



TECHNICAL BULLETIN # 27
PARTICLE SIZE AND MMI™

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Abstract

In this study samples from a Mississippi-style Pb-Zn mineral occurrence in Nova Scotia, Canada were used to test the hypothesis that MMI analyses is size (surface area) dependent. Samples from the Gay's River property were initially split. Part of the sample was sieved to minus 150 mesh to obtain a 50g charge. A 50g sample of the remainder was left unsieved. Both were analyzed for 46 elements, in parallel, after MMI-M extraction. The results show that; (a) correlation coefficients for all elements between batches are positive (i.e. data are similar), (b) means for elements between batches differ by less than 25% for all elements, and in many cases higher values are from the untreated data set and (c) there is no discernible difference in the behaviour of Pb and Zn in resolution of the anomaly. It is concluded that MMI data is not size fraction (surface area) dependent.

Introduction

It is believed that MMI solutions leach and detach weakly bound elements from substrate(s) in a soil (Mann et al. 1998). It is a matter of conjecture 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 analyzing 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.

A Mississippi-style Pb-Zn mineral occurrence in Nova Scotia, Canada was used to test this hypothesis. The weak soil anomaly assessed lies to the north east of a known deposit and economic mineralization (Gay's River property). Soil samples were taken from till.

Experimental Design

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 remainder (unsieved) portion was analysed in parallel after MMI-M extraction. 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 leach by MMI-M solution, and the extracted solutions were analyzed on an ICP-MS (SGS Laboratory in Toronto) 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 were made:

- Correlation coefficient calculations
- Comparison of absolute values
- Comparison of "Anomalies".

Correlation coefficients

Correlation coefficient calculations support the initial visual inspection of the database that the ICP-MS element analysis for sieved and untreated samples are similar in magnitude and vary systematically within the data set for most elements involved (Table 1). For some elements, e.g. Pt and Te, there was insufficient data above the lower detection limit (LDL) to allow for comparison.

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 1. Correlation coefficients relating minus 150 mesh sieved samples and untreated MMI samples for various elements.

For most elements (28 out of 39), there is a positive linear correlation above 0.5 between the sieved and untreated samples including 25 elements above 0.6. Correlation coefficients vary from a low of 0.25 for Mo and Pb to a high of 0.96 for Au. These correlations, in general, suggest similarity rather than differences in the data.

Figure 1 illustrates the spread of determinations for the two sample treatments for Fe. It is evident that similar concentrations of iron are extracted from samples from each of the two treatments. In this case, slightly higher Fe values are observed from the untreated samples.

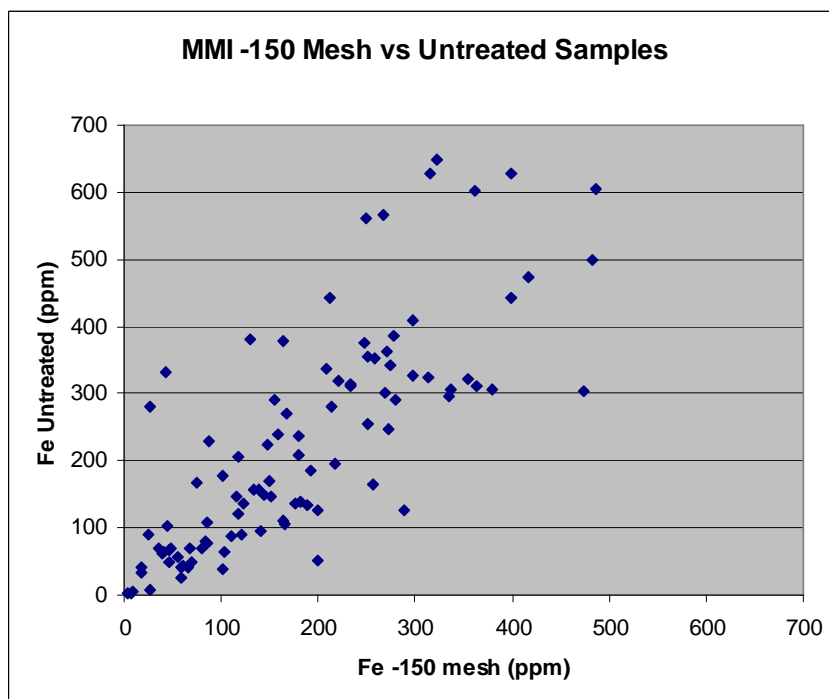


Figure 1. Comparisons of concentrations of iron extracted from the -150 mesh and untreated samples.

Comparison of absolute values

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

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		

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).

Percentage differences are small – in no case is the difference in mean values between batches in excess of 25%. Seven elements out of 44 (16%) show greater than 10% higher mean values in the minus 150 mesh samples – Ag, Ba, Ca, Mg, Pd, Sr and U. Thirteen elements (30%) show greater than 10% higher mean values in the untreated samples. Interestingly, Pb has higher values on average from the untreated samples, while Zn has very similar extracted concentrations from samples in each batch.

Comparison of “Anomalies”

Details of the anomalies were not made available and no coordinates were given for the samples. In Figures 2 and 3, samples are plotted as a single line. It is evident that any anomaly, if present, is subtle.

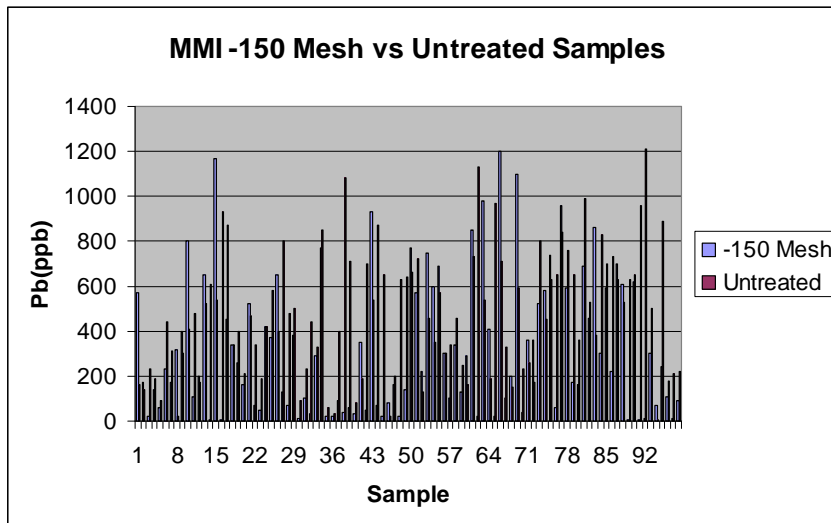


Figure 2. Untreated and -150 mesh samples for Pb plotted as adjacent pairs.

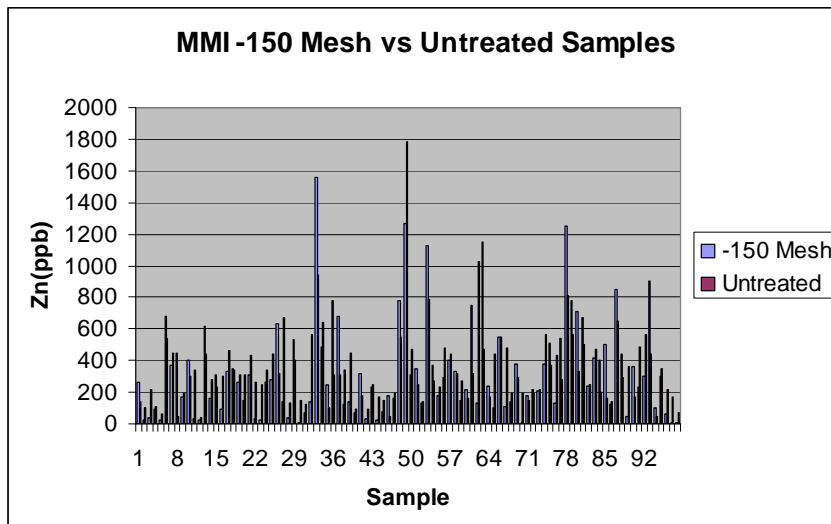


Figure 3. Untreated and -150 mesh samples for Zn plotted as adjacent pairs.

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 lows coincide for the two samples sets.

Discussion and Conclusions

Minus 150 mesh and untreated MMI samples produce very similar data for commodity elements following MMI-M extraction. Some small systematic differences 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 fraction with greater surface area would be expected to show increased concentrations of extracted elements – unless the best substrates for adsorption are large particles that report preferentially in the coarse fraction. This may be the case for e.g. organic matter and/or amorphous iron oxide coatings.

Pb and Zn (often associated with the carbonates class of minerals) are not more abundant in the fine fraction despite the fact that other carbonate-associated elements such as Ba, Ca, Mg and Sr, are more abundant. Carbonate minerals, 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 appears to have been 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 (although not conclusively by this study) that if the mechanism of attachment (and by implication detachment) of unbound metals is related to amorphous iron oxides, then these exist as entities (coatings, films, aggregates) that are slightly more prevalent in larger size fractions.

References

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- Thornber, M.R. (1983). *Chemical aspects of gossan formation* In: Geochemical Exploration in Deeply Weathered Terrain. CSIRO Workshop Sydney, 1-4 March 1983.