

# MMI™ SAMPLING IN TROPICAL AND TEMPERATE CLIMATE ZONES

## INTRODUCTION

A great deal of experimental and field work has been put into studying geochemical processes in soils, with respect to the optimum location for MMI™ sampling. Capillary rise and evaporation have been found to be very important processes in soils. The optimum location for an adsorbed metal imprint is in the "A" horizon, just below the surface close to where the maximum water removal (by evapo-transpiration) takes place. Figure 1 below is an experimental illustration of that phenomenon.

In this experiment, a plastic box was filled with sand, and saturated with water to the level marked on the left-hand side as W.L. Blue dye was then injected at the bottom of the tank and used to investigate convection, which caused a plume to ascend to the W.L. on the left-hand side of the tank. Approximately two months after the experiment ceased, it was noted that a blue dye imprint had developed above the water table, and just below the surface. This was created by capillary rise. Figure 2 shows in the field, that the sampling position just below the surface often coincides with active root development – the zone of maximum water abstraction from the profile (which leaves solutes no option but to adsorb/precipitate).



**Figure 1: Experimental Evidence for Capillary Rise, and Anomaly Emplacement**

The roots are also involved in the adsorption process – possibly chemically as well as physically. Water and some elements (in an ionic form) will be taken across the root membrane, but some will be excluded possibly adsorbed to the root surface. This, and examples of MMI™ concentrations versus sampling depth are discussed in Mann et al (2005).

## SAMPLE COLLECTION

### Sampling Position

The depth of sampling is related to the physics and chemistry of the capillary rise and evapo-transpiration process,

and is therefore related to distance below the soil interface irrespective of soil type. Do not vary depth beneath the true soil interface, or target a specific layer/feature of a soil profile when sampling. Extensive research has shown that element concentrations can vary markedly with a change in sampling depth. Any significant variation in sampling depth and technique can cause severe problems for interpretation. It is imperative that all samples are collected in a consistent manner. In most tropical terrains, the true soil interface is the ground surface. In terrains with deep organic overburden, the true soil interface is the position where plant

matter and debris ceases and organic soil material with an obvious mineral content becomes evident (see TB14).

In undisturbed environments samples should be collected 10 to 25 cm below the true soil interface at a consistent depth. - The initial step in taking an MMI™ soil sample requires the 10cm surface soil layer to be scraped away eliminating loose organic matter, debris,

and any possible contamination. The sample is then taken between 10 and 25 cm depth. In cases where there is an extensive organic horizon (O or Ao) at the surface, (e.g. Canada), the sample should be taken 10 to 25 cm below the lower interface between the predominantly organic layer and soil, i.e. into the A horizon. Samples DO NOT have to be completely free of organics. Before actually taking the soil sample material, equipment should be brushed to eliminate residue from previous samples and preferably flushed with the soil from the new sample site. During sample collection and handling, no jewellery (watches, rings, bracelets, and chains) should be worn, as this can be a major source of contamination.

**Moist Samples** - Damp samples should be collected in a similar manner to soils in dry environments. Samples should not be dried in ovens or pulverised in crushers or mills. In the case of dry plastic clays, sample material can be desegregated by crushing with a mallet between disposable plastic sheets. Sieving should be avoided if there is any possibility of serious cross-contamination during sample collection via the sieve. In this case, larger rocks and twigs/leaves etc can be removed carefully by hand.

**Organic Material** - Organic material in the form of fine roots and hairs, decomposing leaf material and other fine organic debris WILL NOT adversely affect MMI™ analyses. Experimental work has shown that variability in sampling depth has a more significant impact on element responses.

**Contaminated Sites** - Where there is a potential contamination problem, samples should be collected at a depth so as to avoid any contaminated material and the sampler's judgment must be relied upon. Another option available to the sampler if there is possible site contamination is to sample in the lee of a tree and/or under a thick layer of organic litter.

**Skeletal Soils** - Occasionally sampling will be required over rock surface where a 10-25cm soil profile is absent. In these



**Figure 2: An MMI™ Sample Collection Site**

circumstances, providing there is a thin layer of soil, this can be taken and used as the soil sample, as it is where the evaporation process will also have been confined to.

#### Equipment

- A 30-cm diameter plastic garden sieve or kitchen colander with minus 5-mm apertures, available from hardware and super markets, is ideal for sample collection;
- Plastic collection dish with similar diameter and a kitchen floor brush used for cleaning the sieve and dish between samples;
- A bare steel (no paint) garden spade; and
- Plastic snap seal bags, do not use calico or brown paper.

#### Sample Specification

A 250 gram sample is collected and stored in a plastic bag (a 90 x 150-mm plastic snap seal sample bag is ideal). Once sealed in the snap seal plastic bags, samples should be placed in polyweave sample dispatch bags (maximum 40 per bag) or packed in boxes. Stored in this manner, samples can be carried on tray-back vehicles

during summer without problems and be stored for long periods.

#### Sample Site

Sample sites should be undisturbed and preferably away from any major contamination: creek beds, drainage, drilling lines, pads, roads, etc. Wind borne contamination should also be eliminated during sample collection by sampling just below the surface.

### MMI™ SOIL SAMPLING – IN SUMMARY

- Use one laboratory wherever possible.
- For a particular survey, avoid submitting samples in small batches (if possible). If this cannot be avoided, calculate Response Ratios (signal to noise or background ratio) for each batch, BEFORE combining the data.
- Always sample consistently 10 – 25 cm below the true soil interface.

### LANDFORM AND REGOLITH SITUATIONS

MMI™ geochemistry has proved successful in a broad range of landform situations including relict, erosional,

and depositional regimes. It is also proving effective in lateritic terrains by identifying primary sources of mineralization from the surface within broader conventional anomalies influenced by specific regolith units.

Surface MMI™ geochemistry essentially responds to sources of mineralization, so that weakly mineralized structures, like subsurface supergene mineralization blankets, are defined at a lower contrast level than the primary zones from which they are derived.

### Relict and Erosional Regimes

Surface regolith units developed on relict and erosional landforms respond well to MMI™ geochemistry. The key advantage is a superior signal to noise ratio over mineralization. Compared to conventional geochemistry, it allows better focusing on follow-up exploration, either further surface sampling or more precise target drilling. Conventional responses are usually broader and maxima are often not directly over mineralization, particularly in deeply-weathered terrains. MMI™ responses are more constrained, and commodity element anomalies are usually closely related to primary mineralization.

This does not automatically ensure that a commercially-viable deposit is identified beneath each MMI™ anomaly. However, the success rate for ore-grade drill intercepts early within an exploration programme can be significantly improved.

At an operational level, MMI™ samples can easily be collected from the surface of these regimes in a straightforward manner as discussed in the sampling procedure section.

### Depositional Regimes

Surface soils on depositional regimes need to be addressed with extra care. Case studies have shown that the MMI™ technique extends the range of effective surface soil geochemistry further into more complex transported regolith units, when compared to conventional geochemical techniques.

Again, it is the superior signal to noise or anomaly to background responses provided by MMI™ geochemistry that allow the technique to identify and highlight anomalous responses from mineralization while reducing the effects of spurious background levels.

Terrain with colluvial soils, where coarser components are obvious, usually respond well to the MMI™ technique. In terrain with extensive alluvium, particularly within larger tracts of sheet wash with intermittent flood activity, care is required with any geochemical technique. MMI™ anomalies in this terrain type can be of the order of 1 ppb or less. In terrain with active alluvium, e.g. aeolian dunes and alluvial stream channels any geochemical signal can be swamped by the influx of background material. At these analytical levels, great care must be taken to ensure quality of data, and correct interpretation.

An effective orientation study is strongly recommended if possible to provide data and confidence before embarking on a full-scale survey.

## ORIENTATION SURVEYS

Although MMI™ geochemistry is a powerful technique, it should not be regarded as a panacea for exploration. Field inspection can be important to establish whether any major landform or regolith changes are likely to influence the MMI™ results. Other relevant background material that can contribute to a successful MMI™ survey programme and interpretation includes: geological maps, aerial photographs, geophysical data including aeromagnetic maps and any interpretation thereof, conventional geochemistry results showing broader anomalies or corridors, and styles of any known mineralization.

As with any geochemical survey, an orientation programme can provide valuable information if a suitable target can be accessed and soils collected at the surface. Prior to any orientation, it is also important for the explorationist to define the parameters for minimum target size, especially when considering sample spacing for future exploration

surveys. An important feature of MMI™ geochemistry is that it essentially responds to primary mineralization. Weakly mineralized structures may not respond clearly or distinctly to an MMI™ programme so an orientation should preferably test a target considered significant. (For further information see TB19).

A sampling interval appropriate to the dimensions of the target and host geology is recommended for orientation surveys. Generally, a 25 – 100 metre interval sample spacing along lines is sufficient. However, in the final stages of NiS exploration, 10 metre spacing is used.

To obtain the further benefit from the analytical data generated using commercial MMI™ analyses, response ratios can be calculated. Background samples provide the necessary data to allow meaningful response ratios to be calculated and therefore orientation sampling must include soils collected off the known mineralization.

## SAMPLE DENSITY AND GRID ORIENTATION

Density of sampling is largely influenced by the type and style of mineralization being sought. Narrow, higher grade styles require a maximum of 50 m sample intervals along lines spaced according to the required strike length of mineralization considered as an economic target within the specific project area. If the minimum strike length is 200 m, then the maximum line spacing should be 200 m. This is assuming that the target mineralization is likely to produce a geochemical halo, giving rise to an anomaly that may extend further than 200 m (for example along strike of a mineralized structure). However, it is recommended that the line spacing be equal or less than the target mineralization length. Generally, for gold targets a sample spacing of 100 m x 50 m will allow a focused drill programme to commence eliminating blanket RAB drilling.

Larger sedimentary styles (for example Mississippi Valley style) can have

expanded sample patterns. However, in these cases it is vital that background is also sampled. Very specific targets, for example massive Ni sulphides along basal contacts, have in the past required 25 m x 25 m and even 20 m x 10 m spacing to allow detailed anomaly definition prior to the first phase of drilling. This pattern density may represent the second or third infill phase of MMI™ sampling after an initial broader-spaced programme to identify contacts, or complementary with geophysical targets.

In desert terrain which contains active aeolian dunes, it is better to have an irregular sampling grid based on interdune swales, than to sample the active dune surfaces.

One important aspect of incorporating MMI™ geochemistry into an exploration programme is that it can substantially reduce drilling costs. If anomalies remain strong along significant strike lengths and more precise targets are desired, it is still more cost effective to undertake infill surface sampling at 50 m x 50 m spacing within the anomalous trend rather than to blanket drill.

### Sample Grids

Where possible, carry a GPS and note each sample point. If a GPS is not available, pre-designated sample grids and numbers should be established prior to sampling to avoid irregular sample spacing/numbering which disrupts later data interpretation and any subsequent follow-up work. Sampling should be conducted in a methodical way, preferably starting from the lowest easting and northing and working upwards. Avoid allocating negative eastings and northings for sample co-ordinates. For orientation, survey traverses across known targets are ideal (see TB19). These traverses can be assessed independently; however, it is imperative that background samples are collected for the general area, even at the expense of maintaining a consistent spacing along the line once the mineralized zone has been covered.

### REFERENCES

Mann, A.W., Birrell, R.D., Fedikow, M.A.F. & de Souza, H.A.F. Geochemistry: Exploration, Environment, Analysis, 5 2005, pp. 201-210.

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