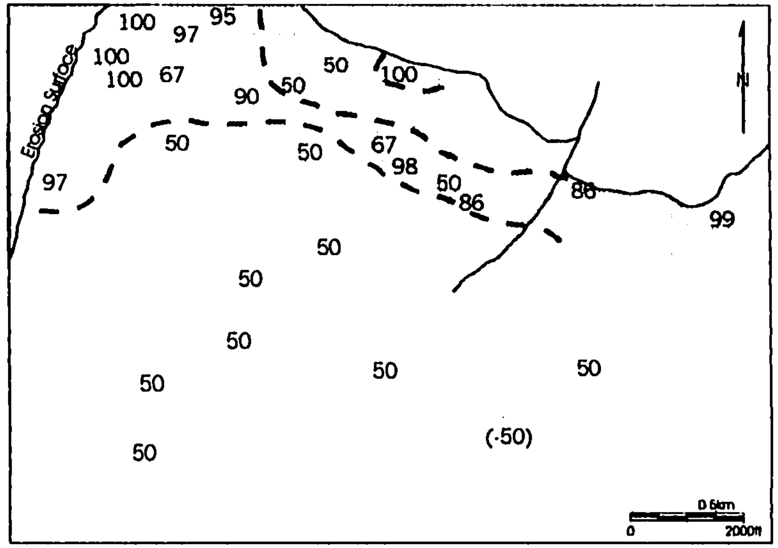
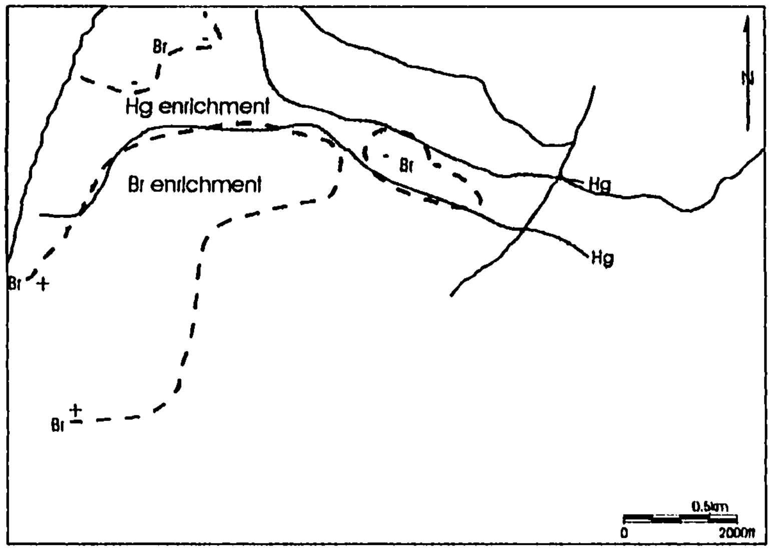


FIGURE 17.3: Correlation of Bromine and Mercury



OTHER ELEMENTS

Gold - Gold has been enriched at shallow depths (~0.5km) and 1.5 to 3 kilometers from the center of the system. There is also a zone of enrichment deeper (~2.5km) and more centrally located that correlates with strong sodic alteration.

Barium - Barium is erratic in behavior with a shallow central zone of depletion that may be related to alteration of K-feldspars.

Bismuth - As with arsenic, bismuth has been enriched in a plume spreading upward and outward in the system.

Hafnium - Hafnium has been enriched in the upper central part of the system.

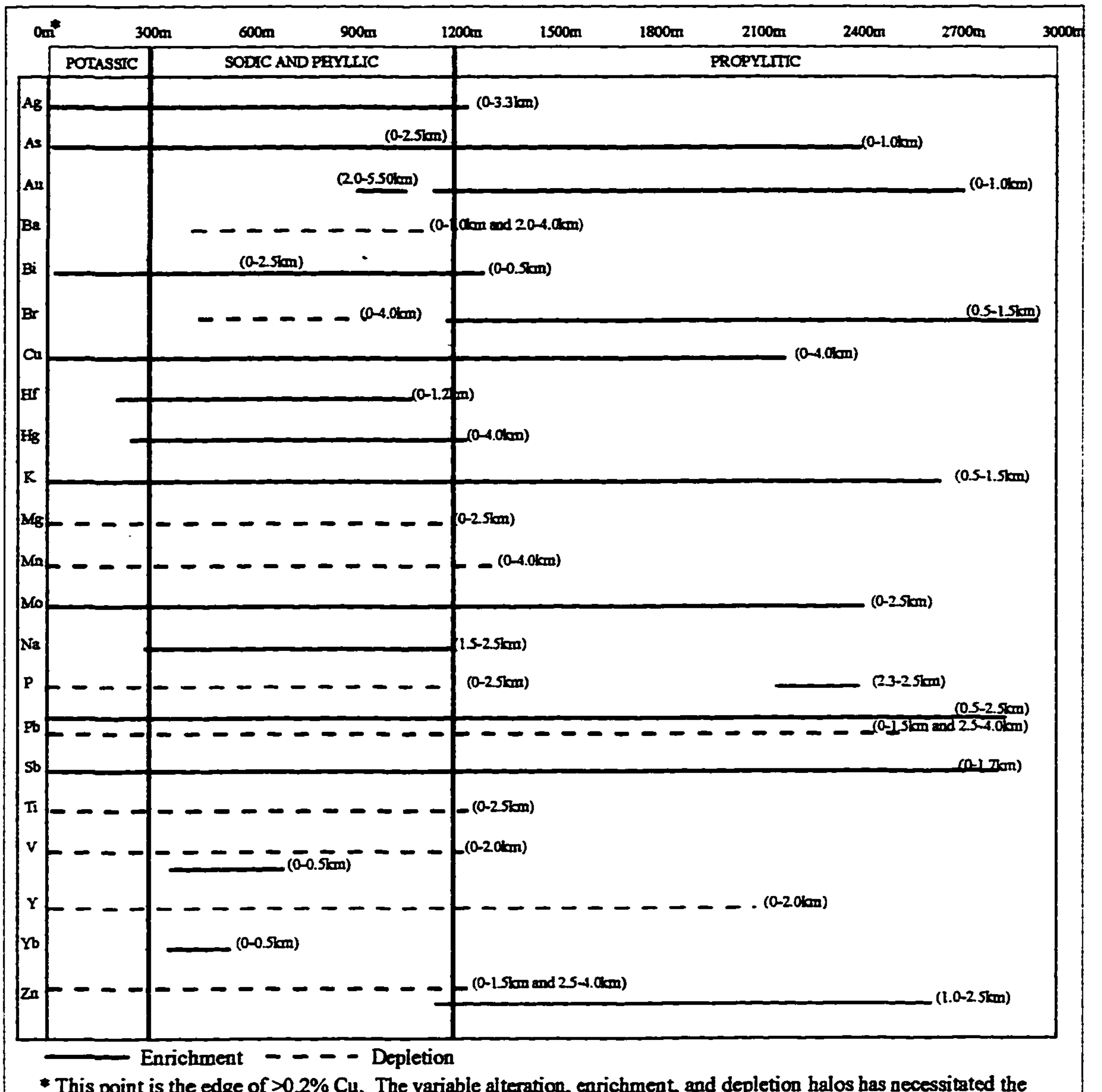
Potassium - Potassium enrichment is seen along a horizon ~1 km deep. This strange distribution may be a result of the extensive sodic alteration characteristic of the Ann Mason system.

Molybdenum - Molybdenum is enriched in an opening upward plume, that does not follow the pattern of copper enrichment.

Yttrium - Yttrium follows a pattern somewhat similar to that of arsenic, with depletion occurring in a broad plume opening upward.

Ytterbium - This element is included only because is appears to correlate to hafnium with central and shallow enrichment.

FIGURE 18: Ann Mason Trace Elements and Alteration



* This point is the edge of >0.2% Cu. The variable alteration, enrichment, and depletion halos has necessitated the estimation of the boundaries on this diagram.

**The interval following the element name is the depth below the Tertiary erosion surface, where the enrichment or depletion occurs.

Conclusions - Ann Mason provides an opportunity to evaluate trace element distributions laterally as well as vertically. It is important to consider how these distributions may be influenced by the hydrothermal alteration event (Figure 11.2 adapted from Dilles and Einaudi, 1992). The alteration zoning shows a strong correlation with results for a number of elements including Ti, V, P, and Mg. Other elements are distributed independently of alteration, copper and silver, for example. It is important that enrichment in some elements is detectable up to 3km away from mineralization, as is seen in copper and antimony.

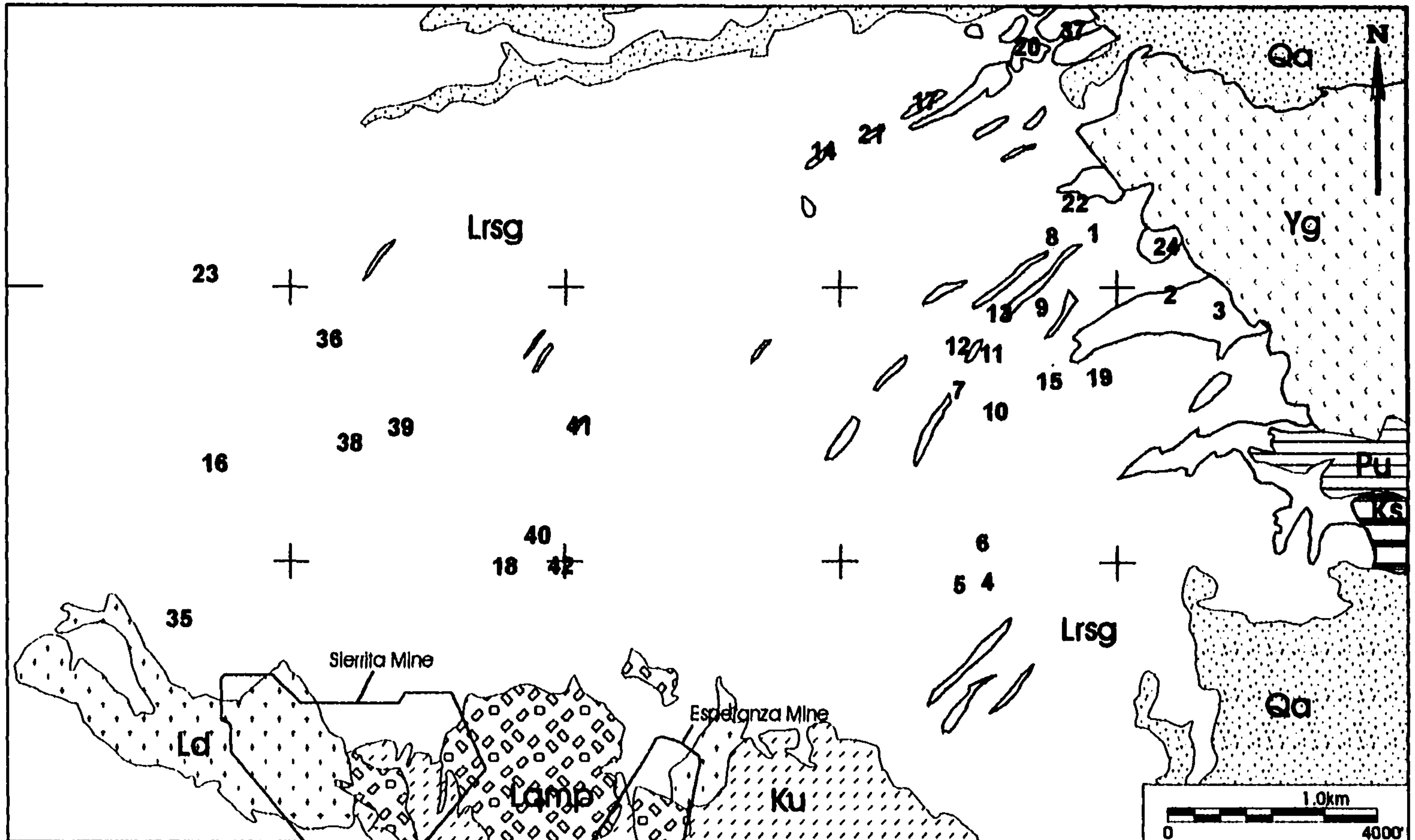
Results for Ann Mason are summarized in Figure 18. At least twelve elements show useful enrichment and depletion trends. The distribution of these patterns suggests that they are not related to a single mineralizing or alteration hydrothermal event. However, they are all zoned around and approximately centered on copper mineralization. This correlation suggests that these patterns, regardless of chronology, can be useful in locating that copper mineralization.

RUBY STAR, AZ

Location. Sampling was done in the Ruby Star granodiorite north of the Sierrita - Esperanza porphyry copper system. The area is located 40 kilometers SSW of Tucson, Arizona, on the SE flank of the Sierrita Mountain range. The mines and major mineralization are located in T18S R12E S7,8,9, and 16. The region covered by sampling includes T17S R12E S34,35 and T18S S2,3,5,8,10. Samples were collected up to 4.5km away from the deposits. Veinlet studies by Manske (1980) and Haynes (1980) indicate that the distal samples are within the area of influence of the mineralizing event.

Geology. This system was selected because of extensive previous study involving the deposits and the generative pluton, especially Titley (1982) and West and Aiken (1988). The deposits result from the intrusion of the Ruby Star quartz monzonite porphyry between Mesozoic volcanics to the south and the Ruby Star granodiorite to the north. The study is centered on distal detection of the porphyry copper systems within the Ruby Star granodiorite. The Ruby Star Batholith is Laramide in age with a quartz monzonite stock on its southern edge that spawned the Sierrita and Esperanza deposits. The batholith is zoned compositionally and

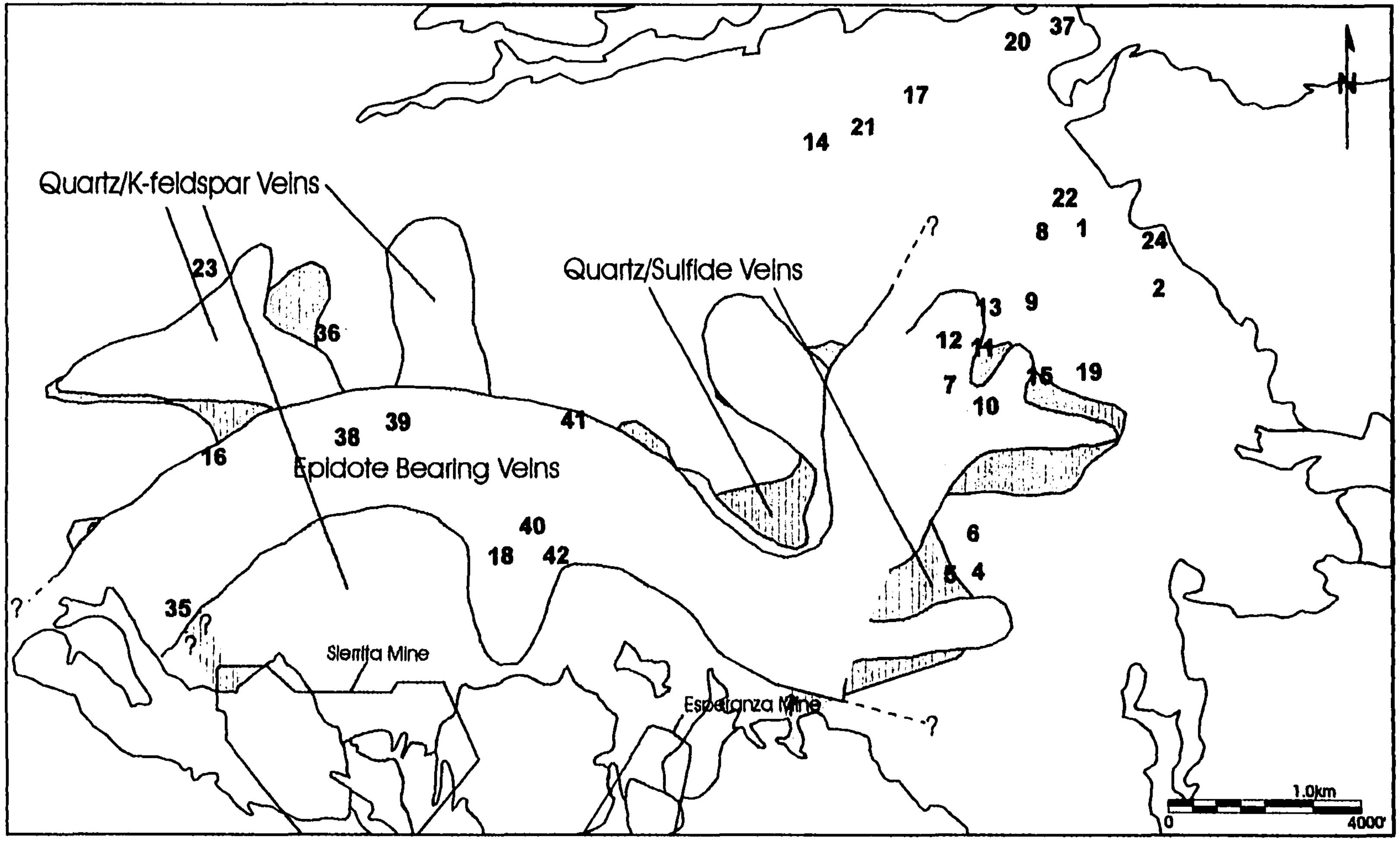
FIGURE 19: SIERRITA/ESPERANZA STUDY AREA



Qa: Quaternary Alluvium
Lqmp: Laramide qtz monzonite porph
Lrsg: Laramide Ruby star granodiorite
Ld: Laramide diorite
Ku: Cretaceous rhyolite, quartzite, cong
Ks: Cretaceous sedimentary units
Pu: Paleozoic undifferentiated units
Yg: PreCambrian granite
Extensive sodic alteration
40 Sample location

(Modified from Cooper 1960)

FIGURE 20: DISTRIBUTION OF VEINS AROUND SIERRITA AND ESPERANZA



(Summarized from Haynes 1980 and Manske 1980) texturally consisting of a granodiorite rim and an inner porphyritic granodiorite core (Hess, 1986).

Fracture density work by Haynes (1980) and Manske (1980) has been summarized (Figure 20) to achieve a better understanding of trace element distributions and how they relate to alteration. Both Haynes and Manske studied the distribution of three vein types: quartz and K-feldspar, quartz and sulfide, and epidote bearing. The three vein sets have overlapping areas of influence. It can be expected that there is enrichment and depletion in particular elements that corresponds to a particular set of veins.

Petrology. The general composition of the granodiorite is quartz, plagioclase, orthoclase, biotite, hornblende, chlorite, magnetite, and zircon. Alteration generally is not evident in hand samples. However, albite and epidote propylitic alteration is intense to the NE of the deposits. Petrographic analysis of the samples reveals minor alteration to chlorite and epidote. The areas of intense propylitic alteration are characterized by alteration to massive epidote and albite.

Presentation of Results. The results in the Ruby Star granodiorite are erratic, but correlation of trace element patterns with the distribution of veinlet mineralization related to the porphyry copper deposits is apparent.

Samples are widely spaced providing only spotty data points from which to draw conclusions, although, zoning of a number of elements is readily apparent. Only those elements with discernible patterns will be presented.

Silver (Figure 21.1) - Silver is enriched up to three kilometers away from the deposits. When silver enrichment is compared to the vein distribution (Figure 24) it is apparent that silver is not enriched beyond the veins and is probably controlled by the vein distribution.

Gold (Figure 21.2) - Gold enrichment, up to three kilometers away, has occurred north and northwest of the Sierrita Mine. The enrichment of gold does not correlate to the distribution of veins (Figure 24).

Bismuth (Figure 21.3) - Bismuth has an enrichment halo similar to that of gold. Enrichment is north and northwest of the Sierrita Mine.

Calcium (Figure 21.4) - Calcium has been included here because it indicates the transition into the anorthite-, albite-, and epidote-dominated alteration zone. The contact between calcium depletion and enrichment corresponds to the NE limit of quartz-pyrite and quartz-sericite veins (Figure 24).

FIGURE 21.1: SILVER (Ag) - PPEt(+)/D(-); Ruby Star Granodiorite, AZ

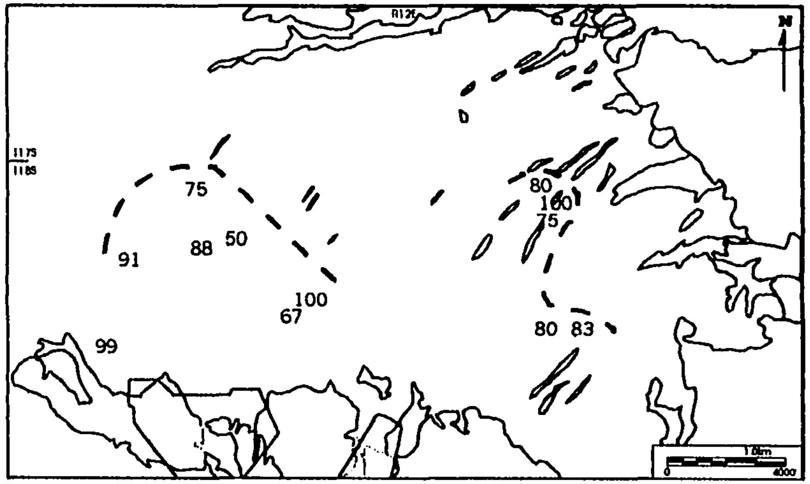


FIGURE 21.2: GOLD (Au) - PPEt(+)/D(-); Ruby Star Granodiorite, AZ

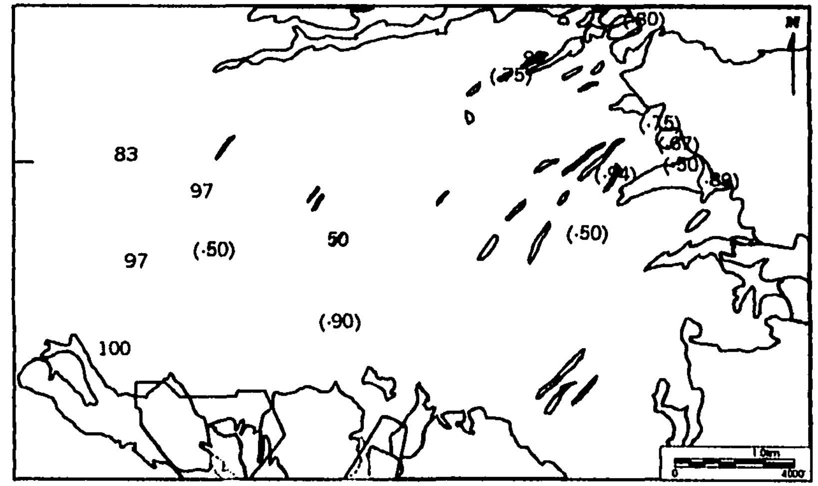


FIGURE 21.3: BISMUTH (Bi) - PPE(+)/D(-); Ruby Star Granodiorite, AZ

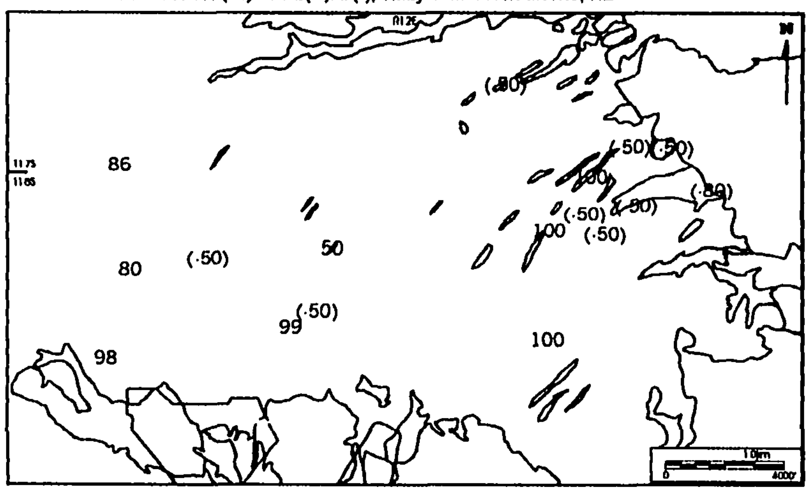
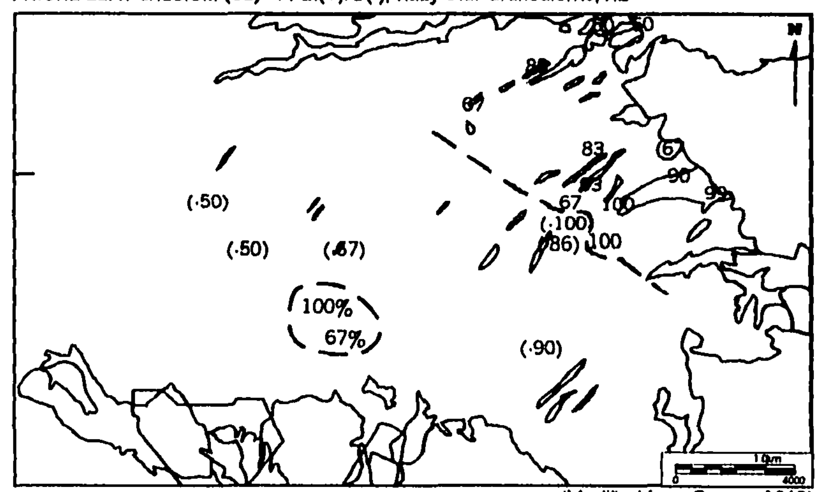


FIGURE 21.4: CALCIUM (Ca) - PPEt(+)/D(-); Ruby Star Granodiorite, AZ



(Modified from Cooper 1960)

Copper (Figure 22.1) - Copper enrichment occurs within 1.5 kilometers of the deposits and correlates with enrichment in silver. Copper enrichment is limited to areas influenced by veins (Figure 24).

Potassium - Potassium enrichment occurs where calcium is depleted. The influx of potassium displaced calcium further away from the porphyry copper deposits. Another interpretation is that the relationship between calcium and potassium is related to the differentiation of the pluton.

Manganese (Figure 22.2) - Manganese displays classic depletion close to the deposits with enrichment occurring up to 3.5 kilometers away. Manganese depletion corresponds to the limits of quartz vein influence (Figure 24).

Lead (Figure 22.3) - Lead is enriched east and northeast of the Esperanza Mine. Enrichment occurs one (1) to four (4) kilometers away from the mine with depletion occurring closer to the mines. Lead does not correlate to the distribution of veins.

Vanadium (Figure 22.4) - There are isolated zones of vanadium enrichment which do not follow any apparent pattern.

FIGURE 22.1: COPPER (Cu) - PPE(+)/D(-); Ruby Star Granodiorite, AZ

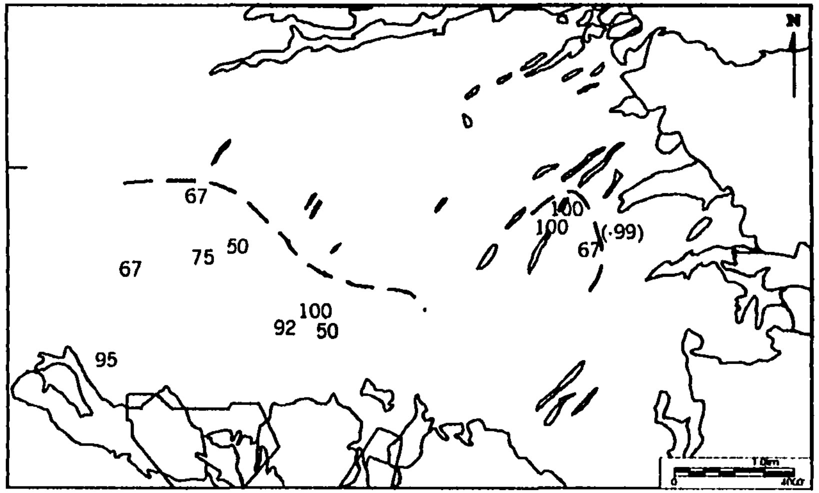


FIGURE 22.2: MANGANESE (Mn) - PPE(+)/D(-); Ruby Star Granodiorite, AZ

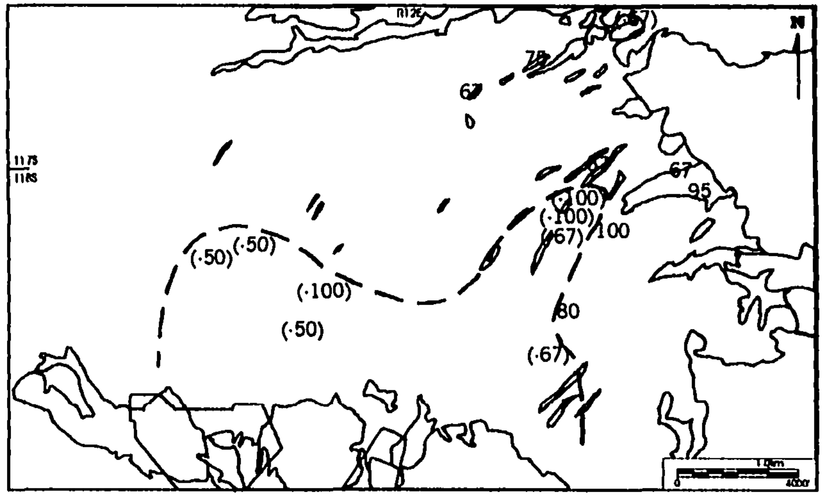
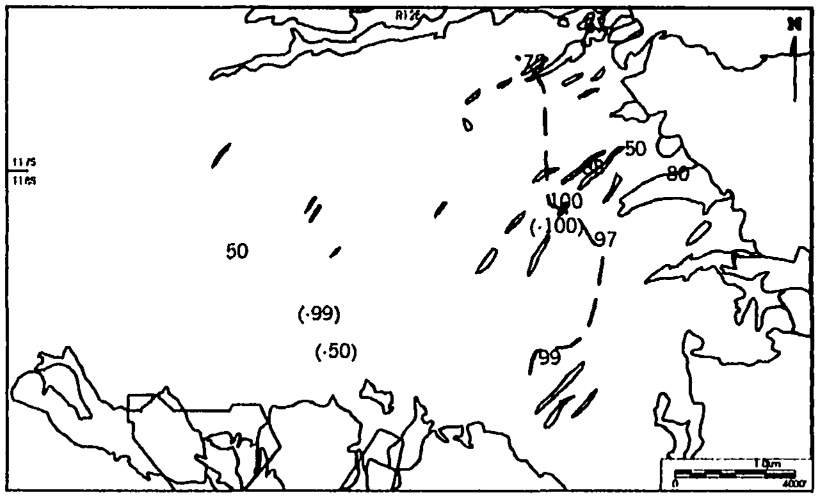


FIGURE 22.3: LEAD (Pb) - PPE(+)/D(-); Ruby Star Granodiorite, AZ



(Modified from Cooper 1960)

FIGURE 23.1: Distribution of Silver, Gold, Copper, and Manganese

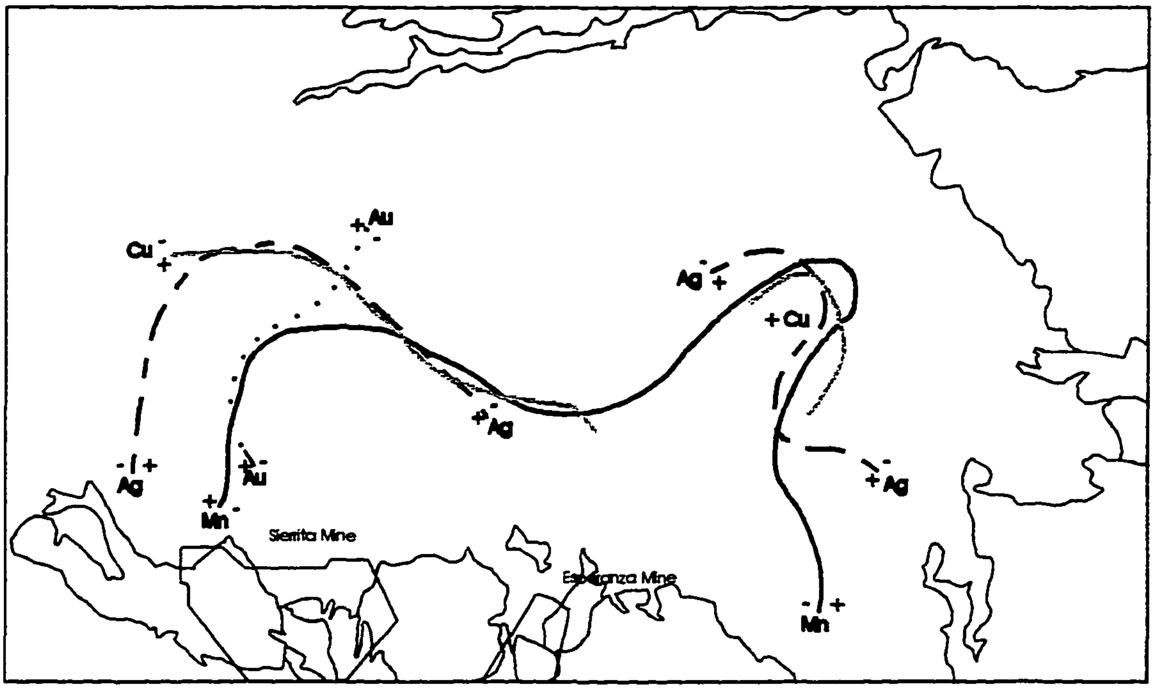
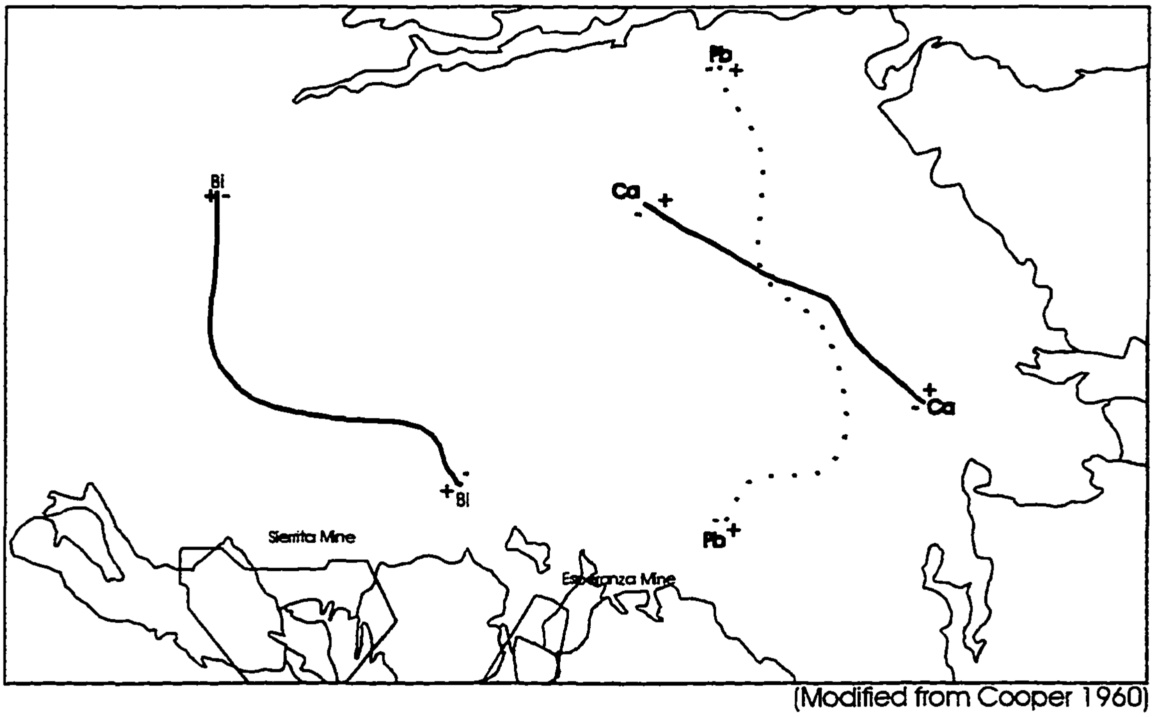
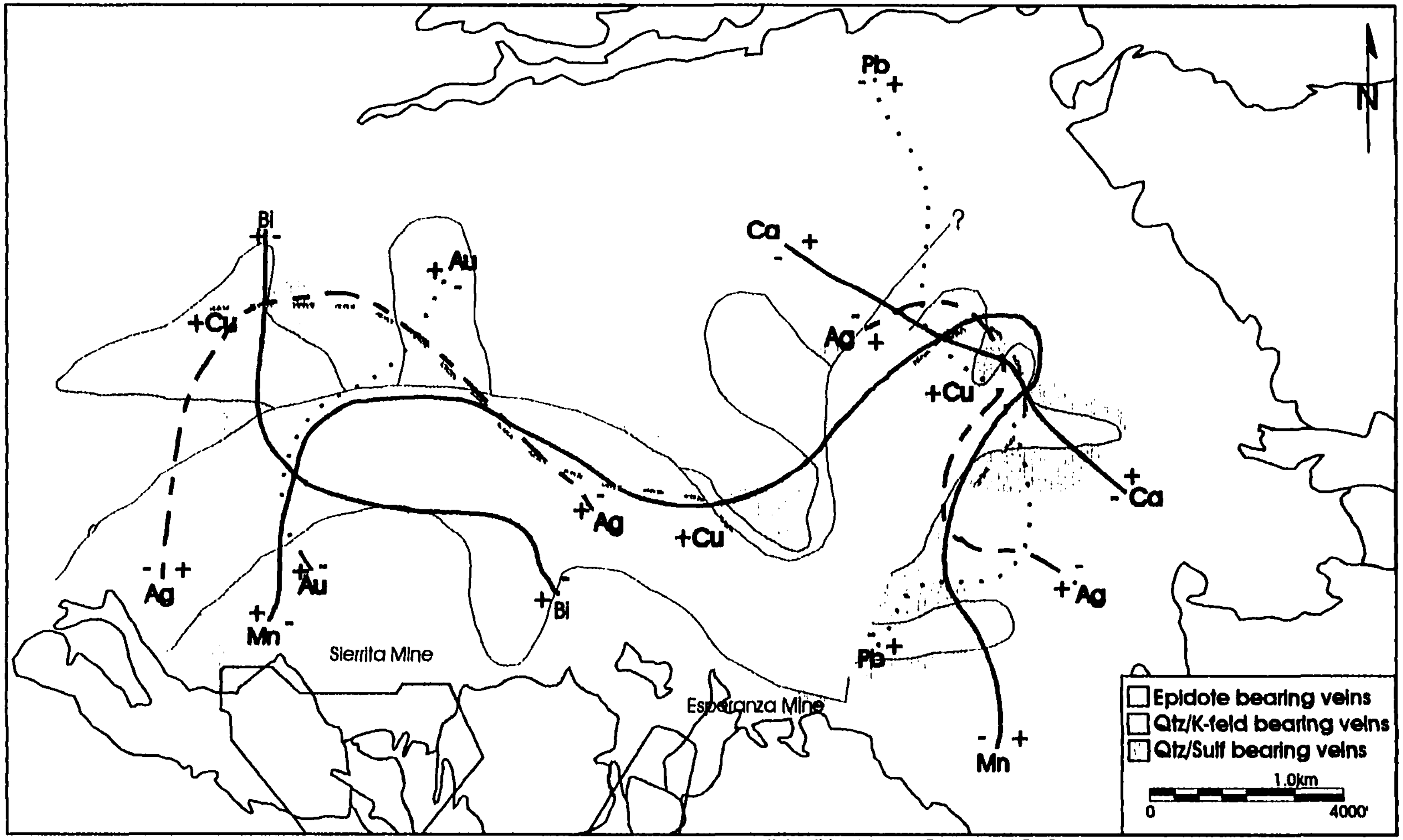


FIGURE 23.2: Distribution of Bismuth, Calcium, and Lead



(Modified from Cooper 1960)

FIGURE 24: Correlation of Enrichment and Depletion to Vein Types

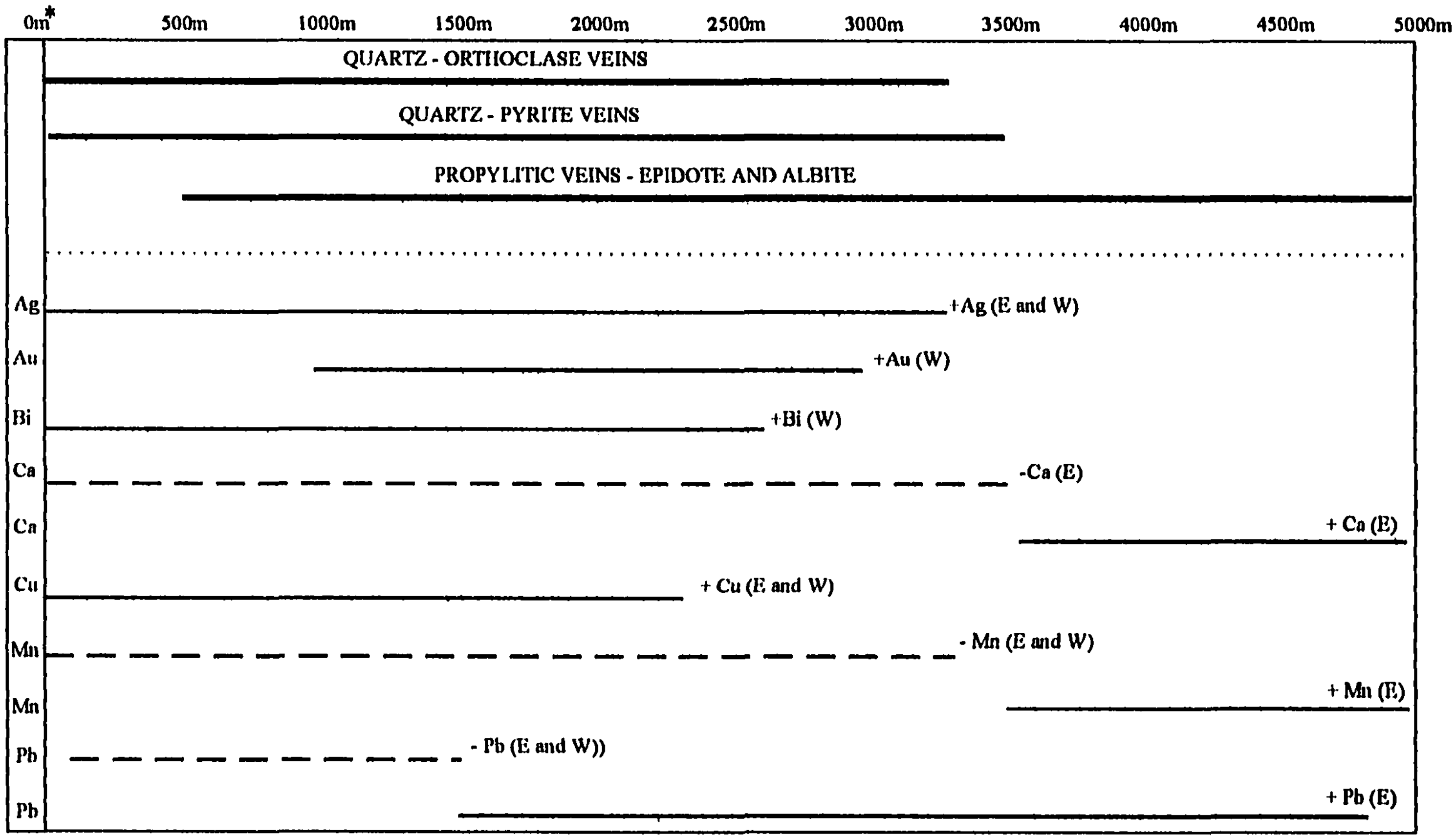


(Modified from Cooper 1960, Hayne 1980, and Manske 1980)

Conclusions. Quartz-orthoclase and quartz-sulfide veins extend up 1.8 kilometers from the Sierrita-Esperanza mineralized center. In most areas these veinlets extend further from the deposits than the epidote veins, except to the E and NE. Propylitic alteration associated with the epidote veins becomes areas of massive epidote and albite to the E and NE (Figure 19). Trends in the trace elements manganese, calcium, and lead indicate that this distal propylitic alteration is related to the deposits. It is also interesting that the epidote-bearing veins are distinctly zoned in a halo 500 meters wide 500 meters away from the deposits (Figure 24). When vein distributions are compared to the trace element patterns (Figure 24) many elemental patterns are directly related to the presence of veins. Silver and copper enrichment and manganese depletion do not appear to occur beyond the influence of sulfide and orthoclase veinlets. Fluid flow appears to remove calcium and manganese closer to the deposits and deposit them to the E and NE.

This system would have been evaluated better if more samples had been taken, with the sample distributions incorporating vein density data. The veins were summarized after sampling was completed. The trace element patterns as they correlate to veinlet mineralogy are presented in Figure 25. It is apparent that the trace element distributions are

FIGURE 25: Ruby Star Trace Elements and Vein Distribution



——— Enrichment — — - Depletion

+/- Enrichment is indicated by a '+' and depletion by a '-'.

* This point is the edge of the deposits. The variable vein, enrichment, and depletion halos have necessitated the estimation of the boundaries on this diagram.

** E and W indicate whether the enrichment or depletion occurred to the E, W, or both directions from the deposits.

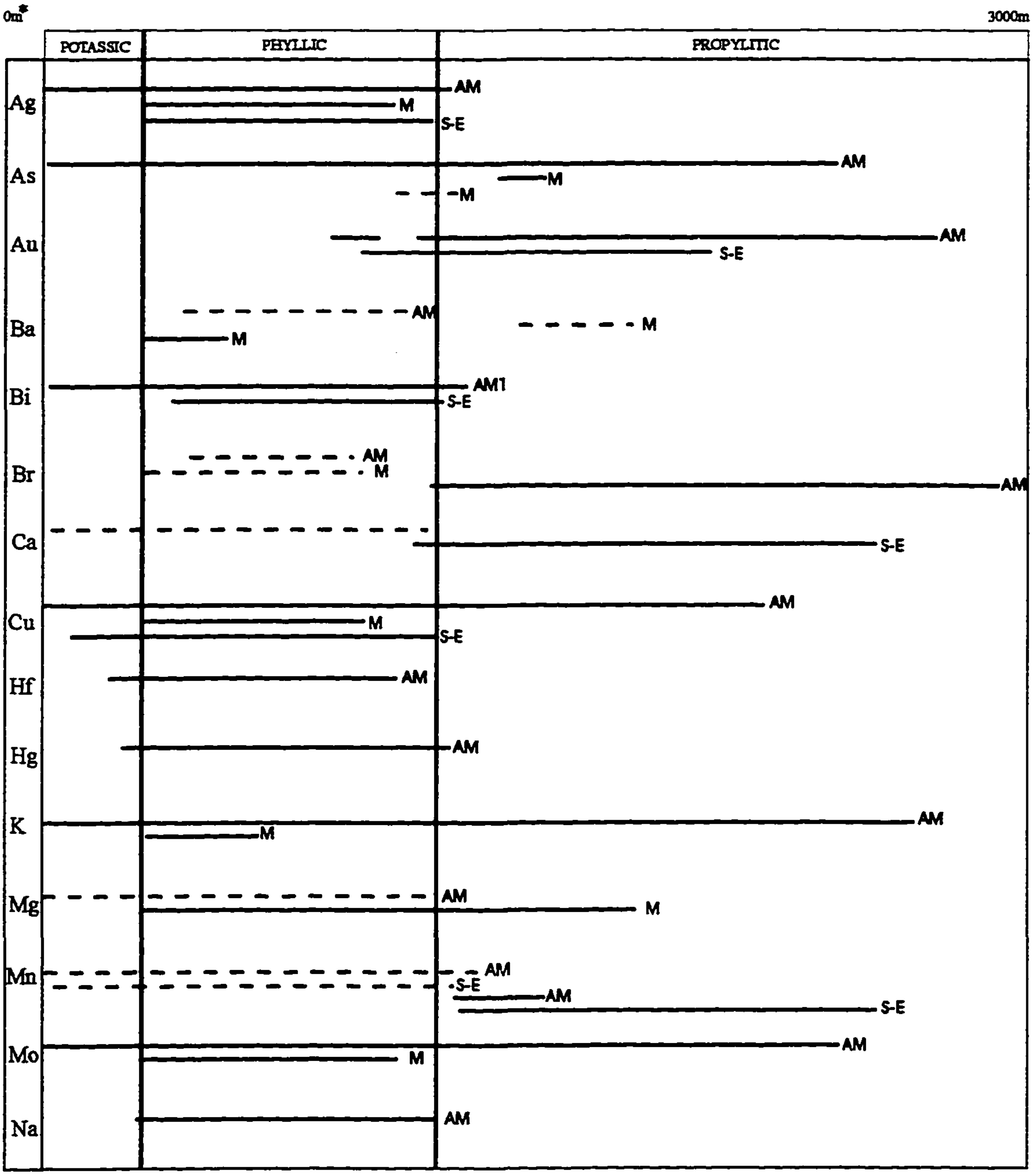
dependent on vein presence. It is obvious that whole rock chemistry, exclusive of veinlet material, is influenced by the veins. The processes that created the deposits influences the host rock, via these veins, more than 3 kilometers away from the deposits.

GEOCHEMICAL SUMMARY

Trace element distributions related to mineralization and alteration are shown here to be detectable in wall rock distal to porphyry copper deposits (Figure 26.1 and 26.2). When these patterns are compared to findings from other research, similar results are seen to have been found for a number of elements (Figures 27.1 through 27.20). The patterns of enrichment and depletion can be determined by following a procedure of normalization and of calculating host-specific probabilities based on 'fresh rock' geochemistry and the standard deviations of these values that incorporate heterogeneity and laboratory error. The patterns are related to mineralization and/or alteration events that are centered on the porphyry copper deposit, but relative ages of elemental distributions and alteration assemblages are not elucidated.

Comparison of the enrichment and depletion patterns of the deposits studied for this report and those selected from the geochemical literature is summarized using geochemical profiles. The profiles measure distance outward from the edge of the respective ore zones. The average 'fresh rock' chemistry is indicated by the solid horizontal line. 'One standard deviation away from the mean' is indicated by the dashed lines. Values outside the standard deviation envelope have a 50% or greater probability of being enriched.

FIGURE 26.1: Summary of Trace Element Distributions

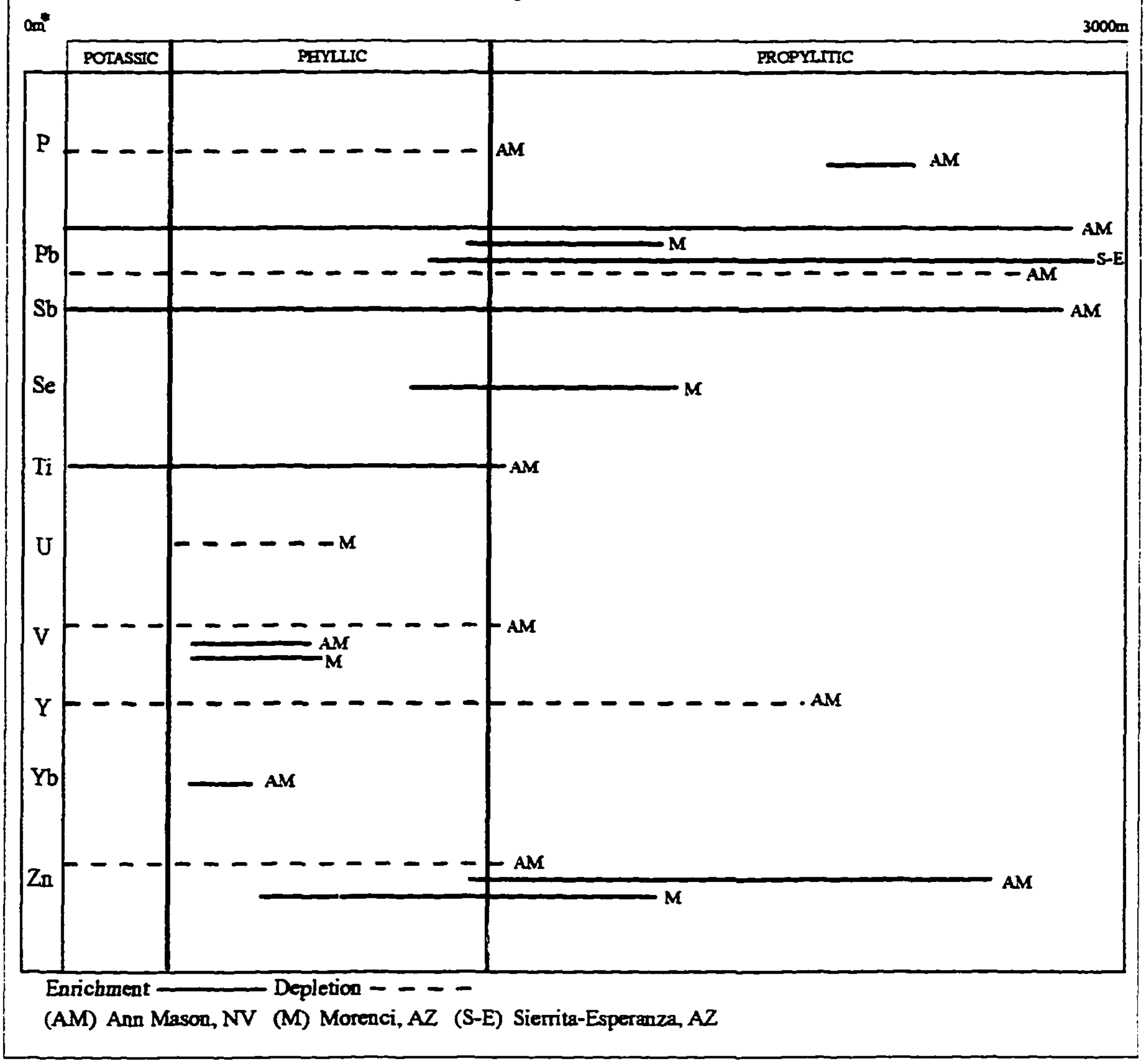


Enrichment ——— Depletion - - - - -

(AM) Ann Mason, NV (M) Morenci, AZ (S-E) Sierrita-Esperanza, AZ

* At edge of ore, note that at Morenci no samples were taken in the potassic alteration

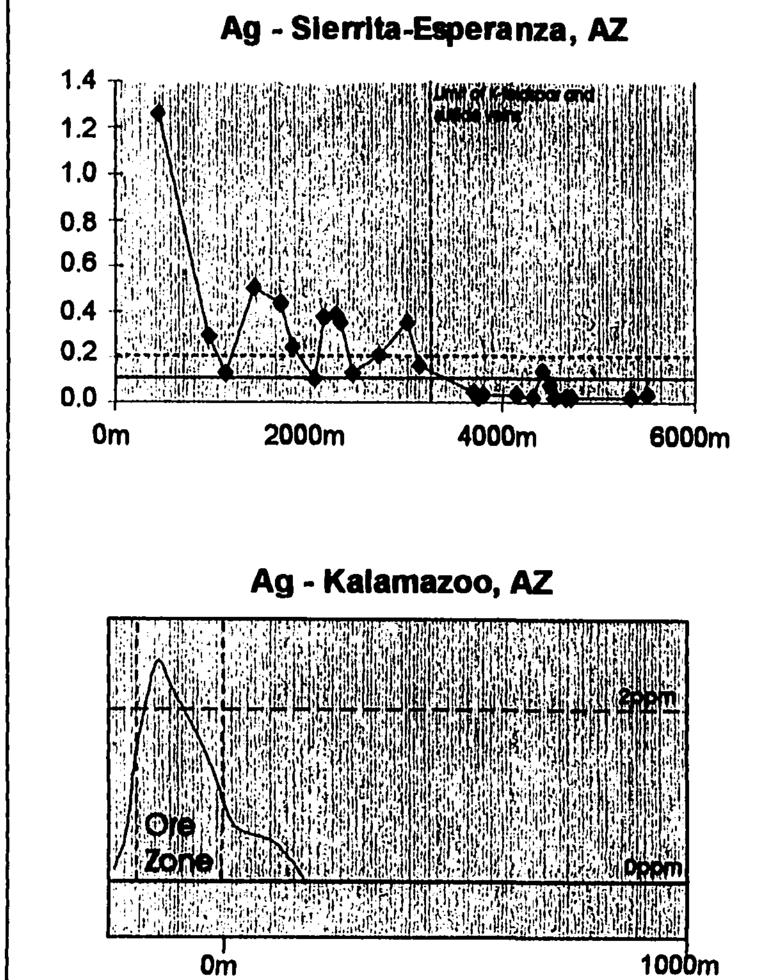
FIGURE 26.2: Summary of Trace Element Distributions



Silver - Silver enrichment is observed in all three systems. Enrichment does not extend beyond the phyllic and/or potassic alteration zones into the propylitic at Ann Mason or Sierrita-Esperanza (Figure 27.1). Similar results were found by Chaffee at San Manuel (Figure 27.1). Morenci does have enrichment in silver within distal chloritic alteration. For purposes of exploration, one would move towards increasing silver values to locate the mineralized system.

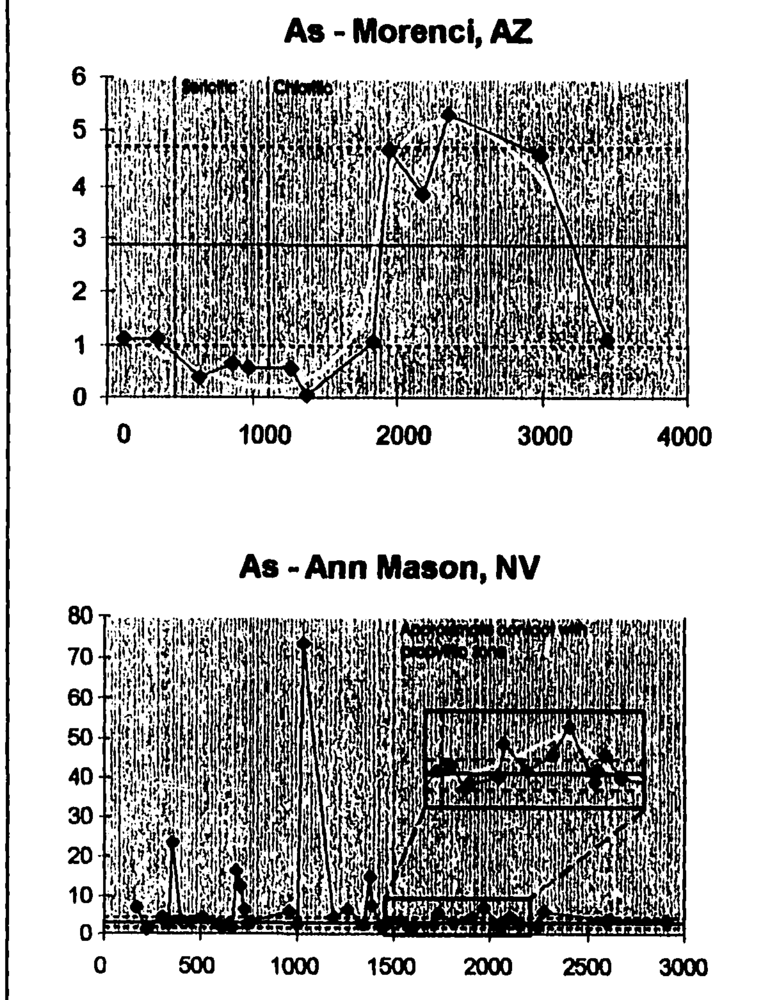
Arsenic - Distal enrichment is observed in two deposits - Morenci and Ann Mason (Figure 27.2). At Morenci, a depletion zone occurs 500m to 1500m from the deposit with distal enrichment within the chloritic alteration at 2500m. It is important to note at Morenci that this anomaly is extremely subtle with variations between 0 and 6ppm. Results at Ann Mason are not represented well in the profile (Figure 16.1). At Ann Mason, arsenic is enriched in the shallow phyllic and propylitic zones, reminiscent of what might be seen in the upper portions of an epithermal system. The subtle anomaly seen at Morenci is reproduced in the propylitic zone at Ann Mason (Figure 27.2, inset). Where propylitic or no alteration is evident, exploration should move from enrichment toward depletion using subtle anomalies like those observed at Morenci.

FIGURE 27.1: Silver Profiles (ppm)



(Modified from Chaffee, 1982)

FIGURE 27.2: Arsenic Profiles (ppm)



Gold - Enrichment is observed at Ann Mason and Sierrita-Esperanza. Gold is enriched within the phyllic and/or potassic zone. Enrichment decreases away from the ore zone and is limited by the presence of alteration veinlets (Figure 27.3). There is enrichment within the propylitic zone that has been duplicated by Chaffee. Exploration would proceed toward increasing gold values where alteration is evident. Gold anomalies in the order of 100ppbs within propylitic alteration appear to be a distal expression of a porphyry copper system.

Barium - Enrichment adjacent to the ore zone tapers off at the limit of alteration related veinlets (Figure 27.4). In exploration, barium may be useful in areas with apparent alteration, but it is not useful in the distal propylitic zone.

FIGURE 27.3: Gold Profiles (ppb)

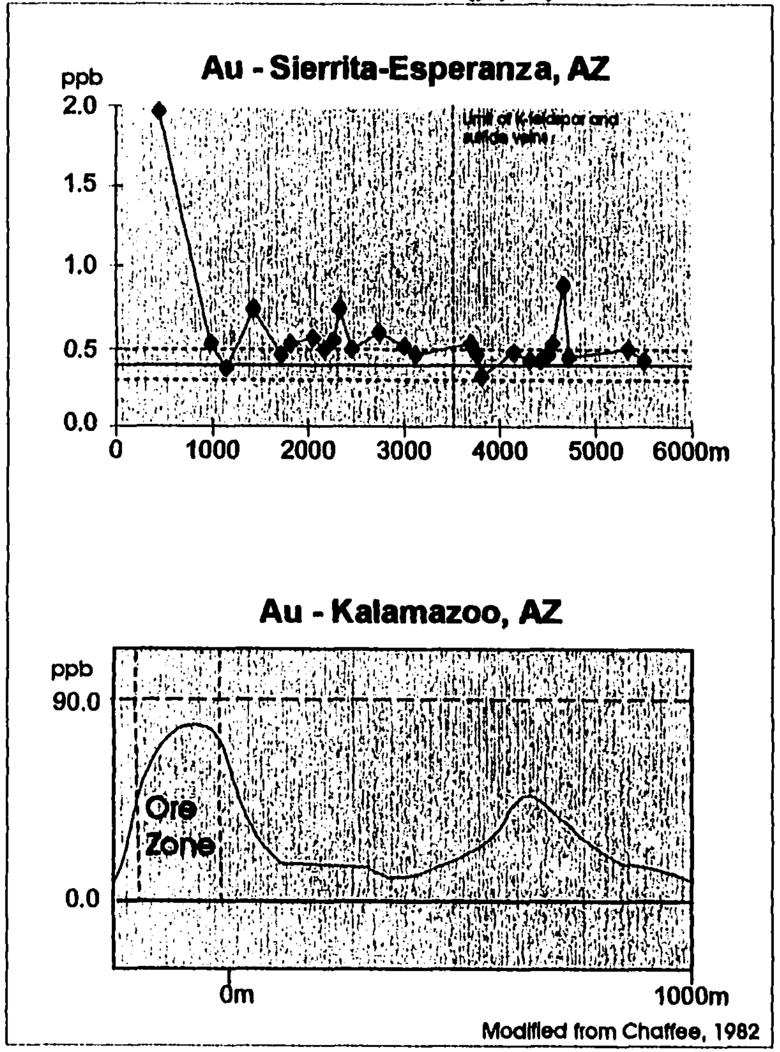
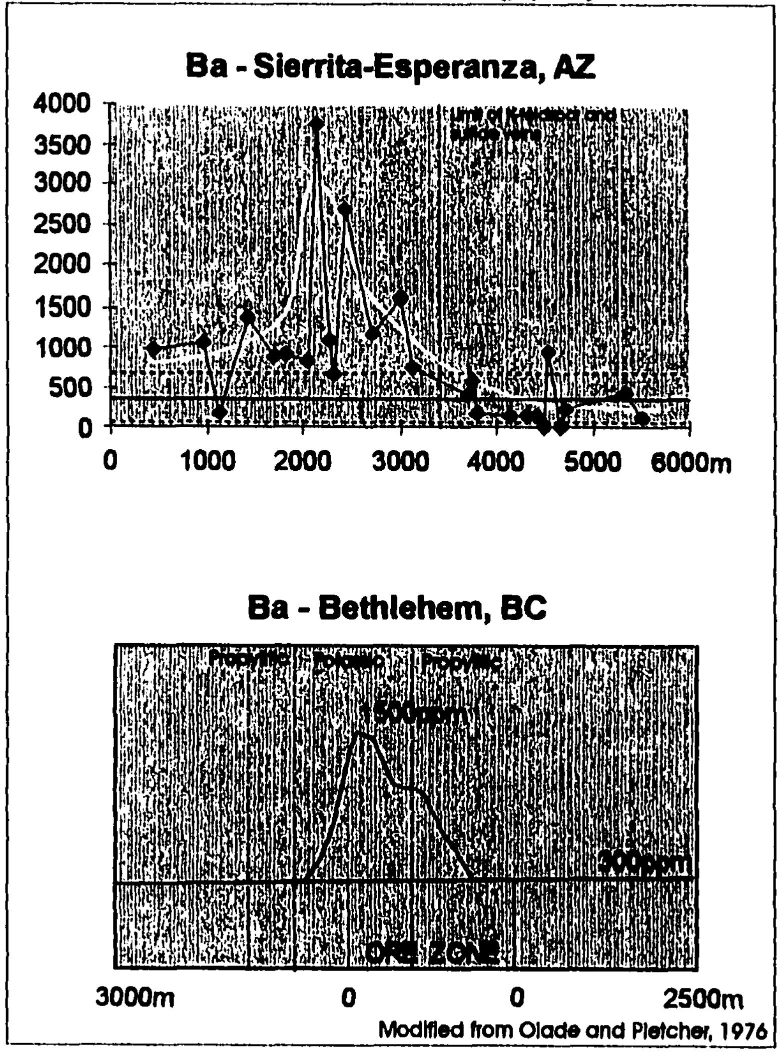


FIGURE 27.4: Barium Profiles (ppm)



Bismuth - Bismuth is enriched in the phyllic and potassic zones in two deposits, Ann Mason and Sierrita-Esperanza. As with arsenic, bismuth is not well represented by the profile. The spatial plot better illustrates the enrichment. Bismuth is not useful in the peripheral propylitic zone.

Bromine - Where bromine was present in the host rocks before alteration, it has been redistributed. Bromine is depleted within the phyllic and potassic zones and is enriched in propylitic zone at Morenci and Ann Mason. If bromine is known to exist in a system, enrichment is followed by depletion in the direction of the deposit.

FIGURE 27.5: Bismuth Profile (ppm) and Plan

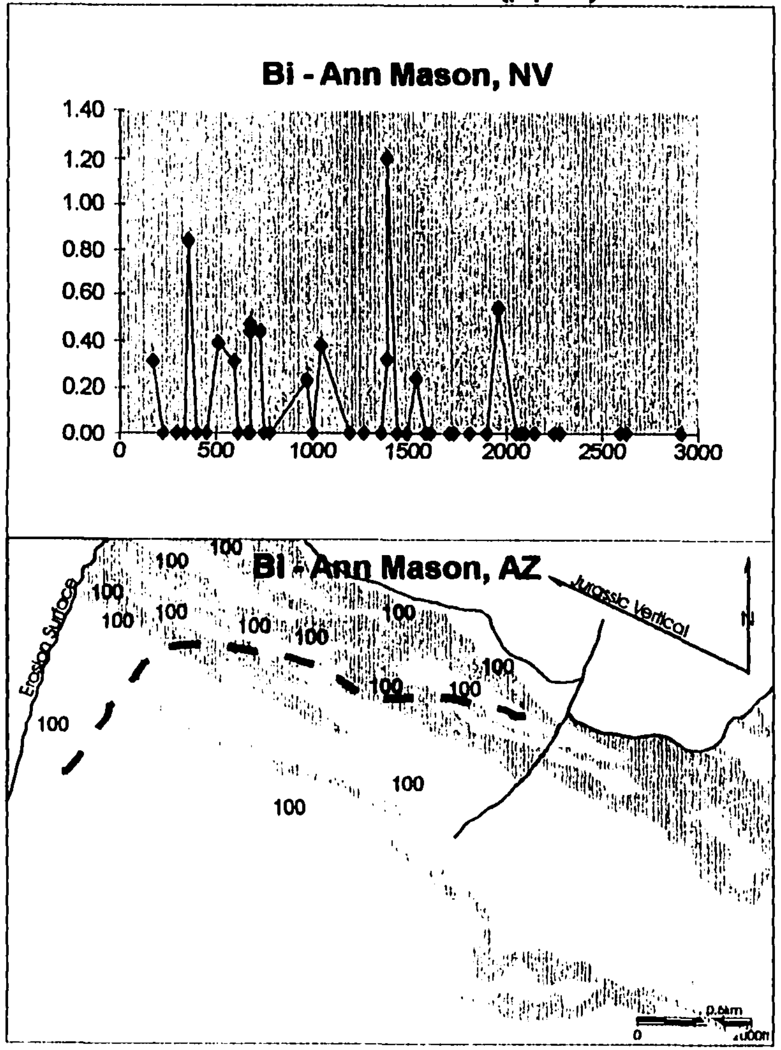
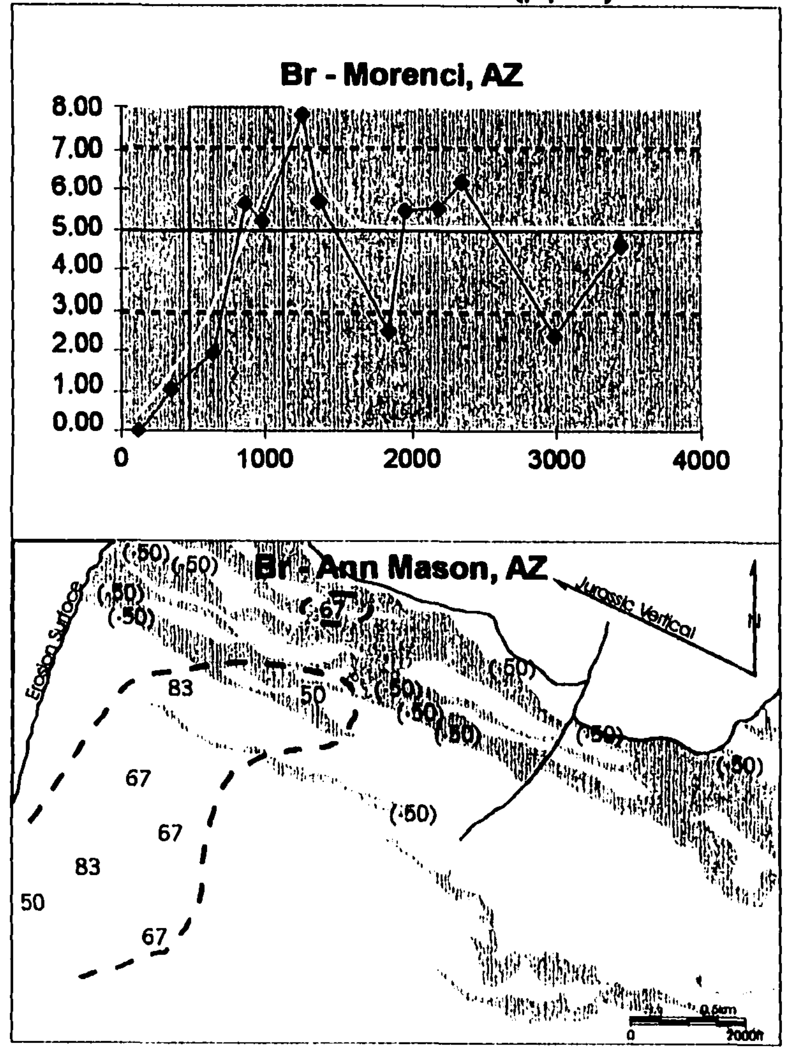


FIGURE 27.6: Bromine Profile (ppm) and Plan



Calcium - Calcium redistribution was observed only at Sierrita-Esperanza. Potassium enrichment occurs in conjunction with calcium depletion out to 3500m (Figure 27.7). The profile reverses approximately at the limit of K-feldspar and quartz-sulfide veinlets, marking the transition into propylitic dominated alteration. Enrichment in calcium may result from stabilization of epidote or calcite. In exploration, a ratio of calcium to potassium may assist in identifying a transition between alteration zones, although this transition should be evident in hand sample anyway.

Copper - As would be expected, copper is enriched closer to the deposits in potassic and phyllic alteration (Figure 27.8). Copper enrichment also occurs well out into the propylitic zone and is still evident 2000m from the high copper zone at Ann Mason. Copper enrichment within the propylitic zone may be used exploration looking in the direction of increasing enrichment.

FIGURE 27.7: Calcium and Potassium Profiles

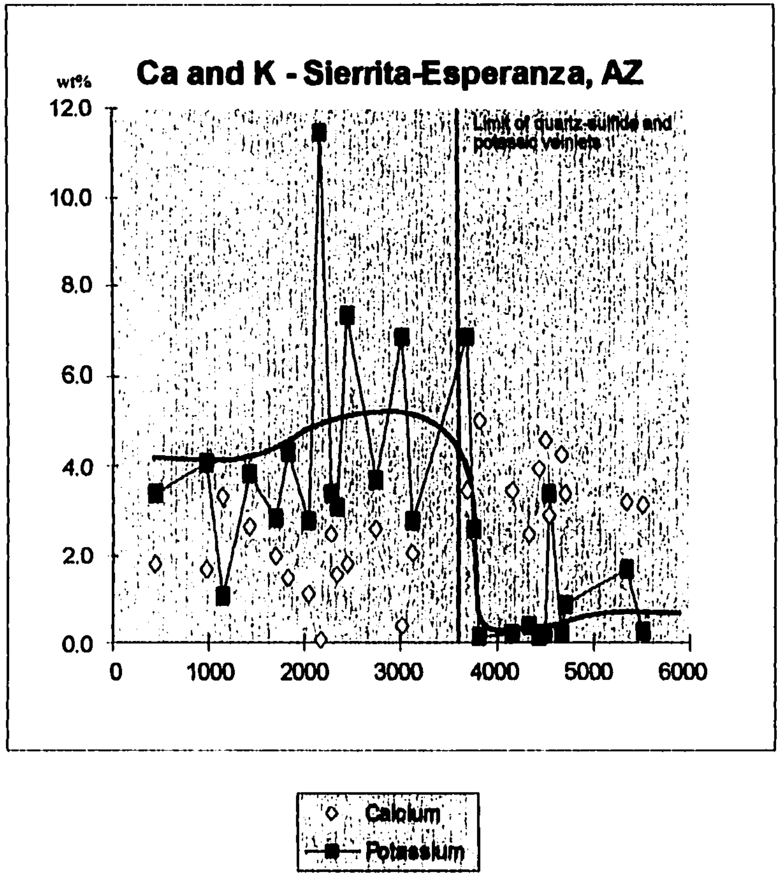
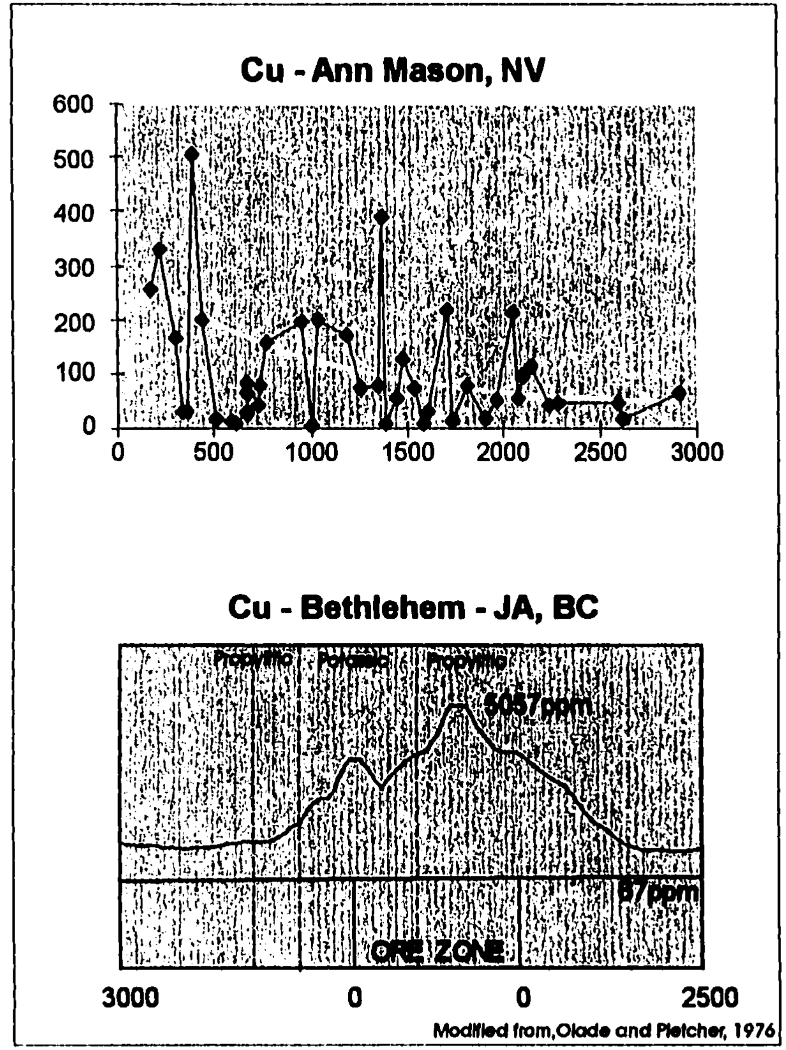


FIGURE 27.8: Copper Profiles (ppm)



Hafnium - Hafnium enrichment was only observed at Ann Mason. Enrichment occurred in the shallowest portion of the phyllic alteration zone, and may be used to identify shallow portions of a system.

Mercury - enrichment occurs in the upper portion of the Ann Mason system (Figure 27.9), similar to what would be expected in an epithermal system. There is also a correlation to bromine enrichment and depletion suggesting that the patterns may have been syngenetic. Mercury enrichment was also observed at the Bethlehem deposit. It appears that increasing mercury values could lead in toward the center of a system.

Manganese - depletion and enrichment patterns are identified in the three deposits analyzed for the study, and are frequently seen in systems studied by others (Figure 27.10). Depletion in manganese occurs within the potassic and phyllic zones and even out into the propylitic zone. Within the propylitic zone manganese enrichment occurs. Progression from enrichment toward depletion should vector toward the center of the system.

FIGURE 27.9: Mercury Profile (ppm) and Plan

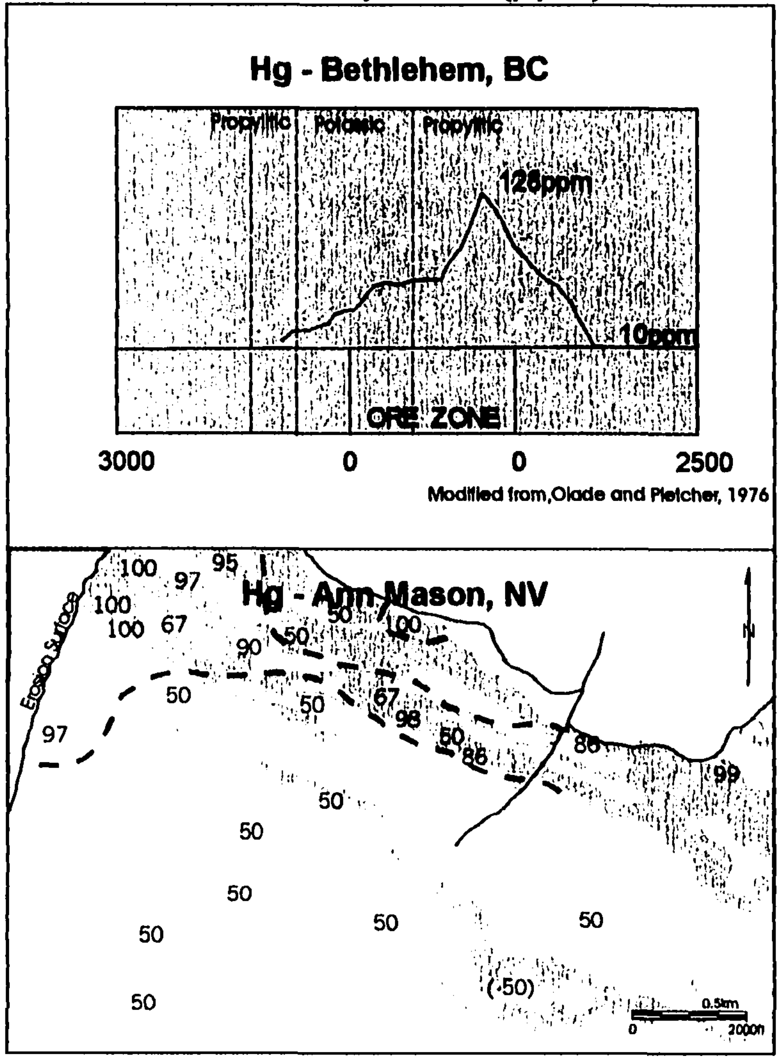
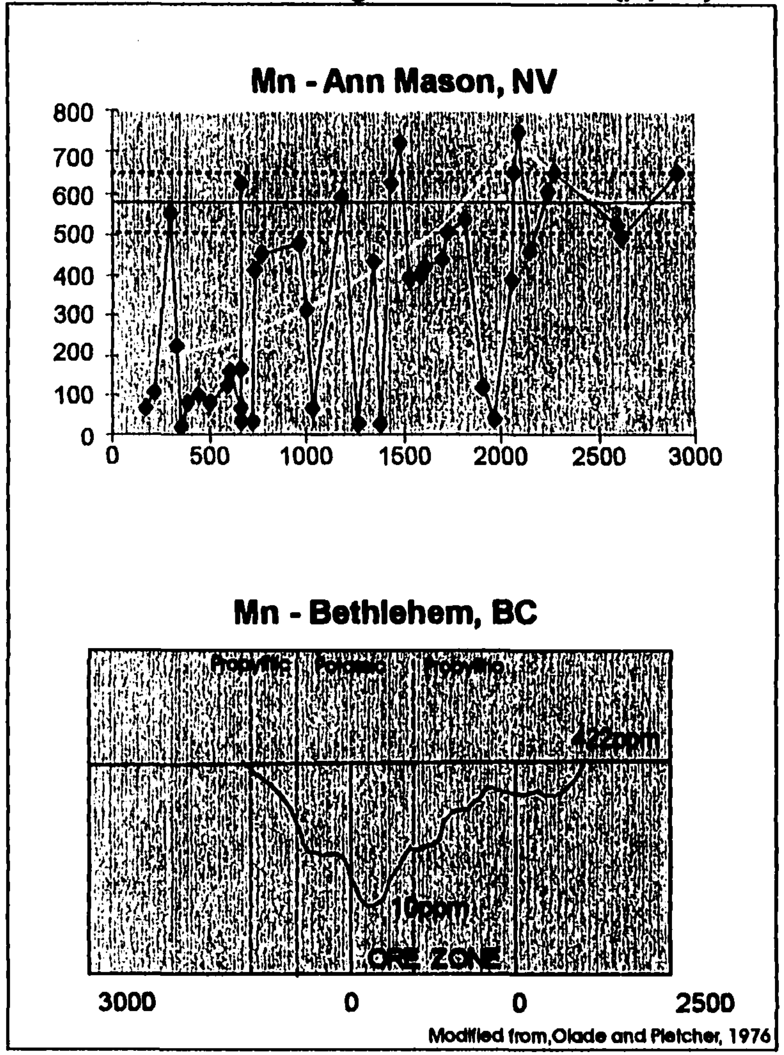


FIGURE 27.10: Manganese Profiles (ppm)



Molybdenum - Molybdenum is enriched in the potassic and phyllic zones at Ann Mason (Figure 27.11). The presence of molybdenum enrichment within phyllic and/or potassic alteration may assist in generating a vector toward increasing enrichment. Distal enrichment molybdenum within the propylitic zone was not observed more than a few hundred meters away from ore.

Phosphorus - Phosphorus has been removed from the potassic and phyllic zones at Ann Mason (Figure 27.12), with minor enrichment in the propylitic zone. Interpretation of the profile must be done carefully because the porphyry and the main phase have very different means and standard deviations. An apparent depletion and enrichment pattern is the result of a transition from porphyry to main phase host. Where depletion truly occurs is indicated by the brackets. This is an instructive example of how the probability of enrichment and depletion is an effective method of presenting data independent of rock type.

FIGURE 27.11: Molybdenum Profiles (ppm)

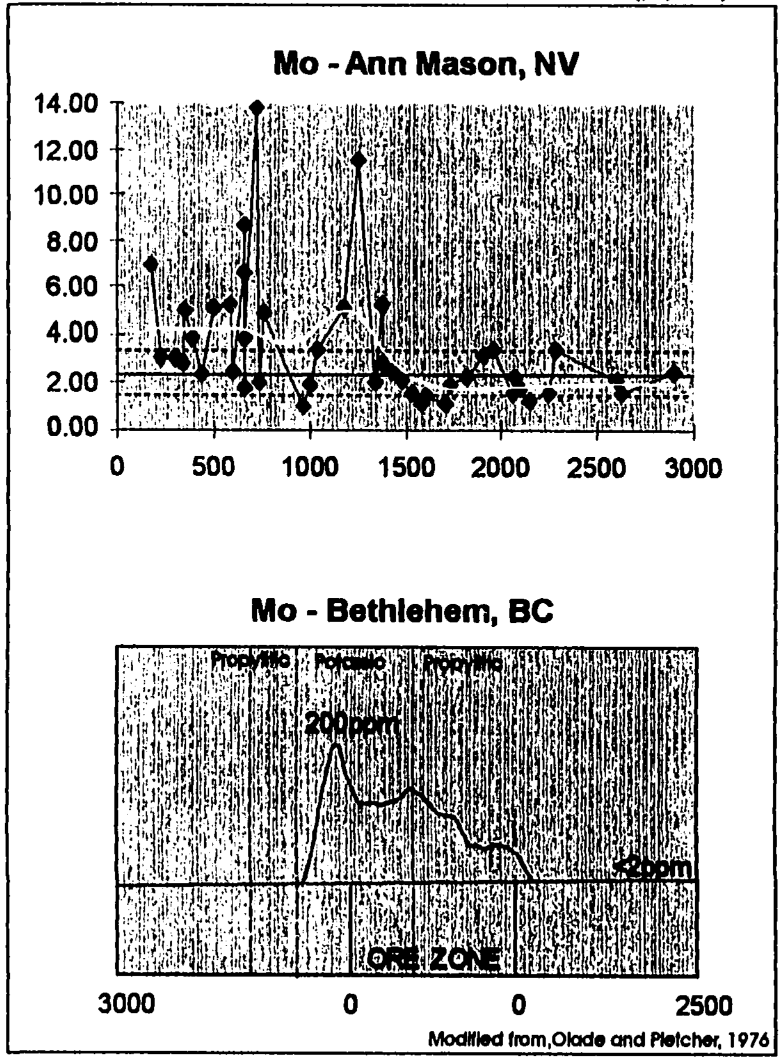
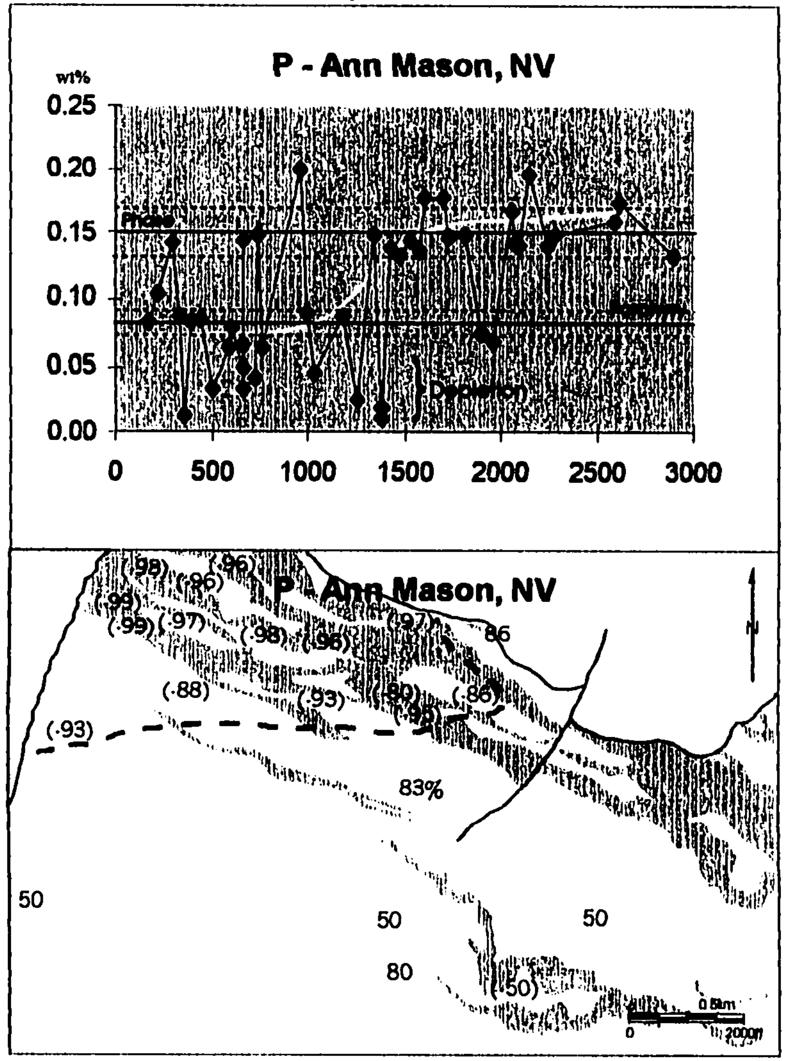


FIGURE 27.12: Phosphorus Profile and Plan



Lead - It appears that lead removed from the phyllic and potassic zones and deeper portions of the system has been redeposited in the propylitic zone at all three deposits (Figure 27.13). Enrichment in the propylitic zone is common in porphyry copper systems. A vector may be generated by moving inward from enrichment toward depletion.

Rubidium and strontium - Patterns were not observed at any of the deposits. These elements are useful in the evaluation of Ajo and so are presented here. Increasing depletion in strontium and increasing enrichment in rubidium occurs with increasing proximity to the ore zone as is illustrated at Bethlehem (Figure 27.14).

Antimony - In one system (Ann Mason) antimony has been enriched in the shallower portion of all three alteration zones. The association of antimony, arsenic, and mercury is suggestive of an epithermal system in the shallower portion of the porphyry copper system. Antimony may be a useful element where the shallower portions of a porphyry copper system are preserved.

FIGURE 27.13: Lead Profiles (ppm)

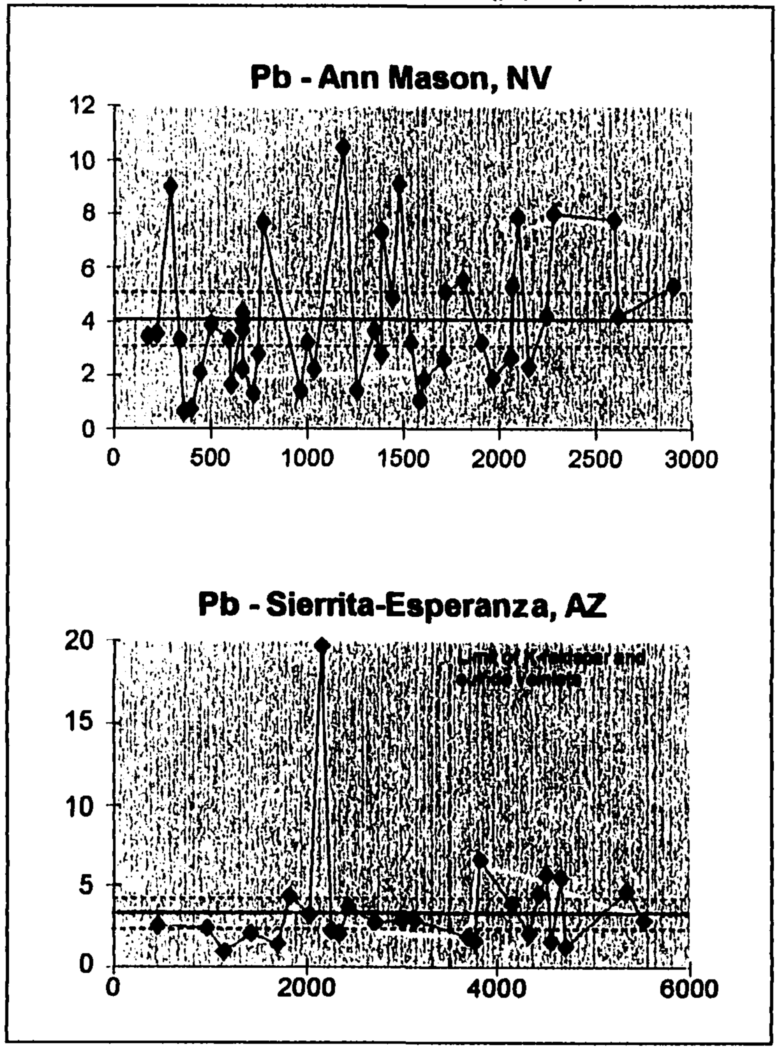
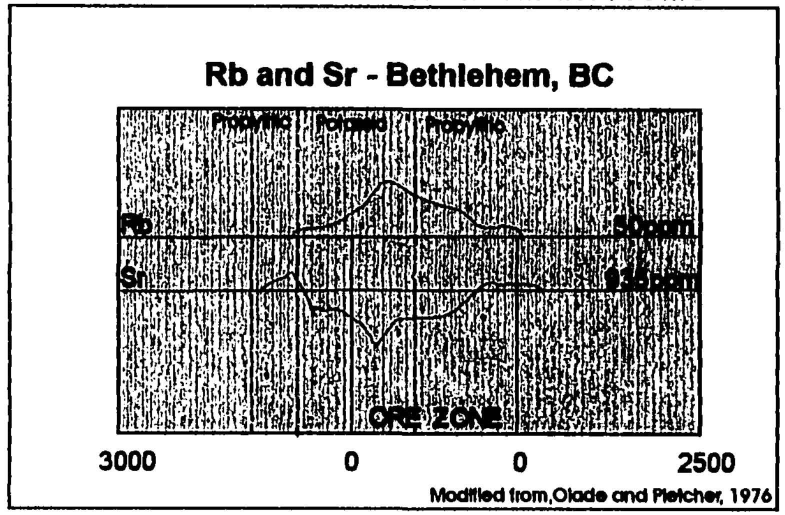


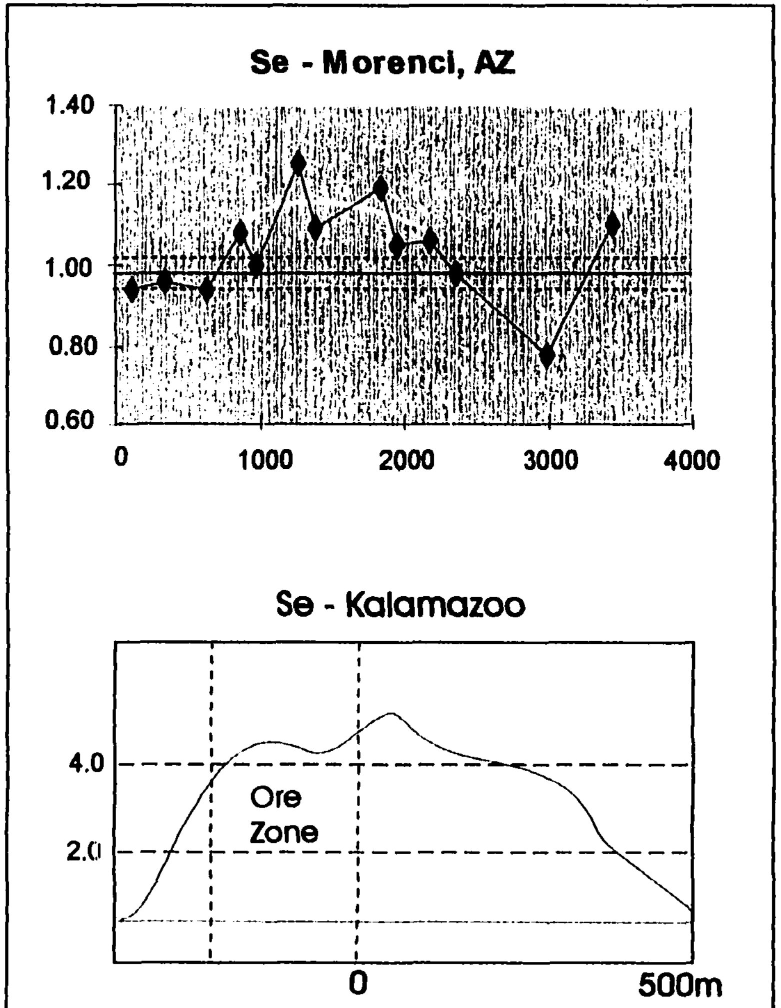
FIGURE 27.14: Rubidium Strontium Profile



Selenium - At one deposit, Morenci, selenium has been enriched in the outer part of the phyllic zone extending into the distal chloritic zone (Figure 27.15). Chaffee observed similar results at San Manuel. A vector toward the ore zone may be derived toward increasing selenium values.

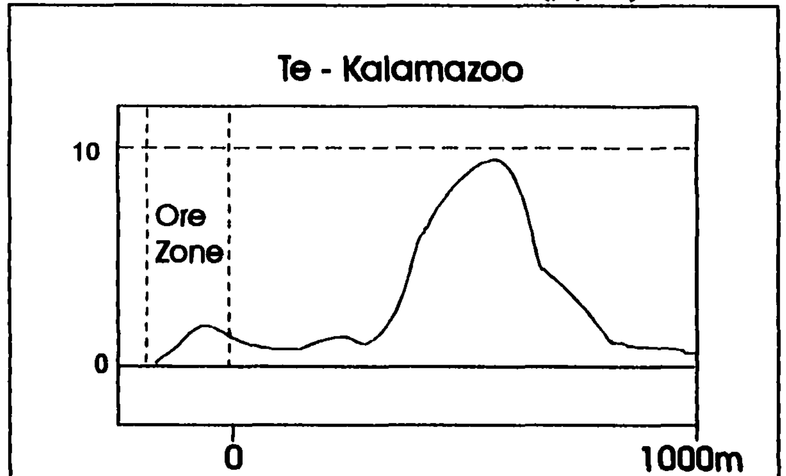
Tellurium - Chaffee found that tellurium is enriched well out into the propylitic zone (Figure 27.16). Tellurium enrichment within propylitic alteration may be a distal expression of a porphyry copper system.

FIGURE 27.15: Selenium Profiles (ppm)



(Modified from Chaffee, 1982)

FIGURE 27.16: Tellurium Profile (ppm)



(Modified from Chaffee, 1982)

Titanium - Titanium has been removed within the potassic and phyllic zones at Ann Mason (Figure 27.17). Other systems did not exhibit any patterns in titanium. The removal titanium is associated with intense phyllic alteration. There does not appear to be any exploration use for titanium in the distal portion of porphyry copper systems.

Vanadium - Depending on vertical location within the system, vanadium is either enriched or depleted in the phyllic zone at Ann Mason (Figure 14.2). Depletion in titanium is associated with depletion in vanadium and the same intense phyllic alteration. Chaffee observed enrichment rather than depletion proximal to the ore zone. It is unclear how one might use vanadium in exploration, but a vector from depletion toward enrichment is probably most useful.

FIGURE 27.17: Titanium Profile (wt%)

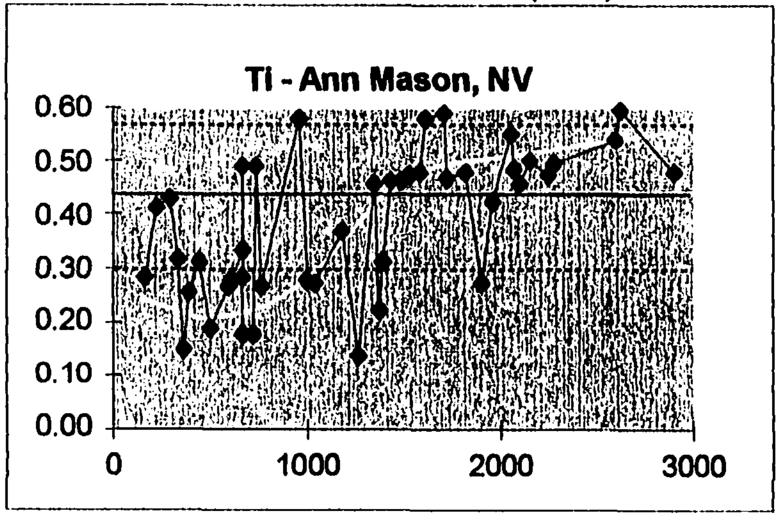
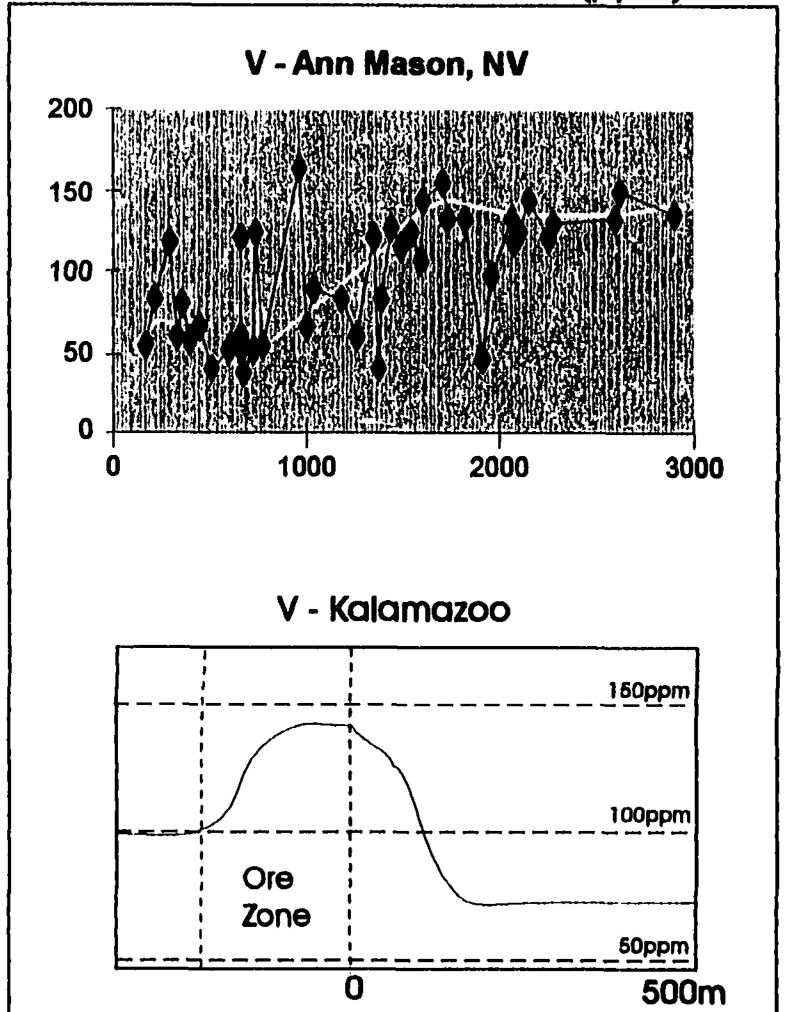


FIGURE 27.18: Vanadium Profiles (ppm)



(Modified from Chaffee, 1982)

Yttrium - Yttrium is removed from the system in all alteration zones at Ann Mason (Figure 27.19). Depletion is most prevalent in the shallower portions of the propylitic zone at Ann Mason. In exploration, depletion in yttrium may useful in the propylitic zone, establishing a vector toward increasing depletion toward the ore zone.

Zinc - Zinc is removed from the potassic and phyllic zones and appears to be redistributed outward into the propylitic zone at Morenci and Ann Mason (Figure 27.20). Distal zinc enrichment in the propylitic zone may be useful in conjunction with adjacent depletion which would be in the direction of the ore zone.

FIGURE 27.19: Yttrium Profile (ppm)

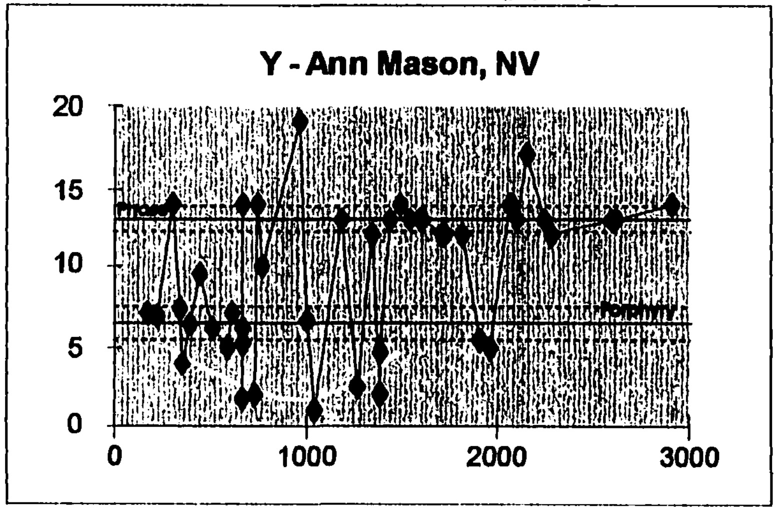
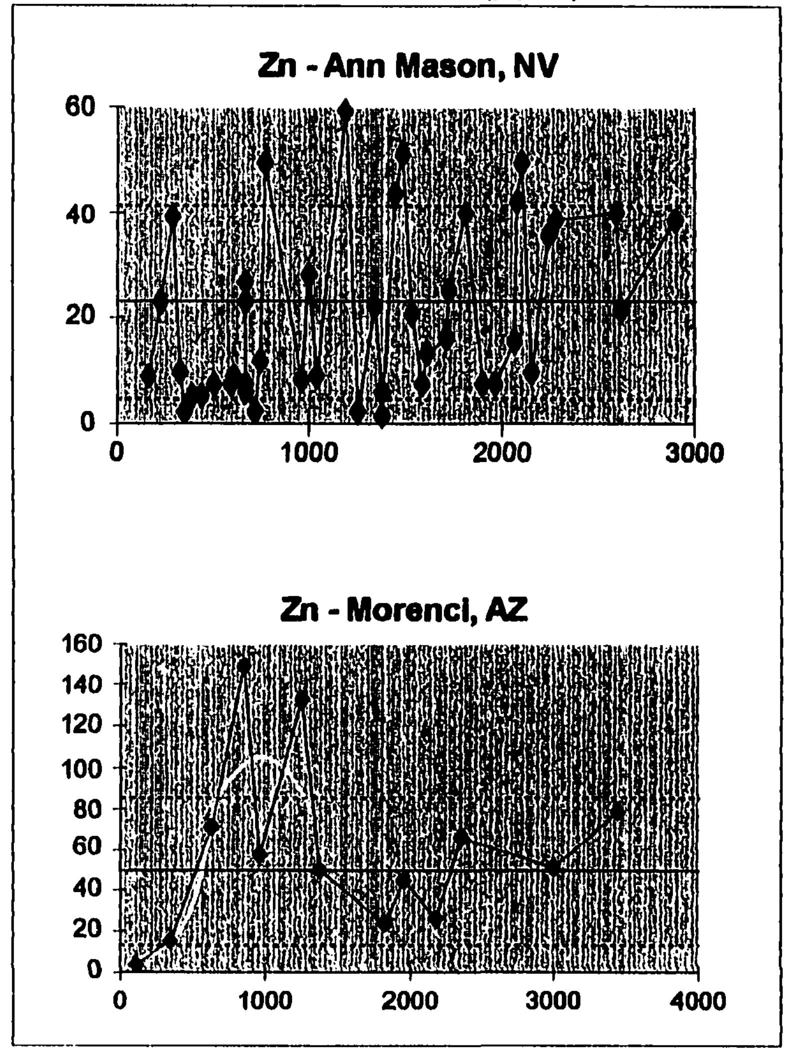


FIGURE 27.20: Zinc Profiles (ppm)



Evaluation of data should combine alteration, probability of enrichment or depletion, and geochemical profiles to determine the direction toward a hidden ore zone. Enrichment and depletion patterns are strongly dependent on alteration. For instance at Sierrita-Esperanza, the contact between enrichment and depletion for silver, barium, calcium, potassium, and lead is related to the limit of potassic and phyllic veinlets. At Ann Mason, there is a direct correlation between the phyllic alteration zone and depletion in titanium, vanadium, phosphorus, and bromine. Titley et al. (1986) document episodic alteration events at Sierrita, each event has its own elemental dispersion pattern. Regardless of whether or not these episodic events occur at the same time as the ore forming event, in the systems studied, they are centered on the ore deposit. Therefore, the depletion and enrichment patterns will be effective tools in exploration even if the alteration patterns are formed by a non-mineralizing but porphyry-copper-related event.

Where there were multiple hosts for mineralization, such as at Ann Mason, the probabilities of enrichment and depletion are effective methods of evaluation independent of rock type, as is well illustrated with phosphorus at Ann Mason (Figure 27.12).

The elements that have reproducible patterns within the phyllic and potassic zones are silver, barium, bismuth, bromine, calcium, copper, gold, hafnium, mercury, manganese, molybdenum, phosphorus, lead, titanium, vanadium, yttrium, and zinc. The elements that have reproducible patterns within distal propylitic zones are silver, arsenic, gold, bromine, calcium, copper, manganese, molybdenum, lead, antimony, selenium, yttrium, and zinc. Presentation of data should combine spatial plots of data as well as profiles, because spatial plots may poorly represent data, as was the case at Ann Mason.

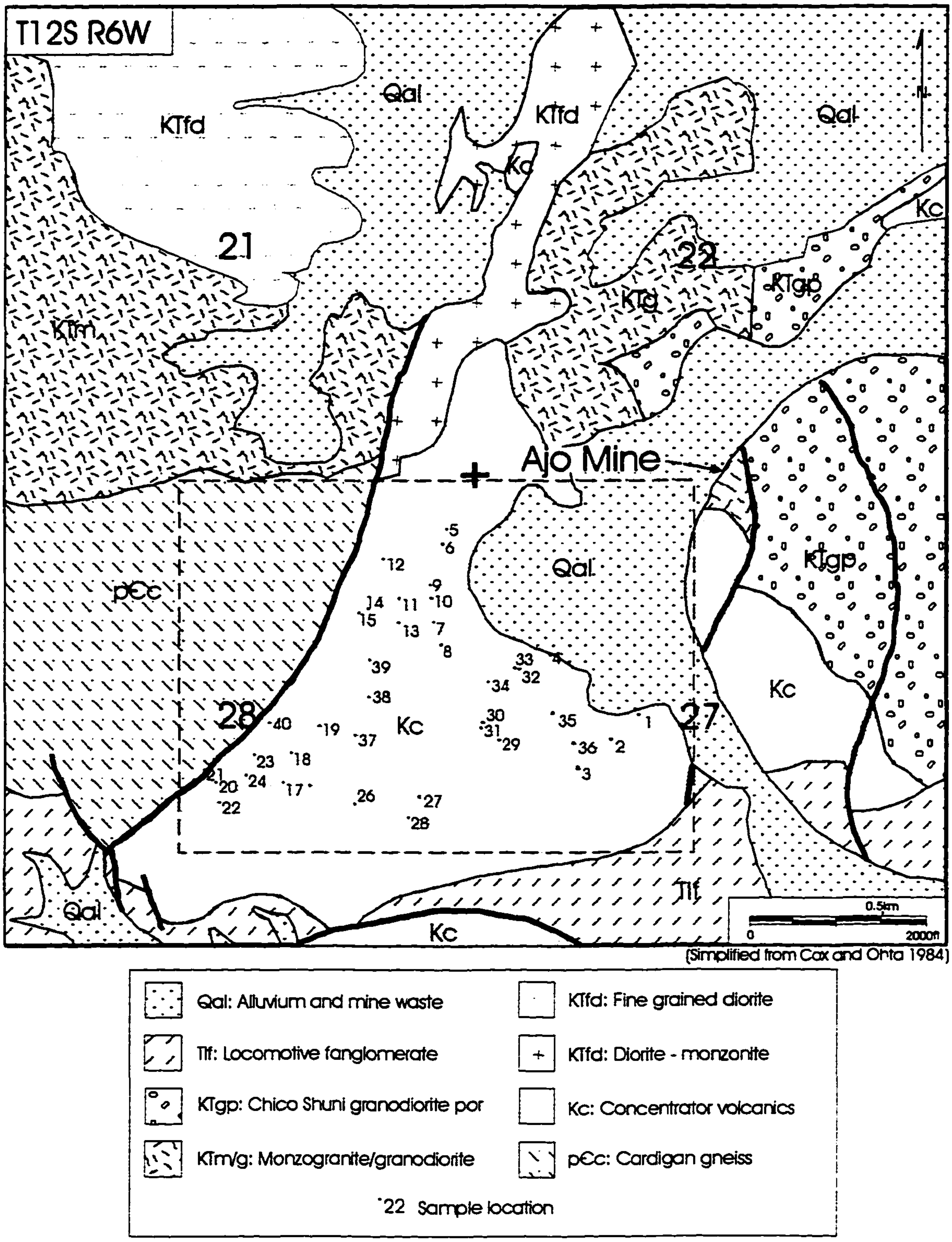
The focus of this study has been to search for patterns that correlate spatially with porphyry copper deposits and determine patterns that might be applicable to any porphyry copper system. Since enrichments and depletions of particular elements are reproducible between deposits, then they are likely to be an effective exploration tool. A further test of patterns detected at Morenci, Ann Mason, and Sierrita-Esperanza, was performed on samples from the Ajo deposit.

TEST CASE - Ajo, AZ

The Ajo deposit is located at the south edge of the town of Ajo, Arizona, 165 kilometers west of Tucson. Ajo was selected as a test case since it is not similar to the systems already studied. It is largely hosted in the Laramide Concentrator Volcanics rather than plutonic rocks. The volcanic unit varies in composition from basaltic to rhyolitic flows. The hypothesis tested was whether or not the trace element patterns identified are present in other porphyry copper systems, enabling geochemical samples in the periphery of the system to be used to determine direction and/or proximity to the deposit.

The Concentrator Volcanics (Kc), intruded by the Chico Shuni porphyry (KTgp), host mineralization at Ajo. The Concentrator Volcanics lie adjacent to Precambrian Cardigan Gneiss along the Gibson Fault, which has a vertical displacement of 1.3 kilometers (Figure 28). The volcanics are overlain nonconformably by the Locomotive Fanglomerate, an alluvial conglomerate with clasts of the aforementioned units. The Concentrator Volcanics consists of flows, flow breccias, and tuffs varying from soft basalt to hard white rhyolite. Alteration is propylitic in the more mafic units and silicification and devitrification in the more silicic units. For more information about the geology at Ajo refer to Dixon (1966). The normalization technique was not

FIGURE 28: AJO MINING DISTRICT



performed due to the compositional variability of the volcanics. An average standard deviation for the freshest rocks was determined, and from this a PPE/D was calculated.

Patterns of enrichment and depletion in the volcanics were found to be useful for Cu, Mn, Pb, Rb/Sr, U, and Y. The spatial distribution for these elements is presented in Figures 29 and 30. These patterns are used to determine the direction toward the ore zone. The geochemistry was then plotted along the determined vector. The profiles generated from the plots are comparable to those seen in other deposits.

Two areas of enrichment were found for copper (Figure 29.2). Two vectors are interpreted from this data, one to the east the other to the southwest. Manganese is enriched in the northern portion of the sampling area and most depleted in the southeast (Figure 29.3) A southeasterly vector is derived from this data. Lead has a distinct zone of enrichment (Figure 29.4), so the vector runs from enrichment toward depletion. The ratio of strontium over rubidium is presented in Figure 30.1. The vector runs from the cluster of high values to the cluster of low values. Uranium is presented here because it has a well defined enrichment distribution. Yttrium has an east - west elongate depletion zone. The yttrium vector is oriented along increasing depletion.

FIGURE 29.1: Ajo study area with sample locations

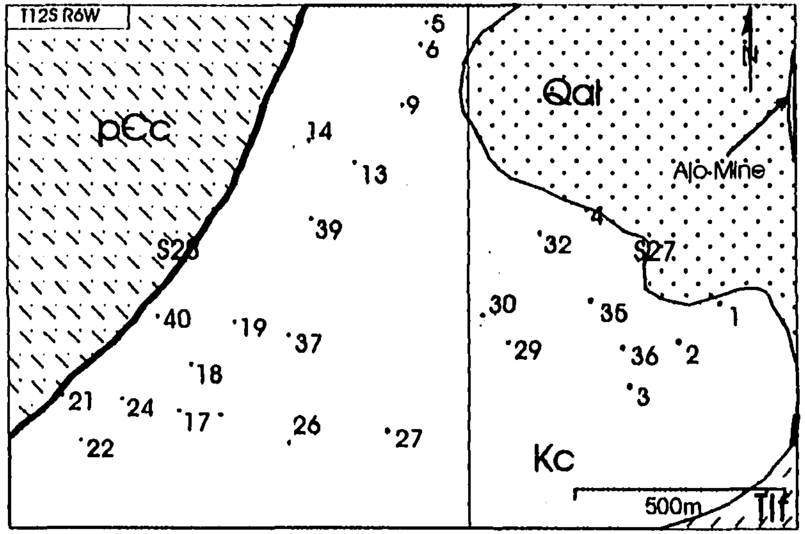


FIGURE 29.3: MANGANESE (Mn) - PPE(+)/D(-); Ajo, AZ

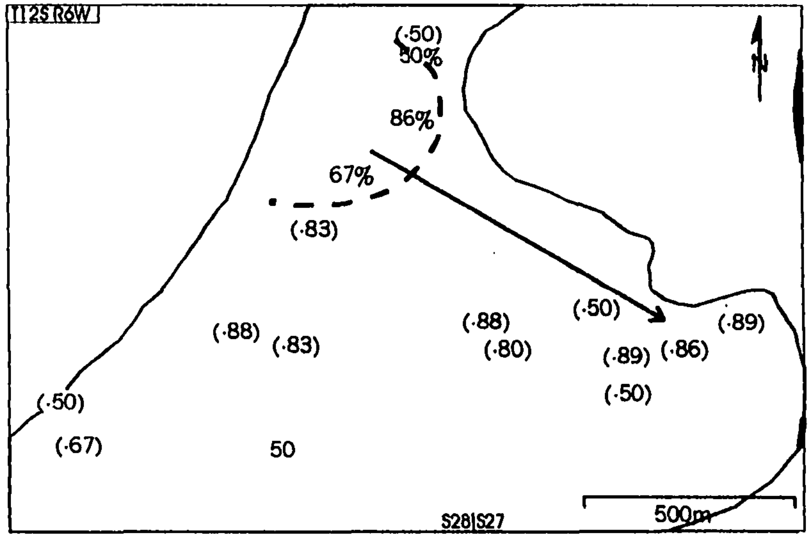


FIGURE 29.3: COPPER (Cu) - PPE(+)/D(-); Ajo, AZ

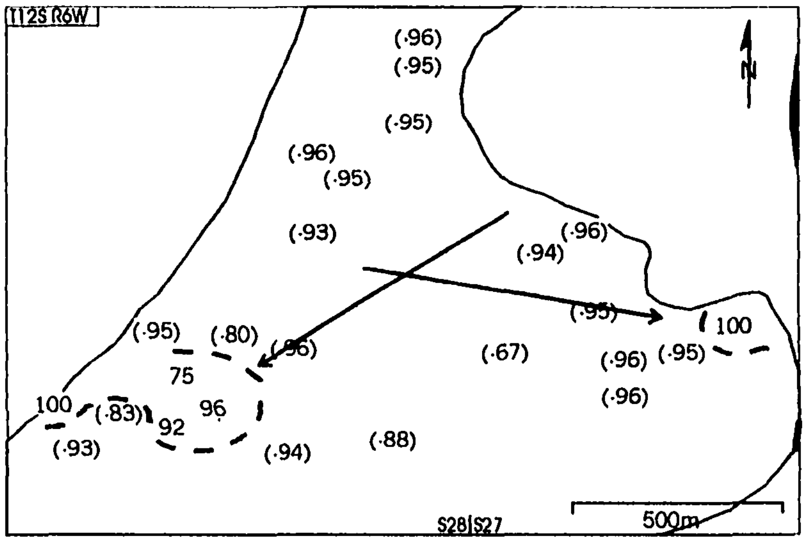


FIGURE 29.4: LEAD (Pb) - PPE(+)/D(-); Ajo, AZ

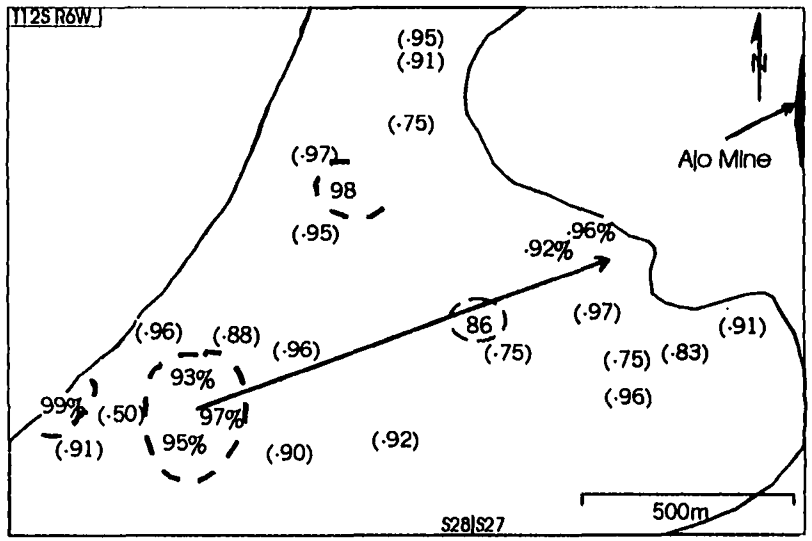


FIGURE 30.1: Strontium divided by rubidium (Sr/Rb)

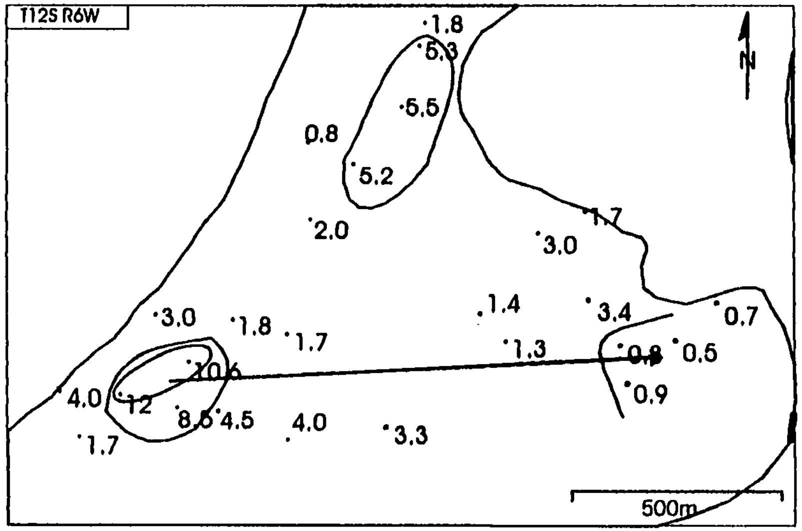


FIGURE 30.3: YTTRIUM (Y) - PPE(+)/D(-); Ajo, AZ

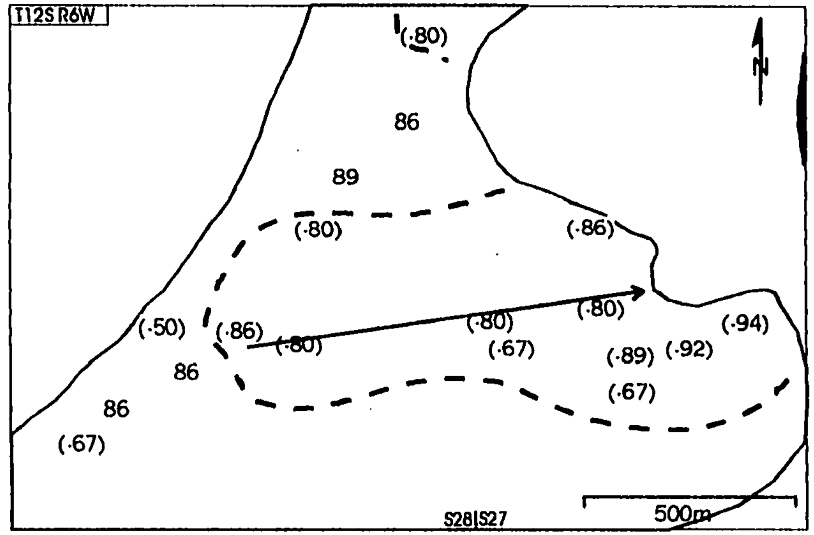


FIGURE 30.3: URANIUM(U) - PPE(+)/D(-); Ajo, AZ

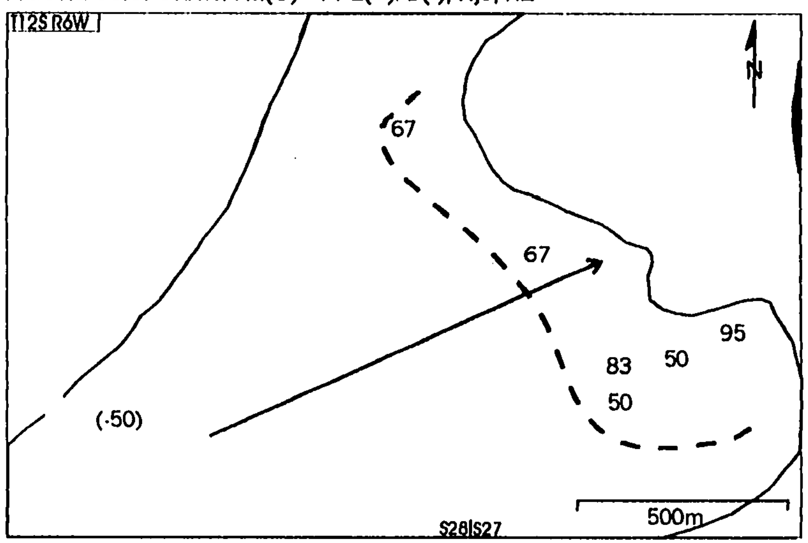
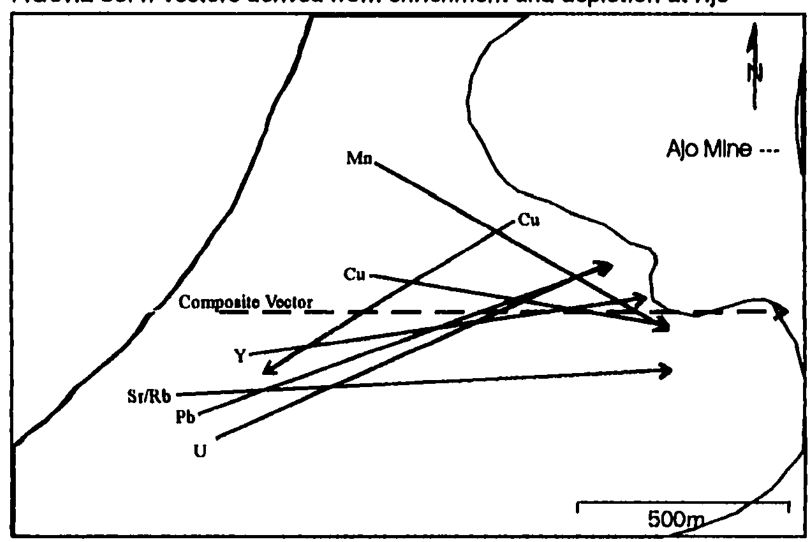
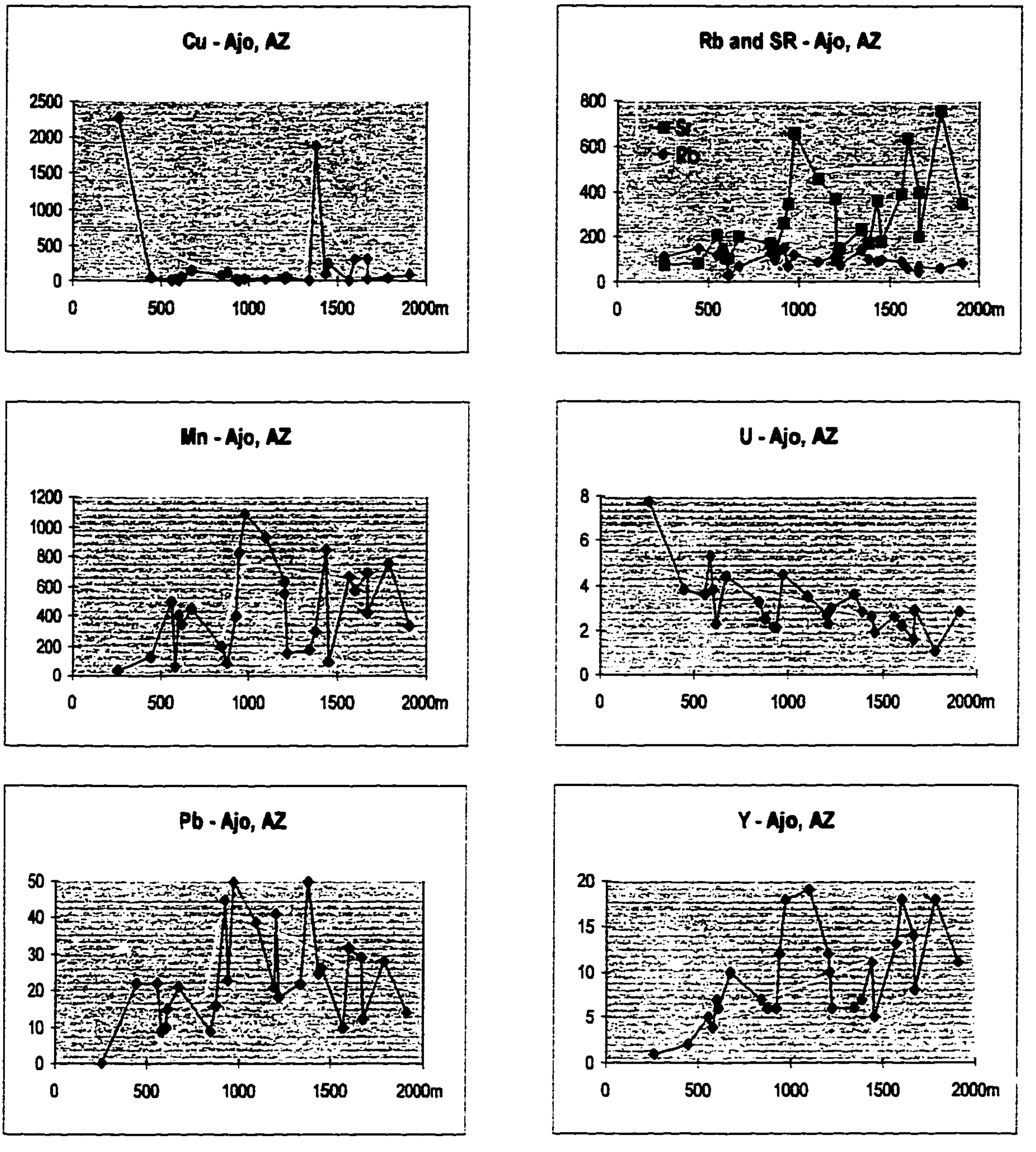


FIGURE 30.4: Vectors derived from enrichment and depletion at Ajo



All of the geochemical vectors are summarized in Figure 30.4. The dashed line is the estimated axis for all of the vectors. The sample values have been projected to the estimated vector and are presented as profiles (Figure 31). Many of the profiles are similar to those presented in the conclusions. Lead, manganese, yttrium, and strontium are depleted closer to the deposit and enriched distally. Rubidium and uranium have been enriched closer to the deposit and decrease away from it. Data for copper is insufficient to provide a useful profile. Theoretically, if the deposit were concealed under gravels, it could be located using this vectoring technique. Results at Ajo show that enrichment and depletion distributions discovered at other deposits are reproducible.

FIGURE 31: Ajo Geochemical Profiles (ppm)



CONCLUSIONS FOR EXPLORATION

The search for blind or partially concealed porphyry copper deposits requires development of new methods and improvement of existing ones. This thesis expands the body of research involving trace element dispersion within porphyry copper systems. Some practical applications of these results include:

- Rock chip sampling of altered-propylitized outcrop to develop vectors similar to those observed at Ajo. Some of the elemental patterns that occur in alteration are replicated enough to suggest proximity to a mineralized system, for instance titanium, vanadium, and phosphorus depletion entirely within phyllic alteration at Ann Mason. Other elements may be applied to distal propylitic alteration: arsenic, gold, bromine, calcium, copper, manganese, lead, yttrium, and zinc. The technique of applying probabilities of enrichment or depletion combined with profiles can be used in conjunction with geologic and alteration mapping to help substantiate vectors toward a mineralized zone.

- The same rock chip sampling may be applied in three dimensions where drilling has encountered the edges of a porphyry copper system. The trace element distributions may assist in establishing a vector for further drilling in a particular direction.

- New geochemical techniques for "looking" through alluvial cover, like enzyme leach and soil gas analysis, can provide a different suite of elements for evaluation from what is usually analyzed utilizing soils or rock chips. A better understanding of trace element distribution provided by this paper can assist in interpretation of that data.

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APPENDIX A

Fresh Host - Calculations

MORENCI

Element	Al	As	Ca	Cu	Fe	K	Mg	Mo	Na	Pb	Rb	Sr
Units	%	ppm	%	ppm	%	%	%	ppm	%	ppm	ppm	ppm
Entire Sample Set												
Mean	5.96	2.84	0.11	57.14	1.69	5.76	0.10	2.58	1.86	17.78	244.76	36.62
Std Dev	0.77	3.66	0.07	117.49	0.51	1.62	0.05	1.23	0.74	20.33	49.46	16.84
% Mean	13%	129%	64%	206%	30%	28%	53%	48%	40%	114%	20%	46%
Fresh Samples: MOR-9, MOR-18, and MOR-21												
Mean	6.28	2.95	0.12	34.08	1.74	6.05	0.04	2.06	2.28	16.29	266.67	33.67
Std Dev	0.90	1.80	0.05	30.70	0.54	1.77	0.02	0.56	0.11	10.20	25.17	11.02
% Mean	14%	61%	44%	90%	31%	29%	35%	27%	5%	63%	9%	33%

ANN MASON - Main Phase

Element	Al	As	Ca	Cu	Fe	K	Mg	Mo	Na	Pb	Rb	Sr
Units	%	ppm	%	ppm	%	%	%	ppm	%	ppm	ppm	%
Entire Sample Set												
Mean	8.01	5.01	3.36	86.42	2.86	2.32	1.33	3.00	3.96	4.51	58.00	948.97
Std Dev	0.63	5.47	1.74	62.56	0.98	1.15	0.59	2.68	4.37	2.56	46.48	401.51
% Mean	8%	109%	52%	72%	34%	50%	45%	89%	110%	57%	80%	42%
Fresh Samples: ANN-3, ANN-8, and ANN-17												
Mean	7.54	3.50	3.62	52.90	2.99	2.47	1.48	1.97	2.98	4.48	43.00	1097.00
Std Dev	0.37	0.90	0.16	25.32	1.02	0.16	0.07	0.55	1.03	0.69	5.57	102.28
% Mean	5%	26%	4%	48%	34%	7%	4%	28%	35%	15%	13%	9%

ANN MASON - Porphyry Phase

Element	Al	As	Ca	Cu	Fe	K	Mg	Mo	Na	Pb	Rb	Sr
Units	%	ppm	%	ppm	%	%	%	ppm	%	ppm	ppm	%
Entire Sample Set												
Mean	7.55	9.44	1.66	272.09	1.33	2.45	0.58	4.38	9.99	2.99	47.94	801.71
Std Dev	0.71	16.38	1.19	696.25	0.47	1.28	0.44	2.17	12.25	1.53	36.72	489.36
% Mean	9%	173%	71%	256%	35%	52%	77%	50%	123%	51%	77%	61%
Fresh Samples: ANN-25, ANN-35, and ANN-52												
Mean	7.46	3.07	2.51	16.12	1.71	3.53	0.69	2.59	11.55	3.19	74.33	1108.67
Std Dev	0.38	1.60	0.59	6.39	0.68	1.49	0.26	0.57	0.58	0.70	46.61	138.14
% Mean	5%	52%	23%	40%	40%	42%	37%	22%	5%	22%	63%	12%

SIERRITA-ESPERANZA

Element	Al	As	Ca	Cu	Fe	K	Mg	Mo	Na	Pb	Rb	Sr
Units	%	ppm	%	ppm	%	%	%	ppm	%	ppm	ppm	ppm
Entire Sample Set												
Mean	7.76	1.29	3.14	221.05	2.02	2.85	0.72	7.88	34.36	3.93	146.22	532.93
Std Dev	1.16	1.36	2.25	307.59	1.18	2.73	0.78	21.65	12.58	3.76	145.50	231.79
% Mean	15%	106%	72%	139%	58%	96%	108%	275%	37%	96%	100%	43%
Fresh Samples: RSG-19, RSG-22, and RSG-39												
Mean	7.23	0.94	2.29	129.87	2.25	3.38	0.71	4.55	30.67	2.50	146.67	353.00
Std Dev	0.64	0.01	0.78	214.89	0.88	0.64	0.42	7.15	0.65	1.39	20.82	41.15
% Mean	9%	1%	34%	165%	39%	19%	60%	157%	2%	56%	14%	12%

APPENDIX B

Normalization Examples - Calculations

Figure 3 - Calculations

	SG	% mineral fresh	1 cm3 grams	% mineral altered	1cm3 grams
quartz	2.65	30	0.795	30	0.795
albite	2.62	38	0.9956	33	0.8646
biotite	3.2	5	0.16	5	0.16
orthoclase	2.57	25	0.6425	25	0.6425
magnetite	5.18	1	0.0518	1	0.0518
zircon	4.68	1	0.0468	1	0.0468
pyrite	5.02	0	0	0	0
total		100	2.6917	95	2.5607

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
Atomic Wt	28.086	26.982	55.847	22.99	39.098	91.22	16	32.06	1.0079
quartz	1						2		
albite	3	1		1			8		
biotite	3	1	3		1		12		2
orthoclase	3	1			1		8		
magnetite			3				4		
zircon	1					1	4		
pyrite			1					2	
total									

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl
quartz	0.46743						0.53257		
albite	0.321313	0.102894		0.087671			0.488121		
biotite	0.1646	0.05271	0.327296		0.076379		0.375077		0.003938
orthoclase	0.302718	0.09694			0.14047		0.459873		
magnetite			0.723591				0.276409		
zircon	0.153219					0.497638	0.349143		
pyrite			0.46552					0.53448	

1 GRAM FRESH SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.122099	0.0391	0	0.033315	0	0	0.185486	0	0
biotite	0.00823	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.34777	0.06597	0.023601	0.033315	0.038936	0.004976	0.485235	0	0.000197

1 GRAM ALTERED SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.147609	0	0	0	0	0	0.16818	0	0
albite	0.111614	0.035742	0	0.030454	0	0	0.169558	0	0
biotite	0.008663	0.002774	0.017226	0	0.00402	0	0.019741	0	0.000207
orthoclase	0.079663	0.02551	0	0	0.036966	0	0.121019	0	0
magnetite	0	0	0.007617	0	0	0	0.00291	0	0
zircon	0.001613	0	0	0	0	0.005238	0.003675	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.349162	0.064027	0.024843	0.030454	0.040986	0.005238	0.485083	0	0.000207

NO CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.001392	-0.00194	0.001242	-0.00286	0.002049	0.000262	-0.00015	0	1.04E-05
change %	0.40%	-2.95%	5.26%	-8.59%	5.26%	5.26%	-0.03%	0.00%	5.26%

P CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.0156	-0.00506	3.31E-05	-0.00434	5.46E-05	6.98E-06	-0.02376	0	2.76E-07
change %	-4.49%	-7.67%	0.14%	-13.04%	0.14%	0.14%	-4.90%	0.00%	0.14%

Zr CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.01607	-0.00514	0	-0.00438	0	0	-0.02441	0	0
change %	-4.62%	-7.80%	0.00%	-13.16%	0.00%	0.00%	-5.03%	0.00%	0.00%

Figure 4.1 - Calculations

	SG	% mineral fresh	1 cm3 grams	% mineral altered	1cm3 grams
quartz	2.65	30	0.795	31.57895	0.836842
albite	2.62	38	0.9956	34.73684	0.910105
biotite	3.2	5	0.16	5.263158	0.168421
orthoclase	2.57	25	0.6425	26.31579	0.676316
magnetite	5.18	1	0.0518	1.052632	0.054526
zircon	4.68	1	0.0468	1.052632	0.049263
pyrite	5.02	0	0	0	0
total		100	2.6917	100	2.695474

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
Atomic Wt	28.086	26.982	55.847	22.99	39.098	91.22	16	32.06	1.0079
quartz	1						2		
albite	3	1		1			8		
biotite	3	1	3		1		12		2
orthoclase	3	1			1		8		
magnetite			3				4		
zircon	1					1	4		
pyrite			1					2	
total									

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl
quartz	0.46743						0.53257		
albite	0.321313	0.102894		0.087671			0.488121		
biotite	0.1646	0.05271	0.327296		0.076379		0.375077		0.003938
orthoclase	0.302718	0.09694			0.14047		0.459873		
magnetite			0.723591				0.276409		
zircon	0.153219					0.497638	0.349143		
pyrite			0.46552					0.53448	

1 GRAM FRESH SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.122099	0.0391	0	0.033315	0	0	0.185486	0	0
biotite	0.00823	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.34777	0.06597	0.023601	0.033315	0.038936	0.004976	0.485235	0	0.000197

1 GRAM ALTERED SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.147609	0	0	0	0	0	0.16818	0	0
albite	0.111614	0.035742	0	0.030454	0	0	0.169558	0	0
biotite	0.008663	0.002774	0.017226	0	0.00402	0	0.019741	0	0.000207
orthoclase	0.079663	0.02551	0	0	0.036966	0	0.121019	0	0
magnetite	0	0	0.007617	0	0	0	0.00291	0	0
zircon	0.001613	0	0	0	0	0.005238	0.003675	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.349162	0.064027	0.024843	0.030454	0.040986	0.005238	0.485083	0	0.000207

NO CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.001392	-0.00194	0.001242	-0.00286	0.002049	0.000262	-0.00015	0	1.04E-05
change %	0.40%	-2.95%	5.26%	-8.59%	5.26%	5.26%	-0.03%	0.00%	5.26%

P CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.001882	-0.00185	0.001277	-0.00282	0.002107	0.000269	0.000528	0	1.07E-05
change %	0.54%	-2.81%	5.41%	-8.46%	5.41%	5.41%	0.11%	0.00%	5.41%

Zr CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.01607	-0.00514	3.47E-18	-0.00438	0	0	-0.02441	0	0
change %	-4.62%	-7.80%	0.00%	-13.16%	0.00%	0.00%	-5.03%	0.00%	0.00%

Figure 4.2 - Calculations

	SG	% mineral fresh	1 cm3 grams	% mineral altered	1cm3 grams
quartz	2.65	30	0.795	35	0.9275
albite	2.62	38	0.9956	33	0.8646
biotite	3.2	5	0.16	5	0.16
orthoclase	2.57	25	0.6425	25	0.6425
magnetite	5.18	1	0.0518	1	0.0518
zircon	4.68	1	0.0468	1	0.0468
pyrite	5.02	0	0	0	0
total		100	2.6917	100	2.6932

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
Atomic Wt	28.086	26.982	55.847	22.99	39.098	91.22	16	32.06	1.0079
quartz	1						2		
albite	3	1		1			8		
biotite	3	1	3		1		12		2
orthoclase	3	1			1		8		
magnetite			3				4		
zircon	1					1	4		
pyrite			1					2	
total									

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl
quartz	0.46743						0.53257		
albite	0.321313	0.102894		0.087671			0.488121		
biotite	0.1646	0.05271	0.327296		0.076379		0.375077		0.003938
orthoclase	0.302718	0.09694			0.14047		0.459873		
magnetite			0.723591				0.276409		
zircon	0.153219					0.497638	0.349143		
pyrite			0.46552					0.53448	

1 GRAM FRESH SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.122099	0.0391	0	0.033315	0	0	0.185486	0	0
biotite	0.00823	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.34777	0.06597	0.023601	0.033315	0.038936	0.004976	0.485235	0	0.000197

1 GRAM ALTERED SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.163601	0	0	0	0	0	0.186399	0	0
albite	0.106033	0.033955	0	0.028931	0	0	0.16108	0	0
biotite	0.00623	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.355076	0.060826	0.023601	0.028931	0.038936	0.004976	0.487457	0	0.000197

NO CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.007306	-0.00514	0	-0.00438	0	0	0.002222	0	0
change %	2.10%	-7.80%	0.00%	-13.16%	0.00%	0.00%	0.46%	0.00%	0.00%

P CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.007504	-0.00511	1.32E-05	-0.00437	2.17E-05	2.77E-06	0.002494	0	1.1E-07
change %	2.16%	-7.75%	0.06%	-13.11%	0.06%	0.06%	0.51%	0.00%	0.06%

Zr CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.007306	-0.00514	0	-0.00438	0	0	0.002222	0	0
change %	2.10%	-7.80%	0.00%	-13.16%	0.00%	0.00%	0.46%	0.00%	0.00%

Figure 4.3 - Calculations

	SG	% mineral fresh	1 cm3 grams	% mineral altered	1cm3 grams
quartz	2.65	30	0.795	30	0.795
albite	2.62	38	0.9956	19	0.4978
biotite	3.2	5	0.16	2.5	0.08
orthoclase	2.57	25	0.6425	44	1.1308
magnetite	5.18	1	0.0518	0	0
zircon	4.68	1	0.0468	1	0.0468
pyrite	5.02	0	0	3.5	0.1757
total		100	2.6917	100	2.7261

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
Atomic Wt	28.086	26.982	55.847	22.99	39.098	91.22	16	32.06	1.0079
quartz	1						2		
albite	3	1		1			8		
biotite	3	1	3		1		12		2
orthoclase	3	1			1		8		
magnetite			3				4		
zircon	1					1	4		
pyrite			1					2	
total									

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl
quartz	0.46743						0.53257		
albite	0.321313	0.102894		0.087671			0.488121		
biotite	0.1646	0.05271	0.327296		0.076379		0.375077		0.003938
orthoclase	0.302718	0.09694			0.14047		0.459873		
magnetite			0.723591				0.276409		
zircon	0.153219					0.497638	0.349143		
pyrite			0.46552					0.53448	

1 GRAM FRESH SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.122099	0.0391	0	0.033315	0	0	0.185486	0	0
biotite	0.00823	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.34777	0.06597	0.023601	0.033315	0.038936	0.004976	0.485235	0	0.000197

1 GRAM ALTERED SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.06105	0.01955	0	0.016658	0	0	0.092743	0	0
biotite	0.004115	0.001318	0.008182	0	0.001909	0	0.009377	0	9.84E-05
orthoclase	0.133196	0.042653	0	0	0.061807	0	0.202344	0	0
magnetite	0	0	0	0	0	0	0	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0.016293	0	0	0	0	0.018707	0
	0.340122	0.063521	0.024476	0.016658	0.063716	0.004976	0.467726	0.018707	9.84E-05

NO CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.00765	-0.00245	0.000875	-0.01666	0.02478	0	-0.01751	0.018707	-9.8E-05
change %	-0.02199	-0.03712	0.03707	-0.5	0.636417	0	-0.03608		-0.5

P CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.0033	-0.00164	0.001188	-0.01644	0.025594	6.36E-05	-0.01153	0.018946	-9.7E-05
change %	-0.00949	-0.02482	0.050324	-0.49361	0.65733	0.01278	-0.02376		-0.49361

Zr CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.00765	-0.00245	0.000875	-0.01666	0.02478	0	-0.01751	0.018707	-9.8E-05
change %	-0.02199	-0.03712	0.03707	-0.5	0.636417	0	-0.03608		-0.5

Figure 4.4 - Calculations

	SG	% mineral fresh	1 cm3 grams	% mineral altered	1cm3 grams
quartz	2.65	30	0.795	32.5	0.86125
albite	2.62	38	0.9956	36.1	0.94582
biotite	3.2	5	0.16	2.375	0.076
orthoclase	2.57	25	0.6425	23.75	0.610375
magnetite	5.18	1	0.0518	0	0
zircon	4.68	1	0.0468	0.95	0.04446
pyrite	5.02	0	0	4.325	0.217115
total		100	2.6917	100	2.75502

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
Atomic Wt	28.086	26.982	55.847	22.99	39.098	91.22	16	32.06	1.0079
quartz	1						2		
albite	3	1		1			8		
biotite	3	1	3		1		12		2
orthoclase	3	1			1		8		
magnetite			3				4		
zircon	1					1	4		
pyrite			1					2	
total									

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl	% of mnrl
quartz	0.46743						0.53257		
albite	0.321313	0.102894		0.087671			0.488121		
biotite	0.1646	0.05271	0.327296		0.076379		0.375077		0.003938
orthoclase	0.302718	0.09694			0.14047		0.459873		
magnetite			0.723591				0.276409		
zircon	0.153219					0.497638	0.349143		
pyrite			0.46552					0.53448	

1 GRAM FRESH SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.140229	0	0	0	0	0	0.159771	0	0
albite	0.122099	0.0391	0	0.033315	0	0	0.185486	0	0
biotite	0.00823	0.002636	0.016365	0	0.003819	0	0.018754	0	0.000197
orthoclase	0.07568	0.024235	0	0	0.035117	0	0.114968	0	0
magnetite	0	0	0.007236	0	0	0	0.002764	0	0
zircon	0.001532	0	0	0	0	0.004976	0.003491	0	0
pyrite	0	0	0	0	0	0	0	0	0
	0.34777	0.06597	0.023601	0.033315	0.038936	0.004976	0.485235	0	0.000197

1 GRAM ALTERED SAMPLE

Elements	Si	Al	Fe	Na	K	Zr	O	S	H
	grams	grams	grams	grams	grams	grams	grams	grams	grams
quartz	0.151915	0	0	0	0	0	0.173085	0	0
albite	0.115994	0.037145	0	0.031649	0	0	0.176212	0	0
biotite	0.003909	0.001252	0.007773	0	0.001814	0	0.008908	0	9.35E-05
orthoclase	0.071896	0.023023	0	0	0.033362	0	0.10922	0	0
magnetite	0	0	0	0	0	0	0	0	0
zircon	0.001456	0	0	0	0	0.004728	0.003317	0	0
pyrite	0	0	0.020134	0	0	0	0	0.023116	0
	0.345169	0.06142	0.027907	0.031649	0.035176	0.004728	0.470742	0.023116	9.35E-05

NO CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	-0.0026	-0.00455	0.004306	-0.00167	-0.00376	-0.00025	-0.01449		-0.0001
change %	-0.00748	-0.06898	0.182465	-0.05	-0.09659	-0.05	-0.02987		-0.525

P CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.005519	-0.00311	0.004963	-0.00092	-0.00293	-0.00014	-0.00342		-0.0001
change %	0.01587	-0.04707	0.210282	-0.02765	-0.07534	-0.02765	-0.00705		-0.51383

Zr CORR	Si	Al	Fe	Na	K	Zr	O	S	H
change gr	0.015566	-0.00132	0.005775	6.94E-18	-0.00191	0	0.010283		-9.8E-05
change %	0.04476	-0.01997	0.2447	2.08E-16	-0.04904	0	0.021192		-0.5

APPENDIX C

Petrographic Descriptions

APPENDIX C
Morenci Sample Petrography

MOR-001: Coarse grained quartz monzonite, plagioclase is entirely altered to sericite, orthoclase altered to sericite and quartz, mafics are also altered, jarosite pseudomorphs after pyrite.

MOR-002: Graphic granite composed of perthitic orthoclase and quartz, orthoclase is fresh, dusted with colloidal hematite, mafics have been altered to pale green sericite.

MOR-003: Graphic granite perthitic orthoclase and lesser amounts of plagioclase, biotite altered to a paste of pale green sericite, feldspars have light sericitic alteration.

MOR-004: Coarse grained granite, with fresh perthitic orthoclase, mafics altered to quartz, pale green sericite, and granular Fe-oxides.

MOR-005: Coarse grained granite with perthite, lesser amounts of quartz and minor plagioclase, biotite altered to green secondary biotite, mafics embedded in accessory fluorite.

MOR-006: Coarse grained granite with perthite and quartz, mafics altered to chlorite, colloidal hematite colors the orthoclase.

MOR-007: Granodiorite with curious texture, possibly a metamorphosed fragmental unit, quartz and plagioclase graphically intergrown, orthoclase is a minor constituent, dusting of sericite in plagioclase, mafics altered to green sericite and Fe-oxides.

MOR-008: Coarse grained granite with perthitic orthoclase and quartz, hematite staining of orthoclase, mafics altered to green sericite or chlorite, and Fe-oxides. Attendant sulfide grains now altered to geothite.

MOR-009: Coarse grained granite with perthitic orthoclase and quartz, hematite stained fresh orthoclase, mafics altered to sericite and Fe-oxides.

MOR-010: Granite, similar to MOR-009, but finer grained, hematite staining on fresh orthoclase, slight chloritic alteration of plagioclase, mafics altered to pale green sericite, quartz, and Fe-oxides.

MOR-011: Graphic textured granite, variable grain size suggesting fragmental protolith, fresh orthoclase, sericitic alteration of plagioclase and mafics, sericitic alteration is strongest along indistinct cracks occupied by recrystallized quartz and orthoclase.

MOR-012: Graphic granite with heavy hematite staining of orthoclase - which has graphic intergrowth with quartz, plagioclase is fresh and biotite shows only deuteric alteration to chlorite.

MOR-013: Bleached, sodic alteration(?). Granitic, microcline is altered to sericite, biotite is altered to quartz and sericite.

MOR-015: Proximal VNS-009, propylitic alteration, specularite, with associated pyrite. Probably same protolith as MOR-012, graphic intergrowth of microcline with quartz, plagioclase has minor sericitic alteration, mafics altered to sericite.

MOR-017: Minimally altered coarse grained graphic granite, fresh microcline intergrown with quartz, fairly fresh plagioclase with dusting of sericite, majority of biotite altered to sericite and quartz.

MOR-018: Unaltered coarse grained graphic granite, fresh feldspars, some biotite is altered to sericite.

MOR-020/021: Coarse graphic granite with hematite stained orthoclase and quartz, possible dusting of calcite in orthoclase, plagioclase are fresh, mafics have minor alteration to Fe-oxides, quartz, and sericite.

MOR-031: Granitic, similar to those above, more primary plagioclase - quite heavily sericitized, biotite books bleached and altered to sericite, microcline usually fresh.

MOR-032: Biotite rich granitic rock, (slightly ordered?) perthitic microcline and plagioclase is fresh, biotite is bleached with some recrystallization and stained with supergene Fe-oxides.

Ann Mason Petrography

ANN-001: Main phase, small epidote veinlets, 1mm - none in sample, disseminated epidote, actinolite, opaque mineral associated with chlorite, some sericite in feldspars. Granodiorite with hornblende, minor amount of biotite, chloritic alteration of mafics and plagioclase altered to albite and epidote along fractures.

ANN-002: Main phase, disseminated epidote, opaque, sericitic mass, chlorite, fairly shot, plagioclase(?) no evident orthoclase(?) no zoned twinned plagioclase. granodiorite w/high hornblende content minor biotite, epidote creation at expense of plagioclase. Possible fractures with albite.

ANN-003: Main phase, chlorite , no epidote, sericitic mass, zoned plagioclase, quartz, chlorite after biotite, opaque. granodiorite higher mafic content with accessory magnetite, rock appears quite fresh. Caliche like calcite films fracture surfaces.

ANN-004: Main phase, albitic alteration(?) w/epidote, chlorite, disseminated epidote, opaque, chlorite, sericitic mass, yellow stained edges k-spar(?). granodiorite hornblende only mafic w/ass magnetite. Epidote developed at expense of plagioclase along ill defined and discontinuous fractures, but chloritic alteration of hornblende is negligible.

ANN-005: Main phase, Epidote on fractures, minor disseminated epidote, chlorite actinolite, fairly fresh siliceous, similar to 003, possible disseminated specular hematite, sericitic mass, opaque, chlorite, zoned plagioclase, and orthoclase.

ANN-006: Main phase, white albitic stringers similar to 004, epidote on fractures, highly variable epidote, albite, chlorite, distribution, specular hematite, some actinolite, chlorite, opaque, zoned plagioclase, some sericitic mass. granodiorite with high hornblende content, albitic alteration of plagioclase with epidote, hornblende shows very little chloritic alteration.

ANN-007: Main phase, aphanitic, epidote on fractures, significant calcite in float, possibly due to proximity to carbonate, manganese-oxide in pockets, chlorite, sericitic mass, opaque, epidote needles, low quartz.

ANN-008: Main phase, epidote restricted largely to cracks/fract trace albite, chl/act epi in thin stringers, chlorite, sericite mass, calcite(?) assoc with feldspar altered to chlorite. Granodiorite, minor biotite bleached and altered to sericite, hornblende major mafic, epidote after hornblende and plagioclase along fracture surfaces, between fractures rock is quite fresh.

ANN-009: Main phase, Calcite from veinlets (up to 2cm wide), not pervasive alteration, minor diss epidote, zoned plag, chlorite, minimal quartz. Granodiorite, hornblende is the only mafic, here showing flow alignment. Magnetite is a common accessory, poorly defined fractures trace of epidote and plagioclase - sausseritized in these features.

ANN-010: Main phase, anomalous not representative sample from zone with high epidote, veining up to 1" wide (2cm) with associated pyrite cubes, zoned plagioclase, chlorite, low qtz content, opaques, thin section is through epidote vein 1cm.

ANN-011: Main phase, fairly unaltered appearance, siliceous, minor epidote on fractures with associated albite, all fracture material avoided in sample will be used as standard. Granodiorite with absolutely fresh hornblende and feldspar, higher quartz content, fractures w/alb formed at expense of anorthite.

ANN-012: Main phase, high biotite content, trace epidote, opaques, biotite, minimal sericitic alteration, low quartz content.

ANN-013: Quartz, sericite, specular hematite, needles of opaques, at contact with heavy sericitic alteration and orthoclase.

ANN-014: Main phase, wallrock adjacent quartz, chalcopyrite and specular hematite vein up to 1' wide. Sample is fairly unaltered , same as 011(?). High biotite content.

ANN-015: Main phase, actinolite and orthoclase skarn(?) - not necessarily representative, only good outcrop, shreddy biotite, chlorite, disseminated epidote adjacent fracture, (probably calcite?, quartz, zoned plagioclase, sericite altered mass. Granodiorite with plagioclase uniformly milky partially albitized, hornblende altered to chlorite, sphene is prominent in altered crystals. Minor amounts of epidote found in plagioclase cores and in vicinity of fractures.

ANN-017: Main phase, unaltered, few albitic zones and chlorite, quartz, zoned plagioclase, opaques, chlorite, minimal sericite alteration, orthoclase. Granodiorite, quite fresh, abundant hornblende, sphene, trace of chlorite in hornblende cores, rock appears perfectly fresh. Sample will be used as example of fresh host.

ANN-020: Main phase, chlorite and some actinolite, epidote on fract, chlorite, sericitic mass, opaques, no quartz. granodiorite, minor biotite, hornblende dominant mafic, biotite partially altered chlorite, swaths of albitized plagioclase, no epidote except on fracture coatings.

ANN-021: Main phase, x-cutting relationship (phase contact), pink vein material zoisite or orthoclase, chlorite, albite veinlet, high biotite, from float, no opaques, epidote, quartz. Finer grained granodiorite, biotite is altered to chlorite, hornblende still relatively fresh, trace epidote on fracture.

ANN-022: Main phase, high feldspar content, chlorite and disseminated epidote after plag, minor quartz. Coarse grained granodiorite with substantial bt content minor hornblende, biotite and hornblende are chloritize. Broad bands of albitized plag with epidote, small oxidized pyrite grains occur in the central portions of these swaths.

ANN-023: Main phase, sample from prospect pit. Copper oxide visible on fractures, hornblende altered to chlorite, minor epidote, plagioclase appears to be more sodic, minor biotite is chloritized, minor granular epi and in plagioclase cores.

ANN-024: Main phase, close to prospect pit with copper oxides, close to #25, disseminated epidote after feldspar, minor epidote veinlets, albitic groundmass(?), minor opaques, zoned plagioclase, minor chlorite, sphene. Granodiorite has flow oriented of hornblende and plagioclase.

ANN-025: Porphyry, small hornblende, albitic groundmass?, quartz eyes some with crystal faces, euhedral plagioclase, fairly unaltered except for occasional epidote replaced feldspars. Granodiorite hornblende phenocrysts in matrix of plagioclase, quartz, and orthoclase. Minor sericitic alteration in spots, hornblende appears fairly fresh.

ANN-026: Main phase, near prospect pit with copper oxide, feldspar altered to epidote and albite, sericitic mass, orthoclase, minor opaques. Granodiorite with some flow align.

ANN-028: Main phase, assoc skarn included in sample some epidote, hornblende to actinolite, some albite, high mafic content, high epidote, low opaques, active replacement of zoned plagioclase, sericitic mass. Granodiorite with abundant hornblende, oxidized pyrite in groundmass possibly where it replaced magnetite.

ANN-029: Main phase, albitized, minor epidote in cores, very fringe of propylitic zone, some sulfide assoc with epidote veins, minor quartz, minor opaques. Granodiorite, with hornblende slightly altered to chlorite.

ANN-031: Main phase, very heavy sericitic alteration, minor opaques - hematite stained, extensive alteration to epidote, minor quartz. Only traces of orthoclase joining qtz and plag, that is heavily but not entirely altered to sericite, qtz, and kaolinite. A trace of iron rich tourmaline has developed in the matrix.

ANN-034: Porphyry, orthoclase groundmass, epidote, orthoclase phenocrysts, epidote, biotite, minor opaques, multiple orthoclase phases. Granodiorite porphyry, B-quartz with plagioclase and hornblende as phenocrysts, matrix has been slightly sericitized, hornblende and biotite altered to sericite.

ANN-035: Porphyry, propylitic alteration, disseminated epidote after feldspar, shreddy bt, zoned plagioclase, orthoclase phenocrysts, minor opaques. Porphyritic granodiorite, hornblende altered to biotite then chlorite, epidote often in albite.

ANN-036: Porphyry, heavy albitization with significant epidote after feldspar, minor opaques, large orthoclase phenocrysts, zoned plagioclase, quartz eyes. Granodiorite porphyry, phenocrysts of plagioclase, all hornblende altered to epidote, epidote and sericite after of plagioclase, euhedral sphene crystals are also present.

ANN-037: Porphyry, visible sulfides, hematite staining, orthoclase, minor opaques, quartz eyes, zoned plag, minor epidote in groundmass. Porphyritic granodiorite, plagioclase throughout matrix is bleached and sericitized, mafics have been entirely leached leaving voids partially occupied by iron stained sericite.

ANN-038: Main phase, fairly unaltered quartz monzonite, dominated by rectangular plagioclase grains of uniform size and random orientation, interstices filled with coarse quartz and perthitic orthoclase, sometimes orthoclase and quartz intergrowth, hornblende clusters with associated biotite and magnetite, largely unaltered with only a trace of magmatic and deuteric alteration.

ANN-039: Porphyry, albitized with epidote and copper oxide, orthoclase groundmass, minor opaques, zoned plagioclase, minor epidote. Porphyritic granodiorite with phenocrysts of hornblende, quartz, orthoclase, and plagioclase in a dense quartz feldspar groundmass.

ANN-044: Main phase(?), heavy sericitic alteration, trace opaques. Fine grained faintly porphyritic granodiorite with quartz, plagioclase clouded by sausseritization, and orthoclase phenocrysts, orthoclase abundant in matrix, rock may be closer to quartz monzonite. Mafics have been leached leaving voids lined with chalcedonic quartz.

ANN-046: Porphyry(?), from prospect pit, heavy alteration, iron oxides after sulfides, epidote needles. Granodiorite with phenocrysts of plagioclase, quartz and hornblende, extensive sericitic alteration of plagioclase, hornblende altered to sericite with remnant of chlorite and traces of tourmaline in the pseudomorphs.

ANN-047: Porphyry, visible sulfides, disseminated epidote, hornblende, biotite books, zoned plagioclase with reaction rims, minor quartz, trace opaques. Probably granodiorite porphyry, flow aligned plagioclase and hornblende phenocrysts, hornblende replaced entirely by epidote and chlorite, plagioclase partially replaced by orthoclase.

ANN-048: Porphyry, Disseminated oxidized sulfides, orthoclase in groundmass and phenocrysts, epidote, trace of opaques, hematite, a few zoned plagioclase. Porphyritic granodiorite, hornblende and biotite both common as phenocrysts some bleaching and alteration to sericite, matrix plagioclase is albitized.

ANN-049: Main phase, chlorite, minor epidote, sericite along fractures, minor opaques, plagioclase, resorbed quartz. Granodiorite with high quartz content and hornblende is the major mafic, replacement by biotite, some primary biotite, sausseritization of plagioclase.

ANN-051: Porphyry, remnant sulfide casts, albitized, orthoclase in groundmass, trace opaques, zoned plagioclase 96% altered to sericite and epidote, few small qtz eyes, minor epidote. Granodiorite porphyry, phenocrysts of plagioclase, hornblende, quartz, and few large orthoclase phenocrysts, plagioclase and hornblende altered to sericite, trace of sulfides associated with alteration.

ANN-052: Porphyry, pink orthoclase after plagioclase, trace opaques, epidote, a few zoned plag, varying degrees of alteration to sericite and epidote, some quartz, orthoclase groundmass, appears largely unaltered.

ANN-054: Main phase, chlorite, hornblende, shreddy biotite, epidote on fractures, opaques, some zoned plagioclase, epidote, quartz, silica influx. Granodiorite with hornblende that is partially altered to chlorite. Minor albitization throughout the rock with attendant granular epidote.

ANN-055: Main phase, gray sericite, siliceous, trace opaques, secondary biotite, hematite staining. Intense sericitic alteration, growth of quartz in the matrix, zones of interlocked qtz and patches of fine shreddy sericite.

ANN-057: Porphyry, Exposure in road albitized with iron oxides, trace opaques, sericite books after biotite, zoned plagioclase, resorbed quartz phenocrysts. Granodiorite porphyry with quartz and heavily sericitized plagioclase phenocrysts, orthoclase remains quite fresh, sericite has replaced the relatively abundant biotite and hornblende crystals throughout sample.

ANN-058: Porphyry, from tourmaline prospect pit, very heavy quartz sericite alteration, aggregate of what appears to be quartz and plagioclase. Granodiorite with all mafics and feldspars bleached and sericitized, growth of quartz throughout at the expense of sericite and residue of feldspars left there.

ANN-059: Main phase, from prospect pit, chloritic alteration?, epidote, some zoned plagioclase, sodic alteration, altered feldspar phenocrysts. Fine grained granodiorite with bleached sericite, biotite and hornblende, plagioclase at one time sausseritized but now is heavily and uniformly sericitized, only magnetite and orthoclase remain fresh.

ANN-061: Porphyry, altered to albite, iron oxide stained. Oxidized sulfides, well zoned plagioclase, trace opaques, quartz phenocrysts. Granodiorite with sericitic alteration of plagioclase, remaining plag is largely sodic, mafics are gone leaving voids containing oxidized pyrite grains disseminated throughout.

ANN-063: Porphyry?, associated with black tourmaline, from prospect pit on knoll, very heavy sericitic alteration, disseminated oxidized sulfides, only a few phenocrysts. Granodiorite porphyry with prominent quartz, plagioclase. And hornblende phenocrysts showing flow lineation, alteration to sericite.

ANN-064: Porphyry?, from prospect pit, heavily altered to sericite, oxidized sulfides, hematite along a veinlet, zoned plagioclase. Plagioclase grains in a continuum of sizes, quartz and orthoclase in groundmass, plagioclase altered to albite, dusting of sericite in larger crystals, former mafics particularly biotite are altered to sericite.

ANN-065: Main phase, shreddy biotite, albite, chlorite, minor epidote along veinlets and disseminated, chlorite, epidote, trace of opaques, quartz, plagioclase. Granodiorite, hornblende dominant mafic, only traces of biotite, plagioclase altered to albite w/granular epidote, only minor chloritic alteration of hornblende.

ANN-068: Porphyry, copper oxides, sulfides, albitized, no strong alteration of plagioclase phenocrysts, and trace opaques. Porphyry, large distinct plagioclase phenocrysts and smaller hornblende, groundmass of interlocked quartz plagioclase almost cherty texture, coarse qtz veins with sharp walls against groundmass, plagioclase alteration to albite, apatite and sphene, chrysocolla stains, sphene conversion to rutile - sulfides associated with conversion.

ANN-069: Porphyry, hornblende, fresh biotite books, albite epidote veinlet, epidote after feldspar, heavy albitization(?), zoned plagioclase, minor epidote.

Granodiorite porphyry with biotite, hornblende, plagioclase, and quartz phenocrysts.

Ruby Star Granodiorite Petrography

RSG-001: Albite, chlorite, massive epidote, all clean unweathered surface, no veins evident, thin section 001a is as above, 001b across contact with massive epidote. Coarse grained equigranular granodiorite, plagioclase partly sausseritized, mafics altered to actinolite, commonly associated with recrystallized sphene, fresh overall

RSG-002: Same as above with disseminated epidote, sample includes epidote veinlet, thin section includes veinlet. Modally a tonalite, plagioclase is moderately sausseritized, mafics altered to actinolite and epidote.

RSG-003: Sample of massive epidote quartz, some hematite staining, caution this is not a typical sample, at this location and may represent distal mineralization. Matrix of coarse clear quartz, with well formed epidote prisms therein, accessory of sphene.

RSG-004: Biotite fairly fresh, minimal veining, sulfides disseminated on fractures and a little at biotite sights, sulfides definitely included in geochemical sample, thin section is oriented perpendicular to sulfide carrying veinlet fracture. Granodiorite, quartz, plagioclase, orthoclase, biotite, minor sericite in plagioclase, rock is relatively fresh.

RSG-005: All mafics gone, disseminated oxidized sulfides, sericitic alteration. Protolith texture is gone potassic alteration - coarse granular orthoclase with occasional grains of quartz, sericite in orthoclase - remnants of plagioclase, disseminated pyrite oxidized to jarosite.

RSG-006: Orthoclase and chlorite, thin section crosscuts orthoclase veinlet, with chlorite halo, propylitic overprint of potassic alteration. Partially metamorphosed intrusive rock, similar to (005), orthoclase/microcline.

RSG-007: Porphyry phase, proximal to mineralization (RSG-026) hematite staining and associated sulfides. Vitric quartz latite, matrix crystallized to cherty-textured orthoclase, plagioclase, and quartz, phenocrysts of plagioclase and biotite appear fresh with a little alteration to actinolite.

RSG-008: Porphyry phase, thin section perpendicular to <<1mm veinlet quartz sericite. Rhyodacite composition, plagioclase with some epidote, biotite to chlorite, suspected former hornblende altered to orthoclase and epidote.

RSG-009: Albitic alteration with massive and veins of epidote, ~1cm epidote vein included in geochemical sample, thin section crosscuts epidote - wall rock contact. Consists mostly of epidote as prisms with a little quartz and plagioclase intersticially, textures of fragments suggest a brecciated unit.

RSG-010: Orthoclase is stable, actinolite, chlorite, epidote, copper oxides on fresh biotite. Granodiorite with cloudy but fresh orthoclase and plagioclase flecked with coarse grained sericite, books of biotite altered to chlorite and granular epidote, overall alteration is mild.

RSG-011: Porphyry phase, propylitically altered. Rhyodacite, plagioclase and biotite phenocrysts, matrix of intergrown quartz and feldspar, only slight alteration.

RSG-012: Porphyry phase, quartz, biotite, pyrite, 011 and 012 both proximal on same dike. Matrix of quartz and feldspar, plagioclase phenocrysts partially altered to epidote and sericite, mafics altered to sericite, epidote, and chlorite.

RSG-013: Quartz monzonite, orthoclase replacing much of the plagioclase present, mafics altered to actinolite with coarse grained sphene, quartz content is low possibly lost during metamorphism.

RSG-014: Chlorite, albite, disseminates epidote alteration. Mafics altered to actinolite and quartz with associated sphene, some plagioclase minor sausseritization.

RSG-015: Porphyry phase, only enough for geochemical work, no phenocrysts evident, biotite altered to chlorite. Rhyodacite, quartz and plagioclase matrix, plagioclase and matrix heavily altered to sericite, calcite and chlorite, iron oxides in mafic sites.

RSG-016: Chalcopyrite veinlets; fairly fresh biotite, potassium stable. Quartz monzonite, uniform sized grains of plagioclase, orthoclase, quartz, and biotite, biotite occurs with sphene, apatite, magnetite, rock is quite fresh.

RSG-017: Chlorite albite alteration. Extensive recrystallization, prisms of diopside altered to actinolite with quartz represent altered mafics. Plagioclase is spotted with epidote and sericite, orthoclase is fresh.

RSG-018: Copper oxides, shreddy biotite. Granodiorite, plagioclase with occasional interstitial perthitic orthoclase and quartz, biotite books, oxidized chalcopyrite along small fractures.

RSG-019: Fresh biotite, potassium stable. Slightly porphyritic, not quite enough orthoclase to be a granodiorite, abundant biotite associated with hornblende, rock is quite fresh.

RSG-020: Some chlorite and disseminated epidote, epidote veinlet ~N30E ~45W, chlorite epidote vnlts. Granodiorite, heavy sausseritization of plagioclase with chlorite and calcite, fresh orthoclase, mafics altered to chlorite and coarse epidote, with associated sphene.

RSG-021: Possible purple fluorite, albite, chlorite. Some plagioclase dusted with sericite and calcite, all mafics gone.

RSG-022: Fairly unaltered but moderately weathered Ruby Star granodiorite. Coarse grained equigranular granodiorite, plagioclase, quartz, orthoclase biotite, and hornblende, rock is quite fresh.

RSG-023: Epidote veinlet with orthoclase or pink epidote (not in sample) fairly unaltered with trace of chlorite and epidote. Granodiorite, quartz, plagioclase, and orthoclase/microcline in matrix, heavy sericitic alteration of plagioclase, partial alteration of biotite in matrix to chlorite and epidote.

RSG-024: Chlorite, epidote, and albite. Granodiorite, recrystallization during alteration altered mafics to iron oxides and epidote, sericite and calcite in plagioclase, remainder is sodic.

RSG-035: Sample from close to pit mineralized. Granodiorite, some sericitic alteration of plagioclase, biotite shows light alteration to chlorite and epidote, epidote also associated with oxidized chalcopyrite.

RSG-036: Sample of porphyritic granite, copper oxide staining. Quartz monzonite, plagioclase, and quartz, very large slightly orthoclase, trace sericite in plagioclase, biotite is quite fresh.

RSG-037: Distal high albite pink tint similar to that seen in RSG-031. Pink coating on fractures - zoisite? Granodiorite, sericite in plagioclase, mafics replaced by quartz with associated apatite, epidote, and sphene.

RSG-038: Chalcopyrite evident, Similar to (037), occasional large perthitic orthoclase, plagioclase and quartz, biotite is perfectly fresh, minimal sericitic alteration of plagioclase.

RSG-039: Fairly fresh appearance with fresh biotite. Porphyritic granodiorite or quartz monzonite, quartz, orthoclase, minor plagioclase, occasional large perthitic orthoclase, biotite is uncommon, possible recrystallization of matrix, minimal alteration.

RSG-040: Porphyry phase, epidote veinlet, fresh biotite, copper oxides, disseminated sulfides. Granodiorite porphyry almost quartz monzonite, light sausseritization of plagioclase, plagioclase phenocrysts in quartz and two feldspar matrix, biotite is only slightly chloritized.

RSG-041: Copper oxides, sulfides, quartz veinlets, chlorite, from trench. Porphyritic close to granodiorite, some orthoclase, heavy sericitic alteration of plagioclase with a little calcite, orthoclase is fresh, oxidized chalcopyrite in grain boundaries and small cracks, cracks with chalcopyrite have associated chlorite, biotite altered to chlorite.

RSG-042: Heavily altered, chlorite, actinolite, minor iron oxides. Granodiorite porphyry with large plagioclase phenocrysts and some hornblende in quartz plagioclase matrix,, quartz, and sphene, hornblende altered to smectite, plagioclase is fresh.

Ajo Petrography

AJO-001: The rock is volcanic, probably a lithic tuff. Most xenocrysts of plagioclase are fresh but the matrix is dusted with sericite. Mafics have disappeared, replaced by sericite and accessory oxides.

AJO-002: Similar to AJO-001 with less alteration to sericite.

AJO-003: Similar to AJO-001 with calcite and hematite in mafic sights, and weak sericitic alteration of plagioclase.

AJO-004: Andesite flow breccia with fresh albite. Some minor alteration of mafics to epidote and sericite.

AJO-005: Andesite flow breccia with fairly strong alteration - sericite forming in some fragments. Some possible secondary biotite altered to chlorite.

AJO-006: Andesite flow breccia with epidote after plagioclase, but plagioclase in matrix is mostly fresh, epidote and chlorite replace mafic. Calcite veinlets throughout.

AJO-009: Andesite flow, most plagioclase is fresh albite with minor epidote alteration. Epidote and chlorite after mafics.

AJO-013: Andesite flow breccia, plagioclase mostly sodic with minor epidote and sericitic alteration. Epidote and chlorite after mafics.

AJO-014: Dacitic flow with plagioclase weakly altered to sericite.

AJO-016: Andesite flow breccia, epidote after plagioclase and mafics, most plagioclase are fresh.

AJO-017: Andesite flow with fresh plagioclase, hornblende altered to Fe-oxides, chlorite, and epidote.

AJO-018: Andesite flow with moderate alteration of plagioclase to epidote. Hornblende altered to Fe-oxides and chlorite. Small quartz stringers throughout.

AJO-019: Dacite flow with glassy fragments, largely fresh sample.

AJO-020: Similar to sample AJO-001, plagioclase is largely sodic. Hornblende completely altered to epidote and Fe-oxides.

AJO-021: Andesite flow largely fresh with minor sericite and occasional quartz stringers.

AJO-022: Dacite flow with glassy fragments, largely fresh with a trace of sericite.

AJO-024: Andesite flow with plagioclase altered to epidote, matrix is fresh. Hornblende is altered to epidote and chlorite. A few fractures filled with quartz.

AJO-026: Lithic tuff with plagioclase fairly fresh - minor sericite. Quartz fills fractures.

AJO-027: Lithic tuff with fragments of dacite and andesite. Plagioclase is generally fresh with only minor sericite. Mafics are replaced by epidote and chlorite.

AJO-029: Lithic tuff with fragments of dacite, andesite, and pinal schist. Plagioclase is generally fresh with only minor sericite. Mafics are replaced by epidote and chlorite.

AJO-030: Dacite flow with vitrophyre - plagioclase shows minor sericite, mafics altered to Fe-oxides and chlorite.

AJO-032: Dacite flow with sericite throughout devitrified areas, and minor epidote after mafics.

AJO-035: Andesite flow breccia, mafics altered to chlorite and plagioclase with minor sericite.

AJO-036: Lithic tuff of mixed composition, including some vitrophyre. Plagioclase are generally fresh but there is a minor dusting of sericite throughout. Oxidized pyrite grains are present.

AJO-037: Dacite lithic tuff with extensive sericitic alteration devitryphed fragments, feldspars and matrix are largely fresh. Mafics have been completely altered.

AJO-039: Massive vitrophyre with alteration to sericite in only a few phenocrysts.

AJO-040: Lithic tuff with plagioclase altered to epidcte and calcite, mafics are altered to epidote, calcite, and chlorite.

APPENDIX D

Raw Geochemical Data

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%
Detection	0.015	0.01	1	0.5	100	0.5	0.25	1	0.01
Lab Perf	0.194	0.052	1.070	0.550	0.232	0.076	1.096	0.250	0.161
Std Dev	0.287	0.772	3.659	2.488	188.64	15.83	0.973	2.490	0.068
% Mean	1.09	0.13	1.29	0.94	0.37	0.82	1.59	0.62	0.64
MOR-001	3.04	5.99	1.12	5	550	17	0.572	1	0.01
MOR-002	0.782	6.11	0.39	1	300	39	0.388	2	0.13
MOR-003	0.173	5.32	0.551	1	510	19	0.11	5	0.13
MOR-004	0.311	5.75	0.546	3	340	61	0.367	5	0.09
MOR-005	0.088	4.6	0.424	0.8	480	32	0.154	6	0.22
MOR-006	0.098	5.24	0.043	5	350	29	0.217	5	0.08
MOR-007	0.839	4.83	0.87	9	210	31	0.622	2	0.06
MOR-008	0.847	5.47	4.25	4	400	21	0.041	5	0.05
MOR-009	0.721	5.41	3.49	0.8	220	25	0.22	5	0.06
MOR-010	0.162	5.85	5.17	3	220	27	4.37	6	0.05
MOR-011	0.38	6.08	1.13	4	690	8	0.05	0	0.01
MOR-012	0.059	5.98	16	0.5	860	18	0.127	7	0.26
MOR-013*	0.067	6.87	0.98	5	360	-2	1.8	0	0.05
MOR-015*	0.078	7.19	0.969	7	550	-2	1.23	0	0.05
MOR-017*	0.176	6.06	0.947	3	580	5	1.21	3	0.18
MOR-018*	0.111	7.2	0.94	1	670	3	0.424	3	0.13
MOR-020	0.067	6.35	3.76	0	670	30	0.167	8	0.15
MOR-021*	0.083	5.81	6.97	0.5	640	6	0.237	7	0.15
MOR-021	0.077	6.24	4.42	0.8	620	29	0.1	7	0.16
MOR-031*	0.078	7.54	5.78	0.5	690	3	0.244	3	0.06
MOR-032*	0.064	5.2	0.954	0.5	720	4	0.239	4	0.16

Element	Cd	Ce	Co	Cr	Cs	Cu	Eu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Detection	0.1	3	5	10	2	0.05	0.2	0.02	0.5
Lab Perf	0.553	0.068	-0.950	0.106	0.550	0.052	0.183	0.061	0.332
Std Dev	0.078	72.421	0.000	89.010	5.282	117.49	0.674	0.508	1.577
% Mean	0.41	0.46	0.00	0.42	1.06	2.06	0.50	0.30	0.69
MOR-001	0.166	170	-5	160	0	67.1	1.3	2.51	1.29
MOR-002	0.243	42	-5	140	3	18.7	0.4	0.59	0.84
MOR-003	0.229	62	-5	190	4	20	1.7	1.75	2.28
MOR-004	0.165	100	-5	200	4	20	0.9	1.03	1.63
MOR-005	0.442	170	-5	140	4	45.7	1.5	1.55	5.02
MOR-006	0.154	71	-5	180	4	21.2	1.3	1.88	1.35
MOR-007	0.151	32	-5	160	0	19.6	0	1.4	0.896
MOR-008	0.286	150	-5	160	3	52.9	1	2.45	0.894
MOR-009	0.223	130	-5	140	3	32.8	0.4	1.14	1.05
MOR-010	0.175	120	-5	210	5	24.5	0.6	1.35	1.97
MOR-011	0.084	200	-5	160	0	555	1.2	1.64	0.543
MOR-012	0.199	180	-5	160	24	7.81	1.9	1.81	3.52
MOR-013*	0.098	86	-5	490	0	29.9	0.7	1.37	0.758
MOR-015*	0.097	240	-5	330	5	103	2.6	1.16	1.77
MOR-017*	0.109	200	-5	320	4	86.4	1.5	1.95	2.97
MOR-018*	0.2	300	-5	290	3	65.4	2.2	2.19	2.24
MOR-020	0.211	190	-5	140	6	3.38	1.6	1.84	4.12
MOR-021*	0.207	260	-5	240	13	3.63	1.8	2.61	5.75
MOR-021	0.216	180	-5	130	6	4.05	1.7	1.88	4.36
MOR-031*	0.239	190	-5	290	8	12.3	2	1.47	0.893
MOR-032*	0.149	220	-5	210	6	6.47	2.1	1.85	4.05

Element	Hf	Hg	Ir	K	La	Lu	Mg	Mn	Mo
Units	ppm	ppm	ppb	%	ppm	ppm	%	ppm	ppm
Detection	1	0.1	5	0.01	1	0.05	0.01	1	0.1
Lab Perf	0.103	3.754	-0.950	0.052	0.062	0.072	0.150	0.064	0.093
Std Dev	3.183	0.040	2.182	1.625	30.237	0.430	0.052	128.626	1.231
% Mean	0.17	0.91	-0.48	0.28	0.41	0.19	0.53	0.95	0.48
MOR-001	13	0.033	-5	5.95	79	1.73	0.19	68	2.74
MOR-002	20	0.065	-5	7.32	14	2.39	0.11	104	1.98
MOR-003	18	0.005	-5	4.77	69	2.28	0.12	119	1.08
MOR-004	23	0.01	-5	5.49	25	2.42	0.03	46	3.3
MOR-005	19	0.009	-5	4.54	110	2.38	0.11	280	2.34
MOR-006	15	0.014	-5	4.89	71	2.17	0.06	68	1.24
MOR-007	16	0.027	-5	3.48	14	1.62	0.14	72	4.17
MOR-008	21	0.002	-5	5.53	69	2.18	0.07	32	2.18
MOR-009	17	0.038	-5	4.69	57	2.01	0.03	28	1.5
MOR-010	17	0.011	-5	5.3	51	3.13	0.03	32	4.21
MOR-011	17	0.017	-5	9.94	86	1.73	0.09	21	3.88
MOR-012	15	0.003	-5	6.33	86	2.26	0.11	552	1.51
MOR-013*	23	0.098	-5	3.85	38	2.02	0.13	54	3
MOR-015*	23	0.097	5	6.68	90	2.67	0.14	66	5.17
MOR-017*	19	0.095	-5	5.86	90	2.6	0.1	72	4.37
MOR-018*	21	0.094	-5	5.42	100	3.42	0.06	89	2.07
MOR-020	23	0.007	-5	8.78	92	2.06	0.04	237	2.63
MOR-021*	21	0.094	-5	4.37	120	2.61	0.08	275	2.29
MOR-021	21	0.014	-5	8.05	83	2.22	0.04	225	2.61
MOR-031*	14	0.097	-5	5.26	98	2.13	0.2	245	0.646
MOR-032*	16	0.095	-5	4.55	99	2.24	0.17	160	1.24

Element	Na	Nd	Ni	P	Pb	Rb	Sb	Sc	Se
Units	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Detection	0.05	5	1	0.005	0.25	30	0.25	0.1	1
Lab Perf	0.073	0.138	0.300	0.606	0.073	0.165	1.058	0.079	1.098
Std Dev	0.744	25.436	3.145	0.005	20.334	49.459	0.405	1.212	0.010
% Mean	0.40	0.46	0.64	0.53	1.14	0.20	1.16	0.34	0.01
MOR-001	0.109	56	4	0.009	10.8	160	0.205	3.1	0.954
MOR-002	1.36	14	6	0.005	7.89	280	0.203	2.3	0.954
MOR-003	2.47	35	4	0.006	6.22	280	0.081	3	0.954
MOR-004	1.84	27	4	0.008	95.2	230	0.108	2.5	0.954
MOR-005	2.28	71	2	0.007	8.85	210	0.029	3.5	0.954
MOR-006	2.27	61	3	0.006	5.09	240	0.085	3.2	0.954
MOR-007	1.82	6	3	0.003	11.7	170	0.248	2	0.954
MOR-008	1.22	50	5	0.009	28.3	270	0.082	3.3	0.954
MOR-009	2.29	27	1	0.005	12.2	270	0.011	1.7	0.954
MOR-010	2.21	43	3	0.006	11.8	290	0.073	2	0.954
MOR-011	2.37	78	1	0.011	8.1	150	0.208	3.8	0.954
MOR-012	2.36	57	4	0.026	24.2	260	1.78	5.4	0.954
MOR-013*	0.0732	24	11	0.009	1.84	160	0.283	2.5	0.98
MOR-015*	1.12	94	9	0.013	2.7	250	0.312	4.1	0.969
MOR-017*	2.11	69	10	0.007	5.37	260	0.569	3.5	0.947
MOR-018*	2.39	97	10	0.016	8.78	240	0.289	4.2	0.94
MOR-020	2.21	62	2	0.014	28.1	310	0.538	4.3	0.954
MOR-021*	2.57	88	5	0.012	33.5	240	1.05	4.5	0.938
MOR-021	2.17	55	1	0.014	27.9	290	0.44	4.4	0.954
MOR-031*	1.15	69	8	0.009	6.65	320	0.394	5.5	0.975
MOR-032*	2.57	66	7	0.018	28.2	260	0.324	6.1	0.954

Element	Sm	Sr	Ta	Tb	Te	Th	Ti	Tl	U
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Detection	0.1	1	1	0.5	0.5	0.5	0.01	0.5	0.5
Lab Perf	0.057	0.080	0.300	0.235	1.973	0.066	0.175	1.098	0.144
Std Dev	6.074	16.836	1.231	1.160	0.274	7.979	0.044	0.005	1.440
% Mean	0.48	0.46	0.33	0.45	0.86	0.28	0.43	0.01	0.26
MOR-001	12	25	3	2	0.592	11	0.05	0.477	3.7
MOR-002	3.6	48	5	1.7	0.176	20	0.08	0.477	6.9
MOR-003	11	41	5	2.8	0.024	31	0.07	0.477	5.3
MOR-004	6.4	31	3	1.9	0.212	35	0.09	0.477	7.2
MOR-005	18	30	0	1.5	0.028	28	0.09	0.477	6.2
MOR-006	15	29	4	3.4	0.26	25	0.08	0.477	5.2
MOR-007	2.2	29	4	1	0.342	16	0.06	0.477	5.6
MOR-008	10	48	6	2.2	0	32	0.07	0.477	4.8
MOR-009	4.6	23	4	1.2	0.032	48	0.05	0.477	5.9
MOR-010	9	11	5	2.7	0.448	37	0.06	0.477	7.7
MOR-011	15	91	3	2.4	0.218	34	0.07	0.477	3.4
MOR-012	14	55	5	0.7	0.016	24	0.14	0.477	4.7
MOR-013*	6.3	16	4	1.8	0.49	19	0.13	0.49	4
MOR-015*	23	36	3	3.8	0.7	28	0.12	0.484	5.1
MOR-017*	16	26	4	3.6	1.06	32	0.07	0.473	5.9
MOR-018*	25	33	4	5.8	0.47	35	0.08	0.47	9.4
MOR-020	14	48	3	3.2	0.12	31	0.17	0.477	5
MOR-021*	20	25	4	3.6	0.469	31	0.18	0.469	5.3
MOR-021	13	45	3	2.7	0.091	29	0.16	0.477	6.2
MOR-031*	15	36	3	2.9	0.487	31	0.17	0.487	3.8
MOR-032*	15	43	3	3.1	0.477	28	0.16	0.477	6.5

Element	V	W	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm
Detection	1	4	2	0.05	1
Lab Perf	0.383	0.850	0.383	0.053	0.068
Std Dev	3.732	5.183	17.277	3.233	36.161
% Mean	0.97	1.15	1.21	0.21	0.68
MOR-001	7	7	8	12.1	15.5
MOR-002	1	5	4	16.2	72.5
MOR-003	1	0	2	15.2	132
MOR-004	1	5	1	16.4	54.9
MOR-005	1	7	4	16.1	102
MOR-006	1	0	6	14.7	43.3
MOR-007	1	6	6	11	19.4
MOR-008	1	0	13	14	41.1
MOR-009	1	0	5	12.2	23.4
MOR-010	1	5	5	21.8	65.1
MOR-011	13	9	1	11.6	3.89
MOR-012	11	10	4	14	84.8
MOR-013*	5	10	19	13.5	8.72
MOR-015*	3	9	58	18	18.9
MOR-017*	1	10	32	17.9	16.7
MOR-018*	3	-4	56	24.3	19.9
MOR-020	5	6	4	13.3	74.3
MOR-021*	7	-4	37	17.3	107
MOR-021	4	4	2	14	78.3
MOR-031*	10	14	20	14.6	64.1
MOR-032*	3	-4	12	15	68.5

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Cd
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm
Detection	0.02	0.01	1	0.5	100	0.5	0.25	1	0.01	0.1
Lab Perf	0.081	0.051	0.052	0.103	0.153	1.000	1.000	1.000	0.053	0.066
Std Dev	0.017	0.626	5.471	4.889	417.181	0.825	0.239	1.823	1.736	0.036
% Mean	0.35	0.08	1.09	1.92	0.49	1.99	2.03	1.15	0.52	3.00
ANN-001	0.052	8.22	4.48	7	1200	0	0	4	3.98	0.117
ANN-002	0.055	7.38	3.5	15	1400	0	0	4	3.58	0
ANN-003	0.047	7.78	3.23	0	870	0	0	0	3.67	0
ANN-004	0.03	7.5	5.19	0	1300	0	0	4	3.9	0
ANN-006	0.048	7.07	5.34	15	1300	0	0	5	3.43	0
ANN-008	0.029	7.34	3.59	0	1400	0	0	3	3.7	0
ANN-009	0.048	7.27	2.86	0	1300	0	0	2	3.58	0
ANN-011	0.048	7.73	2.96	0	970	0	0	0	3.61	0
ANN-015	0.039	7.97	2.66	0	170	2	0	0	5.35	0
ANN--017	0.05	8.08	1.88	0	650	0	0	0	3.96	0
ANN-020	0.039	7.84	2.45	0	450	0	0	0	3.38	0
ANN-021	0.04	8.14	2.05	0	1100	0	0	0	3.65	0
ANN-022	0.04	8.27	3.5	0	1400	0	0.25	3	3.22	0
ANN-023	0.033	7.81	2.14	0	160	0	0	0	5.45	0
ANN-024	0.048	7.63	2.06	0	370	0	0	2	4.55	0
ANN-026	0.038	7.4	2.45	0	440	0	0	0	5.08	0
ANN-027	0.089	7.96	2.79	0	990	0	0	0	3.69	0.121
ANN-028	0.043	8.69	6.66	6	560	2	0.256	0	5.57	0
ANN-029	0.029	8.12	2.82	9	130	0	0	0	4.98	0
ANN-031	0.044	9.17	8.41	11	670	0	0.623	0	0.49	0
ANN-038	0.037	8	1.72	0	1100	0	0	2	3.86	0
ANN-043	0.069	8.33	4.68	0	1300	0	0	4	3.6	0
ANN-044	0.042	7.66	4.28	0	930	0	0.377	2	0.24	0
ANN-046	0.058	8.89	26.4	0	1000	0	0.932	0	0.08	0
ANN-049	0.094	7.77	3.06	0	1100	2	0	3	1.83	0
ANN-054	0.06	7.16	4.05	11	1100	0	0	5	2.02	0.109
ANN-055	0.074	8.55	6.87	0	710	2	0.478	0	0.21	0
ANN-059	0.075	8.62	21	0	650	2	0.492	3	0.23	0
ANN-065	0.026	9.83	2.17	0	150	2	0	0	6.46	0

Element	Ce	Co	Cr	Cs	Cu	Eu	Fe	Ga	Hf	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Detection	3	5	10	2	0.1	0.2	0.2	0.5	1	0.1
Lab Perf	0.104	0.550	0.127	1.000	0.058	0.204	0.115	0.061	0.288	0.927
Std Dev	10.445	4.903	70.099	0.986	62.560	0.343	0.980	0.960	1.281	0.263
% Mean	0.20	0.58	0.49	2.04	0.72	0.29	0.34	0.35	0.29	1.58
ANN-001	52	12	110	2	99.9	1.1	3.91	3.62	4	0
ANN-002	61	12	140	0	43.2	1.5	3.79	2.75	5	0.126
ANN-003	54	14	120	0	64.7	1.3	3.99	3.29	5	0.122
ANN-004	44	8	150	0	11	1.2	3.43	3.14	4	0.105
ANN-006	49	11	140	0	43.7	1.2	3.75	3.69	5	0
ANN-008	54	9	99	0	14.4	1.5	3.85	3.02	5	0
ANN-009	56	11	120	0	71.7	1.3	3.68	4.38	3.5	0.108
ANN-011	63	13	170	0	55	1.4	3.83	3.36	5.5	0.12
ANN-015	32	6	51	0	113	0.8	1.47	1.41	2.6	0.113
ANN–017	32	8	86	0	44.6	0.7	2.16	2.91	2.6	0
ANN-020	31	5	45	0	76	0.8	1.85	3.31	2.5	0.101
ANN-021	54	12	160	0	57.9	1.4	3.55	3.56	5	0.117
ANN-022	59	9	98	0	74.4	1.5	3.65	3.34	4	0.102
ANN-023	52	10	110	0	30.3	1.5	2.53	1.6	3	0.118
ANN-024	60	9	89	0	205	1.4	2.68	2.76	5	0.106
ANN-026	51	10	71	0	202	1.3	3.07	2.37	3	0.107
ANN-027	57	12	130	2	124	1.5	3.67	2.99	5	0.112
ANN-028	65	14	39	0	214	1.9	3.17	2.52	3	0.106
ANN-029	59	14	120	0	79.2	1.5	2.26	1.96	3.6	0.114
ANN-031	41	0	160	0	57.4	1	1.65	3.96	4.2	0.518
ANN-038	58	13	160	0	65.1	1.4	3.61	2.58	3.8	0.115
ANN-043	62	13	160	2	174	1.5	4.29	4.08	4.6	0.129
ANN-044	57	0	250	0	15.4	0.9	1.04	0.948	5	0.136
ANN-046	29	0	220	0	35.6	0.4	1.13	1.12	4.1	1.42
ANN-049	55	0	250	3	154	0.9	2.01	3.61	5.8	0.131
ANN-054	59	9	270	2	153	0.9	3.09	1.79	6.9	0.127
ANN-055	57	0	200	0	44.6	0.6	1.59	0.912	6.6	0.389
ANN-059	68	0	340	3	175	0.9	1.79	1.95	7.6	0.175
ANN-065	56	10	120	0	8.06	1.3	2.4	2.09	4	0

Element	K	La	Lu	Mg	Mn	Mo	Na	Nd	Ni	P
Units	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
Detection	0.01	1	0.05	0.01	1	0.1	0.05	5	1	0.01
Lab Perf	0.054	0.084	0.277	0.057	0.052	0.068	0.065	0.277	0.095	0.120
Std Dev	1.153	5.230	0.068	0.594	208.657	2.683	4.365	4.850	7.244	0.052
% Mean	0.50	0.19	0.33	0.45	0.47	0.89	1.10	0.22	0.34	0.41
ANN-001	2.57	29	0.21	1.57	775	1.93	3.21	18	21	0.146
ANN-002	2.65	31	0.26	1.5	489	1.97	3.6	26	22	0.147
ANN-003	2.36	27	0.28	1.61	637	2.5	3.15	20	18	0.129
ANN-004	2.57	22	0.17	1.41	478	1.84	3.44	24	22	0.139
ANN-006	2.87	27	0.27	1.47	578	2.99	3.38	20	23	0.132
ANN-008	2.61	25	0	1.72	453	1.48	3.93	28	31	0.16
ANN-009	2.79	28	0.2	1.46	495	2.1	3.28	24	27	0.137
ANN-011	2.22	31	0.31	1.39	634	2.27	3.62	21	23	0.139
ANN-015	0.5	17	0.17	1.54	460	1.25	2.38	12	19	0.196
ANN-017	2.3	16	0.15	1.6	615	1.64	1.89	16	27	0.142
ANN-020	2.04	16	0.11	1.57	427	1.97	2.23	16	23	0.146
ANN-021	2.69	28	0.17	1.54	639	2.6	2.79	19	24	0.141
ANN-022	3.25	33	0.17	1.52	413	1.68	3.43	26	23	0.15
ANN-023	0.34	27	0.21	1.91	416	1.41	4.46	27	34	0.175
ANN-024	0.81	29	0.28	1.61	373	1.48	4.29	28	21	0.16
ANN-026	0.49	27	0.23	1.85	407	1.01	4.21	28	30	0.166
ANN-027	2.64	29	0.23	1.4	725	2.15	3.21	22	17	0.132
ANN-028	1.14	32	0.3	2.6	527	1.07	4.04	32	30	0.219
ANN-029	0.32	30	0.23	1.62	420	2.05	4.47	25	22	0.153
ANN-031	2.17	22	0.15	0.33	47	3.91	2.4	19	10	0.079
ANN-038	2.74	29	0.22	1.47	630	1.85	3.08	24	25	0.146
ANN-043	2.77	32	0.29	1.53	577	3.21	3.09	25	22	0.149
ANN-044	2.98	31	0.14	0.12	73	4.91	3.07	19	8	0.032
ANN-046	4.02	15	0.12	0.42	22	5.64	1.41	11	7	0.015
ANN-049	3.7	29	0.25	0.58	444	4.83	26.2	21	15	0.062
ANN-054	4.02	31	0.26	0.77	531	4.64	3.25	22	22	0.078
ANN-055	3.94	30	0.19	0.26	32	14.8	0.955	18	6	0.045
ANN-059	3.57	33	0.24	0.23	64	6.39	2.25	21	12	0.013
ANN-065	0.27	27	0.25	1.88	495	1.43	4.05	23	29	0.169

Element	Pb	Rb	Sb	Sc	Se	Sm	Sr	Tb	Te
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Detection	0.3	30	0.25	0.1	1	0.1	0.01	0.5	0.5
Lab Perf	0.063	0.534	0.067	0.061	1.000	0.075	0.050	1.000	1.000
Std Dev	2.562	46.479	0.244	2.808	0.438	0.904	401.513	0.167	0.263
% Mean	0.57	0.80	0.45	0.34	3.04	0.24	0.42	5.39	4.08
ANN-001	8.19	0	0.536	9.3	0	3.9	1228	0	0
ANN-002	7.25	110	0.564	9.1	0	4.7	1244	0.9	0
ANN-003	5.2	54	0.564	10	0	4.2	987	0	0
ANN-004	4.84	67	0.544	9.4	0	3.6	1227	0	0
ANN-006	7.17	120	0.51	8.8	0	3.9	1108	0	0
ANN-008	3.87	61	0.381	10	0	4.3	1076	0	0
ANN-009	5.04	62	0.497	9.5	0	4.2	1043	0	0
ANN-011	5.15	45	0.423	7.9	0	4.7	1055	0	0
ANN-015	2.37	0	0.52	5.9	0	2.6	965	0	0
ANN-017	4.25	50	0.405	4.8	0	2.4	1191	0	0
ANN-020	3.57	0	0.469	5.6	0	2.3	1021	0	0
ANN-021	5	63	0.372	8.9	0	4	1134	0	0
ANN-022	3.36	85	0.505	10	0	4.4	1068	0	0
ANN-023	1.85	39	0.538	11	0	4.3	1295	0	0
ANN-024	2.6	0	0.354	8.9	0	4.4	1035	0	0
ANN-026	2.4	0	0.331	10	0	4.2	1268	0	0
ANN-027	9.13	83	0.446	8.9	0	4	1109	0	0
ANN-028	1.55	0	0.672	16	0	5.9	1245	0	0
ANN-029	2.79	0	0.41	10	0	4.4	1207	0	0
ANN-031	2.18	73	0.59	8.8	1.16	3	259	0	0
ANN-038	3.68	78	0.288	9.1	0	4.3	1190	0	0
ANN-043	9.45	0	0.58	10	0	4.6	1149	0	0
ANN-044	3.7	96	0.61	2.9	0	3.3	204	0	0
ANN-046	0.752	96	0.636	5.6	1.33	1.6	103	0	1.33
ANN-049	7.53	130	0.494	4.2	0	3.3	667	0	0
ANN-054	9.45	120	0.519	5.6	0	3.8	721	0	0
ANN-055	1.48	130	1.13	4.6	1.69	2.4	64	0	0.543
ANN-059	5.63	120	1.53	3	0	3.9	158	0	0
ANN-065	1.44	0	0.34	10	0	4.2	1499	0	0

Element	Th	Ti	Tl	U	V	Y	Yb	Zn
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Detection	0.5	0.01	0.5	0.5	1	2	0.1	1
Lab Perf	0.113	0.071	0.099	0.193	0.058	0.204	0.142	0.079
Std Dev	6.692	0.124	0.091	2.096	31.268	3.777	0.240	16.206
% Mean	0.69	0.28	0.17	0.55	0.27	0.32	0.23	0.63
ANN-001	8.3	0.47	0.495	5.7	126	13	0.92	51.1
ANN-002	7.8	0.5	0.457	3.5	122	13	1.12	37.4
ANN-003	9.6	0.47	0.496	0	131	14	1.38	37.6
ANN-004	7.1	0.44	0.611	0	123	12	0.94	23.5
ANN-006	10	0.44	0.577	5.3	114	12	1.09	34.4
ANN-008	8.5	0.55	0.498	2.6	137	13	1.15	20.2
ANN-009	6.9	0.44	0.497	3.4	121	12	0.88	36.6
ANN-011	11	0.47	0.605	5.1	114	14	1.21	41.2
ANN-015	6.1	0.5	0.561	3	144	17	0.8	9.56
ANN-017	5.7	0.48	0.498	1.6	122	13	0.7	36.2
ANN-020	3.9	0.45	0.482	1.7	119	12	0.56	21.7
ANN-021	7.9	0.47	0.466	3	130	13	0.87	44.6
ANN-022	7.8	0.49	0.494	1.8	127	13	0.94	21.8
ANN-023	4.6	0.57	0.607	2.7	141	13	0.98	12.9
ANN-024	11	0.53	0.479	3.9	125	14	1.16	15
ANN-026	4.1	0.55	0.489	1.6	143	12	0.91	15.2
ANN-027	8	0.46	0.498	3.8	114	14	1.26	51.2
ANN-028	6.2	0.63	0.561	5.7	178	19	1.58	8.53
ANN-029	8	0.5	0.612	3.8	125	14	1.18	11.9
ANN-031	5.4	0.49	0.498	4.3	111	5	0.8	8.71
ANN-038	9.2	0.49	0.483	3.5	121	14	1.12	26.8
ANN-043	9.9	0.45	0.493	3.7	124	14	1.28	41.2
ANN-044	22	0.18	0.678	6.6	39	6	0.75	7.11
ANN-046	4.5	0.17	0.496	3.1	90	4	0.54	2.13
ANN-049	19	0.26	0.778	6.9	53	10	1.13	48.3
ANN-054	19	0.33	0.707	5.4	76	13	1.24	53.4
ANN-055	8	0.19	0.481	6	56	2	0.84	2.01
ANN-059	36	0.21	0.777	9.7	53	6	1.19	13.8
ANN-065	5.3	0.59	0.484	3.3	131	13	1.09	9.43

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Cd
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm
Detection	0.02	0.01	1	0.5	100	0.5	0.25	1	0.01	0.1
Lab Perf	0.081	0.051	0.052	0.103	0.133	1.000	0.106	1.000	0.055	0.066
Std Dev	0.040	0.714	16.378	4.981	671.067	0.939	0.333	1.057	1.186	0.040
% Mean	0.82	0.09	1.73	2.42	0.66	1.60	1.59	1.63	0.71	4.12
ANN-025	0.029	7.21	4.41	0	1900	2	0	3	1.89	0
ANN-034	0.037	7.7	2.45	0	1600	0	0.317	2	2.1	0
ANN-035	0.025	7.97	2.46	0	1700	0	0	0	2.79	0
ANN-036	0.015	7.39	1.71	0	1200	0	0	0	3.01	0
ANN-037	0.03	6.19	2.22	9	1900	0	0	0	1.44	0
ANN-039	0.062	8.04	3	0	530	2	0	0	3.46	0
ANN-047	0.134	7.77	0.962	8	1200	0	0	2	2.22	0
ANN-048	0.163	8.5	7.81	0	1400	0	0.35	0	2.18	0
ANN-051	0.039	7.27	15.8	0	1600	0	0.42	0	1.79	0
ANN-052	0.022	7.2	2.34	0	1500	0	0	2	2.84	0
ANN-057	0.029	7.24	70.1	0	120	2	0.365	0	0.26	0
ANN-058	0.05	5.93	5.27	0	170	0	0	0	0.07	0
ANN-061	0.052	8.5	14.2	0	1100	0	0.525	2	0.25	0
ANN-063	0.05	8.01	8.01	18	460	0	1.27	0	0.12	0
ANN-064	0.027	7.44	14.8	0	0	0	0.312	0	0.16	0
ANN-068	0.036	8.4	3.75	0	110	2	0	0	0.66	0.164
ANN-069	0.024	7.59	1.23	0	670	2	0	0	2.99	0

Element	Ce	Co	Cr	Cs	Cu	Eu	Fe	Ga	Hf	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Detection	3	5	10	2	0.1	0.2	0.2	0.5	1	0.1
Lab Perf	0.115	1.000	0.106	1.000	0.058	0.272	0.061	0.238	0.300	0.844
Std Dev	13.053	2.264	48.104	0.485	696.250	0.294	0.468	1.347	0.736	0.370
% Mean	0.28	2.26	0.26	4.12	2.56	0.34	0.35	0.49	0.18	0.19
ANN-025	44	0	180	0	14.8	0.8	0.91	0	4	0.1
ANN-034	48	0	270	0	13.2	0.8	1.55	2.31	4.6	0.111
ANN-035	54	5	120	0	3.35	1	2.26	4.51	3.9	0.123
ANN-036	46	0	200	0	6.54	0.9	1.39	2.18	4.2	0.123
ANN-037	33	0	170	0	26.3	0.8	1.04	2.79	3.5	0.124
ANN-039	72	0	180	0	212	1.2	0.91	1.18	4.1	0.134
ANN-047	42	0	140	0	336	1.1	1.98	5.28	4.4	0.119
ANN-048	54	0	200	0	287	1.5	1.33	1.83	4.6	0.126
ANN-051	37	0	200	0	23.2	0.9	1.77	3.27	3.7	0.116
ANN-052	54	0	150	0	30.2	1	1.96	3.55	4.1	0.106
ANN-057	56	0	120	0	190	1	1.26	3.78	3.8	0.139
ANN-058	29	0	300	0	57.2	0.4	0.63	1.54	5.7	0.386
ANN-061	30	0	160	0	94.3	0.4	1.55	3.15	3.7	0.145
ANN-063	26	0	190	0	8.41	0.4	1.01	1.63	4	1.65
ANN-064	53	0	210	0	380	0.6	0.86	2.58	6	0.208
ANN-068	68	7	140	0	2929	1	0.81	4.55	3	0.188
ANN-069	43	5	210	2	14	0.9	1.41	2.66	4	0.136

Element	K	La	Lu	Mg	Mn	Mo	Na	Nd	Ni	P
Units	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
Detection	0.01	1	0.05	0.01	1	0.1	0.05	5	1	0.01
Lab Perf	0.053	0.090	0.435	0.072	0.060	0.081	0.062	0.313	0.127	0.195
Std Dev	1.278	7.082	0.051	0.445	82.009	2.174	12.247	4.803	4.794	0.029
% Mean	0.52	0.29	0.40	0.77	0.74	0.50	1.23	0.27	0.37	0.47
ANN-025	4.2	25	0.13	0.46	111	3.05	3.45	18	14	0.071
ANN-034	3.22	26	0.11	0.41	127	5.34	3.1	16	13	0.065
ANN-035	3.17	28	0.12	0.97	333	1.98	2.8	21	17	0.093
ANN-036	2.32	23	0.14	0.48	154	2.45	3.26	19	13	0.077
ANN-037	2.71	18	0.08	0.21	55	5.39	3.18	18	8	0.041
ANN-039	1.05	39	0.13	0.87	106	2.51	4.14	27	21	0.09
ANN-047	2.87	19	0.12	1.07	105	3.1	32.1	21	20	0.105
ANN-048	3.47	26	0.2	0.51	72	7.83	33.1	21	18	0.092
ANN-051	3.33	20	0.1	0.28	155	8.33	31.4	16	12	0.064
ANN-052	3.22	28	0.14	0.64	212	2.75	28.4	19	16	0.083
ANN-057	0.63	29	0.13	0.38	63	3.24	4.99	21	9	0.044
ANN-058	2.94	14	0.14	0.15	18	8.95	0.792	10	8	0.019
ANN-061	2.37	17	0	0.13	37	4.37	4.54	10	6	0.038
ANN-063	4.28	13	0.15	0.38	25	2.98	0.768	10	5	0.012
ANN-064	0.31	28	0.25	0.26	24	5.11	5.24	23	11	0.018
ANN-068	0.35	36	0.14	1.93	87	4.25	4.68	19	17	0.092
ANN-069	1.26	22	0.1	0.67	197	2.83	3.95	13	15	0.069

Element	Pb	Rb	Sb	Sc	Se	Sm	Sr	Tb	Te
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Detection	0.3	30	0.25	0.1	1	0.1	0.01	0.5	0.5
Lab Perf	0.063	0.638	0.067	0.072	0.320	0.087	0.050	1.000	1.000
Std Dev	1.532	36.724	0.592	1.068	0.276	0.822	489.365	0.000	0.369
% Mean	0.51	0.77	0.79	0.22	4.12	0.29	0.61	N/A	1.26
ANN-025	3.06	84	0.506	4.2	0	2.6	886	0	0
ANN-034	3.38	65	0.351	4.5	0	2.6	1216	0	0
ANN-035	3.39	77	0.395	6.4	0	3.4	1081	0	0
ANN-036	1.66	51	0.447	4.1	0	2.7	1045	0	0
ANN-037	3.28	70	0.52	3.8	0	2.7	1269	0	0
ANN-039	2.28	0	0.474	5.3	0	3.5	1254	0	0
ANN-047	3.68	50	0.335	6.1	0	3.6	977	0	0
ANN-048	3.87	55	0.583	5.1	0	4.3	1152	0	0.493
ANN-051	4.14	49	0.644	4.5	0	2.5	1132	0	0.701
ANN-052	3.12	62	0.695	5	0	3.2	1359	0	0
ANN-057	2.1	0	2.3	4.6	0	3.6	201	0	0.73
ANN-058	1.11	89	2.21	3.2	0	1.6	47	0	0
ANN-061	2.51	43	0.597	4	1.14	1.4	358	0	0.69
ANN-063	7.69	120	0.665	7.1	0	1.6	37	0	0.765
ANN-064	2.72	0	0.935	3.1	0	2.9	103	0	0.646
ANN-068	0.827	0	0.862	5.2	0	3.9	359	0	0.935
ANN-069	2.04	0	0.28	4.6	0	2.5	1153	0	0

Element	Th	Ti	Tl	U	V	Y	Yb	Zn
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Detection	0.5	0.01	0.5	0.5	1	2	0.1	1
Lab Perf	0.113	0.087	0.099	0.164	0.067	0.450	0.214	0.079
Std Dev	4.186	0.065	0.069	1.460	15.418	2.448	0.219	7.712
% Mean	0.47	0.23	0.13	0.31	0.26	0.46	0.36	0.77
ANN-025	7.9	0.26	0.485	3.4	44	5	0	7.25
ANN-034	8.7	0.27	0.484	4.4	51	5	0.42	7.52
ANN-035	8.4	0.29	0.665	3.7	70	7	0.52	29.2
ANN-036	8.1	0.27	0.492	4.3	53	7	0.52	8.32
ANN-037	4.4	0.27	0.488	2.6	43	5	0.51	6.29
ANN-039	8.5	0.33	0.476	5.2	71	10	0.66	5.59
ANN-047	6.6	0.42	0.481	3.3	86	7	0.64	23.5
ANN-048	8.7	0.32	0.591	5.5	62	8	0.73	10
ANN-051	7	0.27	0.551	5.7	58	5	0.61	22.1
ANN-052	7.9	0.3	0.463	4.6	58	7	0.61	9.19
ANN-057	7.1	0.26	0.477	5.1	85	1	0.57	8.22
ANN-058	15	0.11	0.486	4.4	48	2	0.72	1.66
ANN-061	7.3	0.2	0.489	5.9	42	2	0.53	6.37
ANN-063	7.8	0.33	0.494	7.1	86	5	0.71	1.26
ANN-064	23	0.22	0.465	8.1	40	2	1.11	5.56
ANN-068	7.9	0.28	0.695	3.9	64	7	0.79	5.81
ANN-069	6.9	0.29	0.495	2.9	54	6	0.57	12.1

ID NUM	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca
Units	ppm	%	ppm	ppb	ppm	ppm	ppb	ppm	%
Detection	0.015	0.01	1	0.5	100	0.5	250	1	0.01
Lab Perf	0.081	0.051	0.052	0.103	0.191	0.300	1.075	1.000	0.054
Std Dev	0.259	1.158	1.362	0.303	840.160	2.654	640.466	0.000	2.253
% Mean	1.25	0.15	1.06	0.51	1.08	0.97	1.40	N/A	0.72
RSG-001	0.167	8.45	1.71	0.5	160	2	248	0	4.62
RSG-002	0.092	8.02	1.26	0.5	0	2	245	0	5.08
RSG-003	0.058	9.56	1.09	0.5	0	0	248	0	10.95
RSG-004	0.36	6.71	0.942	0.5	1000	2	235	0	2.28
RSG-005	0.377	7.32	8.05	0.5	3800	0	2190	0	0.05
RSG-006	0.136	7.28	0.977	0.5	2700	0	244	0	1.79
RSG-007	0.348	7.18	1	0.5	1600	2	1030	0	0.38
RSG-009	0.049	11.17	0.958	0.5	280	7	2970	0	7.74
RSG-010	0.177	7.92	0.971	0.5	820	2	243	0	2.22
RSG-013	0.041	6.98	0.952	0.5	380	9	238	0	3.3
RSG-014	0.035	7.75	0.977	0.5	140	6	244	0	3.7
RSG-016	0.414	5.86	0.928	0.6	1100	2	232	0	2.14
RSG-017	0.033	8.23	1.14	1	0	3	243	0	4.85
RSG-018	0.283	6.88	1.36	0.5	1000	2	412	0	1.59
RSG-019	0.032	7.97	0.926	0.5	620	2	231	0	2.71
RSG-020	0.026	7.43	0.973	0.5	440	0	243	0	3.29
RSG-021	0.026	8.47	0.986	0.5	160	3	247	0	2.9
RSG-022	0.024	6.88	0.954	0.5	890	0	239	0	2.77
RSG-023	0.179	6	0.98	0.5	970	2	245	0	2.15
RSG-024	0.033	8.39	0.963	0.5	260	3	241	0	3.92
RSG-035	1.28	7.37	0.969	2	1000	2	401	0	1.83
RSG-036	0.383	7.91	0.994	0.8	710	2	249	0	1.67
RSG-037	0.042	8.75	0.916	0.5	150	4	229	0	3.78
RSG-038	0.487	8.05	0.926	0.5	1000	2	231	0	2.18
RSG-039	0.234	6.84	0.943	0.5	870	2	236	0	1.39
RSG-041	0.091	6.44	0.945	0.5	750	2	236	0	0.99
RSG-042	0.169	9.66	0.951	0.5	240	11	294	0	4.47
Std Dev	0.25	0.41	0.02	0.00	559.40	0.89	177.50	0.00	0.65
% Mean	1.01	0.06	0.03	0.00	0.59	0.34	0.42	N/A	0.37
RSG-008	0.063	7.14	0.975	0.5	1600	2	670	0	1.56
RSG-011	0.083	6.09	0.992	0.5	250	4	248	0	2.52
RSG-012	0.558	6.26	0.96	0.5	1400	3	524	0	0.8
RSG-015	0.053	6.41	0.996	0.5	580	2	275	0	1.78
RSG-040	0.48	6.68	0.935	0.5	950	2	374	0	2.15

ID NUM	Cd	Ce	Co	Cr	Cs	Cu	Eu	Fe	Ga
Units	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Detection	100	3	5	10	2	0.05	0.2	0.02	0.1
Lab Perf	0.066	0.090	0.950	0.103	0.717	0.058	0.232	0.061	0.061
Std Dev	12.157	14.823	4.662	64.759	2.653	307.593	0.564	1.177	1383.669
% Mean	0.12	0.20	1.25	0.39	0.87	1.39	0.47	0.58	0.51
RSG-001	99	77	0	240	0	2.42	1.2	1.02	674
RSG-002	98	81	0	200	0	2.57	1.1	1.75	1090
RSG-003	99	83	0	260	0	5.6	1.1	4.58	1370
RSG-004	94	70	5	200	6	250	1	2.23	4390
RSG-005	99	75	0	53	7	114	0.8	3.08	495
RSG-006	98	110	19	110	10	15.2	1.9	2.12	2800
RSG-007	100	61	0	81	4	190	0.9	1.05	2430
RSG-009	96	89	6	65	0	40.8	3.8	5.99	4530
RSG-010	97	91	8	200	5	505	1	2.28	4420
RSG-013	95	77	0	66	4	9.85	1.4	0.94	734
RSG-014	98	72	0	170	0	1.95	1.1	0.88	1300
RSG-016	93	62	0	220	4	427	1.1	2.41	4510
RSG-017	97	85	6	130	0	0.805	1.3	1.49	1680
RSG-018	108	53	0	200	3	887	1.2	1.49	3600
RSG-019	93	75	9	200	6	5.79	1.1	2.86	4320
RSG-020	97	67	5	140	2	1.67	1	1.78	3070
RSG-021	99	60	7	47	0	1.76	1.2	1.02	3200
RSG-022	95	65	9	220	5	5.81	1.1	2.65	3970
RSG-023	98	75	6	250	3	112	1.2	2.41	4620
RSG-024	96	80	8	220	5	4.39	1.1	2.15	2450
RSG-035	158	64	7	160	4	1145	1.2	2.25	3440
RSG-036	99	61	0	210	4	532	0.9	1.63	2950
RSG-037	92	86	0	180	0	2.75	1	0.24	458
RSG-038	103	43	6	190	4	624	0.8	2.21	3630
RSG-039	94	47	0	170	3	378	0.8	1.25	2500
RSG-041	95	66	0	190	3	185	1	1.62	3150
RSG-042	95	93	0	64	0	518	1.4	1.13	1630
	18.85	9.94	3.13	42.44	1.95	491.93	0.14	0.57	1170.70
	0.18	0.13	2.24	0.30	0.54	1.74	0.13	0.39	0.45
RSG-008	97	80	0	120	2	6.68	1.2	1.24	2070
RSG-011	99	90	0	88	3	34.2	1.3	0.9	1780
RSG-012	96	72	0	160	3	216	1	1.84	3920
RSG-015	100	71	0	200	7	5.46	1	1.05	1450
RSG-040	140	64	7	130	3	1148	1	2.25	3810

ID NUM	Hf	Hg	Ir	K	La	Lu	Mg	Mn	Mo
Units	ppm	ppb	ppb	%	ppm	ppm	%	ppm	ppm
Detection	1	100	5	0.01	1	0.05	0.01	1	0.1
Lab Perf	0.217	1.081	0.950	0.053	0.074	0.250	0.069	0.053	0.068
Std Dev	0.934	2.310	1.334	2.729	11.500	0.074	0.776	323.954	21.647
% Mean	0.15	0.02	3.60	0.96	0.26	0.30	1.08	0.73	2.75
RSG-001	6	99	0	0.13	48	0.29	0.84	622	0.518
RSG-002	6	98	0	0.22	47	0.3	0.66	714	0.558
RSG-003	6	99	0	0.01	49	0.3	0.36	1520	2.5
RSG-004	5	94	0	3.13	41	0.26	0.69	316	6.06
RSG-005	8	99	0	11.59	44	0.19	0.13	88	114
RSG-006	8	98	0	7.4	70	0.45	1.13	770	2.12
RSG-007	6	100	0	6.78	36	0.25	0.13	64	7.36
RSG-009	4	96	0	0.18	55	0	0.5	993	0.744
RSG-010	6	97	0	3.02	74	0.24	0.7	320	1.77
RSG-013	7	95	0	6.61	49	0.24	0.67	423	1.31
RSG-014	7	98	0	0.18	43	0.25	0.63	701	0.524
RSG-016	6	93	0	3.1	31	0.28	0.5	234	4.66
RSG-017	7	97	0	0.18	49	0.26	0.9	803	0.281
RSG-018	6	99	0	3.84	31	0.23	0.44	171	7.92
RSG-019	6	93	0	2.84	41	0.28	1.03	501	0.621
RSG-020	6	97	0	1.68	40	0.26	0.77	399	0.633
RSG-021	7	99	0	0.45	29	0.34	4.33	433	0.306
RSG-022	5	95	0	3.21	39	0.21	0.87	473	0.221
RSG-023	6	98	0	3.05	41	0.2	0.47	307	5.48
RSG-024	6	96	0	1	50	0.25	1.09	568	1.43
RSG-035	6	97	0	3.46	33	0.24	0.54	224	16.2
RSG-036	6	99	0	3.39	38	0.29	0.41	279	12.1
RSG-037	6	92	5	0.27	53	0.25	0.1	80	0.463
RSG-038	6	93	5	3.17	28	0.2	0.54	178	7.35
RSG-039	5	94	0	4.09	28	0.18	0.23	152	12.8
RSG-041	7	95	0	2.46	36	0.2	0.5	361	1.77
RSG-042	8	95	0	1.38	54	0.32	0.23	270	3.11
	0.84	2.74	0.00	2.41	6.77	0.04	0.09	167.73	3.28
	0.14	0.03	N/A	0.71	0.16	0.15	0.22	0.66	1.35
RSG-008	5	97	0	5.7	45	0.25	0.34	308	0.797
RSG-011	5	99	0	0.56	53	0.22	0.45	131	0.425
RSG-012	7	96	0	5.93	39	0.22	0.3	91	1.54
RSG-015	6	100	0	1.57	39	0.31	0.36	513	1.13
RSG-040	6	93	0	3.2	36	0.25	0.51	225	8.24

ID NUM	Na	Nd	Ni	P	Pb	Rb	Sb	Sc	Se
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppb
Detection	500	5	1	0.01	0.25	30	0.25	0.1	1000
Lab Perf	0.066	0.300	0.133	0.232	0.063	0.264	0.067	0.069	1.080
Std Dev	12578	5.399	4.449	0.017	3.764	145.504	0.083	1.739	363.792
% Mean	0.37	0.26	0.35	0.29	0.96	1.00	0.29	0.31	0.35
RSG-001	47200	28	18	0.064	5.37	0	0.378	7.6	992
RSG-002	43100	20	12	0.066	6.34	0	0.424	6.9	978
RSG-003	1140	32	15	0.07	2.91	0	0.404	6	992
RSG-004	29000	15	10	0.042	2.14	140	0.291	5.3	942
RSG-005	2970	25	6	0.023	19.9	560	0.323	5.2	2850
RSG-006	29200	30	20	0.077	3.78	470	0.276	8.1	977
RSG-007	21400	18	5	0.039	2.88	360	0.344	3.6	1000
RSG-009	38200	27	12	0.074	10.4	0	0.357	8.1	958
RSG-010	31700	20	13	0.053	3.14	220	0.291	5.4	971
RSG-013	27800	22	15	0.072	1.89	350	0.238	6.9	952
RSG-014	55600	18	12	0.055	4.13	0	0.353	5.8	977
RSG-016	31800	20	8	0.055	1.74	150	0.331	4.2	928
RSG-017	48400	24	13	0.067	6.29	0	0.243	7.2	971
RSG-018	29700	19	9	0.047	2.3	180	0.247	3.8	988
RSG-019	30700	22	13	0.055	1.8	140	0.231	8.3	926
RSG-020	38900	15	14	0.053	4.91	90	0.465	5.8	973
RSG-021	52200	19	14	0.075	2.53	50	0.247	7.5	986
RSG-022	30000	18	17	0.051	1.59	130	0.239	6.3	954
RSG-023	33500	17	9	0.113	2.25	160	0.315	4.3	980
RSG-024	39600	22	27	0.06	1.44	110	0.031	7.4	963
RSG-035	31000	21	12	0.06	2.63	180	0.338	4.4	969
RSG-036	31600	17	13	0.041	2.32	190	0.249	3.7	994
RSG-037	46800	25	10	0.062	3.51	0	0.254	2.1	916
RSG-038	35700	11	12	0.055	1.55	150	0.231	4.3	926
RSG-039	31300	12	8	0.037	4.1	170	0.236	2.8	943
RSG-041	41100	19	11	0.049	2.94	110	0.315	3.8	945
RSG-042	48100	31	12	0.061	1.22	38	0.238	5.3	951
	10173.10	1.82	1.92	0.02	0.95	77.34	0.06	0.33	24.99
	0.30	0.08	0.23	0.26	0.31	0.45	0.20	0.09	0.03
RSG-008	24300	21	7	0.053	3.45	250	0.306	3.9	975
RSG-011	48400	24	9	0.053	1.82	96	0.249	3.9	992
RSG-012	24300	24	6	0.055	4.18	260	0.24	3.7	960
RSG-015	38300	23	8	0.088	3.47	110	0.321	3.4	996
RSG-040	34100	20	11	0.052	2.36	150	0.389	4.3	935

ID NUM	Sm	Sr	Ta	Tb	Te	Th	Ti	Tl	U
Units	ppm	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
Detection	0.1	1	1	0.5	500	0.5	0.01	500	0.5
Lab Perf	0.076	0.052	0.950	0.950	1.081	0.071	0.098	1.075	0.116
Std Dev	0.823	231.791	0.877	0.000	140.914	7.357	0.050	49.686	8.338
% Mean	0.22	0.43	1.32	N/A	0.27	0.33	0.25	0.10	0.88
RSG-001	4.2	825	2	0	496	26	0.26	496	7.2
RSG-002	4.2	849	1	0	489	24	0.25	489	9
RSG-003	4.5	1147	0	0	496	25	0.24	496	11
RSG-004	3.3	369	0	0	471	24	0.17	597	5.6
RSG-005	3.4	300	1	0	1190	6.6	0.1	495	2.4
RSG-006	5.8	354	0	0	488	35	0.15	488	11
RSG-007	2.9	516	1	0	684	14	0.13	500	15
RSG-009	4.2	911	0	0	479	38	0.27	479	48
RSG-010	3.1	420	0	0	485	27	0.19	485	15
RSG-013	4	463	2	0	476	26	0.25	476	6.3
RSG-014	3.7	765	0	0	488	25	0.22	488	6.3
RSG-016	3.8	384	1	0	464	12	0.2	527	4.2
RSG-017	4.2	711	0	0	485	26	0.25	485	8.6
RSG-018	2.8	356	0	0	494	15	0.15	641	5.9
RSG-019	4.3	349	2	0	463	28	0.26	660	7.6
RSG-020	3.3	404	0	0	486	26	0.22	486	8.9
RSG-021	4.6	448	2	0	493	31	0.16	493	6.2
RSG-022	3.1	396	0	0	477	24	0.23	477	10
RSG-023	3.9	354	2	0	490	15	0.21	490	5.1
RSG-024	3.8	811	0	0	482	31	0.24	482	10
RSG-035	3.5	391	0	0	484	14	0.16	484	6.2
RSG-036	3.1	327	2	0	497	19	0.14	497	12
RSG-037	3.8	739	0	0	458	27	0.24	458	7.9
RSG-038	2.3	451	0	0	463	16	0.19	463	5.1
RSG-039	2	314	2	0	472	19	0.11	472	4.3
RSG-041	3.3	323	0	0	473	18	0.15	473	4.6
RSG-042	5.2	712	0	0	475	18	0.24	475	11
	0.52	111.23	0.84	0.00	12.66	3.07	0.04	12.66	1.94
	0.13	0.27	0.70	N/A	0.03	0.21	0.24	0.03	0.35
RSG-008	4.2	453	0	0	487	15	0.18	487	7.7
RSG-011	4.6	580	2	0	496	15	0.17	496	5.5
RSG-012	3.4	349	1	0	480	14	0.15	480	6.9
RSG-015	3.9	289	2	0	498	9.5	0.09	498	2.7
RSG-040	3.4	390	1	0	467	18	0.17	467	4.9

ID NUM	V	W	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm
Detection	1	4	2	0.05	1
Lab Perf	0.069	0.850	0.300	0.086	0.096
Std Dev	38.708	31.770	3.168	0.305	10.104
% Mean	0.64	2.02	0.40	0.21	0.53
RSG-001	67	0	11	1.72	15.5
RSG-002	82	0	11	1.6	13
RSG-003	93	0	16	1.88	10.2
RSG-004	55	0	6	1.3	24.3
RSG-005	50	15	1	1.07	5.19
RSG-006	66	0	13	2.2	37.5
RSG-007	35	120	6	1.24	8.58
RSG-009	234	39	11	1.97	9.7
RSG-010	62	10	6	1.18	25.9
RSG-013	60	93	8	1.5	7.17
RSG-014	48	16	8	1.3	6.4
RSG-016	53	0	7	1.56	30.5
RSG-017	48	0	10	1.6	11.4
RSG-018	36	5	5	1.45	30
RSG-019	77	5	11	1.61	33.5
RSG-020	60	0	8	1.4	13.9
RSG-021	43	0	11	1.91	22.3
RSG-022	73	0	7	1.2	29.4
RSG-023	51	6	7	1.31	32.6
RSG-024	72	5	10	1.57	16.8
RSG-035	48	15	6	1.28	27
RSG-036	30	0	7	1.38	21.9
RSG-037	18	0	8	1.33	3.28
RSG-038	49	0	4	1.03	25.3
RSG-039	26	5	4	1	21.8
RSG-041	44	5	5	1.39	25.9
RSG-042	53	86	8	1.92	6.53
	8.97	36.62	2.30	0.37	16.81
	0.24	1.25	0.31	0.26	0.65
RSG-008	39	19	8	1.17	30.6
RSG-011	36	39	7	1.45	8.67
RSG-012	40	88	6	1.07	39.7
RSG-015	25	0	11	2.03	7.87
RSG-040	50	0	5	1.45	43.1

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca
Units	PPM	%	PPM	PPB	PPM	PPM	PPM	PPM	%
Detection	0.2	0.01	2	5	100	0.5	5	1	0.01
Lab Perf	0.000	0.052	0.450	0.000	0.166	0.300	0.000	0.000	0.059
Std Dev	1.523	1.030	14.375	14.807	327.855	0.818	0.000	0.000	1.109
% Mean	4.16	0.16	1.73	2.01	0.34	0.33	0.00	0.00	0.78
AJO-001	0	4.39	4	0	1300	3	0	0	0.17
AJO-002	0	5.57	4	0	840	4	0	0	0.22
AJO-003	0	5.41	6	0	570	3	0	0	1.52
AJO-004	0	4.24	4	0	1000	3	0	0	0.44
AJO-005	0	6.05	3	0	1400	2	0	0	0.62
AJO-006	0	6.48	6	0	650	3	0	0	2.85
AJO-009	0	8.01	7	0	1500	4	0	0	3.05
AJO-013	0	7.76	8	0	610	4	0	0	3.56
AJO-014	0	6.49	5	19	600	2	0	0	1.73
AJO-016	0	6.94	9	0	1300	3	0	0	2.1
AJO-017	0	7.1	9	0	1200	3	0	0	1.67
AJO-018	0	8.03	5	0	1000	3	0	0	4.01
AJO-019	0	5.89	4	0	780	3	0	0	0.71
AJO-021	0	5.88	3	0	1500	2	0	0	0.76
AJO-022	9	5.81	5	0	800	3	0	0	1.25
AJO-024	0	8.12	9	0	990	3	0	0	4.05
AJO-026	0.9	7.67	6	0	1100	2	0	0	2.33
AJO-027	0	7.53	6	0	1400	4	0	0	1.14
AJO-029	0	7.16	7	0	980	2	0	0	1.4
AJO-030	0	5.91	5	0	850	2	0	0	0.39
AJO-032	0	6.11	6	0	720	2	0	0	0.93
AJO-035	0.5	4.78	7	0	140	2	0	0	1.03
AJO-036	0	7.08	5	5	760	2	0	0	0.14
AJO-037	0	6.01	4	0	1100	3	0	0	0.54
AJO-039	0	5.26	3	0	860	2	0	0	0.31
AJO-040	0	5.57	3	0	350	2	0	0	1.2
AJO-041	0	6.37	3	9	1100	2	0	0	0.32
AJO-042	0	6.71	3	0	840	3	0	0	0.31
AJO-043	0.6	7.69	3	25	840	2	0	0	2.44
AJO-045	0	7.37	5	16	1500	0	0	0	0.57
AJO-046	0	7.63	10	29	810	2	0	0	2.36
AJO-048	0.8	6.38	16	50	1400	2	0	0	0.82
AJO-049	0	6.57	89	15	1000	2	0	0	1.05
AJO-050	0.5	6.6	15	59	840	2	0	0	1.33
AJO-051	0.5	7.38	4	31	750	2	0	0	2.44

Element	Cd	Ce	Co	Cr	Cs	Cu	Eu	Fe	Hf
Units	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	PPM
Detection	0.5	3	5	10	2	1	0.2	0.02	1
Lab Perf	0.000	0.088	0.000	0.150	1.050	0.061	0.204	0.060	0.217
Std Dev	0.234	21.872	6.735	70.810	1.992	1004.100	0.393	1.565	1.268
% Mean	2.05	0.28	1.20	0.60	0.92	1.67	0.30	0.64	0.22
AJO-001	0	83	0	48	2	2261	1.4	1.28	6
AJO-002	0	76	0	60	2	42	1.2	3.92	6
AJO-003	0	80	0	61	4	9	1.3	1.8	5
AJO-004	0	77	0	69	2	7	1.1	1.34	6
AJO-005	0	57	0	84	4	12	0.9	0.87	4
AJO-006	0	59	18	100	0	7	1.4	4.24	4
AJO-009	0	110	12	36	3	23	2.1	4.29	10
AJO-013	0	98	14	50	3	17	2	4.38	9
AJO-014	0	27	0	70	7	13	0.8	0.87	4
AJO-016	0	76	12	100	0	10	1.3	2.24	6
AJO-017	0	87	18	49	0	317	1.8	6.24	7
AJO-018	0	90	18	59	0	295	1.9	5.35	7
AJO-019	0	55	0	110	3	239	0.8	0.45	5
AJO-021	0	72	0	210	0	99	0.9	1.45	5
AJO-022	0.6	87	0	81	3	1882	0.8	1.25	5
AJO-024	0	88	16	59	0	56	2	5.11	6
AJO-026	0	81	12	54	3	94	1.5	3.43	6
AJO-027	0	79	15	40	2	40	1.5	3.95	6
AJO-029	0	60	0	140	4	78	1.1	1.93	7
AJO-030	0	47	0	150	2	111	0.7	0.95	5
AJO-032	0.5	110	10	39	0	151	2	5.15	7
AJO-035	0	84	0	54	0	45	1.5	3.03	6
AJO-036	0	93	0	110	2	22	1.3	1.35	6
AJO-037	0.6	88	0	150	5	11	1.1	0.97	6
AJO-039	0	58	0	300	3	45	0.6	0.86	4
AJO-040	0	72	0	120	3	12	0.9	1.59	5
AJO-041	0.5	90	7	190	0	953	1.3	0.92	5
AJO-042	0	80	12	130	2	369	1.3	2.34	6
AJO-043	0	77	10	170	3	1263	1.5	2.77	6
AJO-045	0	160	0	120	0	970	1.5	1.38	6
AJO-046	0.7	73	9	240	0	1519	1.3	2.88	5
AJO-048	0	78	0	200	0	3088	1.1	1.52	5
AJO-049	0	94	0	240	7	1003	1.4	1.17	5
AJO-050	0.6	70	7	180	5	1646	1.2	2.54	5
AJO-051	0.5	65	6	240	2	4339	1.1	2.13	5

Element	Hg	Ir	K	La	Lu	Mg	Mn	Mo	Na
Units	PPM	PPB	%	PPM	PPM	%	PPM	PPM	PPM
Detection	1	5	0.01	1	0.05	0.01	1	5	500
Lab Perf	0.000	0.000	0.053	0.077	0.197	0.066	0.053	0.000	168.969
Std Dev	0.000	0.000	0.912	11.992	0.075	0.509	280.514	25.548	0.706
% Mean	0.00	0.00	0.29	0.32	0.23	0.71	0.75	4.47	0.23
AJO-001	0	0	2.89	39	0.45	0.29	34	0	3.8
AJO-002	0	0	4.59	37	0.37	0.46	121	0	2.72
AJO-003	0	0	3.01	36	0.33	0.2	395	0	3.12
AJO-004	0	0	3.23	37	0.38	0.37	488	0	3.81
AJO-005	0	0	4	26	0.36	0.29	396	0	2.38
AJO-006	0	0	1.86	27	0.2	1.35	823	0	3.93
AJO-009	0	0	3.55	48	0.37	1.06	1086	0	2.99
AJO-013	0	0	2.68	45	0.32	1.41	925	0	2.85
AJO-014	0	0	2.87	13	0.47	0.24	547	0	2.6
AJO-016	0	0	3.58	35	0.33	1.07	667	0	2.74
AJO-017	0	0	2.64	39	0.34	1.45	681	0	3.93
AJO-018	0	0	2.27	41	0.3	1.6	573	0	3.33
AJO-019	0	0	2.97	25	0.37	0.1	86	0	4.21
AJO-021	0	0	3.47	35	0.31	0.26	335	0	2.77
AJO-022	0	0	2.34	41	0.33	0.24	299	0	2.11
AJO-024	0	0	2.18	39	0.27	1.39	754	0	3.11
AJO-026	0	0	2.77	37	0.32	1.12	844	0	3.87
AJO-027	0	0	3.62	35	0.36	1.45	632	0	3.03
AJO-029	0	0	4.45	26	0.41	0.17	198	0	2.76
AJO-030	0	0	2.93	20	0.35	0.17	80	0	3.23
AJO-032	0	0	2.71	53	0.38	1.38	447	0	4.66
AJO-035	0	0	0.49	33	0.34	0.74	347	0	5.43
AJO-036	0	0	4.16	43	0.47	0.24	54	0	2.33
AJO-037	0	0	3.82	42	0.41	0.22	170	0	2.44
AJO-039	0	0	2.68	29	0.29	0.1	143	0	2.98
AJO-040	0	0	1.87	34	0.26	0.47	424	0	3
AJO-041	0	0	4.58	45	0.39	0.15	192	150	2.31
AJO-042	0	0	3.05	37	0.37	0.69	243	0	3.33
AJO-043	0	0	3.3	37	0.26	1.2	255	0	2.83
AJO-045	0	0	5.26	89	0.34	0.83	167	17	2.85
AJO-046	0	0	2.86	34	0.25	1.36	179	17	2.96
AJO-048	0	0	4	40	0.29	0.28	114	0	2.64
AJO-049	0	0	3.45	44	0.36	0.63	172	16	2.73
AJO-050	0	0	3.47	34	0.15	0.79	152	0	2.86
AJO-051	0	0	3.49	30	0.15	1.17	106	0	2.63

Element	Nd	Ni	P	Pb	Rb	Sb	Sc	Se	Sm
Units	PPM	PPM	%	PPM	PPM	PPM	PPM	PPM	PPM
Detection	5	1	0	2	30	0.2	0.1	5	0.1
Lab Perf	0.222	0.161	0.000	0.175	0.376	0.450	0.067	0.000	0.073
Std Dev	6.917	7.928	0.044	13.894	29.174	0.561	3.446	0.000	1.173
% Mean	0.25	0.72	0.70	0.74	0.30	0.76	0.53	0.00	0.26
AJO-001	27	10	0.029	0	110	0.6	5.6	0	4.8
AJO-002	30	8	0.062	22	150	0.3	5.9	0	4.4
AJO-003	29	8	0.031	10	120	0.4	5.2	0	4.2
AJO-004	26	9	0.03	22	120	0.3	4.7	0	4
AJO-005	23	4	0.017	45	150	0.5	2.5	0	3.1
AJO-006	24	47	0.08	23	64	1.3	12	0	4.4
AJO-009	39	11	0.125	50	120	0.5	9	0	6.9
AJO-013	39	23	0.123	39	88	1.4	11	0	6.5
AJO-014	10	4	0.016	41	120	1	2.2	0	1.9
AJO-016	29	16	0.09	10	87	0.8	7.8	0	4.5
AJO-017	33	23	0.144	29	47	1.1	14	0	6
AJO-018	37	19	0.145	32	60	1.2	13	0	6.3
AJO-019	18	5	0.017	26	99	1.1	3.5	0	3.1
AJO-021	24	7	0.034	14	85	0.4	3.1	0	3.6
AJO-022	30	4	0.017	50	100	0.9	3.1	0	4
AJO-024	39	12	0.144	28	62	0.4	12	0	6.1
AJO-026	31	12	0.117	25	90	0.6	7.8	0	5
AJO-027	29	17	0.107	21	110	0.4	11	0	5.1
AJO-029	24	8	0.044	9	130	0.8	5.6	0	3.7
AJO-030	16	8	0.019	16	95	0.5	2.7	0	2.6
AJO-032	36	12	0.127	21	68	0.8	13	0	6.4
AJO-035	36	5	0.07	15	31	0.4	7.5	0	5.8
AJO-036	31	6	0.01	9	150	0.4	4.1	0	4.7
AJO-037	29	7	0.014	22	140	0.4	3.5	0	4.3
AJO-039	18	4	0.018	18	74	0.9	2.5	0	2.9
AJO-040	24	8	0.04	12	67	0.5	3.9	0	3.6
AJO-041	31	8	0.016	0	85	0.4	2.5	0	4.7
AJO-042	26	14	0.041	12	100	0.5	5.8	0	4.6
AJO-043	30	12	0.085	7	120	0.3	7.5	0	4.2
AJO-045	39	10	0.054	0	110	0	7	0	5.2
AJO-046	27	12	0.084	7	82	0.3	7.4	0	4.3
AJO-048	24	9	0.047	5	75	0.3	4	0	3.8
AJO-049	31	7	0.043	8	92	3	5.5	0	4.9
AJO-050	23	8	0.083	0	92	1.1	7	0	3.7
AJO-051	21	11	0.08	13	79	1.9	6.5	0	3.4

Element	Sn	Sr	Ta	Tb	Th	Ti	U	V	W
Units	%	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM
Detection	0.01	1	1	0.5	0.5	0.01	0.5	1	4
Lab Perf	0.000	0.054	0.000	0.883	0.100	0.127	0.222	0.080	0.000
Std Dev	0.000	179.724	0.739	0.333	2.253	0.157	1.392	39.095	2.431
% Mean	0.00	0.60	1.29	0.62	0.22	0.81	0.43	0.81	2.93
AJO-001	0	77	0	0.9	11	0.03	7.8	26	0
AJO-002	0	79	1	0.8	11	0.08	3.8	33	0
AJO-003	0	107	2	0.7	11	0.09	3.8	28	0
AJO-004	0	208	2	0.6	11	0.1	3.6	26	0
AJO-005	0	265	0	0.6	8.3	0.05	2.1	6	0
AJO-006	0	342	0	0.7	5	0.35	2.1	136	0
AJO-009	0	656	1	1	13	0.44	4.5	82	0
AJO-013	0	456	0	0.8	12	0.4	3.5	96	0
AJO-014	0	99	1	0.7	7.8	0.03	2.3	6	0
AJO-016	0	388	0	0.7	8	0.31	2.6	35	0
AJO-017	0	399	0	0.8	6.9	0.47	1.6	94	0
AJO-018	0	637	0	0.9	7.1	0.5	2.2	113	0
AJO-019	0	182	2	0.6	9.3	0.07	1.9	15	0
AJO-021	0	341	0	0.6	11	0.08	2.8	17	0
AJO-022	0	169	1	0.6	12	0.05	2.8	10	0
AJO-024	0	752	0	0.8	6.9	0.48	1.1	130	0
AJO-026	0	357	0	0.8	7.1	0.29	2.6	67	6
AJO-027	0	368	1	0.6	7.5	0.43	2.7	84	0
AJO-029	0	174	0	0.6	15	0.13	3.3	32	5
AJO-030	0	129	1	0	11	0.08	2.5	7	0
AJO-032	0	204	0	0.8	7.6	0.45	4.4	109	0
AJO-035	0	104	0	0.8	9.2	0.21	2.3	40	0
AJO-036	0	124	0	0	14	0.06	5.3	12	0
AJO-037	0	235	2	0.7	13	0.06	3.6	6	0
AJO-039	0	146	0	0	10	0.05	3	3	0
AJO-040	0	202	1	0	10	0.13	2.9	26	0
AJO-041	0	180	0	0.6	12	0.02	3	5	0
AJO-042	0	147	2	0.7	12	0.07	5.5	29	0
AJO-043	0	500	1	0	11	0.2	6.7	70	0
AJO-045	0	291	1	0.7	10	0.14	2.7	43	0
AJO-046	0	515	0	0	11	0.3	3.3	80	0
AJO-048	0	260	0	0	10	0.09	2.5	28	0
AJO-049	0	401	0	0.6	10	0.09	4.1	34	0
AJO-050	0	310	1	0	12	0.24	3.1	76	8
AJO-051	0	594	0	0	9.8	0.2	2	77	10

Element	Y	Yb	Zn
Units	PPM	PPM	PPM
Detection	2	0.05	1
Lab Perf	0.336	0.071	0.066
Std Dev	4.562	0.456	52.345
% Mean	0.52	0.20	0.68
AJO-001	1	2.66	61
AJO-002	2	2.33	67
AJO-003	7	2.36	58
AJO-004	5	2.46	92
AJO-005	6	2.23	97
AJO-006	12	2.13	203
AJO-009	18	2.99	146
AJO-013	19	2.93	194
AJO-014	10	3.19	148
AJO-016	13	2.58	87
AJO-017	14	2.73	134
AJO-018	18	2.96	74
AJO-019	5	2.32	43
AJO-021	11	2.03	47
AJO-022	7	2.17	51
AJO-024	18	2.74	90
AJO-026	11	2.48	117
AJO-027	12	2.76	92
AJO-029	7	2.39	30
AJO-030	6	2.25	21
AJO-032	10	2.64	82
AJO-035	6	2.38	74
AJO-036	4	2.55	26
AJO-037	6	2.57	28
AJO-039	6	1.73	24
AJO-040	8	1.99	77
AJO-041	4	2.3	23
AJO-042	4	2.32	216
AJO-043	10	1.61	46
AJO-045	8	2.28	59
AJO-046	11	1.48	40
AJO-048	7	2.02	34
AJO-049	7	2.37	47
AJO-050	7	1.33	33
AJO-051	8	1.23	37

APPENDIX E

Normalized Geochemical Data

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Cd	Ce	Cr	Cs
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Std Dev	0.32	0.00	3.65	2.73	183	17.11	0.98	2.64	0.08	0.10	68	70	5.29
% Mean	1.15	0.00	1.29	1.00	0	0.83	1.61	0.63	0.68	0.52	0	0	1.05
MOR-001	3.05	6.00	1.12	5.01	551	17.03	0.57	1.00	0.01	0.17	170	160	0.00
MOR-002	0.77	6.00	0.38	0.98	295	38.30	0.38	1.96	0.13	0.24	41	137	2.95
MOR-003	0.20	6.00	0.62	1.13	575	21.43	0.12	5.64	0.15	0.26	70	214	4.51
MOR-004	0.32	6.00	0.57	3.13	355	63.65	0.38	5.22	0.09	0.17	104	209	4.17
MOR-005	0.11	6.00	0.55	1.04	626	41.74	0.20	7.83	0.29	0.58	222	183	5.22
MOR-006	0.11	6.00	0.05	5.73	401	33.21	0.25	5.73	0.09	0.18	81	206	4.58
MOR-007	1.04	6.00	1.08	11.18	261	38.51	0.77	2.48	0.07	0.19	40	199	0.00
MOR-008	0.93	6.00	4.66	4.39	439	23.03	0.04	5.48	0.05	0.31	165	176	3.29
MOR-009	0.80	6.00	3.87	0.89	244	27.73	0.24	5.55	0.07	0.25	144	155	3.33
MOR-010	0.17	6.00	5.30	3.08	226	27.69	4.48	6.15	0.05	0.18	123	215	5.13
MOR-011	0.38	6.00	1.12	3.95	681	7.89	0.05	0.00	0.01	0.08	197	158	0.00
MOR-012	0.06	6.00	16.05	0.50	863	18.06	0.13	7.02	0.26	0.20	181	161	24.08
MOR-013*	0.06	6.00	0.86	4.37	314	-1.75	1.57	0.00	0.04	0.09	75	428	0.00
MOR-015*	0.07	6.00	0.81	5.84	459	-1.67	1.03	0.00	0.04	0.08	200	275	4.17
MOR-017*	0.17	6.00	0.94	2.97	574	4.95	1.20	2.97	0.18	0.11	198	317	3.96
MOR-018*	0.09	6.00	0.78	0.83	558	2.50	0.35	2.50	0.11	0.17	250	242	2.50
MOR-020	0.06	6.00	3.55	0.00	633	28.35	0.16	7.56	0.14	0.20	180	132	5.67
MOR-021*	0.09	6.00	7.20	0.52	661	6.20	0.24	7.23	0.15	0.21	269	248	13.43
MOR-021	0.07	6.00	4.25	0.77	596	27.88	0.10	6.73	0.15	0.21	173	125	5.77
MOR-031*	0.06	6.00	4.60	0.40	549	2.39	0.19	2.39	0.05	0.19	151	231	6.37
MOR-032*	0.07	6.00	1.10	0.58	831	4.62	0.28	4.62	0.18	0.17	254	242	6.92

Element	Cu	Eu	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn	Mo	Na	Nd
Units	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
Std Dev	115	0.65	0.56	1.77	3.33	0.04	1.47	33	0.44	0.05	133	1.23	0.85	24.6
% Mean	2	0.48	0.32	0.74	0.18	0.87	0.25	0	0.19	0.53	1	0.47	0.44	0.4
MOR-001	67	1.30	2.51	1.29	13.02	0.03	5.96	79	1.73	0.19	68	2.74	0.11	56.1
MOR-002	18	0.39	0.58	0.82	19.64	0.06	7.19	14	2.35	0.11	102	1.94	1.34	13.7
MOR-003	23	1.92	1.97	2.57	20.30	0.01	5.38	78	2.57	0.14	134	1.22	2.79	39.5
MOR-004	21	0.94	1.07	1.70	24.00	0.01	5.73	26	2.53	0.03	48	3.44	1.92	28.2
MOR-005	60	1.96	2.02	6.55	24.78	0.01	5.92	143	3.10	0.14	365	3.05	2.97	92.6
MOR-006	24	1.49	2.15	1.55	17.18	0.02	5.60	81	2.48	0.07	78	1.42	2.60	69.8
MOR-007	24	0.00	1.74	1.11	19.88	0.03	4.32	17	2.01	0.17	89	5.18	2.26	7.5
MOR-008	58	1.10	2.69	0.98	23.03	0.00	6.07	76	2.39	0.08	35	2.39	1.34	54.8
MOR-009	36	0.44	1.26	1.16	18.85	0.04	5.20	63	2.23	0.03	31	1.66	2.54	29.9
MOR-010	25	0.62	1.38	2.02	17.44	0.01	5.44	52	3.21	0.03	33	4.32	2.27	44.1
MOR-011	548	1.18	1.62	0.54	16.78	0.02	9.81	85	1.71	0.09	21	3.83	2.34	77.0
MOR-012	8	1.91	1.82	3.53	15.05	0.00	6.35	86	2.27	0.11	554	1.52	2.37	57.2
MOR-013*	26	0.61	1.20	0.66	20.09	0.09	3.36	33	1.76	0.11	47	2.62	0.06	21.0
MOR-015*	86	2.17	0.97	1.48	19.19	0.08	5.57	75	2.23	0.12	55	4.31	0.93	78.4
MOR-017*	86	1.49	1.93	2.94	18.81	0.09	5.80	89	2.57	0.10	71	4.33	2.09	68.3
MOR-018*	55	1.83	1.83	1.87	17.50	0.08	4.52	83	2.85	0.05	74	1.73	1.99	80.8
MOR-020	3	1.51	1.74	3.89	21.73	0.01	8.30	87	1.95	0.04	224	2.49	2.09	58.6
MOR-021*	4	1.86	2.70	5.94	21.69	0.10	4.51	124	2.70	0.08	284	2.36	2.65	90.9
MOR-021	4	1.63	1.81	4.19	20.19	0.01	7.74	80	2.13	0.04	216	2.51	2.09	52.9
MOR-031*	10	1.59	1.17	0.71	11.14	0.08	4.19	78	1.69	0.16	195	0.51	0.92	54.9
MOR-032*	7	2.42	2.13	4.67	18.46	0.11	5.25	114	2.58	0.20	185	1.43	2.97	76.2

Element	Ni	P	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Tb	Te	Th	Ti
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Std Dev	2.72	0.01	21.3	52	0.41	1.23	0.12	5.9	17.0	1.42	1.02	0.26	9.0	0.04
% Mean	0.57	0.52	1.2	0	1.18	0.34	0.13	0.5	0.5	0.38	0.40	0.84	0.3	0.41
MOR-001	4.01	0.01	10.8	160	0.21	3.11	0.96	12.0	25.0	3.01	2.00	0.59	11.0	0.05
MOR-002	5.89	0.00	7.7	275	0.20	2.26	0.94	3.5	47.1	4.91	1.67	0.17	19.6	0.08
MOR-003	4.51	0.01	7.0	316	0.09	3.38	1.08	12.4	46.2	5.64	3.16	0.03	35.0	0.08
MOR-004	4.17	0.01	99.3	240	0.11	2.61	1.00	6.7	32.3	3.13	1.98	0.22	36.5	0.09
MOR-005	2.61	0.01	11.5	274	0.04	4.57	1.24	23.5	39.1	0.00	1.96	0.04	36.5	0.12
MOR-006	3.44	0.01	5.8	275	0.10	3.66	1.09	17.2	33.2	4.58	3.89	0.30	28.6	0.09
MOR-007	3.73	0.00	14.5	211	0.31	2.48	1.19	2.7	36.0	4.97	1.24	0.42	19.9	0.07
MOR-008	5.48	0.01	31.0	296	0.09	3.62	1.05	11.0	52.7	6.58	2.41	0.00	35.1	0.08
MOR-009	1.11	0.01	13.5	299	0.01	1.89	1.06	5.1	25.5	4.44	1.33	0.04	53.2	0.06
MOR-010	3.08	0.01	12.1	297	0.07	2.05	0.98	9.2	11.3	5.13	2.77	0.46	37.9	0.06
MOR-011	0.99	0.01	8.0	148	0.21	3.75	0.94	14.8	89.8	2.96	2.37	0.22	33.6	0.07
MOR-012	4.01	0.03	24.3	261	1.79	5.42	0.96	14.0	55.2	5.02	0.70	0.02	24.1	0.14
MOR-013*	9.61	0.01	1.6	140	0.25	2.18	0.86	5.5	14.0	3.49	1.57	0.43	16.6	0.11
MOR-015*	7.51	0.01	2.3	209	0.26	3.42	0.81	19.2	30.0	2.50	3.17	0.58	23.4	0.10
MOR-017*	9.90	0.01	5.3	257	0.56	3.47	0.94	15.8	25.7	3.96	3.56	1.05	31.7	0.07
MOR-018*	8.33	0.01	7.3	200	0.24	3.50	0.78	20.8	27.5	3.33	4.83	0.39	29.2	0.07
MOR-020	1.89	0.01	26.6	293	0.51	4.06	0.90	13.2	45.4	2.83	3.02	0.11	29.3	0.16
MOR-021*	5.16	0.01	34.6	248	1.08	4.65	0.97	20.7	25.8	4.13	3.72	0.48	32.0	0.19
MOR-021	0.96	0.01	26.8	279	0.42	4.23	0.92	12.5	43.3	2.88	2.60	0.09	27.9	0.15
MOR-031*	6.37	0.01	5.3	255	0.31	4.38	0.78	11.9	28.6	2.39	2.31	0.39	24.7	0.14
MOR-032*	8.08	0.02	32.5	300	0.37	7.04	1.10	17.3	49.6	3.46	3.58	0.55	32.3	0.18

Element	Tl	U	V	W	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Std Dev	0.06	1.60	3.5	4.9	14.9	3.2	41
% Mean	0.13	0.28	0.9	1.1	1.1	0.2	1
MOR-001	0.48	3.71	7.0	7.0	8.0	12.1	16
MOR-002	0.47	6.78	1.0	4.9	3.9	15.9	71
MOR-003	0.54	5.98	1.1	0.0	2.3	17.1	149
MOR-004	0.50	7.51	1.0	5.2	1.0	17.1	57
MOR-005	0.62	8.09	1.3	9.1	5.2	21.0	133
MOR-006	0.55	5.95	1.1	0.0	6.9	16.8	50
MOR-007	0.59	6.96	1.2	7.5	7.5	13.7	24
MOR-008	0.52	5.27	1.1	0.0	14.3	15.4	45
MOR-009	0.53	6.54	1.1	0.0	5.5	13.5	26
MOR-010	0.49	7.90	1.0	5.1	5.1	22.4	67
MOR-011	0.47	3.36	12.8	8.9	1.0	11.4	4
MOR-012	0.48	4.72	11.0	10.0	4.0	14.0	85
MOR-013*	0.43	3.49	4.4	8.7	16.6	11.8	8
MOR-015*	0.40	4.26	2.5	7.5	48.4	15.0	16
MOR-017*	0.47	5.84	1.0	9.9	31.7	17.7	17
MOR-018*	0.39	7.83	2.5	-3.3	46.7	20.3	17
MOR-020	0.45	4.72	4.7	5.7	3.8	12.6	70
MOR-021*	0.48	5.47	7.2	-4.1	38.2	17.9	110
MOR-021	0.46	5.96	3.8	3.8	1.9	13.5	75
MOR-031*	0.39	3.02	8.0	11.1	15.9	11.6	51
MOR-032*	0.55	7.50	3.5	-4.6	13.8	17.3	79

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Ce	Co	Cr
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Std Dev	0.02	0.00	4.87	5.14	444.84	0.77	0.22	1.92	1.68	11.11	4.93	69.6
% Mean	0.35	0.00	1.01	1.97	0.51	2.00	2.00	1.17	0.50	0.21	0.58	0.5
ANN-001	0.05	7.94	4.33	6.76	1159.12	0.00	0.00	3.86	3.84	50.23	11.59	106.3
ANN-002	0.06	7.94	3.77	16.14	1506.23	0.00	0.00	4.30	3.85	65.63	12.91	150.6
ANN-003	0.05	7.94	3.30	0.00	887.89	0.00	0.00	0.00	3.75	55.11	14.29	122.5
ANN-004	0.03	7.94	5.49	0.00	1376.27	0.00	0.00	4.23	4.13	46.58	8.47	158.8
ANN-006	0.05	7.94	6.00	16.85	1459.97	0.00	0.00	5.62	3.85	55.03	12.35	157.2
ANN-008	0.03	7.94	3.88	0.00	1514.44	0.00	0.00	3.25	4.00	58.41	9.74	107.1
ANN-009	0.05	7.94	3.12	0.00	1419.81	0.00	0.00	2.18	3.91	61.16	12.01	131.1
ANN-011	0.05	7.94	3.04	0.00	996.35	0.00	0.00	0.00	3.71	64.71	13.35	174.6
ANN-015	0.04	7.94	2.65	0.00	169.36	1.99	0.00	0.00	5.33	31.88	5.98	50.8
ANN--017	0.05	7.94	1.85	0.00	638.74	0.00	0.00	0.00	3.89	31.45	7.86	84.5
ANN-020	0.04	7.94	2.48	0.00	455.74	0.00	0.00	0.00	3.42	31.40	5.06	45.6
ANN-021	0.04	7.94	2.00	0.00	1072.97	0.00	0.00	0.00	3.56	52.67	11.71	156.1
ANN-022	0.04	7.94	3.36	0.00	1344.14	0.00	0.24	2.88	3.09	56.65	8.64	94.1
ANN-023	0.03	7.94	2.18	0.00	162.66	0.00	0.00	0.00	5.54	52.87	10.17	111.8
ANN-024	0.05	7.94	2.14	0.00	385.03	0.00	0.00	2.08	4.73	62.44	9.37	92.6
ANN-026	0.04	7.94	2.63	0.00	472.11	0.00	0.00	0.00	5.45	54.72	10.73	76.2
ANN-027	0.09	7.94	2.78	0.00	987.51	0.00	0.00	0.00	3.68	56.86	11.97	129.7
ANN-028	0.04	7.94	6.09	5.48	511.67	1.83	0.23	0.00	5.09	59.39	12.79	35.6
ANN-029	0.03	7.94	2.76	8.80	127.12	0.00	0.00	0.00	4.87	57.69	13.69	117.3
ANN-031	0.04	7.94	7.28	9.52	580.13	0.00	0.54	0.00	0.42	35.50	0.00	138.5
ANN-038	0.04	7.94	1.71	0.00	1091.75	0.00	0.00	1.99	3.83	57.57	12.90	158.8
ANN-043	0.07	7.94	4.46	0.00	1239.14	0.00	0.00	3.81	3.43	59.10	12.39	152.5
ANN-044	0.04	7.94	4.44	0.00	963.99	0.00	0.39	2.07	0.25	59.08	0.00	259.1
ANN-046	0.05	7.94	23.58	0.00	893.14	0.00	0.83	0.00	0.07	25.90	0.00	196.5
ANN-049	0.10	7.94	3.13	0.00	1124.07	2.04	0.00	3.07	1.87	56.20	0.00	255.5
ANN-054	0.07	7.94	4.49	12.20	1219.83	0.00	0.00	5.54	2.24	65.43	9.98	299.4
ANN-055	0.07	7.94	6.38	0.00	659.35	1.86	0.44	0.00	0.20	52.93	0.00	185.7
ANN-059	0.07	7.94	19.34	0.00	598.72	1.84	0.45	2.76	0.21	62.64	0.00	313.2
ANN-065	0.02	7.94	1.75	0.00	121.16	1.62	0.00	0.00	5.22	45.23	8.08	96.9

Element	Cs	Cu	Eu	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn	Mo
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Std Dev	0.98	62.8	0.35	1.07	1.01	1.35	0.23	1.16	5.63	0.07	0.59	211.45	2.49
% Mean	2.04	0.7	0.30	0.37	0.37	0.30	1.47	0.50	0.21	0.34	0.44	0.47	0.85
ANN-001	1.93	96.5	1.06	3.78	3.50	3.86	0.00	2.48	28.01	0.20	1.52	748.60	1.86
ANN-002	0.00	46.5	1.61	4.08	2.96	5.38	0.14	2.85	33.35	0.28	1.61	526.11	2.12
ANN-003	0.00	66.0	1.33	4.07	3.36	5.10	0.12	2.41	27.56	0.29	1.64	650.10	2.55
ANN-004	0.00	11.6	1.27	3.63	3.32	4.23	0.11	2.72	23.29	0.18	1.49	506.04	1.95
ANN-006	0.00	49.1	1.35	4.21	4.14	5.62	0.00	3.22	30.32	0.30	1.65	649.13	3.36
ANN-008	0.00	15.6	1.62	4.16	3.27	5.41	0.00	2.82	27.04	0.00	1.86	490.03	1.60
ANN-009	0.00	78.3	1.42	4.02	4.78	3.82	0.12	3.05	30.58	0.22	1.59	540.62	2.29
ANN-011	0.00	56.5	1.44	3.93	3.45	5.65	0.12	2.28	31.84	0.32	1.43	651.22	2.33
ANN-015	0.00	112.6	0.80	1.46	1.40	2.59	0.11	0.50	16.94	0.17	1.53	458.27	1.25
ANN--017	0.00	43.8	0.69	2.12	2.86	2.55	0.00	2.26	15.72	0.15	1.57	604.34	1.61
ANN-020	0.00	77.0	0.81	1.87	3.35	2.53	0.10	2.07	16.20	0.11	1.59	432.45	2.00
ANN-021	0.00	56.5	1.37	3.46	3.47	4.88	0.11	2.62	27.31	0.17	1.50	623.30	2.54
ANN-022	0.00	71.4	1.44	3.50	3.21	3.84	0.10	3.12	31.68	0.16	1.46	396.52	1.61
ANN-023	0.00	30.8	1.52	2.57	1.63	3.05	0.12	0.35	27.45	0.21	1.94	422.92	1.43
ANN-024	0.00	213.3	1.46	2.79	2.87	5.20	0.11	0.84	30.18	0.29	1.68	388.15	1.54
ANN-026	0.00	216.7	1.39	3.29	2.54	3.22	0.11	0.53	28.97	0.25	1.99	436.70	1.08
ANN-027	1.99	123.7	1.50	3.66	2.98	4.99	0.11	2.63	28.93	0.23	1.40	723.18	2.14
ANN-028	0.00	195.5	1.74	2.90	2.30	2.74	0.10	1.04	29.24	0.27	2.38	481.52	0.98
ANN-029	0.00	77.4	1.47	2.21	1.92	3.52	0.11	0.31	29.33	0.22	1.58	410.69	2.00
ANN-031	0.00	49.7	0.87	1.43	3.43	3.64	0.45	1.88	19.05	0.13	0.29	40.70	3.39
ANN-038	0.00	64.6	1.39	3.58	2.56	3.77	0.11	2.72	28.78	0.22	1.46	625.28	1.84
ANN-043	1.91	165.9	1.43	4.09	3.89	4.38	0.12	2.64	30.50	0.28	1.46	549.99	3.06
ANN-044	0.00	16.0	0.93	1.08	0.98	5.18	0.14	3.09	32.13	0.15	0.12	75.67	5.09
ANN-046	0.00	31.8	0.36	1.01	1.00	3.66	1.27	3.59	13.40	0.11	0.38	19.65	5.04
ANN-049	3.07	157.4	0.92	2.05	3.69	5.93	0.13	3.78	29.63	0.26	0.59	453.71	4.94
ANN-054	2.22	169.7	1.00	3.43	1.99	7.65	0.14	4.46	34.38	0.29	0.85	588.85	5.15
ANN-055	0.00	41.4	0.56	1.48	0.85	6.13	0.36	3.66	27.86	0.18	0.24	29.72	13.74
ANN-059	2.76	161.2	0.83	1.65	1.80	7.00	0.16	3.29	30.40	0.22	0.21	58.95	5.89
ANN-065	0.00	6.5	1.05	1.94	1.69	3.23	0.00	0.22	21.81	0.20	1.52	399.83	1.16

Element	Na	Nd	Ni	P	Pb	Rb	Sb	Sc	Se	Sm	Sr	Th	Ti
Units	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	%
Std Dev	4.48	5.34	7.62	0.05	2.69	47.32	0.22	2.77	0.40	0.95	402	6.57	0.13
% Mean	1.12	0.24	0.36	0.41	0.59	0.81	0.41	0.34	3.05	0.25	0	0.68	0.29
ANN-001	3.10	17.39	20.28	0.14	7.91	0.00	0.52	8.98	0.00	3.77	1186	8.02	0.45
ANN-002	3.87	27.97	23.67	0.16	7.80	118.35	0.61	9.79	0.00	5.06	1338	8.39	0.54
ANN-003	3.21	20.41	18.37	0.13	5.31	55.11	0.58	10.21	0.00	4.29	1007	9.80	0.48
ANN-004	3.64	25.41	23.29	0.15	5.12	70.93	0.58	9.95	0.00	3.81	1299	7.52	0.47
ANN-006	3.80	22.46	25.83	0.15	8.05	134.77	0.57	9.88	0.00	4.38	1244	11.23	0.49
ANN-008	4.25	30.29	33.53	0.17	4.19	65.99	0.41	10.82	0.00	4.65	1164	9.19	0.59
ANN-009	3.58	26.21	29.49	0.15	5.50	67.71	0.54	10.38	0.00	4.59	1139	7.54	0.48
ANN-011	3.72	21.57	23.62	0.14	5.29	46.22	0.43	8.11	0.00	4.83	1084	11.30	0.48
ANN-015	2.37	11.95	18.93	0.20	2.36	0.00	0.52	5.88	0.00	2.59	961	6.08	0.50
ANN--017	1.86	15.72	26.53	0.14	4.18	49.13	0.40	4.72	0.00	2.36	1170	5.60	0.47
ANN-020	2.26	16.20	23.29	0.15	3.62	0.00	0.47	5.67	0.00	2.33	1034	3.95	0.46
ANN-021	2.72	18.53	23.41	0.14	4.88	61.45	0.36	8.68	0.00	3.90	1106	7.71	0.46
ANN-022	3.29	24.96	22.08	0.14	3.23	81.61	0.48	9.60	0.00	4.22	1025	7.49	0.47
ANN-023	4.53	27.45	34.57	0.18	1.88	39.65	0.55	11.18	0.00	4.37	1317	4.68	0.58
ANN-024	4.46	29.14	21.85	0.17	2.71	0.00	0.37	9.26	0.00	4.58	1077	11.45	0.55
ANN-026	4.52	30.04	32.19	0.18	2.58	0.00	0.36	10.73	0.00	4.51	1361	4.40	0.59
ANN-027	3.20	21.94	16.96	0.13	9.11	82.79	0.44	8.88	0.00	3.99	1106	7.98	0.46
ANN-028	3.69	29.24	27.41	0.20	1.42	0.00	0.61	14.62	0.00	5.39	1138	5.66	0.58
ANN-029	4.37	24.45	21.51	0.15	2.73	0.00	0.40	9.78	0.00	4.30	1180	7.82	0.49
ANN-031	2.08	16.45	8.66	0.07	1.89	63.21	0.51	7.62	1.00	2.60	224	4.68	0.42
ANN-038	3.06	23.82	24.81	0.14	3.65	77.42	0.29	9.03	0.00	4.27	1181	9.13	0.49
ANN-043	2.95	23.83	20.97	0.14	9.01	0.00	0.55	9.53	0.00	4.38	1095	9.44	0.43
ANN-044	3.18	19.69	8.29	0.03	3.84	99.51	0.63	3.01	0.00	3.42	211	22.80	0.19
ANN-046	1.26	9.82	6.25	0.01	0.67	85.74	0.57	5.00	1.19	1.43	92	4.02	0.15
ANN-049	26.77	21.46	15.33	0.06	7.69	132.84	0.50	4.29	0.00	3.37	682	19.42	0.27
ANN-054	3.60	24.40	24.40	0.09	10.48	133.07	0.58	6.21	0.00	4.21	800	21.07	0.37
ANN-055	0.89	16.72	5.57	0.04	1.37	120.73	1.05	4.27	1.57	2.23	59	7.43	0.18
ANN-059	2.07	19.34	11.05	0.01	5.19	110.53	1.41	2.76	0.00	3.59	146	33.16	0.19
ANN-065	3.27	18.58	23.42	0.14	1.16	0.00	0.27	8.08	0.00	3.39	1211	4.28	0.48

Element	Tl	U	V	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm	ppm
Std Dev	0.11	2.06	32	3.8	0.25	16.9
% Mean	0.19	0.54	0	0.3	0.25	0.6
ANN-001	0.48	5.51	122	13.0	0.89	49.4
ANN-002	0.49	3.77	131	13.0	1.20	40.2
ANN-003	0.51	0.00	134	14.0	1.41	38.4
ANN-004	0.65	0.00	130	12.0	1.00	24.9
ANN-006	0.65	5.95	128	12.0	1.22	38.6
ANN-008	0.54	2.81	148	13.0	1.24	21.9
ANN-009	0.54	3.71	132	12.0	0.96	40.0
ANN-011	0.62	5.24	117	14.0	1.24	42.3
ANN-015	0.56	2.99	143	17.0	0.80	9.5
ANN--017	0.49	1.57	120	13.0	0.69	35.6
ANN-020	0.49	1.72	121	12.0	0.57	22.0
ANN-021	0.45	2.93	127	13.0	0.85	43.5
ANN-022	0.47	1.73	122	13.0	0.90	20.9
ANN-023	0.62	2.74	143	13.0	1.00	13.1
ANN-024	0.50	4.06	130	14.0	1.21	15.6
ANN-026	0.52	1.72	153	12.0	0.98	16.3
ANN-027	0.50	3.79	114	14.0	1.26	51.1
ANN-028	0.51	5.21	163	19.0	1.44	7.8
ANN-029	0.60	3.72	122	14.0	1.15	11.6
ANN-031	0.43	3.72	96	5.0	0.69	7.5
ANN-038	0.48	3.47	120	14.0	1.11	26.6
ANN-043	0.47	3.53	118	14.0	1.22	39.3
ANN-044	0.70	6.84	40	6.0	0.78	7.4
ANN-046	0.44	2.77	80	4.0	0.48	1.9
ANN-049	0.80	7.05	54	10.0	1.15	49.4
ANN-054	0.78	5.99	84	13.0	1.38	59.2
ANN-055	0.45	5.57	52	2.0	0.78	1.9
ANN-059	0.72	8.93	49	6.0	1.10	12.7
ANN-065	0.39	2.67	106	13.0	0.88	7.6

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Ce	Co	Cr	Cs
Units	ppm	%	ppm	ppb	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Std Dev	0.04	0.00	17.14	4.98	718	0.93	0.32	1.07	1.17	11.51	2.13	64	0.48
% Mean	0.76	0.00	1.78	2.36	1	1.60	1.57	1.65	0.71	0.25	2.25	0	4.12
ANN-025	0.03	7.59	4.64	0.00	1999	2.10	0.00	3.16	1.99	46.29	0.00	189	0.00
ANN-034	0.04	7.59	2.41	0.00	1576	0.00	0.31	1.97	2.07	47.28	0.00	266	0.00
ANN-035	0.02	7.59	2.34	0.00	1618	0.00	0.00	0.00	2.66	51.39	4.76	114	0.00
ANN-036	0.02	7.59	1.76	0.00	1232	0.00	0.00	0.00	3.09	47.21	0.00	205	0.00
ANN-037	0.04	7.59	2.72	11.03	2328	0.00	0.00	0.00	1.76	40.44	0.00	208	0.00
ANN-039	0.06	7.59	2.83	0.00	500	1.89	0.00	0.00	3.26	67.93	0.00	170	0.00
ANN-047	0.13	7.59	0.94	7.81	1171	0.00	0.00	1.95	2.17	41.00	0.00	137	0.00
ANN-048	0.15	7.59	6.97	0.00	1249	0.00	0.31	0.00	1.95	48.19	0.00	178	0.00
ANN-051	0.04	7.59	16.48	0.00	1669	0.00	0.44	0.00	1.87	38.60	0.00	209	0.00
ANN-052	0.02	7.59	2.47	0.00	1580	0.00	0.00	2.11	2.99	56.89	0.00	158	0.00
ANN-057	0.03	7.59	73.44	0.00	126	2.10	0.38	0.00	0.27	58.67	0.00	126	0.00
ANN-058	0.06	7.59	6.74	0.00	217	0.00	0.00	0.00	0.09	37.09	0.00	384	0.00
ANN-061	0.05	7.59	12.67	0.00	982	0.00	0.47	1.78	0.22	26.77	0.00	143	0.00
ANN-063	0.05	7.59	7.59	17.04	436	0.00	1.20	0.00	0.11	24.62	0.00	180	0.00
ANN-064	0.03	7.59	15.09	0.00	0	0.00	0.32	0.00	0.16	54.03	0.00	214	0.00
ANN-068	0.03	7.59	3.39	0.00	99	1.81	0.00	0.00	0.60	61.40	6.32	126	0.00
ANN-069	0.02	7.59	1.23	0.00	670	2.00	0.00	0.00	2.99	42.97	5.00	210	2.00

Element	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn	Mo	Na	Nd	Ni
Units	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Std Dev	0.45	1.31	1.03	0.35	1.33	6.33	0.05	0.40	81	2.58	12.07	4.68	4.31
% Mean	0.34	0.47	0.24	0.19	0.53	0.26	0.39	0.71	1	0.57	1.22	0.26	0.33
ANN-025	0.96	0.00	4.21	0.11	4.42	26.30	0.14	0.48	117	3.21	3.63	18.94	14.73
ANN-034	1.53	2.28	4.53	0.11	3.17	25.61	0.11	0.40	125	5.26	3.05	15.76	12.81
ANN-035	2.15	4.29	3.71	0.12	3.02	26.65	0.11	0.92	317	1.88	2.66	19.99	16.18
ANN-036	1.43	2.24	4.31	0.13	2.38	23.61	0.14	0.49	158	2.51	3.35	19.50	13.34
ANN-037	1.27	3.42	4.29	0.15	3.32	22.06	0.10	0.26	67	6.60	3.90	22.06	9.80
ANN-039	0.86	1.11	3.87	0.13	0.99	36.79	0.12	0.82	100	2.37	3.91	25.47	19.81
ANN-047	1.93	5.15	4.30	0.12	2.80	18.55	0.12	1.04	103	3.03	31.34	20.50	19.52
ANN-048	1.19	1.63	4.10	0.11	3.10	23.20	0.18	0.46	64	6.99	29.54	18.74	16.06
ANN-051	1.85	3.41	3.86	0.12	3.47	20.87	0.10	0.29	162	8.69	32.76	16.69	12.52
ANN-052	2.06	3.74	4.32	0.11	3.39	29.50	0.15	0.67	223	2.90	29.92	20.02	16.86
ANN-057	1.32	3.96	3.98	0.15	0.66	30.38	0.14	0.40	66	3.39	5.23	22.00	9.43
ANN-058	0.81	1.97	7.29	0.49	3.76	17.91	0.18	0.19	23	11.45	1.01	12.79	10.23
ANN-061	1.38	2.81	3.30	0.13	2.11	15.17	0.00	0.12	33	3.90	4.05	8.92	5.35
ANN-063	0.96	1.54	3.79	1.56	4.05	12.31	0.14	0.36	24	2.82	0.73	9.47	4.73
ANN-064	0.88	2.63	6.12	0.21	0.32	28.55	0.25	0.27	24	5.21	5.34	23.45	11.21
ANN-068	0.73	4.11	2.71	0.17	0.32	32.51	0.13	1.74	79	3.84	4.23	17.16	15.35
ANN-069	1.41	2.66	4.00	0.14	1.26	21.99	0.10	0.67	197	2.83	3.95	12.99	14.99

Element	Cu	Eu	Element	Rb	Sb	Sc	Se	Sm	Sr	Th	Ti	Tl
Units	ppm	ppm	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	%	ppm
Std Dev	628.3	0.27	Std Dev	39.12	0.71	0.88	0.2	0.74	511	4.74	0.06	0.06
% Mean	2.5	0.31	% Mean	0.79	0.90	0.18	4.1	0.26	1	0.52	0.22	0.12
ANN-025	15.6	0.84	ANN-025	88.37	0.53	4.42	0.0	2.74	932	8.31	0.27	0.51
ANN-034	13.0	0.79	ANN-034	64.03	0.35	4.43	0.0	2.56	1198	8.57	0.27	0.48
ANN-035	3.2	0.95	ANN-035	73.28	0.38	6.09	0.0	3.24	1029	7.99	0.28	0.63
ANN-036	6.7	0.92	ANN-036	52.35	0.46	4.21	0.0	2.77	1073	8.31	0.28	0.50
ANN-037	32.2	0.98	ANN-037	85.78	0.64	4.66	0.0	3.31	1555	5.39	0.33	0.60
ANN-039	200.0	1.13	ANN-039	0.00	0.45	5.00	0.0	3.30	1183	8.02	0.31	0.45
ANN-047	328.0	1.07	ANN-047	48.81	0.33	5.95	0.0	3.51	954	6.44	0.41	0.47
ANN-048	256.1	1.34	ANN-048	49.08	0.52	4.55	0.0	3.84	1028	7.76	0.29	0.53
ANN-051	24.2	0.94	ANN-051	51.12	0.67	4.69	0.0	2.61	1181	7.30	0.28	0.57
ANN-052	31.8	1.05	ANN-052	65.32	0.73	5.27	0.0	3.37	1432	8.32	0.32	0.49
ANN-057	199.1	1.05	ANN-057	0.00	2.41	4.82	0.0	3.77	211	7.44	0.27	0.50
ANN-058	73.2	0.51	ANN-058	113.84	2.83	4.09	0.0	2.05	60	19.19	0.14	0.62
ANN-061	84.1	0.36	ANN-061	38.37	0.53	3.57	1.0	1.25	319	6.51	0.18	0.44
ANN-063	8.0	0.38	ANN-063	113.63	0.63	6.72	0.0	1.52	35	7.39	0.31	0.47
ANN-064	387.4	0.61	ANN-064	0.00	0.95	3.16	0.0	2.96	105	23.45	0.22	0.47
ANN-068	2644.8	0.90	ANN-068	0.00	0.78	4.70	0.0	3.52	324	7.13	0.25	0.63
ANN-069	13.99	0.90	ANN-069	0.00	0.28	4.60	0.0	2.50	1152	6.90	0.29	0.49

Element	P	Pb
Units	%	ppm
Std Dev	0.03	1.46
% Mean	0.44	0.49
ANN-025	0.07	3.22
ANN-034	0.06	3.33
ANN-035	0.09	3.23
ANN-036	0.08	1.70
ANN-037	0.05	4.02
ANN-039	0.08	2.15
ANN-047	0.10	3.59
ANN-048	0.08	3.45
ANN-051	0.07	4.32
ANN-052	0.09	3.29
ANN-057	0.05	2.20
ANN-058	0.02	1.42
ANN-061	0.03	2.24
ANN-063	0.01	7.28
ANN-064	0.02	2.77
ANN-068	0.08	0.75
ANN-069	0.07	2.04

Element	U	V	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm
Std Dev	1.41	14.3	2.29	0.23	7.5
% Mean	0.30	0.2	0.43	0.38	0.8
ANN-025	3.58	46.3	5.26	0.00	7.6
ANN-034	4.33	50.2	4.93	0.41	7.4
ANN-035	3.52	66.6	6.66	0.49	27.8
ANN-036	4.41	54.4	7.18	0.53	8.5
ANN-037	3.19	52.7	6.13	0.62	7.7
ANN-039	4.91	67.0	9.43	0.62	5.3
ANN-047	3.22	84.0	6.83	0.62	22.9
ANN-048	4.91	55.3	7.14	0.65	8.9
ANN-051	5.95	60.5	5.22	0.64	23.1
ANN-052	4.85	61.1	7.37	0.64	9.7
ANN-057	5.34	89.1	1.05	0.60	8.6
ANN-058	5.63	61.4	2.56	0.92	2.1
ANN-061	5.26	37.5	1.78	0.47	5.7
ANN-063	6.72	81.4	4.73	0.67	1.2
ANN-064	8.26	40.8	2.04	1.13	5.7
ANN-068	3.52	57.8	6.32	0.71	5.2
ANN-069	2.90	54.0	6.00	0.57	12.1

ID NUM	Ag	Al	As	Au	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppb	%	ppb	ppm	ppm	ppm	ppm	ppm
Std Dev	0.3	0.0	1.4	0.0	850	2.2	499	1.6	17.8	13.7	4.5	69.4	2.6	303.0
% Mean	1.3	0.0	1.1	0.5	1.1	0.9	1.2	0.6	0.2	0.2	1.3	0.4	0.9	1.4
RSG-001	0.1	7.2	1.5	0.4	137	1.7	212	4.0	85	66	0.0	205	0.0	2
RSG-002	0.1	7.2	1.1	0.5	0	1.8	221	4.6	88	73	0.0	180	0.0	2
RSG-003	0.0	7.2	0.8	0.4	0	0.0	188	8.3	75	63	0.0	197	0.0	4
RSG-004	0.4	7.2	1.0	0.5	1077	2.2	253	2.5	101	75	5.4	215	6.5	269
RSG-005	0.4	7.2	8.0	0.5	3753	0.0	2163	0.0	98	74	0.0	52	6.9	113
RSG-006	0.1	7.2	1.0	0.5	2681	0.0	242	1.8	97	109	18.9	109	9.9	15
RSG-007	0.4	7.2	1.0	0.5	1611	2.0	1037	0.4	101	61	0.0	82	4.0	191
RSG-009	0.0	7.2	0.6	0.3	181	4.5	1922	5.0	62	58	3.9	42	0.0	26
RSG-010	0.2	7.2	0.9	0.5	749	1.8	222	2.0	89	83	7.3	183	4.6	461
RSG-013	0.0	7.2	1.0	0.5	394	9.3	247	3.4	98	80	0.0	68	4.1	10
RSG-014	0.0	7.2	0.9	0.5	131	5.6	228	3.5	91	67	0.0	159	0.0	2
RSG-016	0.5	7.2	1.1	0.7	1357	2.5	286	2.6	115	76	0.0	271	4.9	527
RSG-017	0.0	7.2	1.0	0.9	0	2.6	213	4.3	85	75	5.3	114	0.0	1
RSG-018	0.3	7.2	1.4	0.5	1051	2.1	433	1.7	113	56	0.0	210	3.2	932
RSG-019	0.0	7.2	0.8	0.5	562	1.8	210	2.5	84	68	8.2	181	5.4	5
RSG-020	0.0	7.2	0.9	0.5	428	0.0	236	3.2	94	65	4.9	136	1.9	2
RSG-021	0.0	7.2	0.8	0.4	137	2.6	211	2.5	85	51	6.0	40	0.0	2
RSG-022	0.0	7.2	1.0	0.5	935	0.0	251	2.9	100	68	9.5	231	5.3	6
RSG-023	0.2	7.2	1.2	0.6	1169	2.4	295	2.6	118	90	7.2	301	3.6	135
RSG-024	0.0	7.2	0.8	0.4	224	2.6	208	3.4	83	69	6.9	190	4.3	4
RSG-035	1.3	7.2	1.0	2.0	981	2.0	393	1.8	155	63	6.9	157	3.9	1123
RSG-036	0.4	7.2	0.9	0.7	649	1.8	228	1.5	90	56	0.0	192	3.7	486
RSG-037	0.0	7.2	0.8	0.4	124	3.3	189	3.1	76	71	0.0	149	0.0	2
RSG-038	0.4	7.2	0.8	0.4	898	1.8	207	2.0	93	39	5.4	171	3.6	560
RSG-039	0.2	7.2	1.0	0.5	920	2.1	249	1.5	99	50	0.0	180	3.2	400
RSG-041	0.1	7.2	1.1	0.6	842	2.2	265	1.1	107	74	0.0	213	3.4	208
RSG-042	0.1	7.2	0.7	0.4	180	8.2	220	3.3	71	70	0.0	48	0.0	388
Std Dev	0.3	0.0	0.1	0.0	536	1.1	160	0.7	18	12.6	3.1	45	2.1	486
% Mean	1.0	0.0	0.1	0.1	0.6	0.4	0.4	0.4	0.2	0.2	2.2	0.3	0.6	1.7
RSG-008	0.1	6.6	0.9	0.5	1482	1.9	621	1.4	90	74	0.0	111	1.9	6
RSG-011	0.1	6.6	1.1	0.5	272	4.3	269	2.7	108	98	0.0	96	3.3	37
RSG-012	0.6	6.6	1.0	0.5	1479	3.2	554	0.8	101	76	0.0	169	3.2	228
RSG-015	0.1	6.6	1.0	0.5	599	2.1	284	1.8	103	73	0.0	206	7.2	6
RSG-040	0.5	6.6	0.9	0.5	941	2.0	370	2.1	139	63	6.9	129	3.0	1137

ID NUM	Eu	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn	Mo	Na	Nd
Units	ppm	%	ppm	ppm	ppb	%	ppm	ppm	%	ppm	ppm	ppm	ppm
Std Dev	0.4	0.9	1509.8	1.2	12.8	2.8	10.1	0.1	0.7	249.5	21.4	11156	4.2
% Mean	0.3	0.5	0.6	0.2	0.1	1.0	0.2	0.3	1.0	0.6	2.7	0.3	0.2
RSG-001	1.0	0.9	577	5.1	85	0.1	41.1	0.2	0.7	532	0.4	40385	24.0
RSG-002	1.0	1.6	983	5.4	88	0.2	42.4	0.3	0.6	644	0.5	38854	18.0
RSG-003	0.8	3.5	1036	4.5	75	0.0	37.1	0.2	0.3	1150	1.9	862	24.2
RSG-004	1.1	2.4	4730	5.4	101	3.4	44.2	0.3	0.7	340	6.5	31247	16.2
RSG-005	0.8	3.0	489	7.9	98	11.4	43.5	0.2	0.1	87	112.6	2933	24.7
RSG-006	1.9	2.1	2781	7.9	97	7.3	69.5	0.4	1.1	765	2.1	28999	29.8
RSG-007	0.9	1.1	2447	6.0	101	6.8	36.3	0.3	0.1	64	7.4	21549	18.1
RSG-009	2.5	3.9	2932	2.6	62	0.1	35.6	0.0	0.3	643	0.5	24726	17.5
RSG-010	0.9	2.1	4035	5.5	89	2.8	67.6	0.2	0.6	292	1.6	28938	18.3
RSG-013	1.5	1.0	760	7.3	98	6.8	50.8	0.2	0.7	438	1.4	28796	22.8
RSG-014	1.0	0.8	1213	6.5	91	0.2	40.1	0.2	0.6	654	0.5	51869	16.8
RSG-016	1.4	3.0	5564	7.4	115	3.8	38.2	0.3	0.6	289	5.7	39234	24.7
RSG-017	1.1	1.3	1476	6.1	85	0.2	43.0	0.2	0.8	705	0.2	42519	21.1
RSG-018	1.3	1.6	3783	6.3	104	4.0	32.6	0.2	0.5	180	8.3	31211	20.0
RSG-019	1.0	2.6	3919	5.4	84	2.6	37.2	0.3	0.9	454	0.6	27850	20.0
RSG-020	1.0	1.7	2987	5.8	94	1.6	38.9	0.3	0.7	388	0.6	37853	14.6
RSG-021	1.0	0.9	2732	6.0	85	0.4	24.8	0.3	3.7	370	0.3	44558	16.2
RSG-022	1.2	2.8	4172	5.3	100	3.4	41.0	0.2	0.9	497	0.2	31526	18.9
RSG-023	1.4	2.9	5567	7.2	118	3.7	49.4	0.2	0.6	370	6.6	40368	20.5
RSG-024	0.9	1.9	2111	5.2	83	0.9	43.1	0.2	0.9	489	1.2	34125	19.0
RSG-035	1.2	2.2	3375	5.9	95	3.4	32.4	0.2	0.5	220	15.9	30411	20.6
RSG-036	0.8	1.5	2696	5.5	90	3.1	34.7	0.3	0.4	255	11.1	28883	15.5
RSG-037	0.8	0.2	378	5.0	76	0.2	43.8	0.2	0.1	66	0.4	38670	20.7
RSG-038	0.7	2.0	3260	5.4	84	2.8	25.1	0.2	0.5	160	6.6	32063	9.9
RSG-039	0.8	1.3	2643	5.3	99	4.3	29.6	0.2	0.2	161	13.5	33085	12.7
RSG-041	1.1	1.8	3536	7.9	107	2.8	40.4	0.2	0.6	405	2.0	46142	21.3
RSG-042	1.0	0.8	1220	6.0	71	1.0	40.4	0.2	0.2	202	2.3	36000	23.2
Std Dev	0.2	0.6	1211	1.0	7.5	2.4	8.3	0.0	0.1	169.7	3.2	11973	3.1
% Mean	0.2	0.4	0.5	0.2	0.1	0.7	0.2	0.1	0.2	0.7	1.3	0.3	0.1
RSG-008	1.1	1.1	1918	4.6	90	5.3	41.7	0.2	0.3	285.4	0.7	22513	19.5
RSG-011	1.4	1.0	1933	5.4	108	0.6	57.6	0.2	0.5	142.3	0.5	52572	26.1
RSG-012	1.1	1.9	4142	7.4	101	6.3	41.2	0.2	0.3	96.2	1.6	25678	25.4
RSG-015	1.0	1.1	1496	6.2	103	1.6	40.2	0.3	0.4	529.4	1.2	39525	23.7
RSG-040	1.0	2.2	3773	5.9	92	3.2	35.6	0.2	0.5	222.8	8.2	33768	19.8

ID NUM	Ni	P	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	%	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	ppb	ppm	%	ppm
Std Dev	4.0	0.0	3.5	146.1	0.1	1.5	387	0.8	158.2	0.9	157.2	5.9	0.0	90.2
% Mean	0.3	0.4	1.0	1.0	0.3	0.3	0.4	0.2	0.3	1.3	0.3	0.3	0.2	0.2
RSG-001	15.4	0.1	4.6	0	0.3	6.5	849	3.6	706	1.7	424	22.2	0.2	424
RSG-002	10.8	0.1	5.7	0	0.4	6.2	882	3.8	765	0.9	441	21.6	0.2	441
RSG-003	11.3	0.1	2.2	0	0.3	4.5	750	3.4	867	0.0	375	18.9	0.2	375
RSG-004	10.8	0.0	2.3	151	0.3	5.7	1015	3.6	398	0.0	508	25.9	0.2	643
RSG-005	5.9	0.0	19.7	553	0.3	5.1	2815	3.4	296	1.0	1175	6.5	0.1	489
RSG-006	19.9	0.1	3.8	467	0.3	8.0	970	5.8	352	0.0	485	34.8	0.1	485
RSG-007	5.0	0.0	2.9	363	0.3	3.6	1007	2.9	520	1.0	689	14.1	0.1	503
RSG-009	7.8	0.0	6.7	0	0.2	5.2	620	2.7	590	0.0	310	24.6	0.2	310
RSG-010	11.9	0.0	2.9	201	0.3	4.9	886	2.8	383	0.0	443	24.6	0.2	443
RSG-013	15.5	0.1	2.0	363	0.2	7.1	986	4.1	480	2.1	493	26.9	0.3	493
RSG-014	11.2	0.1	3.9	0	0.3	5.4	911	3.5	714	0.0	455	23.3	0.2	455
RSG-016	9.9	0.1	2.1	185	0.4	5.2	1145	4.7	474	1.2	572	14.8	0.2	650
RSG-017	11.4	0.1	5.5	0	0.2	6.3	853	3.7	625	0.0	426	22.8	0.2	426
RSG-018	9.5	0.0	2.4	189	0.3	4.0	1038	2.9	374	0.0	519	15.8	0.2	674
RSG-019	11.8	0.0	1.6	127	0.2	7.5	840	3.9	317	1.8	420	25.4	0.2	599
RSG-020	13.6	0.1	4.8	88	0.5	5.6	947	3.2	393	0.0	473	25.3	0.2	473
RSG-021	12.0	0.1	2.2	43	0.2	6.4	842	3.9	382	1.7	421	26.5	0.1	421
RSG-022	17.9	0.1	1.7	137	0.3	6.6	1003	3.3	416	0.0	501	25.2	0.2	501
RSG-023	10.8	0.1	2.7	193	0.4	5.2	1181	4.7	427	2.4	590	18.1	0.3	590
RSG-024	23.3	0.1	1.2	95	0.0	6.4	830	3.3	699	0.0	415	26.7	0.2	415
RSG-035	11.8	0.1	2.6	177	0.3	4.3	951	3.4	384	0.0	475	13.7	0.2	475
RSG-036	11.9	0.0	2.1	174	0.2	3.4	909	2.8	299	1.8	454	17.4	0.1	454
RSG-037	8.3	0.1	2.9	0	0.2	1.7	757	3.1	611	0.0	378	22.3	0.2	378
RSG-038	10.8	0.0	1.4	135	0.2	3.9	832	2.1	405	0.0	416	14.4	0.2	416
RSG-039	8.5	0.0	4.3	180	0.2	3.0	997	2.1	332	2.1	499	20.1	0.1	499
RSG-041	12.3	0.1	3.3	123	0.4	4.3	1061	3.7	363	0.0	531	20.2	0.2	531
RSG-042	9.0	0.0	0.9	28	0.2	4.0	712	3.9	533	0.0	356	13.5	0.2	356
Std Dev	2.0	0.0	1.0	75	0.1	0.3	73	0.6	125	0.9	36.7	3.0	0.0	37
% Mean	0.2	0.3	0.3	0.4	0.2	0.1	0.1	0.2	0.3	0.7	0.1	0.2	0.2	0.1
RSG-008	6.5	0.0	3.2	232	0.3	3.6	903	3.9	420	0.0	451	13.9	0.2	451
RSG-011	9.8	0.1	2.0	104	0.3	4.2	1078	5.0	630	2.2	539	16.3	0.2	539
RSG-012	6.3	0.1	4.4	275	0.3	3.9	1014	3.6	369	1.1	507	14.8	0.2	507
RSG-015	8.3	0.1	3.6	114	0.3	3.5	1028	4.0	298	2.1	514	9.8	0.1	514
RSG-040	10.9	0.1	2.3	149	0.4	4.3	926	3.4	386	1.0	462	17.8	0.2	462

ID NUM	U	V	W	Y	Yb	Zn
Units	ppm	ppm	ppm	ppm	ppm	ppm
Std Dev	5.3	24.7	30.3	2.5	0.3	11.4
% Mean	0.6	0.4	2.1	0.3	0.2	0.6
RSG-001	6.2	57.3	0.0	9.4	1.5	13.3
RSG-002	8.1	73.9	0.0	9.9	1.4	11.7
RSG-003	8.3	70.3	0.0	12.1	1.4	7.7
RSG-004	6.0	59.3	0.0	6.5	1.4	26.2
RSG-005	2.4	49.4	14.8	1.0	1.1	5.1
RSG-006	10.9	65.5	0.0	12.9	2.2	37.2
RSG-007	15.1	35.2	120.8	6.0	1.2	8.6
RSG-009	31.1	151.5	25.2	7.1	1.3	6.3
RSG-010	13.7	56.6	9.1	5.5	1.1	23.6
RSG-013	6.5	62.1	96.3	8.3	1.6	7.4
RSG-014	5.9	44.8	14.9	7.5	1.2	6.0
RSG-016	5.2	65.4	0.0	8.6	1.9	37.6
RSG-017	7.6	42.2	0.0	8.8	1.4	10.0
RSG-018	6.2	37.8	5.3	5.3	1.5	31.5
RSG-019	6.9	69.9	4.5	10.0	1.5	30.4
RSG-020	8.7	58.4	0.0	7.8	1.4	13.5
RSG-021	5.3	36.7	0.0	9.4	1.6	19.0
RSG-022	10.5	76.7	0.0	7.4	1.3	30.9
RSG-023	6.1	61.5	7.2	8.4	1.6	39.3
RSG-024	8.6	62.0	4.3	8.6	1.4	14.5
RSG-035	6.1	47.1	14.7	5.9	1.3	26.5
RSG-036	11.0	27.4	0.0	6.4	1.3	20.0
RSG-037	6.5	14.9	0.0	6.6	1.1	2.7
RSG-038	4.6	44.0	0.0	3.6	0.9	22.7
RSG-039	4.5	27.5	5.3	4.2	1.1	23.0
RSG-041	5.2	49.4	5.6	5.6	1.6	29.1
RSG-042	8.2	39.7	64.4	6.0	1.4	4.9
Std Dev	1.9	8.7	39.0	2.4	0.4	16.8
% Mean	0.3	0.2	1.3	0.3	0.3	0.6
RSG-008	7.1	36.1	17.6	7.4	1.1	28.4
RSG-011	6.0	39.1	42.4	7.6	1.6	9.4
RSG-012	7.3	42.3	93.0	6.3	1.1	42.0
RSG-015	2.8	25.8	0.0	11.4	2.1	8.1
RSG-040	4.9	49.5	0.0	5.0	1.4	42.7

APPENDIX F

Probability Enrichment/Depletion Data

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Cd	Ce	Cr	Cs
Fresh S.D.	0.41	0.00	1.90	0.06	193	14.6	0.13	2.18	0.04	0.04	55	61	1.70
Frsh Mean	0.32	6.00	2.97	0.83	466	19.4	0.23	4.93	0.11	0.21	189	174	3.87
MOR-001	98%	0%	0%	100%	0%	0%	88%	-75%	-83%	-50%	0%	0%	-83%
MOR-002	50%	0%	-50%	86%	0%	50%	50%	-50%	0%	0%	-88%	0%	0%
MOR-003	0%	0%	-50%	96%	0%	0%	0%	0%	0%	50%	-80%	0%	0%
MOR-004	0%	0%	-50%	100%	0%	90%	50%	0%	0%	0%	-67%	0%	0%
MOR-005	0%	0%	-50%	93%	0%	67%	0%	50%	94%	99%	0%	0%	0%
MOR-006	0%	0%	-67%	100%	0%	0%	0%	0%	0%	0%	-75%	0%	0%
MOR-007	75%	0%	0%	100%	-50%	50%	94%	-50%	0%	0%	-88%	0%	-83%
MOR-008	67%	0%	0%	100%	0%	0%	-67%	0%	-50%	86%	0%	0%	0%
MOR-009	50%	0%	0%	0%	-50%	0%	0%	0%	0%	0%	0%	0%	0%
MOR-010	0%	0%	50%	100%	-50%	0%	100%	0%	-50%	0%	-50%	0%	0%
MOR-011	0%	0%	0%	100%	50%	0%	-50%	-83%	-83%	-90%	0%	0%	-83%
MOR-012	0%	0%	98%	-97%	80%	0%	0%	0%	92%	0%	0%	0%	99%
MOR-013*	0%	0%	-50%	100%	0%	-67%	99%	-83%	-67%	-90%	-80%	94%	-83%
MOR-015*	0%	0%	-50%	100%	0%	-67%	97%	-83%	-67%	-90%	0%	67%	0%
MOR-017*	0%	0%	-50%	100%	0%	0%	98%	0%	67%	-86%	0%	83%	0%
MOR-018*	0%	0%	-50%	0%	0%	-50%	0%	-50%	0%	-50%	50%	50%	0%
MOR-020	0%	0%	0%	-99%	0%	0%	0%	50%	0%	0%	0%	0%	50%
MOR-021*	0%	0%	80%	-97%	50%	0%	0%	50%	50%	0%	67%	50%	97%
MOR-021	0%	0%	0%	-50%	0%	0%	-50%	0%	50%	0%	0%	0%	50%
MOR-031*	0%	0%	0%	-98%	0%	-50%	0%	-50%	-67%	0%	0%	0%	67%
MOR-032*	0%	0%	0%	-95%	75%	-50%	0%	0%	67%	0%	50%	50%	75%

Element	Cu	Eu	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn	Mo
Fresh S.D.	25.6	0.75	0.32	1.58	1.3	0.03	1.7	10.7	0.39	0.01	97	0.47
Fresh Mean	31.6	1.30	1.63	2.41	18.8	0.04	5.8	75.5	2.40	0.04	107	1.97
MOR-001	50%	0%	88%	0%	-95%	0%	0%	0%	-67%	100%	0%	67%
MOR-002	0%	-50%	-91%	0%	0%	0%	0%	-97%	0%	98%	0%	0%
MOR-003	0%	0%	50%	0%	50%	-50%	0%	0%	0%	99%	0%	-67%
MOR-004	0%	0%	-75%	0%	93%	-50%	0%	-95%	0%	-50%	0%	90%
MOR-005	50%	0%	50%	86%	95%	-50%	0%	98%	75%	99%	88%	83%
MOR-006	0%	0%	67%	0%	-50%	0%	0%	0%	0%	91%	0%	-50%
MOR-007	0%	-75%	0%	0%	0%	0%	0%	-97%	-50%	100%	0%	98%
MOR-008	50%	0%	91%	0%	90%	-50%	0%	0%	0%	94%	0%	0%
MOR-009	0%	-50%	-50%	0%	0%	0%	0%	-50%	0%	0%	0%	0%
MOR-010	0%	0%	0%	0%	-50%	-50%	0%	-80%	80%	-50%	0%	96%
MOR-011	100%	0%	0%	-50%	-67%	0%	83%	0%	-75%	97%	0%	94%
MOR-012	0%	0%	0%	0%	-88%	-50%	0%	50%	0%	99%	95%	0%
MOR-013*	0%	0%	-50%	-50%	0%	50%	-67%	-94%	-67%	99%	0%	50%
MOR-015*	80%	50%	-80%	0%	0%	50%	0%	0%	0%	99%	0%	96%
MOR-017*	80%	0%	0%	0%	0%	67%	0%	50%	0%	98%	0%	96%
MOR-018*	0%	0%	0%	0%	-50%	50%	0%	0%	50%	50%	0%	0%
MOR-020	-50%	0%	0%	0%	80%	-50%	67%	50%	-50%	0%	50%	50%
MOR-021*	-50%	0%	92%	80%	80%	67%	0%	95%	0%	96%	75%	0%
MOR-021	-50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	50%	50%
MOR-031*	0%	0%	-67%	-50%	-97%	50%	0%	0%	-75%	99%	0%	-90%
MOR-032*	0%	67%	67%	67%	0%	75%	0%	93%	0%	100%	0%	-50%

Element	Na	Nd	P	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Te
Fresh S.D.	0.29	25.5	0.00	10.0	52	0.21	1.20	0.14	7.87	9.7	0.80	0.19
Fresh Mean	2.21	54.6	0.01	15.9	259	0.23	3.21	0.92	12.81	32.1	3.55	0.17
MOR-001	-98%	0%	0%	0%	-75%	0%	0%	0%	0%	0%	0%	80%
MOR-002	-89%	-67%	-50%	0%	0%	0%	0%	0%	-50%	67%	67%	0%
MOR-003	75%	0%	0%	0%	50%	0%	0%	50%	0%	67%	86%	0%
MOR-004	0%	-50%	0%	99%	0%	0%	0%	0%	0%	0%	0%	0%
MOR-005	86%	67%	0%	0%	0%	0%	50%	83%	50%	0%	-95%	0%
MOR-006	50%	0%	0%	-50%	0%	0%	0%	50%	0%	0%	50%	0%
MOR-007	0%	-75%	-67%	0%	0%	0%	0%	75%	-50%	0%	75%	50%
MOR-008	-89%	0%	0%	67%	0%	0%	0%	0%	0%	80%	93%	0%
MOR-009	50%	0%	-50%	0%	0%	-50%	-50%	50%	0%	0%	50%	0%
MOR-010	0%	0%	-50%	0%	0%	0%	0%	0%	0%	-80%	75%	67%
MOR-011	0%	0%	0%	0%	-80%	0%	0%	0%	0%	97%	0%	0%
MOR-012	0%	0%	92%	0%	0%	98%	75%	0%	0%	83%	75%	0%
MOR-013*	-98%	-50%	0%	-67%	-83%	0%	0%	0%	0%	-75%	0%	50%
MOR-015*	-95%	0%	0%	-50%	0%	0%	0%	0%	0%	0%	-50%	80%
MOR-017*	0%	0%	0%	-50%	0%	67%	0%	0%	0%	0%	0%	95%
MOR-018*	0%	50%	0%	0%	-50%	0%	0%	0%	50%	0%	0%	50%
MOR-020	0%	0%	0%	50%	0%	50%	0%	0%	0%	50%	0%	0%
MOR-021*	67%	67%	0%	75%	0%	94%	50%	0%	0%	0%	0%	67%
MOR-021	0%	0%	0%	50%	0%	0%	0%	0%	0%	50%	0%	0%
MOR-031*	-95%	0%	0%	-50%	0%	0%	0%	-50%	0%	0%	-67%	50%
MOR-032*	86%	0%	80%	67%	0%	0%	91%	50%	0%	75%	0%	75%

Element	Th	Ti	Tl	U	V	W	Y	Zn
Fresh S.D.	14.3	0.05	0.07	0.96	1.37	3.59	24.9	31.5
Fresh Mean	36.8	0.09	0.46	6.78	2.49	0.17	18.0	39.3
MOR-001	-75%	0%	0%	-91%	91%	75%	0%	0%
MOR-002	-50%	0%	0%	0%	-50%	50%	0%	50%
MOR-003	0%	0%	50%	0%	0%	0%	0%	92%
MOR-004	0%	0%	0%	0%	-50%	50%	0%	0%
MOR-005	0%	0%	83%	50%	0%	86%	0%	89%
MOR-006	0%	0%	50%	0%	0%	0%	0%	0%
MOR-007	-50%	0%	75%	0%	0%	80%	0%	0%
MOR-008	0%	0%	0%	-67%	-50%	0%	0%	0%
MOR-009	50%	0%	50%	0%	-50%	0%	0%	0%
MOR-010	0%	0%	0%	50%	-50%	50%	0%	0%
MOR-011	0%	0%	0%	-92%	98%	83%	0%	-50%
MOR-012	0%	0%	0%	-80%	98%	88%	0%	67%
MOR-013*	-50%	0%	0%	-92%	50%	83%	0%	-50%
MOR-015*	0%	0%	0%	-86%	0%	80%	50%	0%
MOR-017*	0%	0%	0%	0%	-50%	88%	0%	0%
MOR-018*	0%	0%	0%	50%	0%	0%	50%	0%
MOR-020	0%	50%	0%	-80%	67%	67%	0%	0%
MOR-021*	0%	75%	0%	-50%	92%	-50%	0%	83%
MOR-021	0%	50%	0%	0%	0%	50%	0%	50%
MOR-031*	0%	0%	-50%	-94%	94%	90%	0%	0%
MOR-032*	0%	67%	50%	0%	0%	-50%	0%	50%

Element	Ag	Al	As	Au	Ba	Be	Bi	Br	Ca	Ce	Co	Cr
Std Dev	0.01	0.01	1.05	0.01	451	0.00	0.00	1.87	0.13	14.7	3.30	19
Average	0.04	7.94	3.01	0.00	1014	0.00	0.00	1.08	3.88	48.3	10.6	105
ANN-001	0%	0%	50%	100%	0%	0%	0%	67%	0%	0%	0%	0%
ANN-002	67%	0%	0%	100%	50%	0%	0%	67%	0%	50%	0%	83%
ANN-003	0%	0%	0%	0%	0%	0%	0%	0%	-50%	0%	50%	0%
ANN-004	-50%	0%	83%	0%	0%	0%	0%	67%	75%	0%	0%	89%
ANN-006	50%	0%	89%	100%	0%	0%	0%	83%	0%	0%	0%	88%
ANN-008	-50%	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
ANN-009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%
ANN-011	0%	0%	0%	0%	0%	0%	0%	0%	-50%	50%	0%	93%
ANN-015	0%	0%	0%	0%	-75%	100%	0%	0%	99%	-50%	-50%	-88%
ANN--017	0%	0%	-50%	0%	0%	0%	0%	0%	0%	-50%	0%	-50%
ANN-020	0%	0%	0%	0%	-50%	0%	0%	0%	-92%	-50%	-67%	-90%
ANN-021	0%	0%	0%	0%	0%	0%	0%	0%	-86%	0%	0%	88%
ANN-022	0%	0%	0%	0%	0%	0%	100%	0%	-97%	0%	0%	0%
ANN-023	0%	0%	0%	0%	-75%	0%	0%	0%	99%	0%	0%	0%
ANN-024	0%	0%	0%	0%	-50%	0%	0%	0%	98%	0%	0%	0%
ANN-026	0%	0%	0%	0%	-50%	0%	0%	0%	99%	0%	0%	-67%
ANN-027	95%	0%	0%	0%	0%	0%	0%	0%	-67%	0%	0%	50%
ANN-028	0%	0%	89%	100%	-50%	100%	100%	0%	99%	0%	0%	-93%
ANN-029	-67%	0%	0%	100%	-75%	0%	0%	0%	98%	0%	0%	0%
ANN-031	0%	0%	94%	100%	0%	0%	100%	0%	-100%	0%	-91%	75%
ANN-038	0%	0%	-50%	0%	0%	0%	0%	0%	0%	0%	0%	89%
ANN-043	83%	0%	50%	0%	0%	0%	0%	67%	-92%	0%	0%	86%
ANN-044	0%	0%	50%	0%	0%	0%	100%	0%	-100%	0%	-91%	98%
ANN-046	0%	0%	100%	0%	0%	0%	100%	0%	-100%	-67%	-91%	96%
ANN-049	97%	0%	0%	0%	0%	100%	0%	50%	-100%	0%	-91%	98%
ANN-054	83%	0%	67%	100%	0%	0%	0%	83%	-99%	50%	0%	99%
ANN-055	86%	0%	91%	0%	0%	100%	100%	0%	-100%	0%	-91%	95%
ANN-059	86%	0%	100%	0%	0%	100%	100%	0%	-100%	0%	-91%	99%
ANN-065	-80%	0%	-50%	0%	-75%	100%	0%	0%	99%	0%	0%	0%

Element	Cs	Cu	Eu	Fe	Ga	Hf	Hg	K	La	Lu	Mg	Mn
Std Dev	0.01	25.3	0.48	1.15	0.27	1.57	0.07	0.29	6.7	0.14	0.15	82
Average	0.00	41.8	1.21	3.45	3.16	4.36	0.04	2.50	23.4	0.14	1.69	581
ANN-001	100%	80%	0%	0%	50%	0%	0%	0%	0%	0%	-50%	80%
ANN-002	0%	0%	0%	0%	0%	0%	50%	50%	67%	0%	0%	0%
ANN-003	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%
ANN-004	0%	-50%	0%	0%	0%	0%	0%	0%	0%	0%	-50%	0%
ANN-006	0%	0%	0%	0%	93%	0%	0%	86%	50%	50%	0%	0%
ANN-008	0%	-50%	0%	0%	0%	0%	0%	50%	0%	-50%	50%	-50%
ANN-009	0%	67%	0%	0%	97%	0%	50%	75%	50%	0%	0%	0%
ANN-011	0%	0%	0%	0%	50%	0%	50%	0%	50%	50%	-75%	0%
ANN-015	0%	88%	0%	-67%	-98%	-50%	0%	-98%	0%	0%	-50%	-67%
ANN--017	0%	0%	-50%	-50%	-50%	-50%	0%	0%	-50%	0%	0%	0%
ANN-020	0%	50%	0%	-50%	0%	-50%	0%	-67%	-50%	0%	0%	-75%
ANN-021	0%	0%	0%	0%	50%	0%	50%	0%	0%	0%	-50%	0%
ANN-022	0%	50%	0%	0%	0%	0%	0%	80%	50%	0%	-67%	-83%
ANN-023	0%	0%	0%	0%	-97%	0%	50%	-98%	0%	0%	67%	-75%
ANN-024	0%	98%	0%	0%	-50%	0%	0%	-97%	50%	50%	0%	-83%
ANN-026	0%	98%	0%	0%	-83%	0%	50%	-98%	0%	0%	75%	-75%
ANN-027	100%	91%	0%	0%	0%	0%	0%	0%	0%	0%	-75%	67%
ANN-028	0%	97%	50%	0%	-91%	-50%	0%	-96%	0%	0%	95%	-50%
ANN-029	0%	50%	0%	-50%	-96%	0%	0%	-98%	0%	0%	0%	-80%
ANN-031	0%	0%	0%	-75%	50%	0%	97%	-80%	0%	0%	-99%	-98%
ANN-038	0%	0%	0%	0%	-83%	0%	50%	0%	0%	0%	-67%	0%
ANN-043	100%	96%	0%	0%	88%	0%	50%	0%	50%	0%	-67%	0%
ANN-044	0%	-50%	0%	-80%	-99%	0%	50%	80%	50%	0%	-99%	-97%
ANN-046	0%	0%	-75%	-80%	-99%	0%	100%	93%	-67%	0%	-99%	-98%
ANN-049	100%	95%	0%	-50%	75%	50%	50%	95%	0%	0%	-98%	-67%
ANN-054	100%	96%	0%	0%	-95%	80%	50%	98%	67%	50%	-97%	0%
ANN-055	0%	0%	-50%	-67%	-99%	50%	95%	94%	0%	0%	-99%	-98%
ANN-059	100%	96%	0%	-67%	-96%	67%	67%	88%	50%	0%	-99%	-98%
ANN-065	0%	-50%	0%	-50%	-97%	0%	0%	-98%	0%	0%	-50%	-80%

Element	Mo	Na	Nd	Ni	P	Pb	Rb	Sb	Sc	Se	Sm	Sr
Std Dev	0.55	1.20	7.44	7.59	0.02	0.65	8.54	0.10	3.36	0.01	1.23	92.35
Average	1.92	3.11	22.14	26.15	0.15	4.56	56.7	0.46	8.58	0.00	3.77	1114
ANN-001	0%	0%	0%	0%	0%	96%	-98%	0%	0%	0%	0%	0%
ANN-002	0%	0%	0%	0%	0%	96%	98%	67%	0%	0%	50%	83%
ANN-003	50%	0%	0%	-50%	0%	50%	0%	50%	0%	0%	0%	-50%
ANN-004	0%	0%	0%	0%	0%	0%	67%	50%	0%	0%	0%	80%
ANN-006	86%	0%	0%	0%	0%	97%	99%	50%	0%	0%	0%	50%
ANN-008	0%	0%	50%	0%	50%	0%	50%	0%	0%	0%	0%	0%
ANN-009	0%	0%	0%	0%	0%	67%	50%	0%	0%	0%	0%	0%
ANN-011	0%	0%	0%	0%	0%	50%	-50%	0%	0%	0%	0%	0%
ANN-015	-50%	0%	-50%	0%	80%	-92%	-98%	0%	0%	0%	0%	-67%
ANN--017	0%	-50%	0%	0%	0%	0%	0%	0%	-50%	0%	-50%	0%
ANN-020	0%	0%	0%	0%	0%	-67%	-98%	0%	0%	0%	-50%	0%
ANN-021	50%	0%	0%	0%	0%	0%	0%	-50%	0%	0%	0%	0%
ANN-022	0%	0%	0%	0%	0%	-80%	89%	0%	0%	0%	0%	0%
ANN-023	0%	50%	0%	50%	50%	-94%	-80%	0%	0%	0%	0%	80%
ANN-024	0%	50%	0%	0%	0%	-89%	-98%	0%	0%	0%	0%	0%
ANN-026	-67%	50%	50%	0%	50%	-90%	-98%	-50%	0%	0%	0%	88%
ANN-027	0%	0%	0%	-50%	0%	98%	90%	0%	0%	0%	0%	0%
ANN-028	-67%	0%	0%	0%	83%	-96%	-98%	67%	75%	0%	50%	0%
ANN-029	0%	50%	0%	0%	0%	-88%	-98%	0%	0%	0%	0%	0%
ANN-031	88%	0%	0%	-83%	-93%	-94%	0%	0%	0%	100%	0%	-99%
ANN-038	0%	0%	0%	0%	0%	-50%	83%	-75%	0%	0%	0%	0%
ANN-043	80%	0%	0%	0%	0%	98%	-98%	0%	0%	0%	0%	0%
ANN-044	97%	0%	0%	-83%	-96%	-50%	96%	67%	-67%	0%	0%	-99%
ANN-046	97%	-67%	-67%	-86%	-97%	-97%	92%	50%	-50%	100%	-75%	-99%
ANN-049	97%	100%	0%	-67%	-93%	96%	99%	0%	-50%	0%	0%	-95%
ANN-054	97%	0%	0%	0%	-88%	99%	99%	50%	0%	0%	0%	-92%
ANN-055	100%	-75%	0%	-88%	-96%	-96%	98%	97%	-50%	100%	-50%	-99%
ANN-059	98%	0%	0%	-75%	-97%	0%	98%	99%	-67%	0%	0%	-99%
ANN-065	-50%	0%	0%	0%	0%	-96%	-98%	-75%	0%	0%	0%	50%

Element	Th	Ti	Tl	U	V	Y	Yb	Zn
Std Dev	2.27	0.07	0.03	1.41	14.16	0.82	0.38	8.84
Average	8.20	0.52	0.51	1.46	134	13.7	1.11	31.9
ANN-001	0%	0%	-50%	89%	0%	-50%	0%	75%
ANN-002	0%	0%	0%	67%	0%	0%	0%	0%
ANN-003	0%	0%	0%	-50%	0%	0%	0%	0%
ANN-004	0%	0%	97%	-50%	0%	-50%	0%	0%
ANN-006	50%	0%	97%	91%	0%	0%	0%	0%
ANN-008	0%	50%	50%	0%	50%	0%	0%	-50%
ANN-009	0%	0%	50%	67%	0%	0%	0%	0%
ANN-011	50%	0%	95%	88%	-50%	0%	0%	50%
ANN-015	0%	0%	75%	50%	0%	94%	0%	-86%
ANN--017	-50%	0%	0%	0%	0%	-50%	-50%	0%
ANN-020	-75%	0%	0%	0%	0%	-75%	-67%	-50%
ANN-021	0%	0%	-83%	50%	0%	-50%	0%	50%
ANN-022	0%	0%	-67%	0%	0%	-67%	0%	-50%
ANN-023	-67%	0%	94%	0%	0%	0%	0%	-80%
ANN-024	67%	0%	0%	75%	0%	50%	0%	-75%
ANN-026	-67%	50%	0%	0%	50%	-50%	0%	-75%
ANN-027	0%	0%	0%	67%	-67%	0%	0%	80%
ANN-028	-50%	0%	0%	88%	80%	95%	0%	-88%
ANN-029	0%	0%	92%	67%	0%	0%	0%	-83%
ANN-031	-67%	-50%	-91%	67%	-88%	-99%	-50%	-88%
ANN-038	0%	0%	-50%	67%	0%	0%	0%	0%
ANN-043	0%	-50%	-67%	67%	-50%	0%	0%	0%
ANN-044	98%	-96%	98%	93%	-98%	-99%	0%	-88%
ANN-046	-75%	-96%	-88%	0%	-93%	-99%	-67%	-92%
ANN-049	96%	-93%	99%	94%	-97%	-95%	0%	75%
ANN-054	97%	-80%	99%	91%	-92%	0%	0%	90%
ANN-055	0%	-96%	-86%	89%	-97%	-100%	0%	-92%
ANN-059	99%	-95%	99%	97%	-97%	-99%	0%	-80%
ANN-065	-67%	0%	-96%	0%	-75%	-94%	0%	-88%

ID NUM	Ag	Al	As	Au	Ba	Be	Bi	Ca	Cd	Cr	Cs	Cu
Std Dev	0.13	0.00	0.09	0.00	211	1.14	24	0.74	8.8	29	1.26	227
Average	0.1	7.2	0.9	0.0	806	1.3	237	2.3	94.5	197	4.6	137
RSG-001	0%	0%	97%	-75%	-91%	0%	-50%	83%	-50%	0%	-93%	0%
RSG-002	0%	0%	80%	-50%	-93%	0%	0%	90%	0%	0%	-93%	0%
RSG-003	0%	0%	-50%	-89%	-93%	-50%	-80%	99%	-80%	0%	-93%	0%
RSG-004	83%	0%	0%	0%	50%	0%	0%	0%	0%	0%	67%	0%
RSG-005	80%	0%	100%	0%	99%	-50%	100%	-90%	0%	-96%	75%	0%
RSG-006	0%	0%	0%	0%	99%	-50%	0%	0%	0%	-90%	94%	0%
RSG-007	75%	0%	0%	0%	93%	0%	100%	-86%	0%	-94%	0%	0%
RSG-009	0%	0%	-92%	-94%	-89%	88%	100%	93%	-93%	-97%	-93%	0%
RSG-010	0%	0%	0%	-50%	0%	0%	0%	0%	0%	0%	0%	67%
RSG-013	0%	0%	0%	0%	-75%	98%	0%	67%	0%	-95%	0%	0%
RSG-014	0%	0%	0%	0%	-91%	93%	0%	67%	0%	-50%	-93%	0%
RSG-016	91%	0%	80%	97%	86%	50%	80%	0%	83%	86%	0%	67%
RSG-017	0%	0%	0%	99%	-93%	50%	0%	88%	-50%	-89%	-93%	0%
RSG-018	67%	0%	96%	0%	50%	0%	99%	0%	80%	0%	-50%	92%
RSG-019	0%	0%	-50%	-50%	-50%	0%	-50%	0%	-50%	0%	0%	0%
RSG-020	0%	0%	0%	0%	-75%	-50%	0%	50%	0%	-80%	-80%	0%
RSG-021	0%	0%	-50%	-75%	-91%	50%	-50%	0%	-50%	-97%	-93%	0%
RSG-022	0%	0%	0%	0%	0%	-50%	0%	0%	0%	50%	0%	0%
RSG-023	0%	0%	86%	83%	67%	0%	86%	0%	88%	92%	0%	0%
RSG-024	0%	0%	-50%	-67%	-88%	50%	-50%	67%	-50%	0%	0%	0%
RSG-035	99%	0%	0%	100%	0%	0%	98%	0%	98%	-50%	0%	95%
RSG-036	75%	0%	0%	97%	0%	0%	0%	-50%	0%	0%	0%	67%
RSG-037	0%	0%	-80%	-80%	-91%	75%	-80%	50%	-80%	-67%	-93%	0%
RSG-038	88%	0%	-50%	-50%	0%	0%	-50%	0%	0%	0%	0%	75%
RSG-039	50%	0%	0%	0%	0%	0%	0%	-50%	0%	0%	-50%	50%
RSG-041	0%	0%	50%	50%	0%	0%	50%	-67%	50%	0%	0%	0%
RSG-042	0%	0%	-86%	-90%	-89%	97%	0%	67%	-88%	-96%	-93%	50%
Std Dev	0.02	0.01	1.00	0.00	100	0.50	250	0.01	100	0.10	0.72	0.06
Average	0.1	6.6	0.9	0.0	1482	1.9	621	1.4	90	111.2	1.9	6.2
RSG-008	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
RSG-011	80%	0%	0%	0%	-99%	96%	-50%	100%	0%	-100%	75%	100%
RSG-012	100%	0%	0%	0%	0%	86%	0%	-100%	0%	100%	75%	100%
RSG-015	0%	0%	0%	0%	-99%	0%	-50%	100%	0%	100%	98%	-99%
RSG-040	100%	0%	0%	0%	-97%	0%	-50%	100%	0%	100%	67%	100%

ID NUM	Eu	Fe	Ga	Hf	K	La	Lu	Mg	Mn	Mo	Na
Std Dev	0.16	0.80	820	0.10	0.87	5.80	0.03	0.39	183	7.58	2688
Average	1.0	2.2	3578	5.3	3.4	35.9	0.2	0.7	371	4.8	30820
RSG-001	0%	-67%	-93%	-75%	-93%	0%	0%	0%	0%	0%	92%
RSG-002	0%	0%	-91%	0%	-93%	50%	67%	0%	67%	0%	89%
RSG-003	-50%	67%	-90%	-98%	-94%	0%	0%	-50%	95%	0%	-99%
RSG-004	0%	0%	50%	0%	0%	67%	75%	0%	0%	0%	0%
RSG-005	-50%	50%	-93%	100%	99%	50%	-50%	-67%	-67%	100%	-99%
RSG-006	97%	0%	0%	100%	95%	97%	98%	50%	80%	0%	0%
RSG-007	0%	-67%	-50%	98%	94%	0%	0%	-67%	-67%	0%	-92%
RSG-009	99%	80%	0%	-100%	-93%	0%	-98%	0%	67%	0%	-83%
RSG-010	0%	0%	0%	67%	0%	97%	0%	0%	0%	0%	0%
RSG-013	89%	-67%	-92%	100%	94%	86%	0%	0%	0%	0%	0%
RSG-014	0%	-75%	-89%	99%	-93%	0%	0%	0%	67%	0%	98%
RSG-016	83%	0%	83%	100%	0%	0%	94%	0%	0%	0%	90%
RSG-017	0%	-50%	-86%	99%	-93%	50%	0%	0%	75%	0%	95%
RSG-018	67%	0%	0%	99%	0%	0%	0%	0%	-50%	0%	0%
RSG-019	0%	0%	0%	50%	0%	0%	50%	0%	0%	0%	-50%
RSG-020	0%	0%	0%	96%	-80%	0%	0%	0%	0%	0%	86%
RSG-021	0%	-67%	-50%	98%	-92%	-75%	80%	98%	0%	0%	96%
RSG-022	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
RSG-023	89%	0%	83%	100%	0%	83%	0%	0%	0%	0%	92%
RSG-024	0%	0%	-75%	-67%	-89%	50%	0%	0%	0%	0%	50%
RSG-035	50%	0%	0%	97%	0%	0%	0%	0%	0%	67%	0%
RSG-036	-50%	0%	-50%	67%	0%	0%	50%	0%	0%	0%	0%
RSG-037	-50%	-86%	-94%	-93%	-93%	50%	0%	-67%	-67%	0%	89%
RSG-038	-75%	0%	0%	0%	0%	-75%	-50%	0%	-50%	0%	0%
RSG-039	0%	-50%	-50%	0%	50%	-50%	0%	-50%	-50%	50%	0%
RSG-041	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	97%
RSG-042	0%	-75%	-89%	98%	-88%	0%	0%	-50%	0%	0%	75%
Std Dev	0.23	0.06	0.06	0.22	0.05	0.07	0.25	0.07	0.05	0.07	0.07
Average	1.1	1.1	1918	4.6	5.3	41.7	0.2	0.3	285.4	0.7	22513
RSG-008	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
RSG-011	50%	-88%	100%	93%	-100%	100%	0%	86%	-100%	-94%	100%
RSG-012	0%	99%	100%	99%	100%	-98%	0%	0%	-100%	99%	100%
RSG-015	0%	-50%	-100%	98%	-100%	-100%	0%	0%	100%	98%	100%
RSG-040	0%	100%	100%	97%	-100%	-100%	0%	88%	-100%	100%	100%

ID NUM	Nd	Ni	P	Pb	Rb	Sb	Se	Sr	Te	Th	Ti
Std Dev	3.93	4.77	0.01	1.55	28	0.02	92	54	46	3.02	0.07
Average	17.2	12.7	0.0	2.5	148	0.2	946	355	473	23.6	0.2
RSG-001	67%	0%	0%	50%	-96%	93%	-50%	98%	-50%	0%	0%
RSG-002	0%	0%	67%	80%	-96%	97%	0%	98%	0%	0%	0%
RSG-003	75%	0%	0%	0%	-96%	89%	-80%	99%	-80%	-67%	0%
RSG-004	0%	0%	0%	0%	0%	91%	0%	0%	0%	0%	0%
RSG-005	75%	-67%	-91%	99%	100%	92%	100%	-50%	100%	-97%	-50%
RSG-006	91%	67%	93%	0%	99%	67%	0%	0%	0%	93%	0%
RSG-007	0%	-67%	-50%	0%	98%	95%	0%	90%	95%	-90%	0%
RSG-009	0%	-50%	0%	88%	-96%	0%	-92%	95%	-92%	0%	0%
RSG-010	0%	0%	0%	0%	75%	50%	0%	0%	0%	0%	0%
RSG-013	67%	0%	92%	0%	98%	0%	0%	83%	0%	50%	0%
RSG-014	0%	0%	0%	0%	-96%	94%	0%	98%	0%	0%	0%
RSG-016	75%	0%	88%	0%	50%	98%	80%	80%	80%	-89%	0%
RSG-017	0%	0%	67%	75%	-96%	0%	-50%	96%	-50%	0%	0%
RSG-018	0%	0%	0%	0%	67%	0%	0%	0%	0%	-86%	0%
RSG-019	0%	0%	0%	0%	0%	-50%	-50%	0%	-50%	0%	0%
RSG-020	0%	0%	0%	67%	-80%	99%	0%	0%	0%	0%	0%
RSG-021	0%	0%	80%	0%	-93%	-50%	-50%	0%	-50%	0%	0%
RSG-022	0%	50%	0%	0%	0%	0%	0%	50%	0%	0%	0%
RSG-023	0%	0%	99%	0%	67%	97%	86%	50%	86%	-75%	0%
RSG-024	0%	80%	0%	0%	-75%	-99%	-50%	98%	-50%	50%	0%
RSG-035	0%	0%	67%	0%	50%	94%	0%	0%	0%	-91%	0%
RSG-036	0%	0%	-50%	0%	0%	0%	0%	-50%	0%	-80%	0%
RSG-037	0%	0%	0%	0%	-96%	-50%	-80%	96%	-80%	0%	0%
RSG-038	-75%	0%	0%	0%	0%	-50%	-50%	0%	-50%	-90%	0%
RSG-039	-50%	0%	-50%	50%	50%	0%	0%	0%	0%	-50%	-50%
RSG-041	50%	0%	0%	0%	0%	96%	50%	0%	50%	-50%	0%
RSG-042	67%	0%	0%	-50%	-95%	-86%	-86%	92%	-86%	-92%	0%

Std Dev	0.30	0.13	0.23	0.06	0.26	0.07	1.08	0.05	1.08	0.07	0.10
Average	19.5	6.5	0.0	3.2	231.6	0.3	903	420	451.2	13.9	0.2
RSG-008	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
RSG-011	100%	100%	0%	-100%	-100%	0%	100%	100%	100%	100%	0%
RSG-012	100%	-50%	0%	100%	100%	0%	100%	-100%	100%	99%	0%
RSG-015	100%	99%	0%	97%	-100%	0%	100%	-100%	100%	-100%	0%
RSG-040	50%	100%	0%	-99%	-100%	67%	100%	-100%	99%	100%	0%

ID NUM	Tl	U	V	W	Y	Yb	Zn
Std Dev	57	3.00	26.66	2.86	2.88	0.20	4.39
Average	533	7.3	58.0	3.3	7.2	1.3	28.1
RSG-001	-75%	0%	0%	-50%	0%	50%	-92%
RSG-002	-67%	0%	0%	-50%	0%	0%	-93%
RSG-003	-88%	0%	0%	-50%	67%	0%	-95%
RSG-004	75%	0%	0%	-50%	0%	0%	0%
RSG-005	0%	-67%	0%	94%	-80%	-50%	-96%
RSG-006	0%	50%	0%	-50%	75%	95%	80%
RSG-007	0%	86%	0%	100%	0%	0%	-95%
RSG-009	-94%	98%	92%	98%	0%	0%	-96%
RSG-010	-67%	80%	0%	80%	0%	0%	-50%
RSG-013	0%	0%	0%	100%	0%	67%	-96%
RSG-014	-50%	0%	0%	94%	0%	0%	-96%
RSG-016	80%	0%	0%	-50%	0%	91%	80%
RSG-017	-75%	0%	0%	-50%	0%	0%	-94%
RSG-018	86%	0%	0%	0%	0%	50%	0%
RSG-019	50%	0%	0%	0%	0%	0%	0%
RSG-020	-50%	0%	0%	-50%	0%	0%	-92%
RSG-021	-75%	0%	0%	-50%	0%	75%	-80%
RSG-022	0%	50%	0%	-50%	0%	0%	0%
RSG-023	50%	0%	0%	50%	0%	67%	86%
RSG-024	-80%	0%	0%	0%	0%	0%	-90%
RSG-035	-50%	0%	0%	94%	0%	0%	0%
RSG-036	-50%	50%	-50%	-50%	0%	0%	-75%
RSG-037	-88%	0%	-67%	-50%	0%	0%	-97%
RSG-038	-80%	0%	0%	-50%	-50%	-67%	-50%
RSG-039	0%	0%	-50%	0%	-50%	-50%	-50%
RSG-041	0%	0%	0%	0%	0%	67%	0%
RSG-042	-90%	0%	0%	100%	0%	0%	-96%
Std Dev	1.07	0.12	0.07	0.85	0.30	0.09	0.10
Average	451.2	7.1	36.1	17.6	7.4	1.1	28.4
RSG-008	0%	0%	0%	0%	0%	0%	0%
RSG-011	100%	-99%	100%	100%	0%	97%	-100%
RSG-012	100%	50%	100%	100%	-92%	0%	100%
RSG-015	100%	-100%	-100%	-100%	99%	99%	-100%
RSG-040	99%	-100%	100%	-100%	-99%	94%	100%