RECENT DEVELOPMENTS IN BIOGEOCHEMICAL METHODS APPLIED TO MINERAL EXPLORATION

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21st IGES, Dublin, 2003
Details of some of the case histories presented during my talk in Dublin, 2nd September, 2003, are confidential at this time, and so have been excluded from the following sequence of slides.

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OUTLINE

- Rationale + Minerals in Plants
- Ash v dry tissue (losses)
- ICP-MS dry – precision
- Au,Cu,Mo – Amazon; BC
- PGEs – Manitoba; Saskatchewan
- Kimberlite – Alberta; NWT; S.Africa
- Hyperspectral studies
- Future directions

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DEMONSTRATE
The use of plant chemistry for:

• Delineating stratigraphy
• Delineating structure/faulting
• Outlining mineralization using different plant species
• Merging data from different plant species
RATIONALE

and new information on Minerals in Plants

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Power of Plants

- Complex – 350 million years
- Sophisticated abilities to select elements that they need
- Tolerate other metals
- Store those they don’t need (often in extremities such as bark and twig ends and tree tops)
## Metals in Primitive Life Forms (*Lepp, 1992*)

### Concentrations (%)

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<th>Bacteria</th>
<th>Fungi</th>
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<tbody>
<tr>
<td>Cd</td>
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<td>3</td>
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<tr>
<td>Co</td>
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<td>Cu</td>
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<td>Pb</td>
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<td>10.4</td>
</tr>
<tr>
<td>Ni</td>
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<tr>
<td>Ag</td>
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</table>

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Mineral Phases in Plants
SEMs
Lodgepole pine twig: Sullivan mine
Ca oxalate in bark of W. hemlock twig
Ca oxalate crystals in black spruce twig

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Fe, Zn, S phase within hemlock twig
Manganese phosphate in conifer trunk wood

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Gold within bark

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Gold

0.5µm
Whether or Not to Ash

- **Pro:** Reduction to ash permits concentration of elements from large samples
- **Con:** During ashing, some elements (Au, As, Sb) partially volatilize from some species
- **However,** *Controlled* ignition results in constant losses, therefore distribution patterns are relevant
Element Losses

Analysis of ash [at 475°C] compared to analysis of dry tissue
Samples split, then analyzed as dry tissue and also reduced to ash and normalized to dry weight.
Substantial loss of Cr; Au in dry tissue not all recovered
Correlations: Ash v dry

Perfect or v. good correlations for most elements except:
Ba, Ge, Hg, Na, S, Se, V, Zr
Elements Typically Only Detected in Ash (ICP-MS) i.e. below detection in dry tissue:

Pt, Pd, Bi, Sb, Se, Te, Tl, In, Re, Th, U, V, most REE
Virtually no difference between 1g and 30g samples
Analytical Precision

Analysis of 0.5g of dry tissue

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Control V6 – analyses within batch of 500 samples
As before – excellent precision
No Hg losses to 80°C – most Hg lost between 150-200°C
MERCURY and GOLD

Dry Larch and Pine Bark

Gold City Industries
Caramelia Property, Southern BC
Osoyoos – Okanagan valley. Field area a few km to east
GOLD (ppb) in Dry Pine Bark
Trends suggest two phases of mineralization – Au-Hg and Cu-As
Unusually high Tl values assoc. with Zn,Pb,Au mineralization
Similar Spatial Patterns from Different Species

Western Amazon
Cu-Mo-Au porphyry
Concentrations in dry tissue
Concentrations in dry tissue
Concentrations in dry tissue
Locations of case history studies in Canada
Preparing to sample treetops from a helicopter
Treetop collection
Pt, Pd, Ni
Rottenstone Deposit
Northern Saskatchewan
Canada
(Uravan Minerals Inc.)

Black Spruce Tops
Boreal forest – N. Saskatchewan
Rottenstone open pit – 1966 (mined out 1968) – courtesy of Jo Brummer
High Ni around Rottenstone and in northeast
High Pt around Rottenstone
High Pd over and surrounding Rottenstone
Similar pattern to Pd
Similar pattern to Pd
Positive Eu anomalies over mineralization in Manitoba
PGEs, Fox River, Manitoba

[Falconbridge Ltd.]

Slide sequence omitted - Confidential

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ALBERTA KIMBERLITES

- Penetrate 1700 m of Phanerozoic sediments
- Overlain by 0-127 m of glacial overburden
- 23 of 36 discovered are diamondiferous
- Up to 600 x 600 m in extent
Only kimberlite outcrop
SELENIUM in ash of White Spruce Top Stems

* Kimberlite

Se - Max. 0.4 ppm Contours at 50, 70, 80, 90th percentiles

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TELLURIUM in ash of White Spruce Top Stems

Contours at 70, 80, 90th percentiles

Te - Max. 0.09 ppm

Kimberlite

metres
0 5000

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LEAD in ash of White Spruce Top Stems

Pb - Max. 38 ppm
Contours at 50, 70, 80, 90th percentiles

Kimberlite

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ELEMENT ENRICHMENTS IN VEGETATION OVER KIMBERLITES - SUMMARY

- Pb, Au, Li, Se, Te, Hg, Ni, REE, Mo, Sr, Ta, Sn
HYPERSPECTRAL STUDIES

Douglas-fir Needles
Treetops
Vancouver Island

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Merging Hyperspectral Data with Canopy Chemistry

D. Goodenough et al., (NRCan. Forestry)

- AVIRIS and Hyperion data acquired from EO-1 flights over Victoria watershed [EVEOSD Project]
- 520 D-fir treetops - 10 in each of 52 plots
- Organic and inorganic content of needles determined
AIMS INCLUDE

- Geochemical mapping
- Focus on spectral wavelength of an element
- Currently resolution is ~10nm
- <1nm is required for detailed work
Future Directions

- Further refinement of analytical technology (esp. PGEs, Se, Te)
- Closer integration of biogeochemical and geophysical data
- Use of bio. data to map stratigraphy, structure, alteration and faulting
- Integration of bio. data with remotely-sensed data