

# Determination of Precious Metals in Ni-Cu-Co sulfide deposits by collision/reaction cell ICP-MS



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## Introduction & Goals

### Background Information

The precise determination of precious metals (PMs) in nickel (Ni)-copper (Cu)-cobalt (Co) enriched massive sulfide deposits (such as Voisey's Bay, Labrador, Canada) by inductively-coupled plasma mass spectrometry (ICPMS) is complicated by chemical interferences and homogeneity issues. The existing NiS fire assay method has the advantage of accommodating a large sample mass, but is **time-consuming, limiting sample throughput**. It often also, results in an analytical blank with relatively high concentrations of PMs. This makes it difficult to analyze nickel-sulfide ores, which have very low concentrations of PMs.

### Our Research

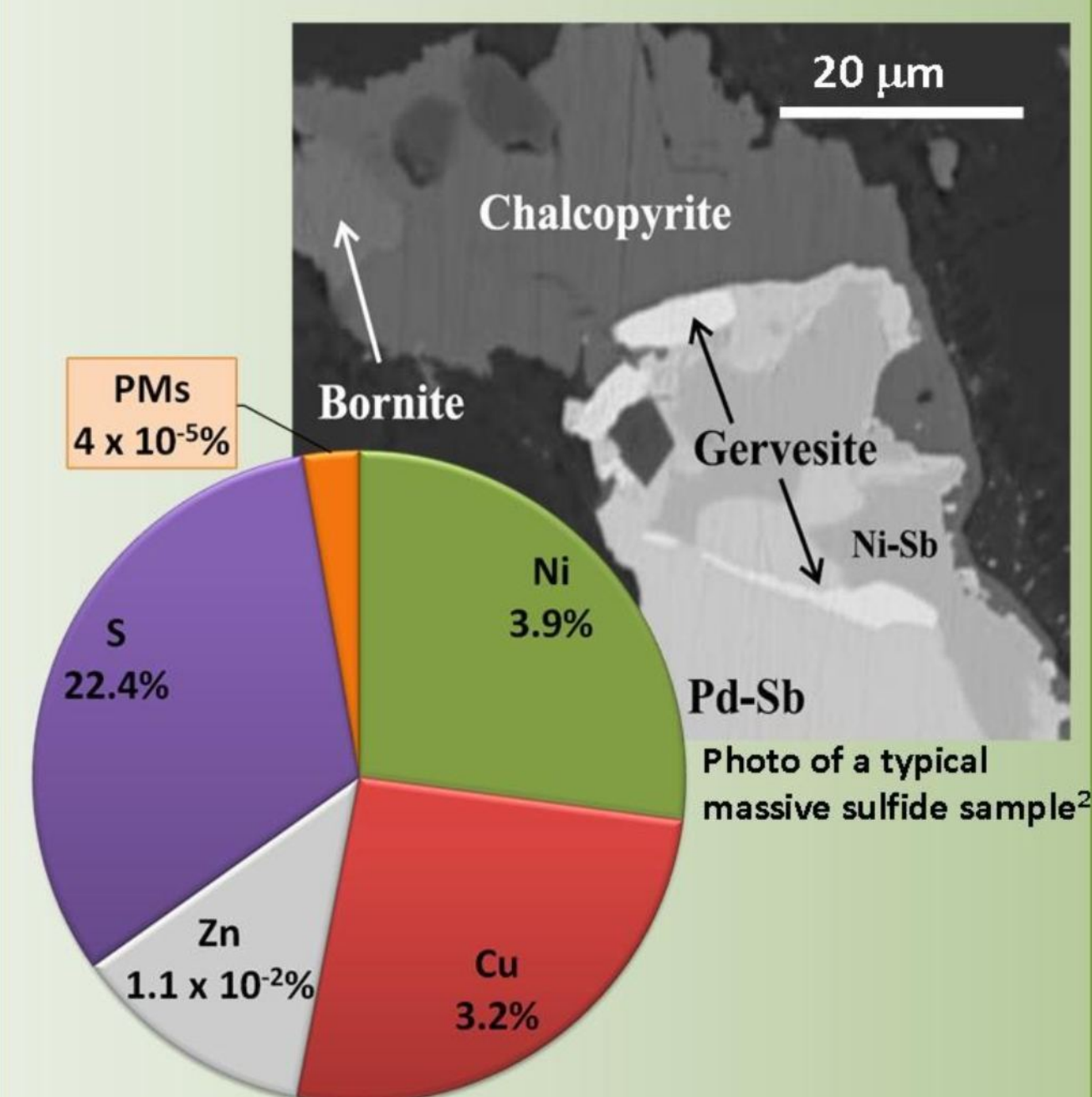
We are developing a simple & efficient analytical method for the determination of Ru, Rh, Pd, Ir, Pt and Au (PMs) in high nickel systems by applying collision/reaction technology and ICPMS.

Compared to accepted analytic methods, our method will:

1. Be more accurate
2. Require smaller sample sizes
3. Increase in time efficiency

### Primary Obstacle

Conc. Ni is ~1 million x conc. PMs



Average Concentrations in Massive Sulfide Ore<sup>1</sup>  
(Divisions are in log-scale)

### Resolution

**Step 1:** use ionic exchange resin to chemically separate the Ni from the rest of the sample before analysis

**Step 2:** use specialized capabilities of the collision reaction interface (CRI) on the ICPMS to further eliminate interferences.

## Methods

### Digestion

High Pressure Asher (HPA-S), 5 mL HNO<sub>3</sub>/HCl (5:2); Temp: 300° C; Pressure: 130 bar; Duration: 4 hr

### Physical Separation

Centrifuge, dry-down, final solution 2% HCl

### Key Points

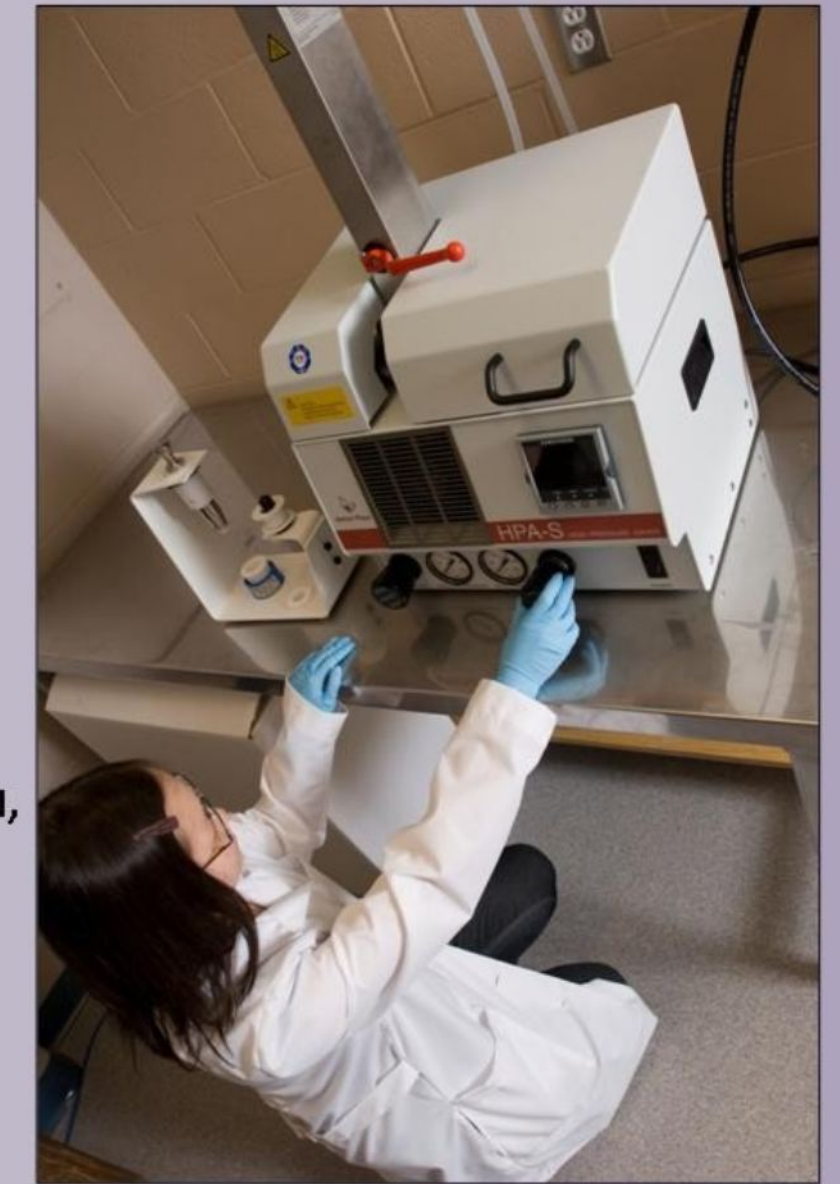
1. Use of 1g of sample (compared to 10g for fire assay)
2. Use of combination of off-line column separation and CRI ICPMS, reduces interferences, thus low conc. PMs can be analyzed

### Column Separation

Cation-exchange column  
Resin: Dowex AG50W-X8, 200 mesh, H<sub>2</sub> form

### Analysis by ICPMS

- Hydrogen gas used in a collision reaction interface (CRI)
- Primary interfering species: oxides, hydroxides, chlorides and argides of Ni, Cu, Zn, Sr, Rb, Y, Zr and Hf.



HPA-S

## Preliminary Results

### Reduced Interferences

- Most of the oxide/hydroxide interferences were minimized – very low <sup>140</sup>Ce<sup>16</sup>O/<sup>140</sup>Ce ratio (<0.002)
- Argides & chlorides of Ni & Cu were removed by the H<sub>2</sub> CRI gas by ~100 times from that of the normal mode.

### Certified Reference Materials

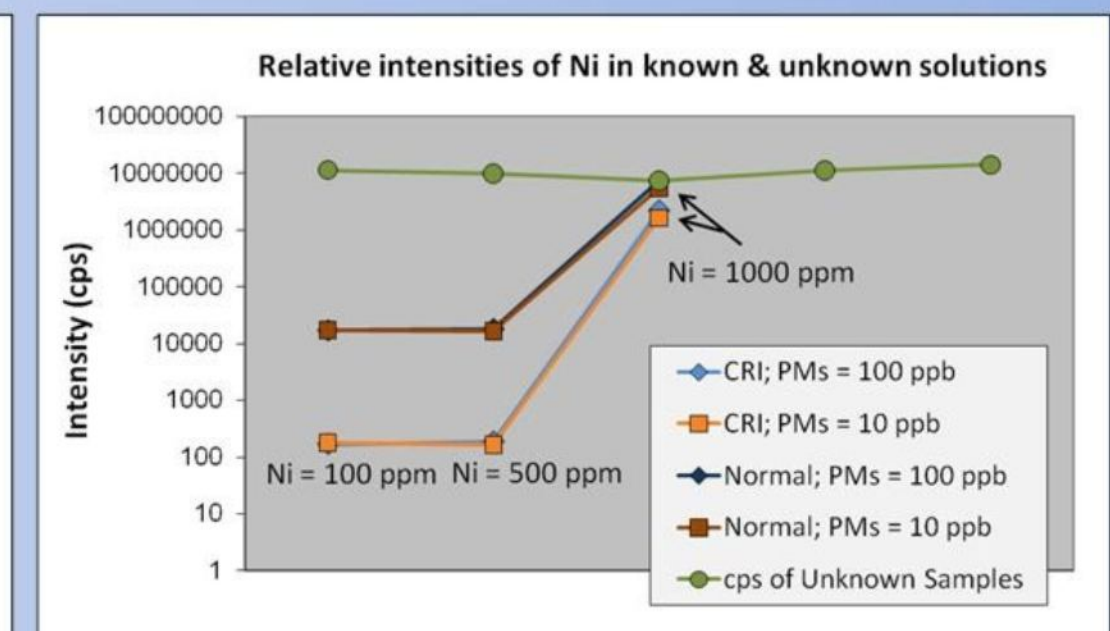
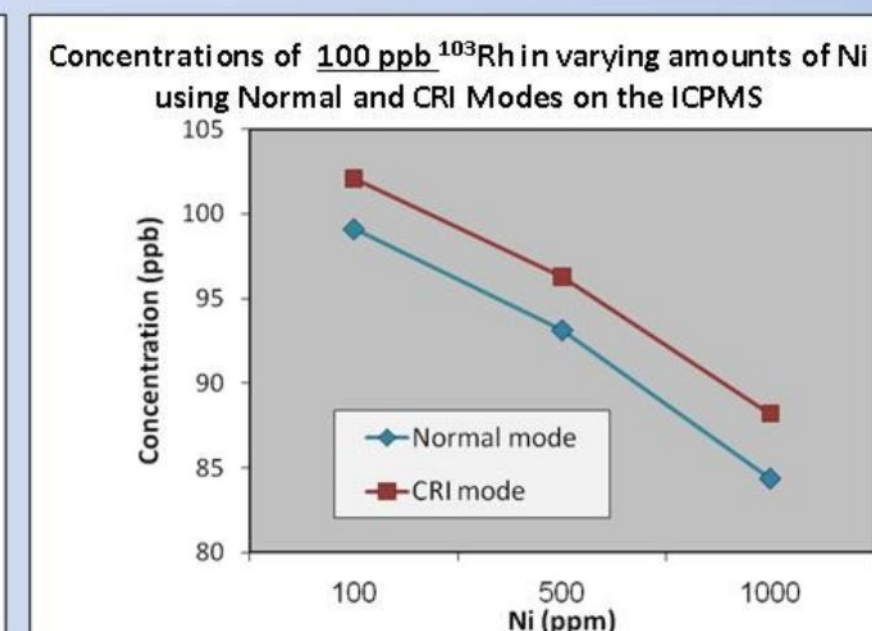
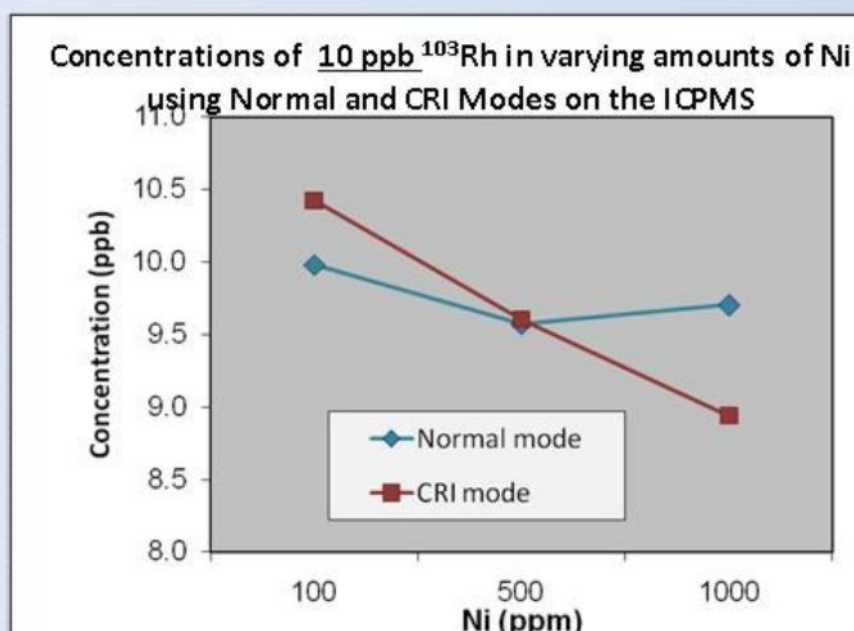
Values of Ru, Rh, Pd, Ir, Pt and Au for SARM-7, WMS-1 & Su-1b were obtained with considerable reproducibility (~10% RSD). Data collected in CRI mode was found to be better than in the normal mode.

### Sulfide Samples

Variation was observed for Pd values in the Ni-Cu-Co sulfide samples that were analyzed, we presume this is due to molecular ion interferences from Ni, which may have not been efficiently removed by the cation-exchange resin. The resin efficiently was found to remove Ni only if its concentration in the eluent does not exceed that in the eluate by more than 1000 ppm.

	UM-1	UM-2	UM-4
Ru101	16-17	20-29	21-37
Rh103	28-36	15-21	11-16
Pd105	165-175	293-422	192-346
Ir193	9-12	6-7	8-9
Pt194	48-57	68-92	59-79
Au197	65-119	19-72	13-46

Preliminary PGE data for three geochemical standards (CCRMP) of sulfide bearing ultramafic rocks UM-1, UM-2 and UM-4 were determined.



## Future Work

1. Te co-precipitation
2. Isotope dilution

## References & Acknowledgments

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 Dr. Qi Liang  
 Dr. Thomas Meisel  
<sup>1</sup>Michelle Kelvin  
<sup>2</sup>Huminiki et al. (2008)

