PARTICLE SIZE AND MMI™

INTRODUCTION

It is believed that MMI™ solutions detach weakly bound elements from substrate(s) in a soil (Mann et al. 1998). It is a manner of conjecturer whether this involves desorption of surface adsorbed species or results from partial dissolution of one or more phases which may or may not include organics and/or amorphous iron oxides. Sieving and analysing the fine fraction of samples is one way to obtain more information about this process – the fine fraction might be expected to contain higher concentrations of "Weakly bound elements" if surface adsorption were the dominant process.

The prospect used in this study is believed to be Mississippi style Pb/Zn in Nova Scotia. The weak soil anomaly lies in the north east of a known deposit and economic mineralization. Soils were from till.

EXPERIMENTAL

In this study 97 samples from the program were split – part of the sample was sieved to minus 150 mesh in a nylon sieve to obtain a 50g charge. A 50g sample of the (un-sieved) portion was analysed in parallel. Of the 97 samples examined, one sample had insufficient material from the fine fraction and this sample was not used in the comparison.

Each sample in each sample batch was subjected to an identical solution of MMI-M, and the extracted solutions were analysed on an ICP-MS (SGS Toronto laboratory) for 46 elements: Ag, Al, As, Au, Bi, Ba, Ca, Cd, Ce, Co, Cr, Cu, Dy, Er, Eu, Fe, Gd, La, Li, Mg, Mo, Nb, Nd, Ni, Pb, Pd, Pr, Pt, Rb, Sb, Sc, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, U, W, Y, Yb, Zn and Zr.

RESULTS

Three separate statistical investigations of the data have been made:

Correlation Coefficients

Correlation coefficient calculations support the initial visual inspection of the data base that for most elements involved, the sieved and untreated samples are similar in magnitude and vary systematically within the data set. Correlation coefficients for the elements are shown in Table 1 (n.b. For some elements e.g. Pt, Te there were insufficient data above L.D.L. to allow for comparison.

For all elements, there is a positive degree of correlation between the sieved and

Table 1: Correlation Coefficients Between Minus 150 Mesh Sieved Samples and Untreated MMI™ Samples for Various Elements

Element	Corr. Coeff.	Element	Corr. Coeff.	Element	Corr. Coeff.
Ag	0.66	Fe	0.79	Sm	0.64
Al	0.78	Gd	0.67	Sn	0.40
As	0.65	La	0.78	Sr	0.73
Au	0.96	Li	0.43	Ta	0.37
Ba	0.26	Mg	0.68	Tb	0.75
Bi	0.53	Mo	0.25	Th	0.84
Ca	0.62	Nb	0.66	Ti	0.71
Cd	0.53	Nd	0.61	Tl	0.43
Ce	0.86	Ni	0.80	U	0.51
Co	0.47	Pb	0.25	W	0.38
Cr	0.65	Pd	0.44	Y	0.68
Cu	0.46	Pr	0.67	Yb	0.71
Dy	0.78	Rb	0.68	Zn	0.62
Er	0.76	Sb	0.27	Zr	0.82
Eu	0.67	Sc	0.71		

Table 2: Percentage Differences for Means of Element Values in -150 Mesh and Untreated Samples (Negative % = Higher Mean for -150 Mesh, Positive % = Higher Mean in Untreated Samples)

Element	Mean Diff. %	Element	Mean Diff. %	Element	Mean Diff. %
Ag	-10.76	Fe	+5.07	Sm	+15.54
Al	+10.50	Gd	+14.29	Sn	+8.78
As	+14.95	La	+16.62	Sr	-19.22
Au	-1.76	Li	+5.32	Ta	+8.29
Ba	-10.46	Mg	-20.12	Tb	+7.04
Bi	+4.00	Mo	+11.62	Th	-6.60
Ca	-10.09	Nb	+17.66	Ti	+21.87
Cd	-8.57	Nd	+17.32	Tl	-9.10
Ce	+19.20	Ni	+6.05	U	-24.75
Co	-6.47	Pb	+8.11	W	+10.34
Cr	+3.33	Pd	-19.74	Y	+4.56
Cu	-1.45	Pr	+15.39	Yb	-10.06
Dy	+5.12	Rb	-5.09	Zn	-0.86
Er	-5.27	Sb	+10.56	Zr	-3.42
Eu	+11.13	Sc	-7.07		

untreated samples; correlation coefficients vary from 0.25 for Mo (and Pb) to 0.96 for Au. Correlations in general suggest similarity rather than differences in the data.

Figure 1 shows graphically the spread of sample values for the two treatments for Fe. It is evident similar concentrations of iron are extracted from samples from each of the two batches, with if anything slightly higher Fe values from the untreated samples.

Comparison of Absolute Values:

In addition to correlation, comparison of absolute values is also important, and potentially could reveal whether extraction is systematically more potent from the fine fraction of a sieved sample. For this the means of the sieved and untreated samples for each element were calculated, and then the percentage differences between these (compared to the overall mean values) were calculated. Table 2 shows these percentage differences.

Percentage differences are small – in no case is the difference the mean values between batches in excess of 25%. Seven elements show greater than 10% higher mean values in the minus 150 mesh samples – Ag, Ba, Ca, Mg, Pd, Sr and U. Significantly the majority of these are alkali metals – often associated with carbonates. Thirteen elements show greater than 10% higher mean values in the untreated samples – the majority of these are large "rare earths" or "incompatible" elements associated with granitoids and/or sediments derived from them. interestingly Pb has higher values on averages from the untreated samples, whilst Zn on average has very similar extracted concentrations form samples in each batch.

Comparison of "Anomalies"

Details of the anomalies were not made available and only partial coordinates were given for the samples. In Figure 2 and 3 samples are plotted as a single line; it is evident that any anomaly, if present is subtle.

Given the degree of information given about the prospect it is not possible to say whether one treatment or the other is superior in resolution of this anomaly. Suffice to say there is similarity between the data sets – for many locations highs and low coincide for the two samples sets.

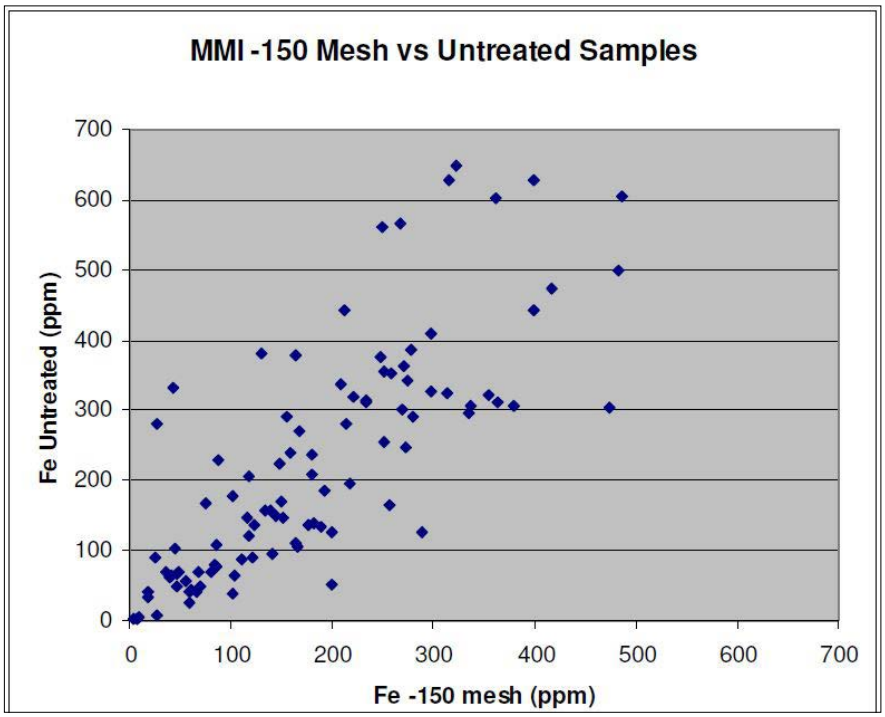

Figure 1: MMI™ Response Ratios (Ratio of Element to the Lowest Quartile Background Data) for the C14 Kimberlite for Selected Elements Sampled at 10-20cm Depth

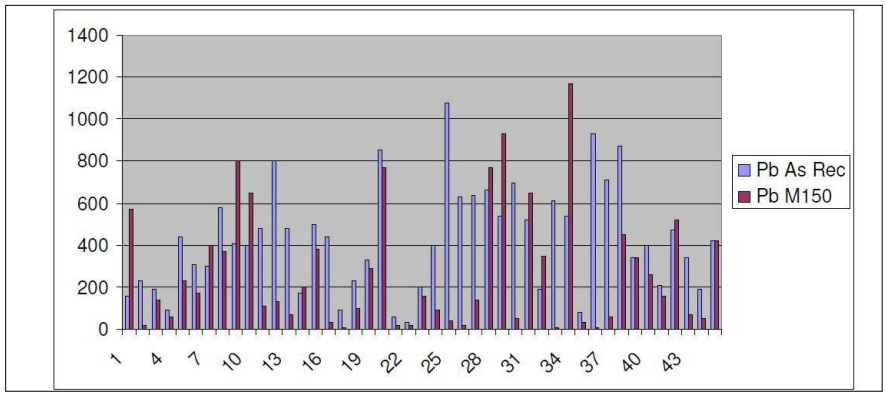

Figure 2: Untreated and -150 Mesh Samples for Pb Plotted as Adjacent Pairs

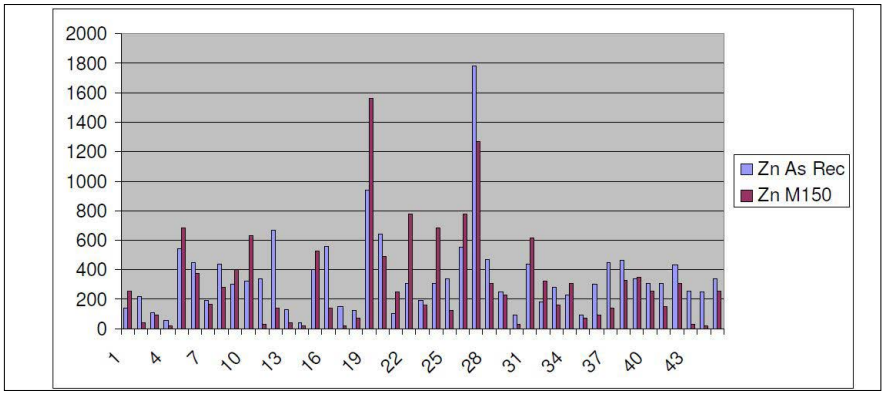

Figure 3: Untreated and -150 Mesh Samples for Zn Plotted as Adjacent Pairs

DISCUSSION AND CONCLUSIONS

Minus 150 mesh and untreated MMI™ samples produce very similar data for commodity elements following MMI-M extraction. Some small systematic difference are observed for lithology-associated elements. Firstly, this suggests that sieving is not advantageous. It also suggests that the mechanism of detachment of "unbound" ions from the soil substrate may not be limited or controlled by simple surface area considerations alone. If this were so the fine traction with greater surface area would be expected to show increased concentrations of extracted elements – unless the best substrates for adsorption are large particles which report preferentially in the coarse fraction. This may be the case for e.g. organic matter and/or amorphous iron oxide coatings.

It is of note that elements such as Pb and Zn are not in higher concentrations in the fine fraction despite the fact that elements such as Ba, Ca, Mg and Sr often associated with carbonates are. Carbonates, apparently more prevalent in the fine fraction here, do not appear to be an important or preferred substrate for adsorption and desorption with respect to MMI™. Approximately 5% more iron was extracted on average from the untreated soil samples. Amorphous iron oxide is a very important and effective precipitating agent for a large number of elements (Thornber 1983), and provides a very efficient binding mechanism when crystalline iron oxides develop. This may suggest that if the mechanism of attachment (and by implication detachment) of unbound metals is related to (say) amorphous iron oxides, then these exist as entities (coatings, films, aggregates) which are slightly more prevalent in larger size fractions.

REFERENCES

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