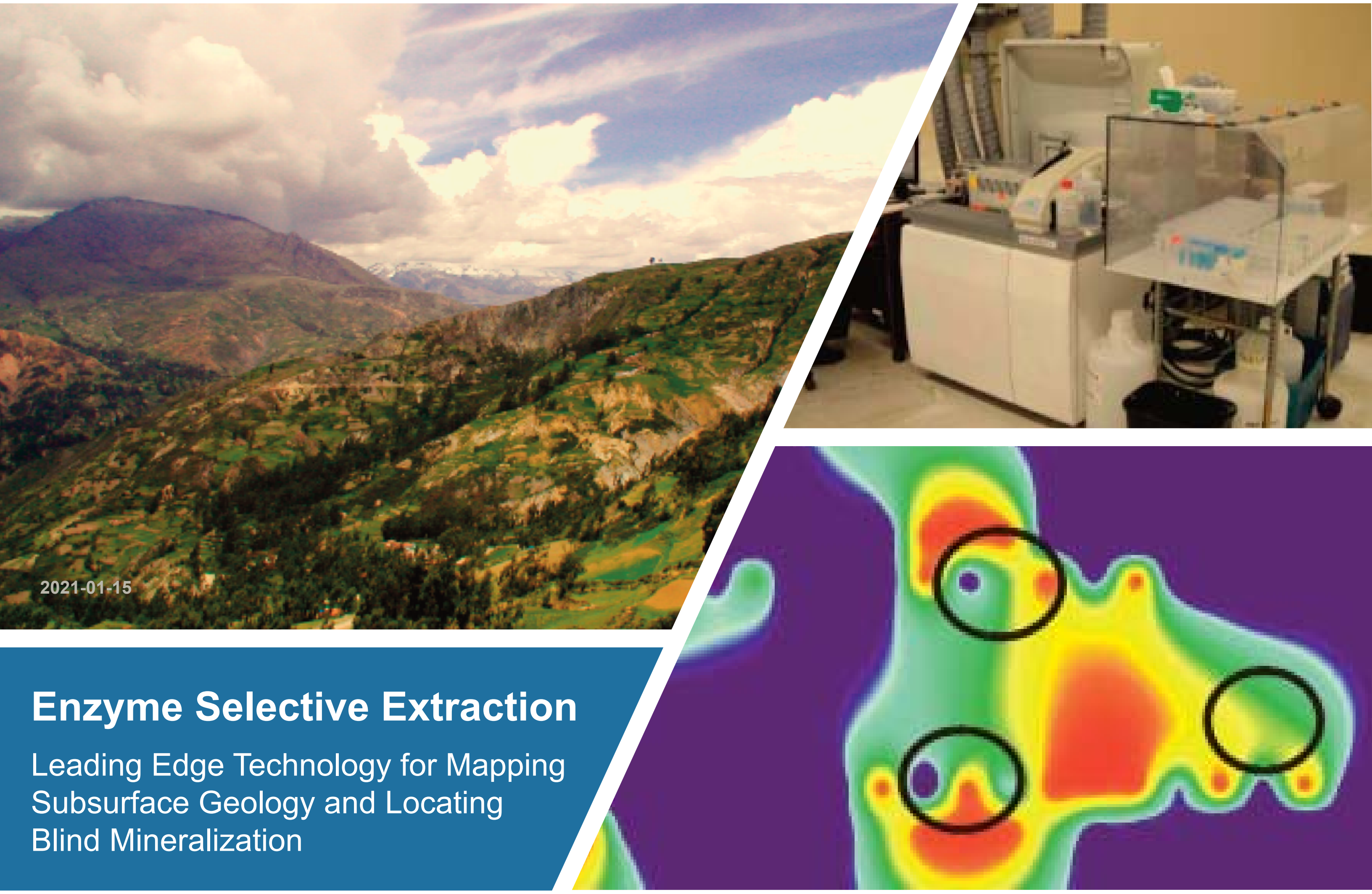
Quality Analysis... Innovative Technologies

Activation Laboratories Ltd.



2021-01-15

Enzyme Selective Extraction

Leading Edge Technology for Mapping Subsurface Geology and Locating Blind Mineralization

30 Years of Innovation
— Since 1987 —

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Selective Extractions

Selective Extractions aid in the detection of mineral deposits at depths ranging from a few meters to more than one thousand meters. Ore bodies are indicated by a host of elements that are distributed into positive and negative patterns at surface, above (apical) and around the margins (halo or 'rabbit ears') of mineral deposits. Trace elements become trapped at parts-per-billion (ppb) and parts-per-trillion (ppt) levels within amorphous oxide coatings on sand and silt grains in the soil or sediment in the near-surface environment. The weaker the leach, the better the ability to detect the more deeply-buried mineralization.

Enzyme Selective Extraction is the most discriminating of the selective analytical extractions used today. It is capable of detecting extremely subtle geochemical anomalies developed in upper B-horizon soils and in peat over and around blind deposits. Conventional partial leaches, like aqua regia extraction-ICP, extract metals from sulphides, oxides and silicates, providing a partial composition of the overburden. Enzyme Selective Extraction on the other hand, tends to detect the very subtle trace element signatures that have been added to the soil by elements migrating to the surface through a variety of mechanisms. Trace amounts of amorphous mixed-oxide coating in soil act as an effective long-term collector of this subtle flux of cations, anions and polar molecules passing through the soil. By selectively removing the amorphous manganese dioxide from these coatings, the mixed oxide coatings collapse, releasing trapped trace elements. Thus Enzyme Selective Extraction provides an effective method of detecting the most subtle signatures of blind deposits in the subsurface without swamping the signal by dissolving the major components of the overburden. At this time, the greatest depth of penetration for Enzyme Selective Extraction for a mineral deposit is greater than 800 metres.

Bioleach^{SM}. Research on Actlabs' SGH technique (Sutherland, Hoffman and Southam, unpublished CAMIRO Research Report) has proven that SGH anomalies are of bacterial origin. Bioleach^{SM} dissolves the remnant bacterial components. Bioleach^{SM} has been specifically designed to extract the mineral signatures associated with these bacteria. This newly developed leach is currently showing great promise at detecting deeply buried mineralization.

TerraSol Selective Extraction is a more aggressive leach that attacks all components of amorphous mixed-oxide coating and certain crystalline iron and manganese oxides. The oxidant used in the process also dissolves a substantial portion of the gold and platinum group elements (PGE) in the soil sample. TerraSol Selective Extraction performs best over shallower mineral deposits.

Other Selective Extractions

Actlabs has considerable experience at developing and applying a variety of selective and sequential extractions developed both by Actlabs and also reported in literature. A selection of these leaches are described below. Actlabs' team of skilled geochemists can advise on the applicability of each of these selective extractions. Detection limits and available elements vary depending on background levels of metals in the leach solutions and potential interferences.

Aurzyme Leach^{SM} - similar to Enzyme Selective Extraction, but dissolves native gold. Background levels for most elements are significantly higher than Enzyme Selective Extraction which may mask some anomalies.

Dizyme Leach^{SM} - will dissolve both amorphous Fe and Mn oxides. Background levels are going to be significantly elevated over Enzyme Selective Extraction which will mask some low level anomalies.

Sodium Phosphate Leach - for organic-rich materials such as humus and peat.

Hydroxylamine Leach (cold) - dissolves majority of Mn and Fe oxides (amorphous + crystalline).

Hydroxylamine Leach (hot) - dissolves nearly all Mn and Fe oxides.

Oxalic Acid Leach - dissolves all oxide coatings and a partial attack on weaker silicates.

Multielement-BLEG Leach - for weak cyanide extractable metals (good for Au + PGE).

Potassium Iodide + Ascorbic Acid - dissolves all of Fe, Mn and Al oxide coatings (halogens cannot be analyzed).

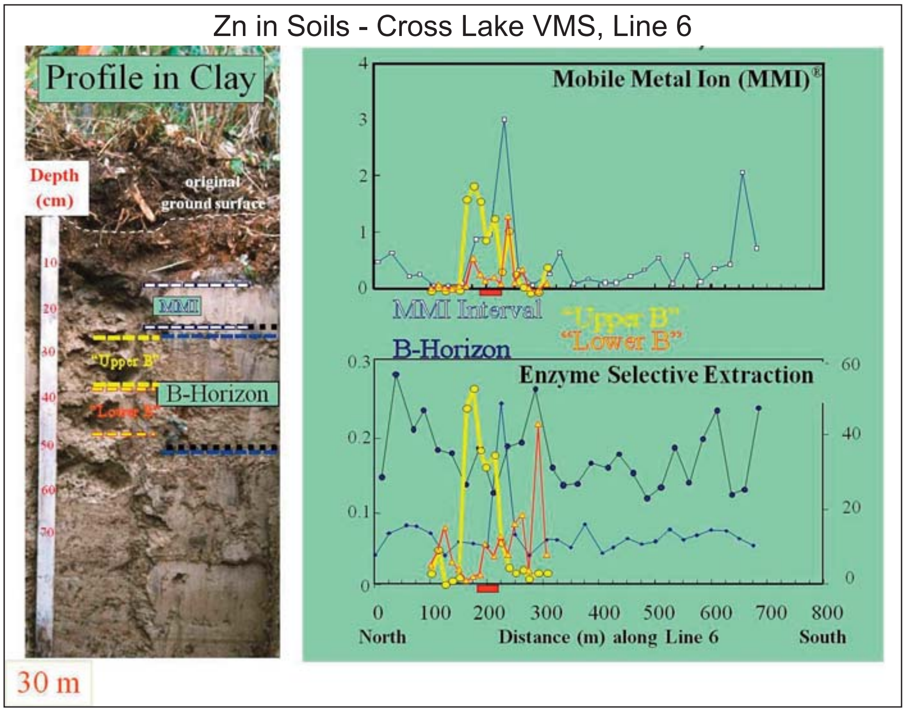
Water Leach (hot/cold) - dissolves any water soluble component and metals released by hydrolysis of silicates.

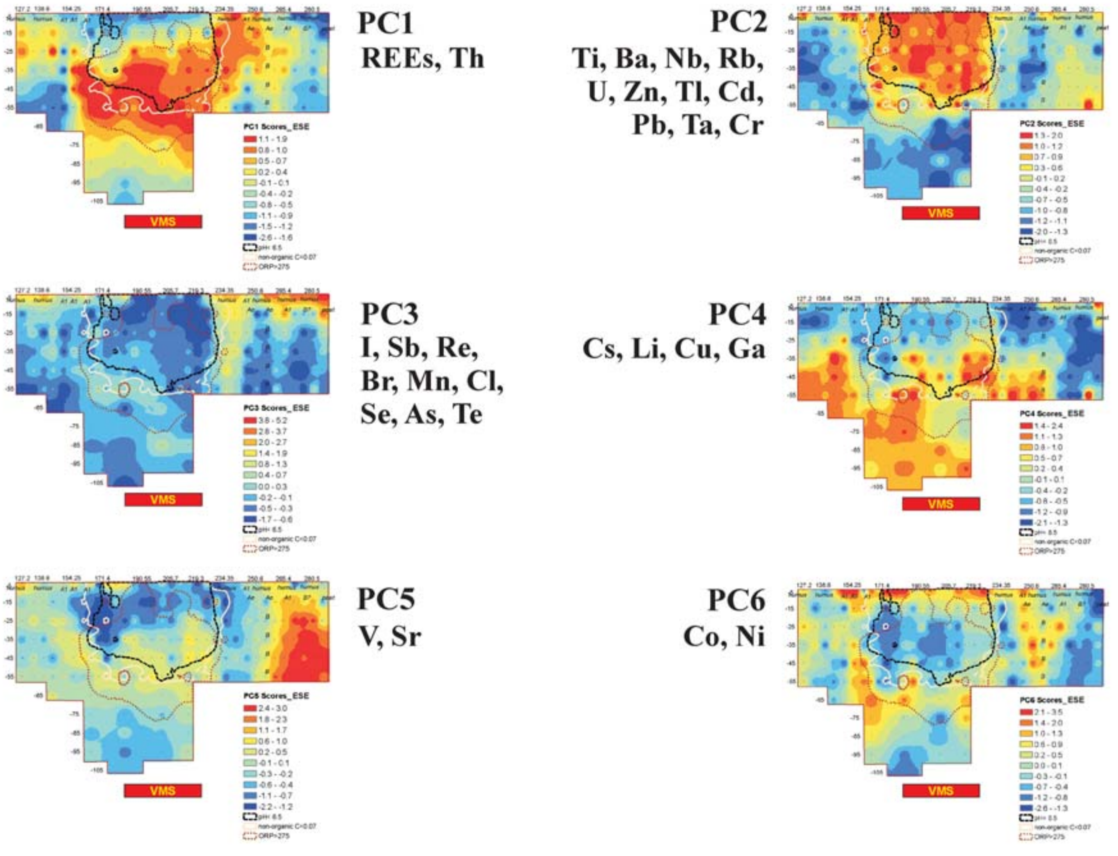
Pink Leach - dissolves water soluble, readily exchangeable and pH reactive phases to determine subtle effects of mineralization in areas of cover.

Glaciolacustrice Clay/Slit, Peatlands and Sand - Trench Study, Cross Lake

Sampling location is critical. The upper part of the B-horizon, shown in yellow, will give the best Enzyme Selective Extraction response. Sampling lower in the B-horizon will lead to erratic results as shown in blue and red.

Deep Penetrating Geochemical Techniques in Exploration (the dos and don'ts). Hamilton, S., Hall, G. and McClenaghan, B. PowerPoint presentation CIM 2005 Exploration Geochemisty Short Course, Toronto, ON.


Zn in Soils - Cross Lake VMS, Line 6



Enzyme Selective Extraction Principal Component Analysis
(S. Hamilton, unpublished Ontario Geological Survey poster, 2003)

Arid Profiles

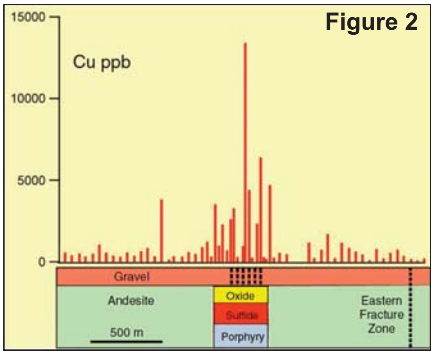
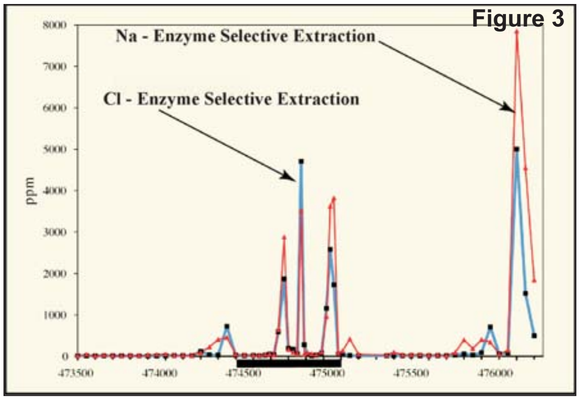


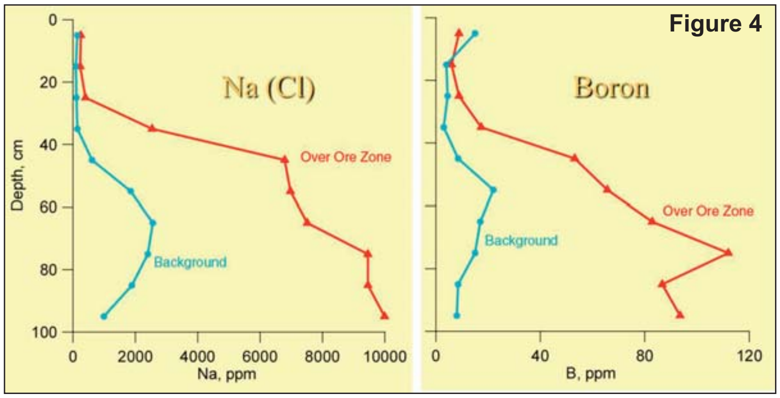
Figure 1: Spence - fracture in gravel

Figure 2: Spence - copper in soil (Enzyme Selective Extraction)

Figure 3: Spence soils - Na and Cl

Figure 4: Trench profiles - Cu (cation) vs. Se (anion) Cold Hydroxylamine

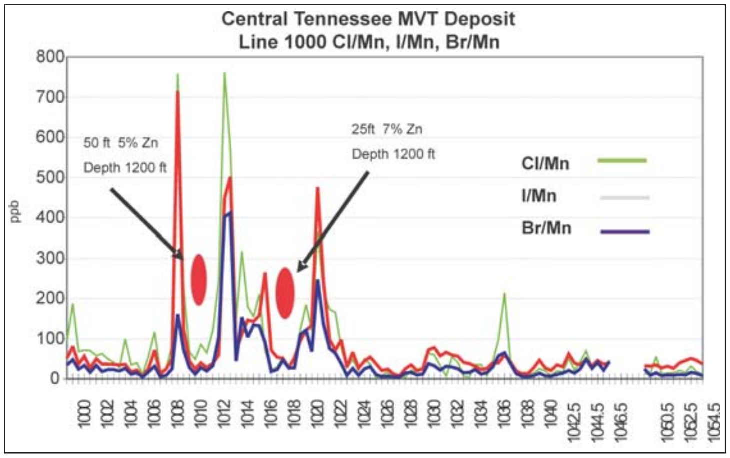




The Spence porphyry copper deposit in the Atacama Desert of Chile is picked up well using Enzyme Selective Extraction. Cu shows an apical anomaly over Spence but not over the unmineralized eastern fault zone which shows up with Na and Cl. Trench profiles indicate that near-surface soil sampling is required to see Cu (top 20 cm) whereas other elements like Re or Se will peak lower in the soil profile (50 - 80 cm). This is opposite to the glacial environment shown for Cross Lake on the preceding page where Cu peaks at 40 - 100 cm below surface.

Deep-penetrating Geochemistry: Northern Chile. Cameron, E. and Leybourne, M. Paper presented at IGES 2003, Dublin, Ireland.

Carbonate Terrain

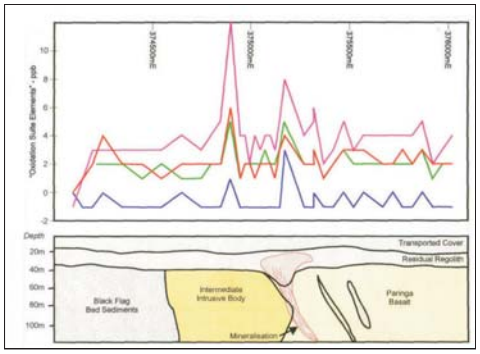


Many people have questioned whether Enzyme Selective Extraction works in areas of carbonate terrain. The following example is of a Mississippi Valley type Pb-Zn deposit in central Tennessee, USA below approximately 400 metres of an intercalated carbonate and shale cover rock. The surface area is actively farmed fields where waste limestone from the mine has been used to "sweeten" the fields to improve crop yield. As a result of this, there are wide swings in the collector amorphous Mn oxides. As a result, we have chosen to ratio the metals to Mn to level the amount of collector available. The two mineral deposits in red show the deposits quite clearly in halogens as rabbit ear anomalies. Apical anomalies also exist with Pb, Zn and Cd.

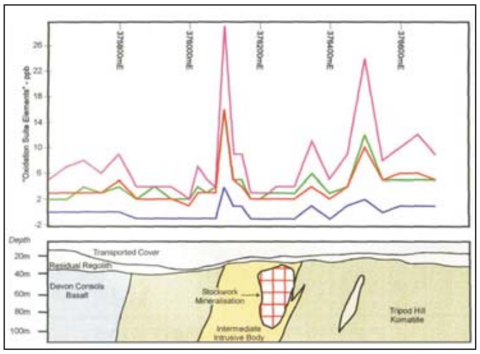
Salt Lake System - Lake Lefroy, Western Australia

Two gold deposits could be identified by sampling salty sludge below the salt crust on Lake Lefroy, Western Australia by Western Mining. Rare earths provided 'rabbit ear' anomalies indicating the Santa Ana and Intrepide Au deposits.

SANTA ANA: Enzyme Selective Extraction Orientation

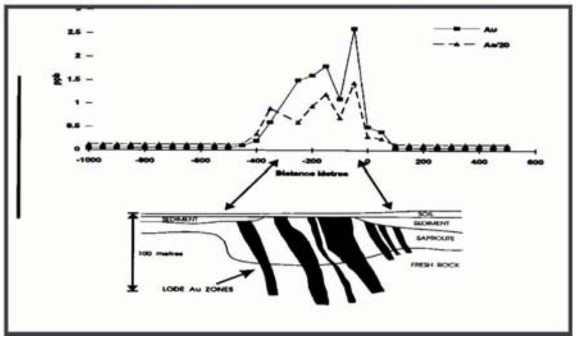


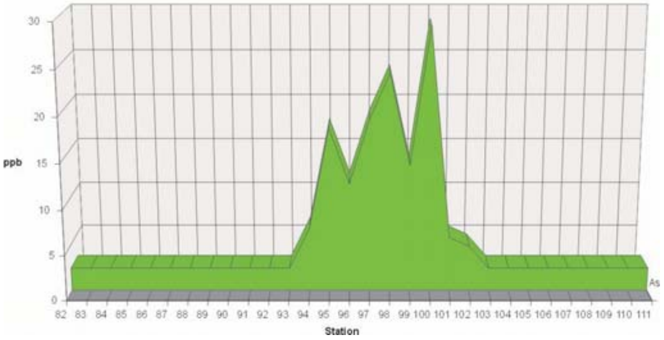
INTREPIDE: Enzyme Selective Extraction Orientation



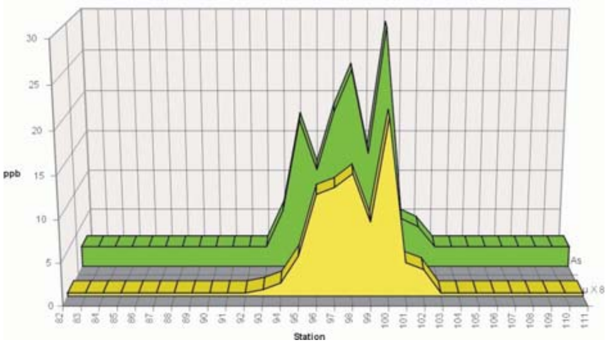
Carey, M.L. and Dusci, M.E., 1999. WMC Resources. Exploration Successes in Lake Terrains - Applications of Element Dispersion Kambalda. In Proceedings Third Australian Regolith Conference, Regolith 98, New Approaches to an Old Continent (eds G. Taylor, C. Pain) pp. 135-148.

Laterite Study - Brazil

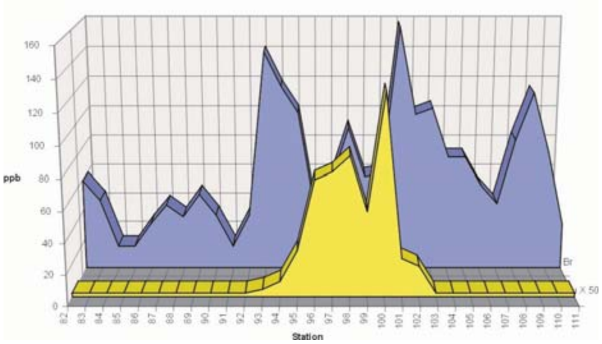




Arsenic



Arsenic and Gold X 8



Bromine and Gold X 50

The Fazenda Nova deposit in Brazil is quite clearly indicated with apical anomalies in arsenic and gold directly over the deposit. Halo 'rabbit ear' anomalies in bromine also occur peripheral to the central apical anomaly. Conventional soil sampling and analysis does not show an anomaly over the deposit. Drilling to sample the saprolite shows very broad anomalies but doesn't specifically indicate targets.

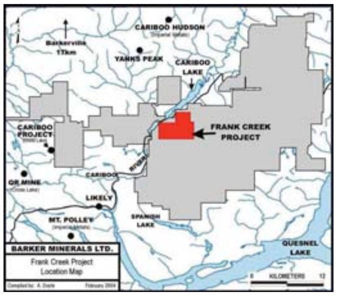
Case Studies

Frank Creek Kuroko Style VMS Discovery

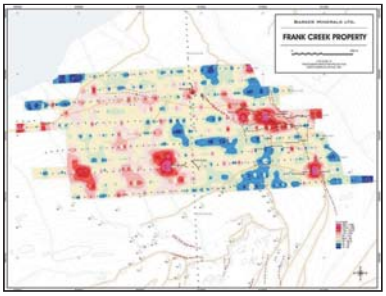
Barker Minerals' Frank Creek property is located in the Cariboo Mining District of British Columbia. An Enzyme Selective Extraction soil survey was incorporated on the Titan grid in order to assist in discriminating conductive anomalies caused by massive sulphide mineralization from graphitic anomalies. It was also used to assist in looking through the glacial overburden to better reflect possible bedrock sources of anomalies rather than conventional soil techniques which can provide false and misleading anomalies due to the deep overburden and glacial action which has moved the soil anomalies from their source areas. Exploration programs on the property, including exploration drilling, a geophysical survey and an Enzyme Selective Extraction soil survey, have vectored current exploration towards a new Kuroko style VMS discovery.

Reference: www.barkerminerals.com Press release Jan. 29, 2008

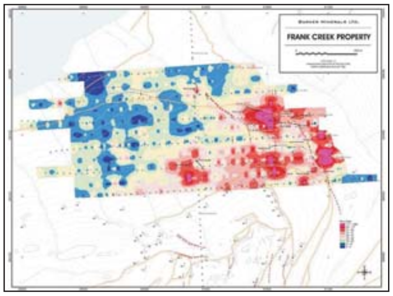
Location Map



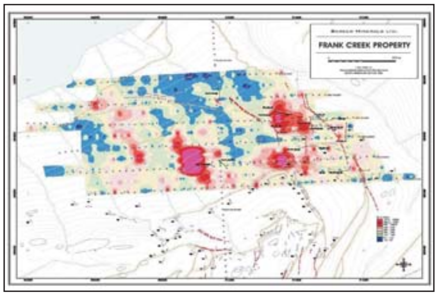
Copper



Lead



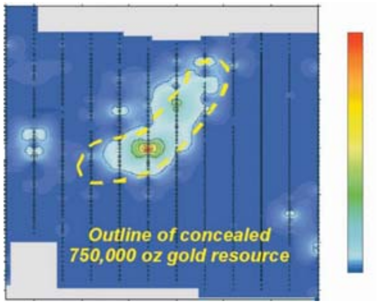
Zinc



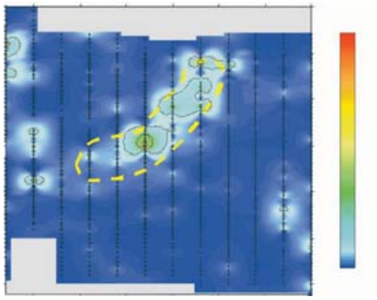
Antimonio Gold Discovery, Mexico

The original target at Antimonio was a set of detachment faults that subcrop beneath about 10 m of alluvium. An Enzyme Selective Extraction survey revealed a combination of apical anomalies and halos. It was initially thought that the Enzyme Selective Extraction anomaly was indicating gold mineralization in this fault zone, but drilling showed these faults to be barren of economic grades of gold. Consequently, deeper drilling was initiated in order to explain the strong Enzyme Selective Extraction anomaly. This led to the discovery of a sizable gold resource (est. 750,000 oz.) in the rocks beneath the detachment faults.

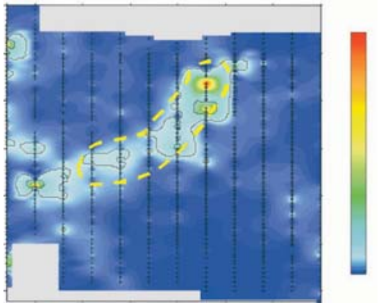
Gold



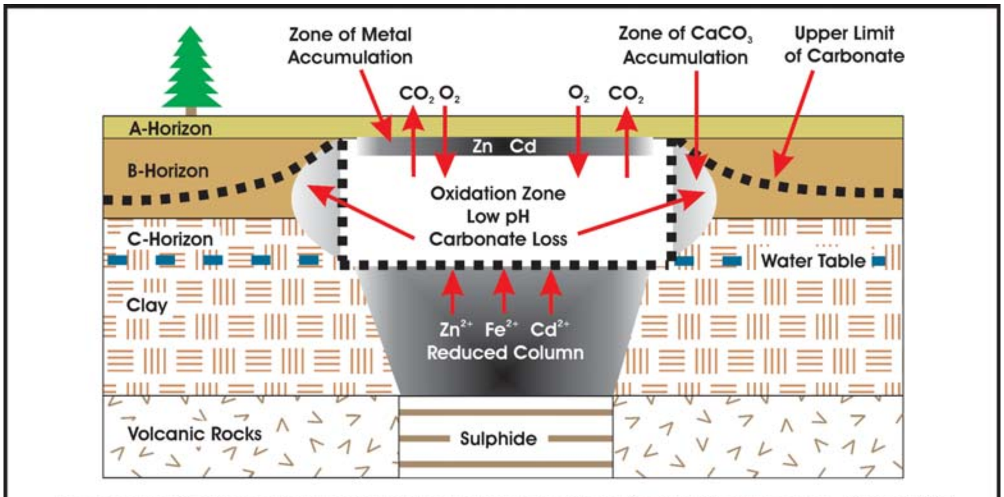
Arsenic



Antimony



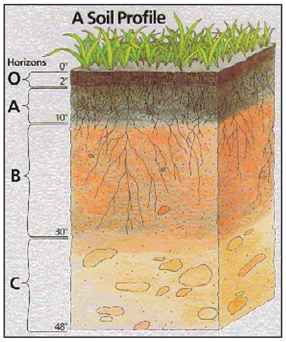
Many ore bodies are buried beneath thick sequences of exotic overburden, lake beds, barren bedrock or younger volcanic rocks. Exploration geologists require a cost-effective method of finding blind mineralization through deep cover. Our Selective Extractions provide the means to do this.



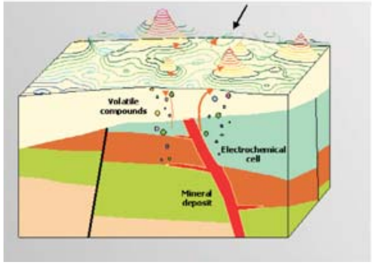
MODEL FOR DEVELOPMENT OF ANOMALIES THROUGH CLAY COVER (S. HAMILTON, 1998; 2000)

Deep Penetrating Geochemical Techniques in Exploration (the dos and don'ts). Hamilton, S., Hall, G. and McClenaghan, B. PowerPoint presentation CIM 2005 Exploration Geochemisty Short Course, Toronto, ON. (available upon request)

Pattern recognition is the key to proper interpretation of Selective Extraction data, since anomaly patterns can be different from conventional geochemical data. Selective Extractions have been shown to work effectively in both acidic and alkaline environments, and have been used successfully in desert, tropical, glacial and permafrost terrains.



Enzyme Selective Extraction Signature



Sample Collection and Sample Handling

Although Selective Extractions can be used as an analysis method for virtually any surficial geological material, the sample media most commonly analyzed with this method is B-horizon soils. Research to date (Cameron et al.) indicates that the upper portion of the B-horizon is optimal. Soil horizons vary in appearance and depth, even within relatively small areas. Therefore is should be emphasized that material from a consistent soil horizon be collected rather then a consistent depth.

Samples should consist of about 100 to 200 grams of material depending on the fineness of the soil. Coarser soils require more material to assure adequate sieved sample material for analysis.

Preparation and Analysis

Sample materials are air dried or dried in special rooms kept below 40°C. It is imperative that the samples not be placed in drying ovens as it is impossible to guarantee consistency of drying temperature even in temperature controlled ovens. Samples are then sieved and a 1 gram sample of -60 mesh material undergoes a proprietary selective extraction under rigidly controlled conditions. The resultant solutions are analyzed by ICP/MS.

Periodic Table of the Elements

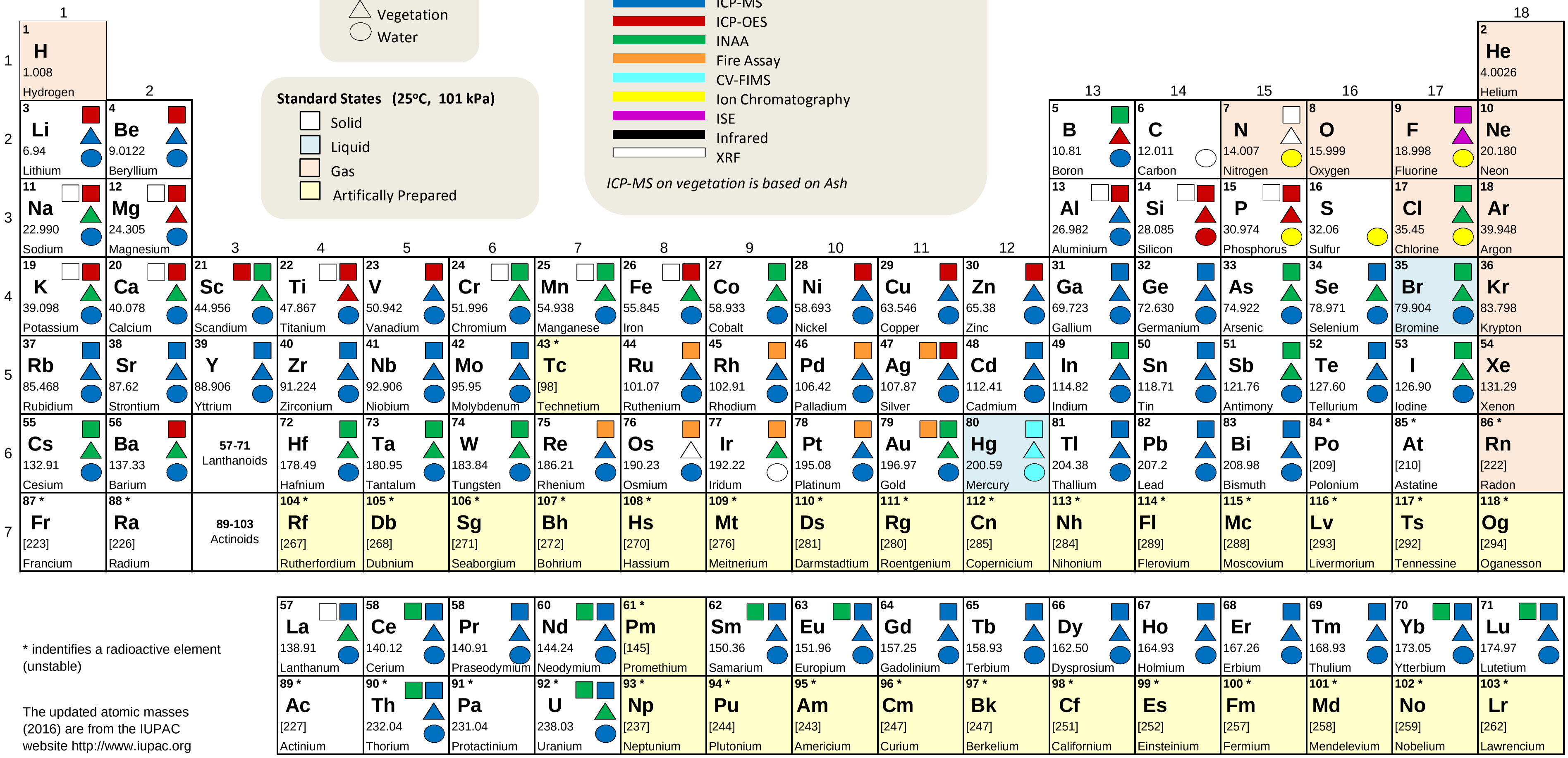
Substrate Type:
- □ Rock
- △ Vegetation
- ○ Water

Standard States (25°C, 101 kPa)
- ☐ Solid
- ☐ Liquid
- ☐ Gas
- ☐ Artifically Prepared

Preferred Analytical Method
- 🟦 ICP-MS
- 🟥 ICP-OES
- 🟩 INAA
- 🟧 Fire Assay
- ▬ CV-FIMS
- 🟨 Ion Chromatography
- 🟪 ISE
- ⬛ Infrared
- ⬜ XRF

ICP-MS on vegetation is based on Ash

Atomic number	6
Element symbol	**C**
Atomic mass	12.011
Name	Carbon
	⬛ ▲ ○



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.008 Hydrogen																	2 **He** 4.0026 Helium
2	3 **Li** 6.94 Lithium 🟥 ▲ 🔵	4 **Be** 9.0122 Beryllium 🟥 ▲ 🔵											5 **B** 10.81 Boron 🟩 ▲ 🔵	6 **C** 12.011 Carbon ⚪	7 **N** 14.007 Nitrogen ⬜ △ 🟡	8 **O** 15.999 Oxygen	9 **F** 18.998 Fluorine 🟪 ▲ 🟡	10 **Ne** 20.180 Neon
3	11 **Na** 22.990 Sodium ⬜🟥 ▲ 🔵	12 **Mg** 24.305 Magnesium ⬜🟥 ▲ 🔵											13 **Al** 26.982 Aluminium ⬜🟥 ▲ 🔵	14 **Si** 28.085 Silicon ⬜🟥 ▲ 🔴	15 **P** 30.974 Phosphorus ⬜🟥 ▲ 🟡	16 **S** 32.06 Sulfur 🟡	17 **Cl** 35.45 Chlorine 🟩 ▲ 🟡	18 **Ar** 39.948 Argon
4	19 **K** 39.098 Potassium ⬜🟥 ▲ 🔵	20 **Ca** 40.078 Calcium ⬜🟥 ▲ 🔵	21 **Sc** 44.956 Scandium 🟥🟩 ▲ 🔵	22 **Ti** 47.867 Titanium ⬜🟥 ▲ 🔵	23 **V** 50.942 Vanadium 🟥 ▲ 🔵	24 **Cr** 51.996 Chromium ⬜🟩 ▲ 🔵	25 **Mn** 54.938 Manganese ⬜🟩 ▲ 🔵	26 **Fe** 55.845 Iron ⬜🟥 ▲ 🔵	27 **Co** 58.933 Cobalt 🟩 ▲ 🔵	28 **Ni** 58.693 Nickel 🟥 ▲ 🔵	29 **Cu** 63.546 Copper 🟥 ▲ 🔵	30 **Zn** 65.38 Zinc 🟥 ▲ 🔵	31 **Ga** 69.723 Gallium 🟦 ▲ 🔵	32 **Ge** 72.630 Germanium 🟦 ▲ 🔵	33 **As** 74.922 Arsenic 🟩 ▲ 🔵	34 **Se** 78.971 Selenium 🟦 ▲ 🔵	35 **Br** 79.904 Bromine 🟩 ▲ 🔵	36 **Kr** 83.798 Krypton
5	37 **Rb** 85.468 Rubidium 🟦 ▲ 🔵	38 **Sr** 87.62 Strontium 🟦 ▲ 🔵	39 **Y** 88.906 Yttrium 🟦 ▲ 🔵	40 **Zr** 91.224 Zirconium 🟦 ▲ 🔵	41 **Nb** 92.906 Niobium 🟦 ▲ 🔵	42 **Mo** 95.95 Molybdenum 🟦 ▲ 🔵	43 * **Tc** [98] Technetium	44 **Ru** 101.07 Ruthenium 🟧 ▲ 🔵	45 **Rh** 102.91 Rhodium 🟧 ▲ 🔵	46 **Pd** 106.42 Palladium 🟧 ▲ 🔵	47 **Ag** 107.87 Silver 🟧🟥 ▲ 🔵	48 **Cd** 112.41 Cadmium 🟦 ▲ 🔵	49 **In** 114.82 Indium 🟩 ▲ 🔵	50 **Sn** 118.71 Tin 🟦 ▲ 🔵	51 **Sb** 121.76 Antimony 🟩 ▲ 🔵	52 **Te** 127.60 Tellurium 🟦 ▲ 🔵	53 **I** 126.90 Iodine 🟩 ▲ 🔵	54 **Xe** 131.29 Xenon
6	55 **Cs** 132.91 Cesium 🟩 ▲ 🔵	56 **Ba** 137.33 Barium 🟥 ▲ 🔵	**57-71** Lanthanoids	72 **Hf** 178.49 Hafnium 🟩 ▲ 🔵	73 **Ta** 180.95 Tantalum 🟩 ▲ 🔵	74 **W** 183.84 Tungsten 🟩 ▲ 🔵	75 **Re** 186.21 Rhenium 🟧 ▲ 🔵	76 **Os** 190.23 Osmium 🟧 △ 🔵	77 **Ir** 192.22 Iridium 🟧 ▲ ⚪	78 **Pt** 195.08 Platinum 🟧 ▲ 🔵	79 **Au** 196.97 Gold 🟧🟩 ▲ 🔵	80 **Hg** 200.59 Mercury ■ ▲ ●	81 **Tl** 204.38 Thallium 🟦 ▲ 🔵	82 **Pb** 207.2 Lead 🟦 ▲ 🔵	83 **Bi** 208.98 Bismuth 🟦 ▲ 🔵	84 * **Po** [209] Polonium	85 * **At** [210] Astatine	86 * **Rn** [222] Radon
7	87 * **Fr** [223] Francium	88 * **Ra** [226] Radium	**89-103** Actinoids	104 * **Rf** [267] Rutherfordium	105 * **Db** [268] Dubnium	106 * **Sg** [271] Seaborgium	107 * **Bh** [272] Bohrium	108 * **Hs** [270] Hassium	109 * **Mt** [276] Meitnerium	110 * **Ds** [281] Darmstadtium	111 * **Rg** [280] Roentgenium	112 * **Cn** [285] Copernicium	113 * **Nh** [284] Nihonium	114 * **Fl** [289] Flerovium	115 * **Mc** [288] Moscovium	116 * **Lv** [293] Livermorium	117 * **Ts** [292] Tennessine	118 * **Og** [294] Oganesson

57 **La** 138.91 Lanthanum ⬜🟦 ▲ 🔵	58 **Ce** 140.12 Cerium 🟩🟦 ▲ 🔵	58 **Pr** 140.91 Praseodymium 🟦 ▲ 🔵	60 **Nd** 144.24 Neodymium 🟩🟦 ▲ 🔵	61 * **Pm** [145] Promethium	62 **Sm** 150.36 Samarium 🟩🟦 ▲ 🔵	63 **Eu** 151.96 Europium 🟩🟦 ▲ 🔵	64 **Gd** 157.25 Gadolinium 🟦 ▲ 🔵	65 **Tb** 158.93 Terbium 🟦 ▲ 🔵	66 **Dy** 162.50 Dysprosium 🟦 ▲ 🔵	67 **Ho** 164.93 Holmium 🟦 ▲ 🔵	68 **Er** 167.26 Erbium 🟦 ▲ 🔵	69 **Tm** 168.93 Thulium 🟦 ▲ 🔵	70 **Yb** 173.05 Ytterbium 🟩🟦 ▲ 🔵	71 **Lu** 174.97 Lutetium 🟩🟦 ▲ 🔵
89 * **Ac** [227] Actinium	90 * **Th** 232.04 Thorium 🟩🟦 ▲ 🔵	91 * **Pa** 231.04 Protactinium	92 * **U** 238.03 Uranium 🟩🟦 ▲ 🔵	93 * **Np** [237] Neptunium	94 * **Pu** [244] Plutonium	95 * **Am** [243] Americium	96 * **Cm** [247] Curium	97 * **Bk** [247] Berkelium	98 * **Cf** [251] Californium	99 * **Es** [252] Einsteinium	100 * **Fm** [257] Fermium	101 * **Md** [258] Mendelevium	102 * **No** [259] Nobelium	103 * **Lr** [262] Lawrencium

* indentifies a radioactive element (unstable)

The updated atomic masses (2016) are from the IUPAC website http://www.iupac.org

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