Processing Stream Sediment Geochemical Data for Mineral Exploration Targeting

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Outline

• Statement of problem
• Data processing options
• Results from northern Vancouver Island, Yukon Territory & northwestern British Columbia to illustrate principles
• Conclusions
The presence of regionally extensive lithologies with commodity or pathfinder elements of interest for mineral exploration potentially generates false geochemical anomalies.

Secondary Fe and Mn hydroxides, clays with high ion exchange capacity, and organic matter in stream sediment samples also act to scavenge commodity and pathfinder elements of interest.

Geochemical data are affected by differential dilution from background sediment in catchment basins of different size.

How can we best filter out the effects of high regional background and metal scavenging to add value to historical and re-analyzed regional geochemical survey samples, as well as new stream sediment data?
Data Processing Approaches

- Compiled and levelled raw data
- Residuals following regression against control elements
- Data levelled by dominant catchment lithology
- Data levelled by presence/absence of a particular unit
- Data levelled by catchment weighted background value
- Multiple regression analysis using catchment geology
- Residuals following regression against principal components
- Productivity analysis
- Weighted sums models
- Weighted sums model adjusted for catchment area size
- Supervised machine learning

All require exploratory data analysis
• Geology is interpreted in terms of lithology, rather than map units.
• The distribution of Cu is clearly influenced by the Karmutsen basalt.
• PC1 provides a better discriminator for the Karmutsen basalt than raw Cu
Cu can be regressed against PC1 (lithological control)

- High positive residuals represent Cu above background
• Data processing methods for NVI were validated against known occurrences

<table>
<thead>
<tr>
<th></th>
<th>Cu Occurrences</th>
<th>No Cu Occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;90th Percentile</td>
<td>True Positives</td>
<td>False Positives</td>
</tr>
<tr>
<td>&lt;90th Percentile</td>
<td>False Negatives</td>
<td>True Negatives</td>
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</tbody>
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![Graph showing data processing methods and their validation results.](image)

- Single Element Methods
- Cu Productivity
- Weighted Sums Model
- WSM * Catchment Area

**Method Validation**
Bowser Basin sedimentary rocks are elevated in many elements important as pathfinders in mineral exploration.
Training data set consisted of catchment basins with known epithermal Ag-Au deposits.

Random Forests supervised learning models show an ability to distinguish between Sb associated with epithermal deposits and Sb in the Bowser Basin sedimentary rocks.
A total of 24,279 original RGS sample pulps re-analysed by ICP-ES/MS by Yukon Geological Survey.

29 entire or partial NTS 1:250,000 map sheets evaluated – lots of variability.

Catchments also assessed for sample location accuracy, slope angle, slope aspect, area and dominant material type.

Levelled by dominant catchment lithology and regressed against principal components.

Case study from the Stevenson Ridge area in a terrain not glaciated during the late Wisconsin-McConnell advance.
PCA component 1 is characterized by high loadings in LOI, Ca, Sr, As, Cu, Co, Fe, Zn.

Note the correspondence of high PC1 with a topographically subdued region.
Regression of As against PC1 reduces (but does not eliminate) the apparent scavenging influence of organics and secondary Fe oxides in the sediments.
• Geochemistry in catchment areas >10 km² mainly reflects regional background
  • Catchments > 10 km² have not been effectively sampled
Conclusions

• The effects of elevated background or scavenging are easily filtered using a variety of methods of varying sophistication.

• Processing methods using weighted sums model with several commodity and pathfinder elements corrected for dilution work best.

• Supervised machine learning approaches hold great promise.

• An empirical assessment of sampling effectiveness can be used to indicate whether there are still opportunities in under-sampled areas.

• There is still much value to be obtained from the interpretation of RGS data, especially where archived material is re-analyzed by ICP-MS.

• Our approach to geochemical data should be more like our approach to geophysical data where filtering and data enhancements are routine.

