



**TECHNICAL BULLETIN – MMI ANALYSIS FOR  
GOLD & SILVER IN CARBONATE  
ENVIRONMENTS**

**JULY 1998**

## **Introduction**

The applicability of the MMI Geochemical Technique for buried Au and Ag mineralization in carbonated terrain is currently of some interest. Three, trial sample sites are examined in this study. They vary from areas characterised by high and low level deserts in extremely arid climates, through to semi-arid environments at low to medium altitudes. A brief description of the three sites is as follows:

### **Site 1. Mt. Gibson, Murchison Province, Western Australia - Gold**

The study area has a semi-arid climate with mild winters and hot summers. Rainfall is restricted to winter months with summer thunderstorms.

### **Site 2. Nepean Nickel Mine, Kalgoorlie, Western Australia - Nickel**

The site has a semi-arid climate with very hot dry summers and cool wet winters with rainfall from frontal activity in winter and thunderstorms in summer.

### **Site 3. San Jorge, Mendoza Province, Argentina – Copper, Gold, Silver**

The area is situated in a desert environment at around 2650 m above sea level.

## **Background**

A number of laboratory-based experiments on the use of MMI-A (acid) extractants in carbonate environments have been undertaken. This work was directed at identifying, and in some cases, quantifying the parameters which influence the mobilisation and accumulation of base metals in carbonate soils, and their subsequent release into MMI extractant solutions. This specific work was the subject of a research project undertaken by MMI Technology at the Geochemistry Research Centre in Perth. A summary of this report (WAMRD9) can be viewed on the MMI web site ([www.mmigeochem.com](http://www.mmigeochem.com)) and a full report can be obtained from MMI Technology on request.

The MMI-B extractant, specific for the metals Au, Ag, Ni, Co, and Pd is a weak base. As such it does not have a partially neutralising reaction. It is therefore potentially directly applicable to a wide range of environments in arid regions, particularly those with well-developed carbonate horizons or caliche layers. A number of case histories using MMI-B have clearly demonstrated that for Au and Ag, distinctive patterns related to sub-surface mineralisation are clearly observed in carbonate rich environments. This bulletin presents a summary of a small number of these in diverse geological and geographical situations.

## **Results From The Sample Sites**

At each of the case study sites, MMI orientation traverses were completed across known mineralization. The depth of overburden at each of the selected case study sites varies considerably. However, the sites are similar in that they all show development of distinctive pedogenic carbonate hardpans or caliche layers. Profile sampling at each site reveals characteristic responses and partitioning of elements within the soil horizons.

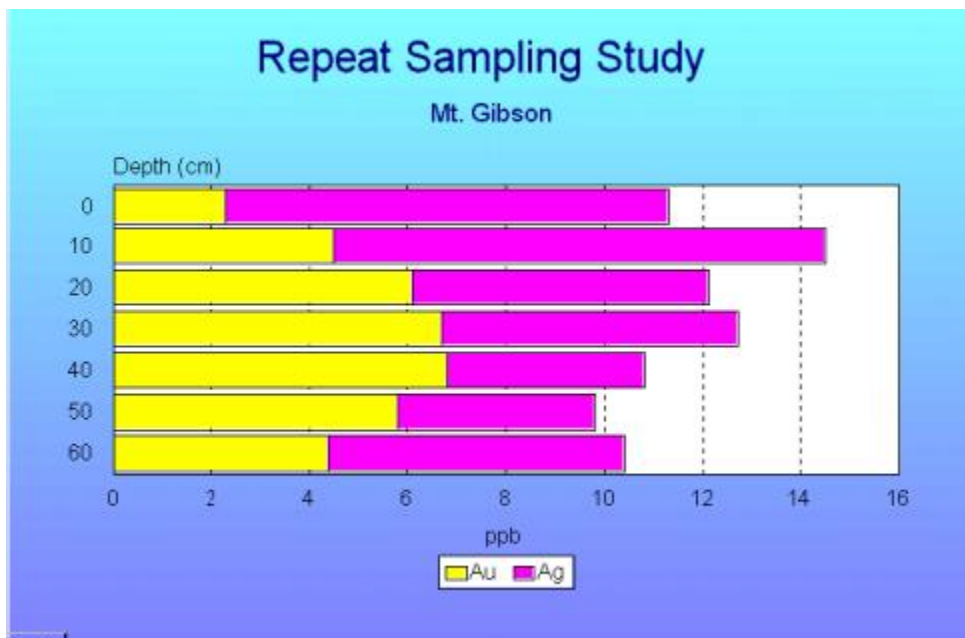
## Site 1, Mt. Gibson, Murchison Province, Western Australia

Data for this case study is from Technical Bulletin TB04 – Repeat Sampling Study that reviews the repeatability of MMI data.

At this site, sub-economic gold mineralization (1 m @ 0.5 g/t) is buried beneath 27 m of transported colluvium and alluvium. Drilling identified a buried caliche layer or carbonate hardpan about 1.5 – 2 m thick at 1.4 m below surface. Surface MMI responses reported a Au anomaly of 9-10 times background, with supporting Ag responses of 7-9, indicative of subeconomic mineralisation.

Soil profile samples were collected from a pit located within a Au, Ag MMI surface anomaly. Samples were taken at 10 cm intervals to a depth of 60 cm. MMI analysis of these profile samples show a partitioning of Au and Ag down the profile, see Figure 1. The highest Ag responses are at the surface, while Au in a mobile form accumulates slightly lower in the profile.

**Figure 1. Down hole MMI results from a sample pit located within an MMI surface geochemical anomaly at Mt Gibson.**

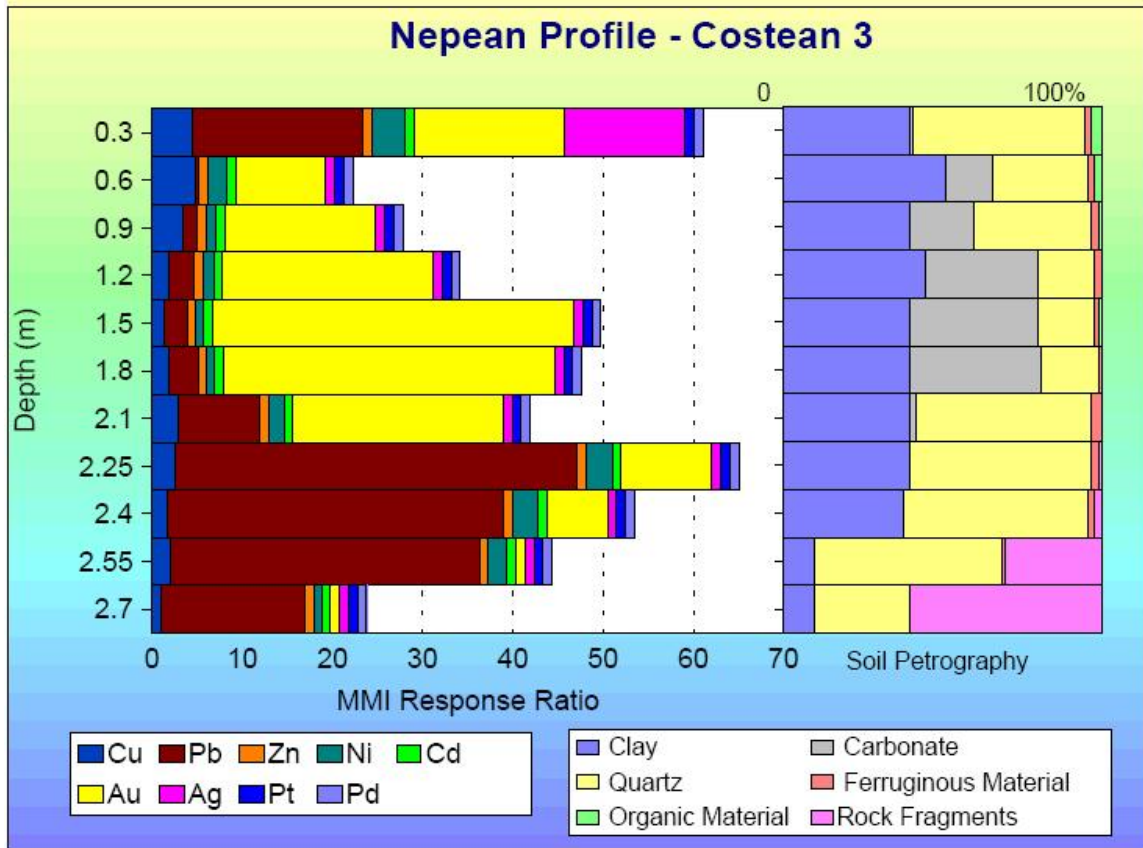


Although maximum values for some elements can occur deeper in the profiles, the geochemical signal above primary mineralisation is clearly anomalous very close to surface, and can provide a cost effective sample position to allow precise drill targeting. General observations suggest there is often an elevated Ag response coincident with the Au anomaly over a primary source.

**Site 2, Nepean Nickel Mine, Kalgoorlie, Western Australia**

Soil profiles in the area typically show a well developed carbonate horizon occurring between 1 and 2 m depth, see Figure 2. Partitioning of base and precious metals, including Au and Ag within the profile is evident. MMI responses in the near surface soil (0-30cm) provided good element contrast within a highly carbonated soil profile.

**Figure 2. Site 2, Nepean Nickel Mine, Coolgardie, Western Australia**



**Site 3, San Jorge, Mendoza Province, Argentina**

Pit sampling from surface to 2.4 m at The San Jorge Project, also clearly shows partitioning of mobile forms of Au and Ag within transported gravels and cobbles over Cu/Au porphyry-style mineralization (see Figure 3 below). As in the previous case study, surface soil samples provide a good MMI response. A well developed caliche layer occurs at 1.8 m depth. Further details are given in Case Study CS06.

**Figure 3. Site 3, San Jorge, Mendoza Province, Argentina**



### Implications For Exploration

The three case studies presented have confirmed observations from elsewhere that carbonate hardpans or caliche does not act as a barrier for the movement and accumulation of Au and Ag mobile metal ions, close to surface. In the presence of carbonate and caliche layers, the most cost effective and reliable sample position for MMI geochemical surveys is between 5-30cm below the surface.

Numerous case history studies indicate that the surface soil provides the optimum sampling position for MMI surveys in most landform situations. However, as shown by the three studies in this report, the concentration of mobile ions in a soil profile varies greatly with depth. It is therefore critical that the depth of sampling is kept consistent.

The ability to collect surface soils in most landform situations is a significant advantage. It avoids problems with drilling to obtain samples. Drilling is an expensive method of sampling and variable element responses within a soil profile can complicate interpretation.

Orientation surveys are always strongly recommended. There are some situations where surface sampling may not be the optimum sampling depth, as discussed in Technical Bulletin TB01 "Sampling Procedures in Active Desert Terrain".

For further advice and assistance please contact MMI Technology.