



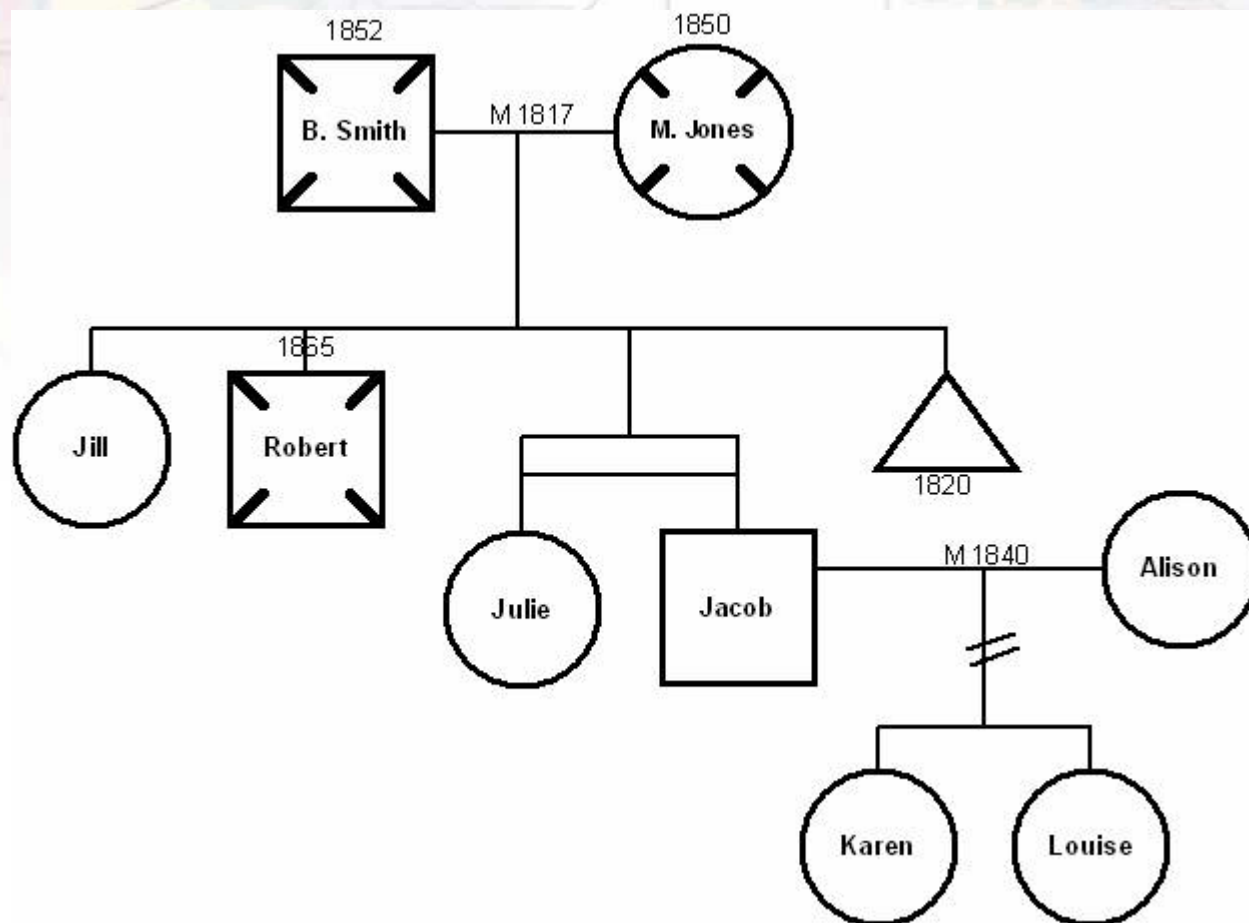
# Integrating Knowledge Representation into GIS:

## An Example from Minerals Exploration

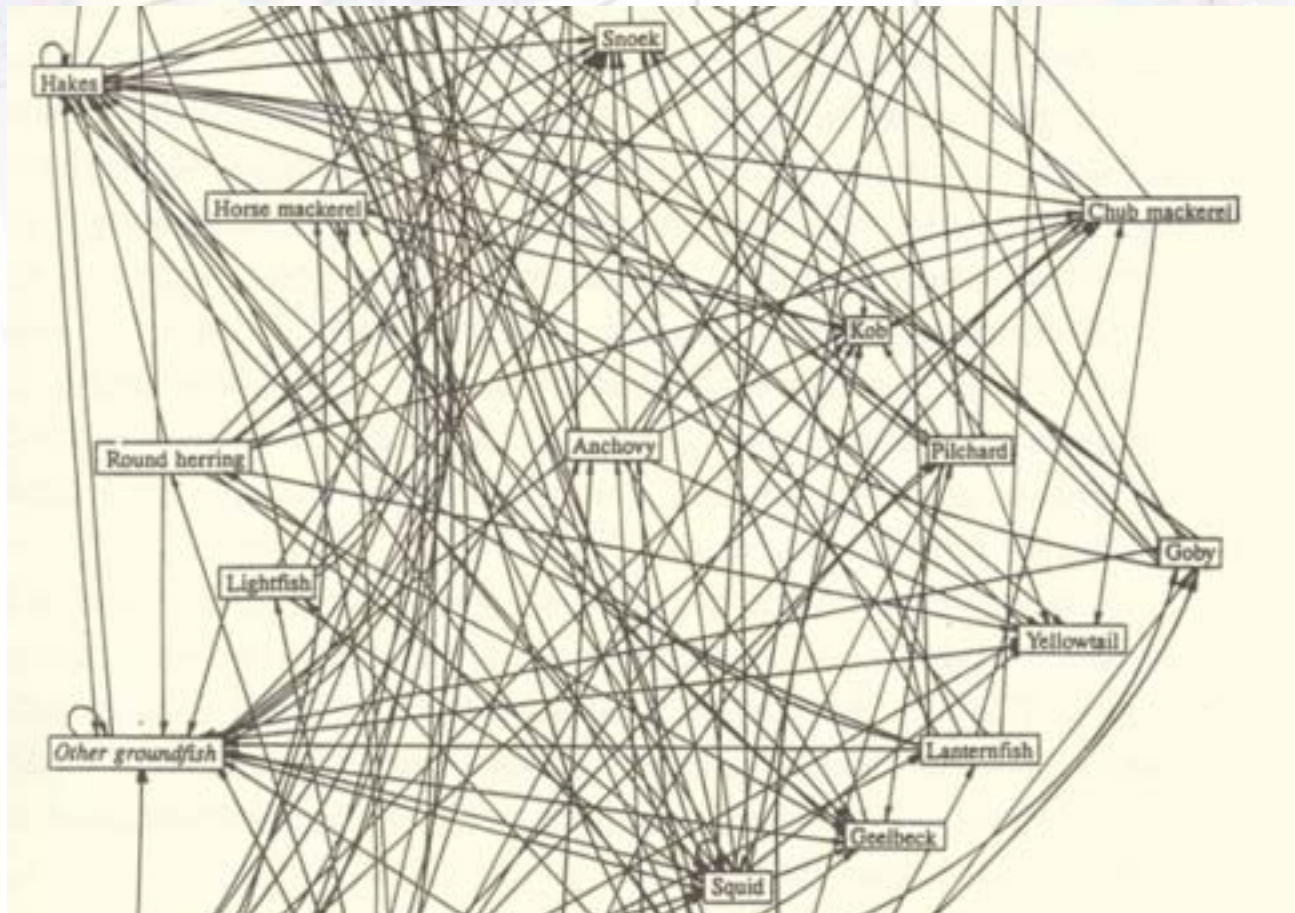
Clinton Smyth, Janice Denovan, Tony Huynh

[www.georeferenceonline.com](http://www.georeferenceonline.com)

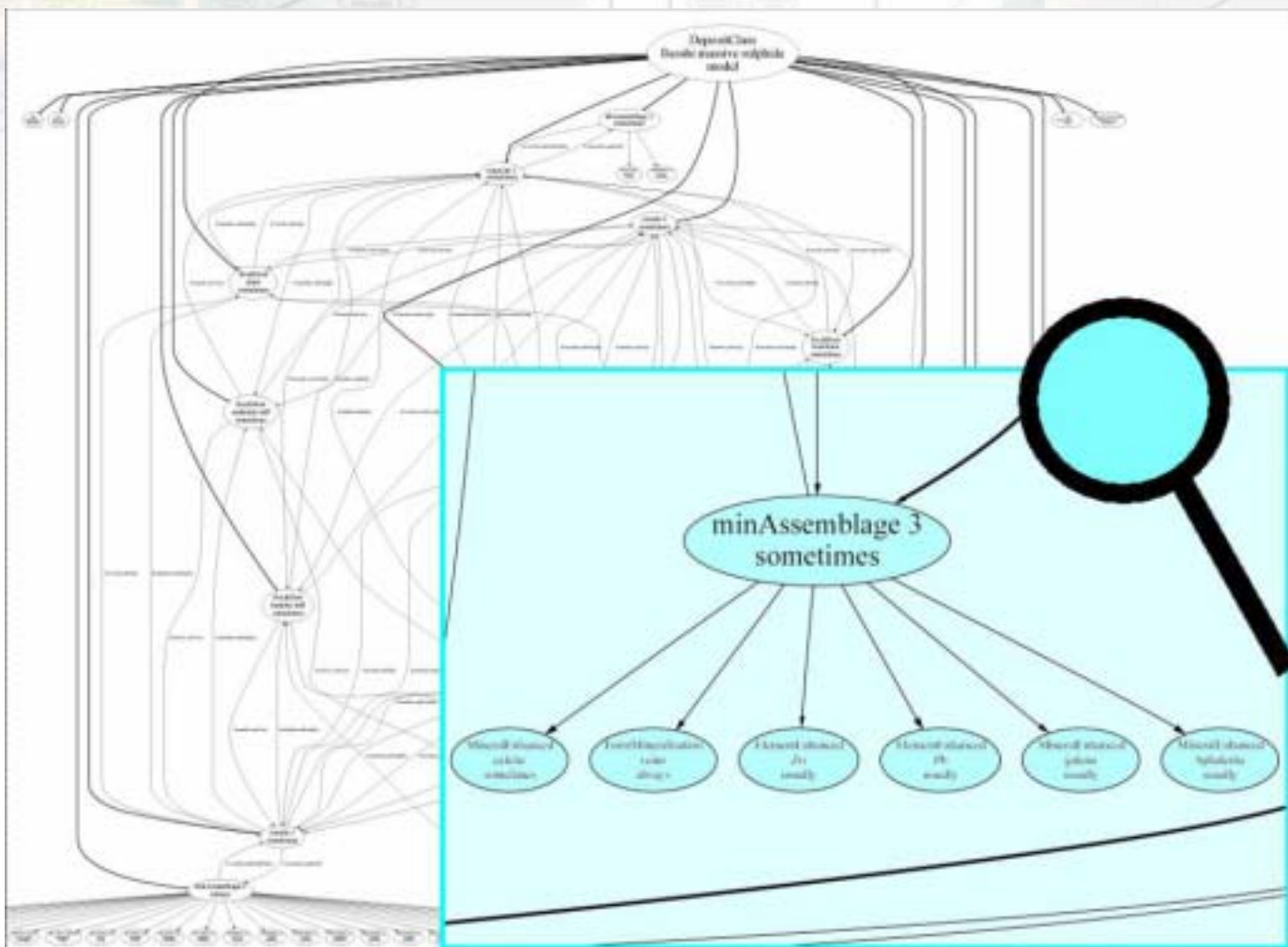
## Representations of Human Knowledge as Networks: Geneology Example (Smith-Jones, 1890)



## Computer Representations of Human Knowledge As Networks: Biology (Yodzis, 1995)



## Computer Representations of Mineral Deposits Knowledge as “Semantic Networks”: (Smyth (2001) from Cox and Singer (1986))



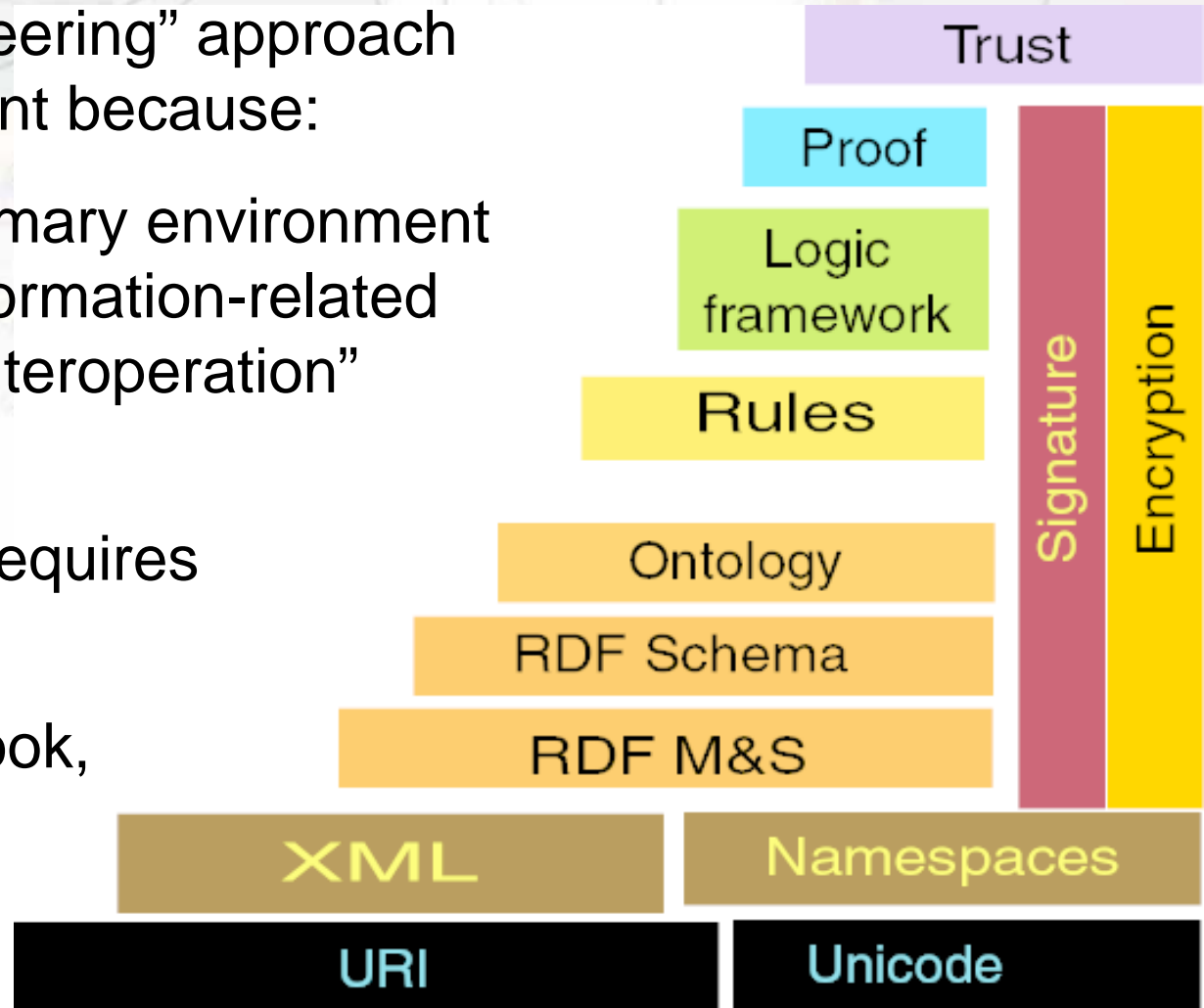
## The Semantic Web

(T. Berners-Lee (2003))

The Internet is the primary driver of the “Knowledge Engineering” approach to data management because:

- (1) It is now the primary environment
  - . within which information-related
  - . collaboration/“interoperation”
  - . takes place.
- (2) Interoperation requires
  - . knowledge.

This is how it will look, according to its inventor:



## The Semantic Web

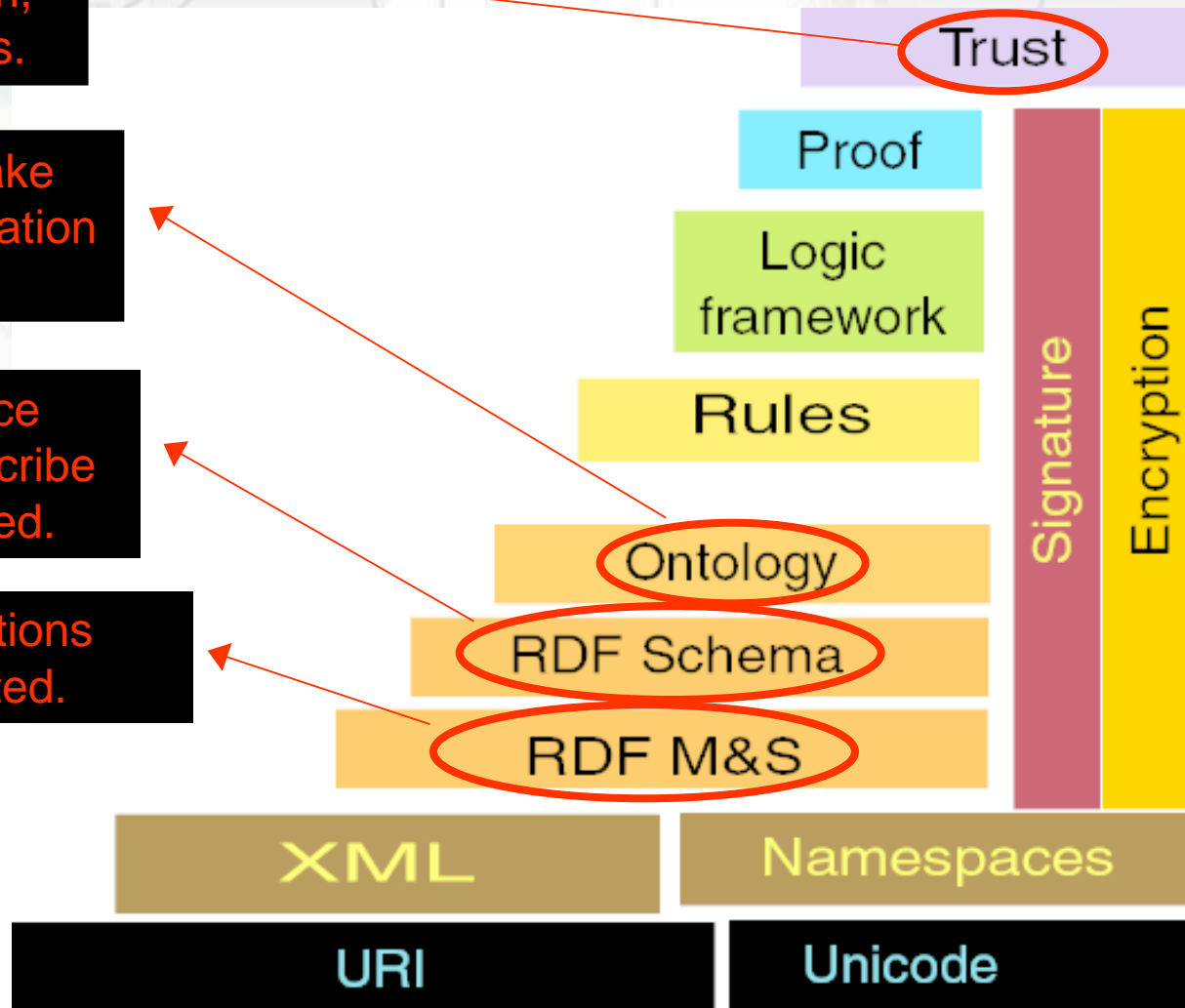
(T. Berners-Lee (2003))

Trust requires a clear understanding of, and satisfaction with, information sources.

“The rules which make meaningful communication possible”.

This is where Science Languages, which describe CLASSES, are located.

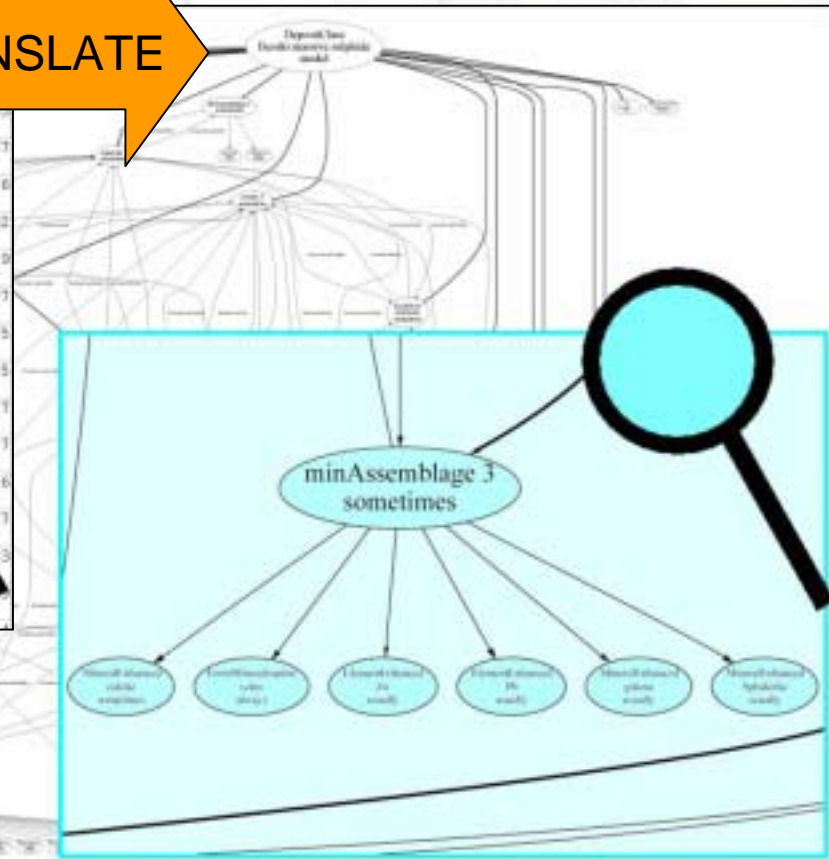
This is where descriptions of THINGS are located.



## Tabular (Relational) Computer Data can be converted to Semantic Networks for Representation of Sophisticated “Knowledge”

MASTER_ID	ROCK_TYPE	CU_AAS	FR_AAS	IN_AAS	LAT	LONG
94D963427	undivided volcanic rocks	3600	2	98	56.75445	-126.34051
94E965060	intrusive rocks, undivided	3200	14	380	57.07476	-126.78993
94E961407	granodioritic intrusive rocks	2800	6	79	57.770	
1030783024	orthogneiss metamorphic rocks	1950	1	295	55.417	
92E765100	quartz dioritic intrusive rocks	1800	75	148	49.861	
92G991420	marine sedimentary					
93M831097	coarse clastic sedi					
92E775303	coarse clastic sedi					
93L861109	coarse clastic sedi					
93E861168	calc-alkaline volca					
92O793134	granodioritic intru					
94E961574	granodioritic intru					
92M813227	intrusive rocks, un					
93E861158	granodioritic intru					
1048871415	andesitic volcanic					
93E861076	calc-alkaline volca					
103F787036	volcaniclastic rock					
93L861686	calc-alkaline volcanic rocks	828	27	438	54.54517	-127.1133
1048871288	volcaniclastic rocks	807	22	185	56.19458	-130.09

TRANSLATE



## Relational DB/Semantic Networks Comparison

Relational	Semantic Networks	Comment
Schema	Ontology	Needs an Ontology Editor
Table	Collection of Instances	
Record	Instance	Eg: "A mineral deposit" (Instance descriptions = semantic networks)
Table Column	Property	Eg: "HostRock"
Column Value	Property Value	Eg: "Granite"
-	Class	"Granite <u>is a</u> Plutonic Rock"
SQL	Logic	There is more than one kind of logic.



## CLASSES

(No Relational Equivalent)

The British Geological Survey  
Rock Classification System

*Thoroughly  
Documented*

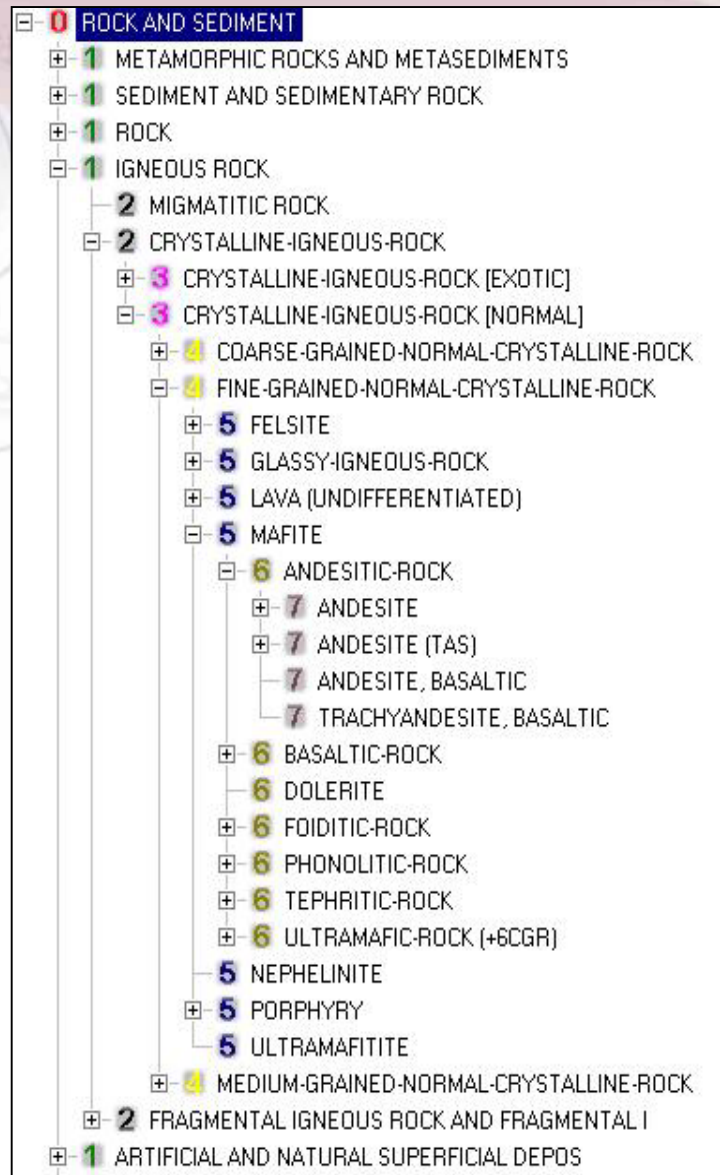
*Accessible*

*Rapidly*

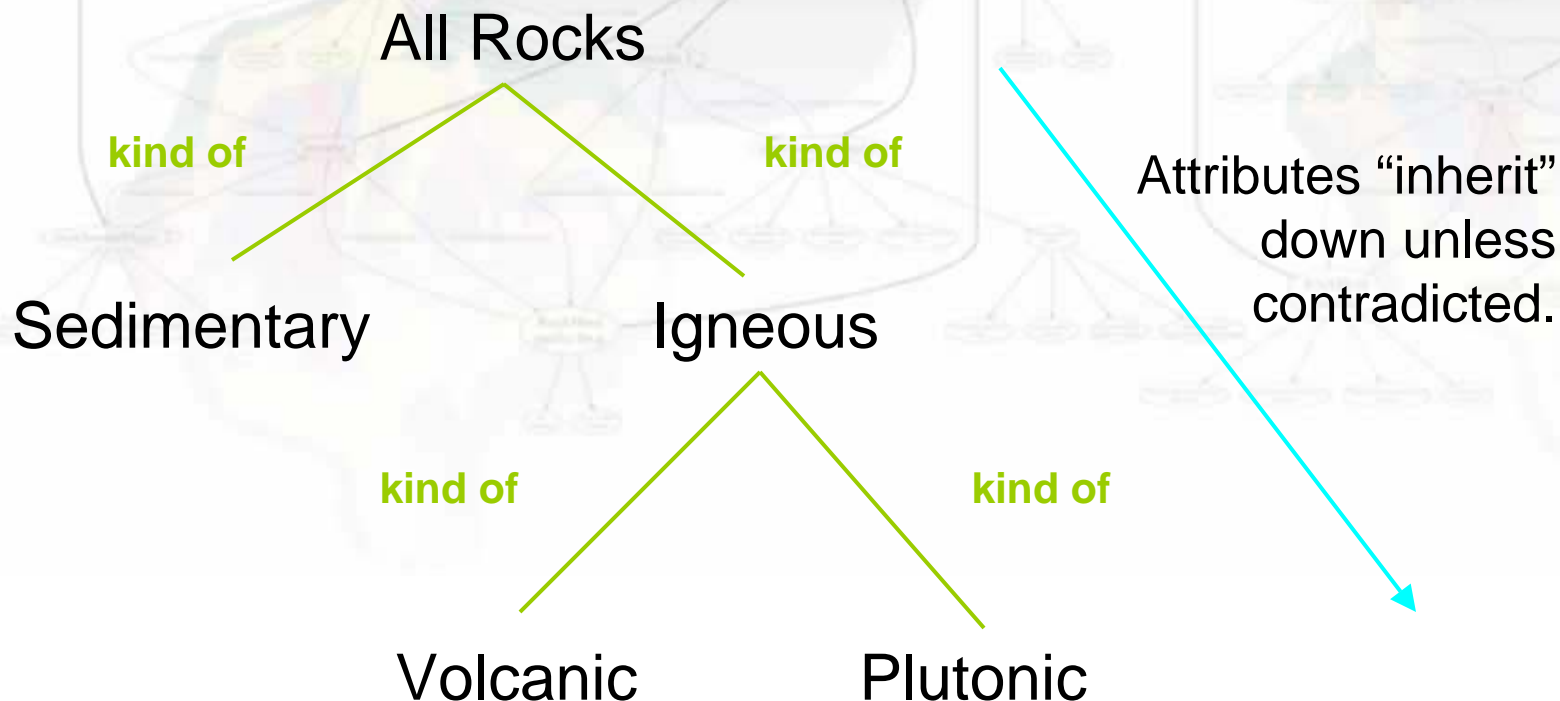
*Navigable*

*Hierarchical*

A Trustworthy Science Language?

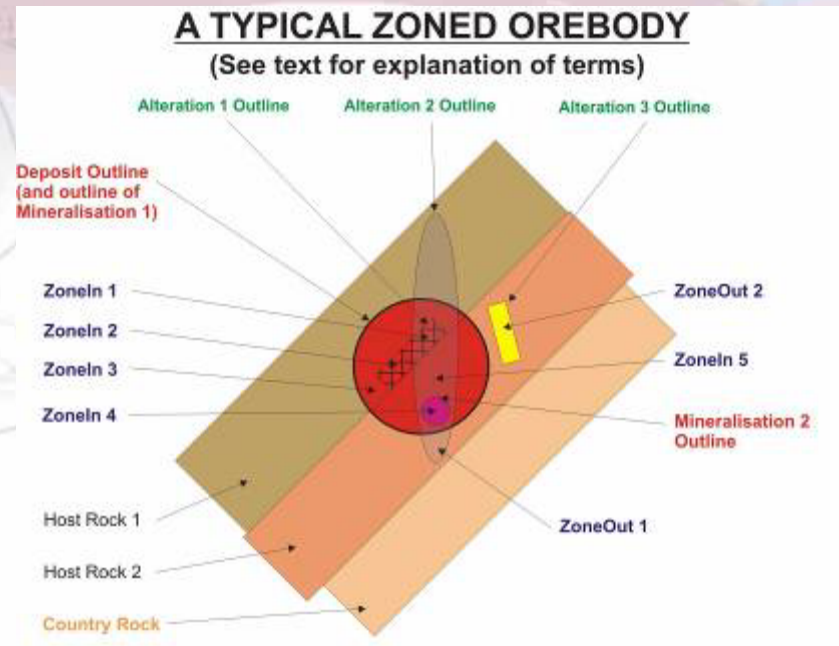


## The BGS RCS is a Taxonomy

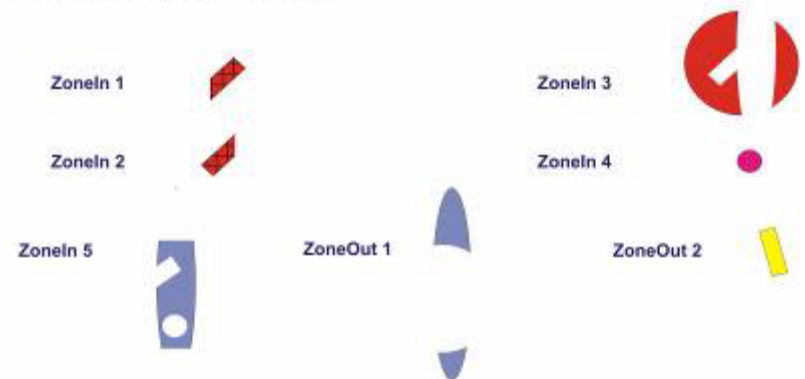


If a Model or Query calls for “Igneous”, “Plutonic” is recognised as a satisfactory match.

Standards:  
 Ontology development requires **concept models**, which often include taxonomies.

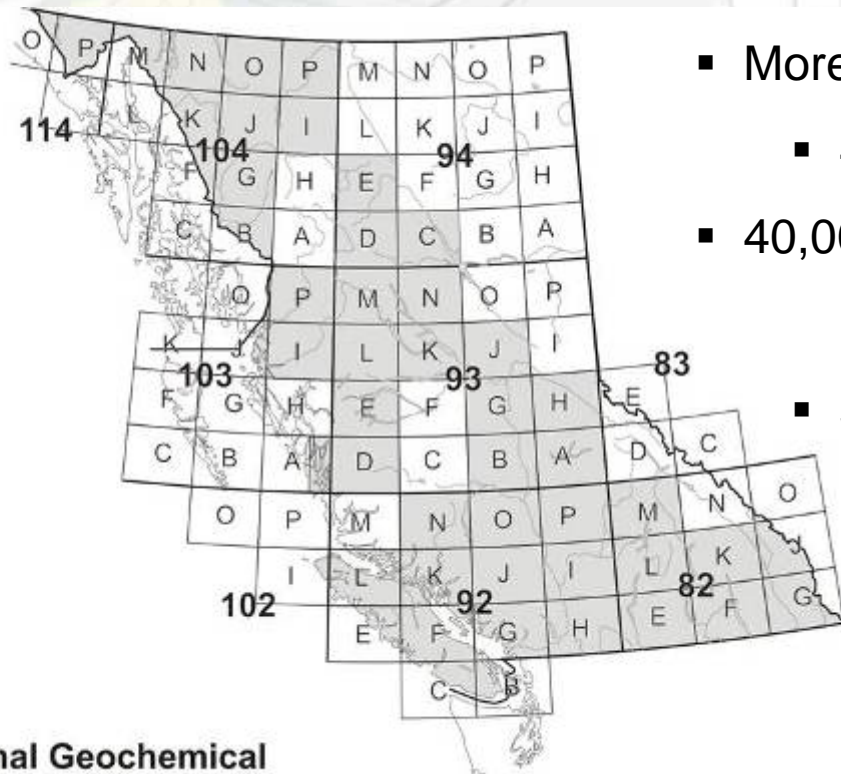


**Individual Zone Limits:**



It requires specification of Entities, Attributes and Attribute Values, as well as the possible relationships between them.

## Study Area



- More than 2/3 of British Columbia
  - 45 1:250K mapsheets
- 40,000 stream sediment samples
  - Sample density: 1 per 13 km<sup>2</sup>
  - 5% field duplicates
  - Recent geology recompilation

 Regional Geochemical Survey Coverage

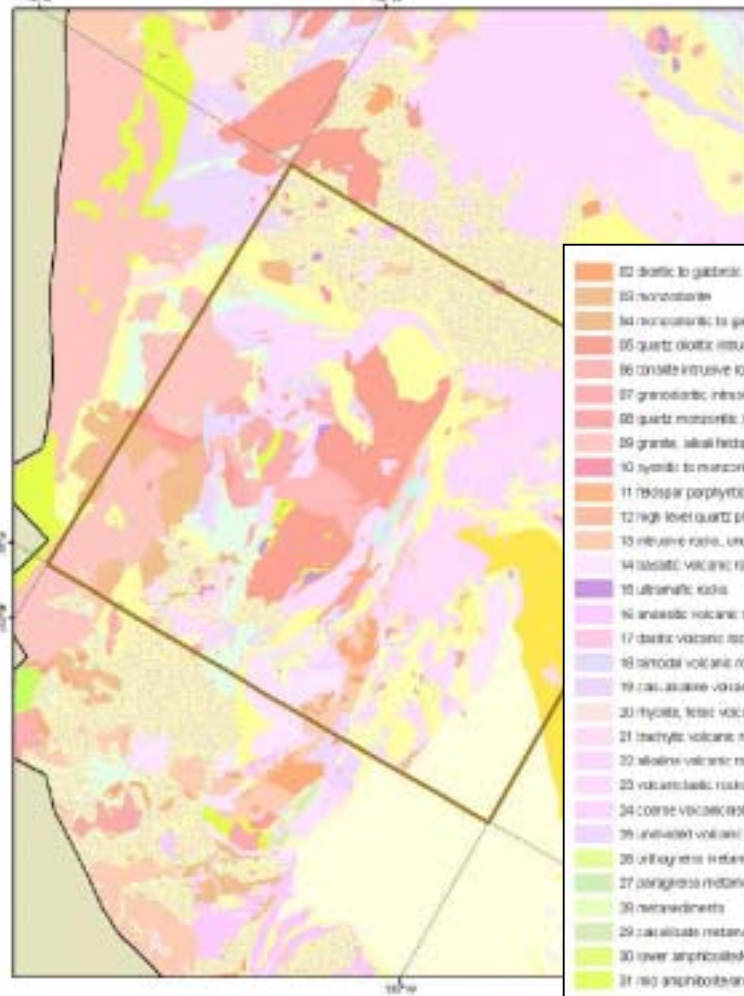
### *Detailed Project Description:*

“British Columbia Regional Geochemical Cluster Anomalies And Best Matches To Mineral Deposit Types”, Smyth C. P. (2003)

<http://www.em.gov.bc.ca/DL/GSBPubs/GeoFldWk/2003/27-Smyth-295-304-w.pdf>

## Bedrock Geology:

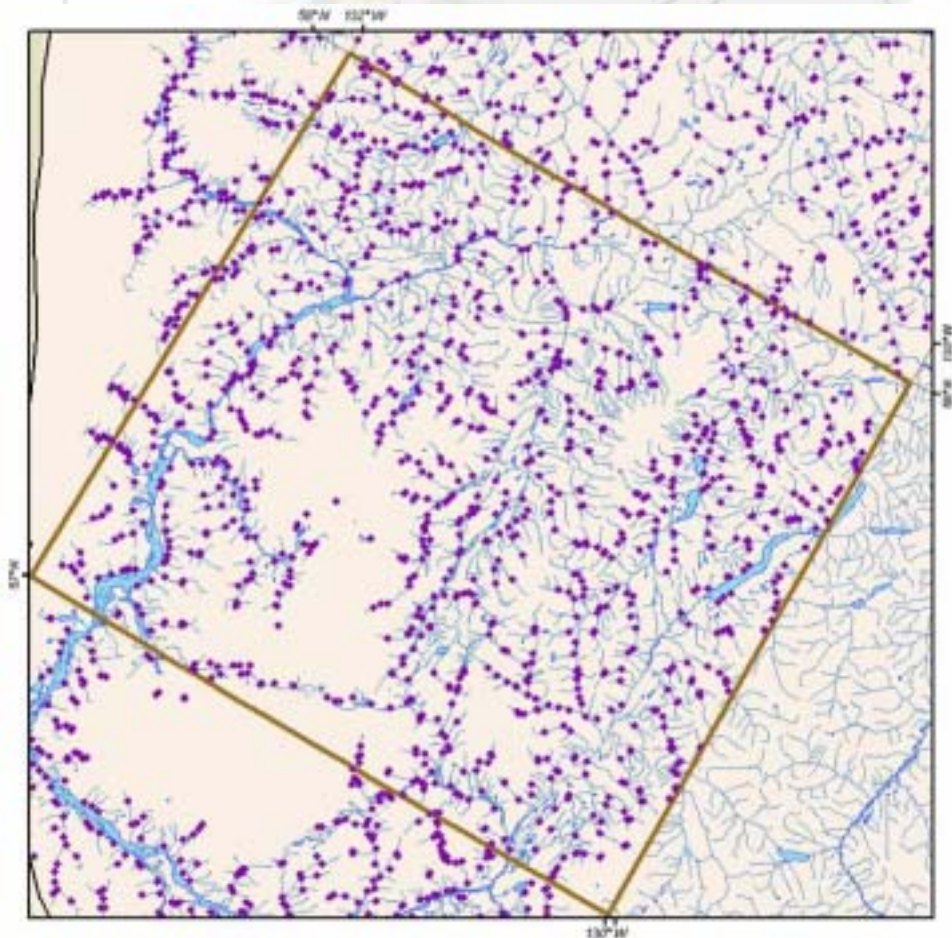
31,000 polygons  
60 lithologies



02 dioritic to gabbroic intrusive rocks	32 greenstone, green schist metamorphic rocks
03 monzonitic	33 eclogite-bearing metabasite
04 monzonitic to gabbroic intrusive rocks	34 seipentine ultrabasic rocks
05 quartz dioritic intrusive rocks	35 migmatitic metabasaltic rocks
06 cordillite intrusive rocks	36 mylonitic metabasaltic rocks
07 granodioritic intrusive rocks	37 metamorphic rocks, unclassified
08 quartz monzonitic intrusive rocks	38 marine sedimentary and volcanic rocks
09 granite, alkali feldspar granite intrusive rocks	39 intracrustal zone
10 syenitic to monzonitic intrusive rocks	41 coarse clastic sedimentary rocks
11 feldspar porphyritic intrusive rocks	42 conglomerate, coarse clastic sedimentary rocks
12 high level quartz phylic, felsic intrusive rocks	43 conglomerate, sandstone, siltstone, mudstone, fine coal
13 intrusive rocks, undivided	44 sandstone, siltstone, carbonaceous and carbonaceous mudstone, minor conglomerate
14 basaltic volcanic rocks	45 sandstone, siltstone, fine conglomerate
15 ultrabasic rocks	46 sandstone, siltstone, conglomerate
16 andesitic volcanic rocks	47 quartzite, quartz arenite sedimentary rocks
17 dioritic volcanic rocks	48 argillite, greywacke, wacke, conglomerate turbidites
18 andesitic volcanic rocks	49 argillite, siltstone
19 calc-alkaline volcanic rocks	50 fine clastic sedimentary rocks
20 rhyolite, felsic volcanic rocks	51 mudstone, siltstone, fine-medium grained sandstone, minor conglomerate, coal
21 trachytic volcanic rocks	52 mudstone, siltstone, shale fine clastic sedimentary rocks
22 alkaline volcanic rocks	53 mudstone/siltstone fine clastic sedimentary rocks
23 volcanoblastic rocks	54 laminated siltstone and fine-grained sandstone, silt pebble conglomerate
24 coarse volcanoclastic and pyroclastic volcanic rocks	55 interbedded and varicoloured siltstone, sandstone and conglomerate, minor coal
25 unclassified volcanic rocks	56 chert, siltstone, argillite, silicified rocks
26 ultrabasic metamorphic rocks	57 limestone, dolomite
27 paragneiss metamorphic rocks	58 limestone, marble, calcareous sedimentary rocks
28 metacarbonates	59 limestone, slate, siltstone, argillite
29 calcareous metamorphic rocks	60 dolomite, carbonate rocks
30 lower amphibolite/omphacite grade metamorphic rocks	61 evaporite
31 low amphibolite/omphacite grade metamorphic rocks	62 undivided sedimentary rocks

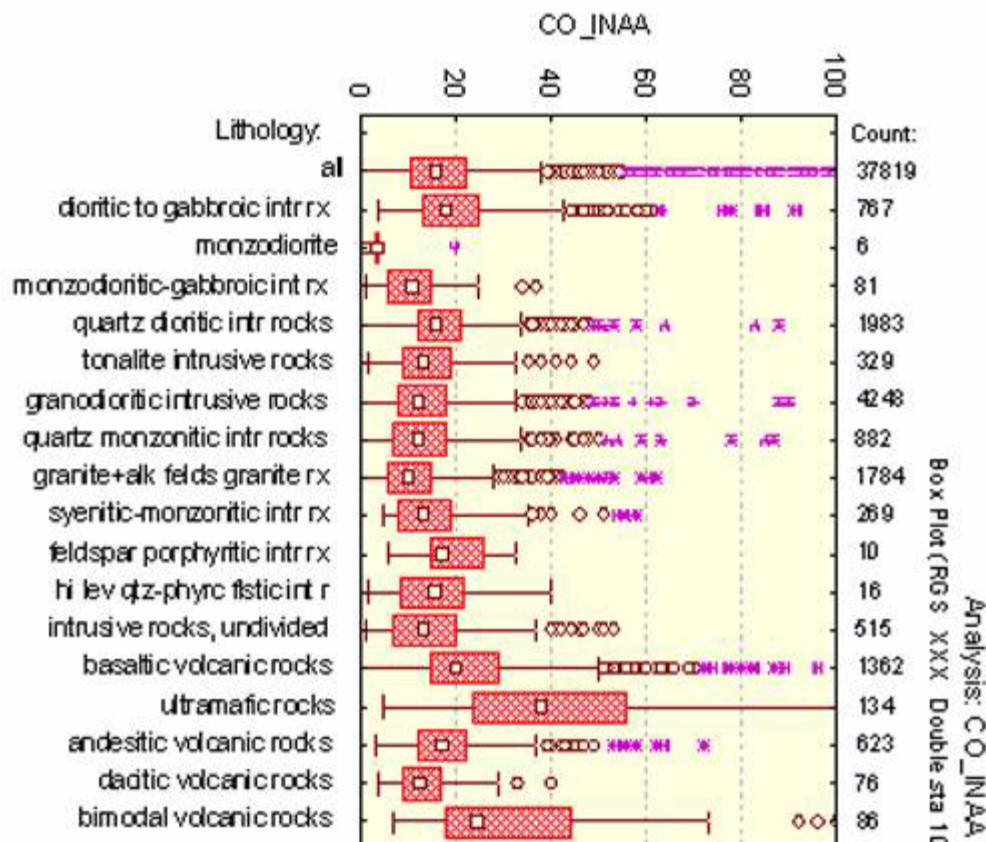
## Geochemistry:

**40,000 points**  
**36 Elements**



Ag	As	Au	Ba
Bi	Br	Cd	Ce
Co	Cr	Cs	Cu
Fe	Hf	Hg	La
Lu	Mn	Mo	Na
Ni	Pb	Rb	Sb
Sc	Sm	Sn	Ta
Tb	Th	U	V
W	Yb	Zn	Zr

## Lithology-specific Anomaly Thresholds

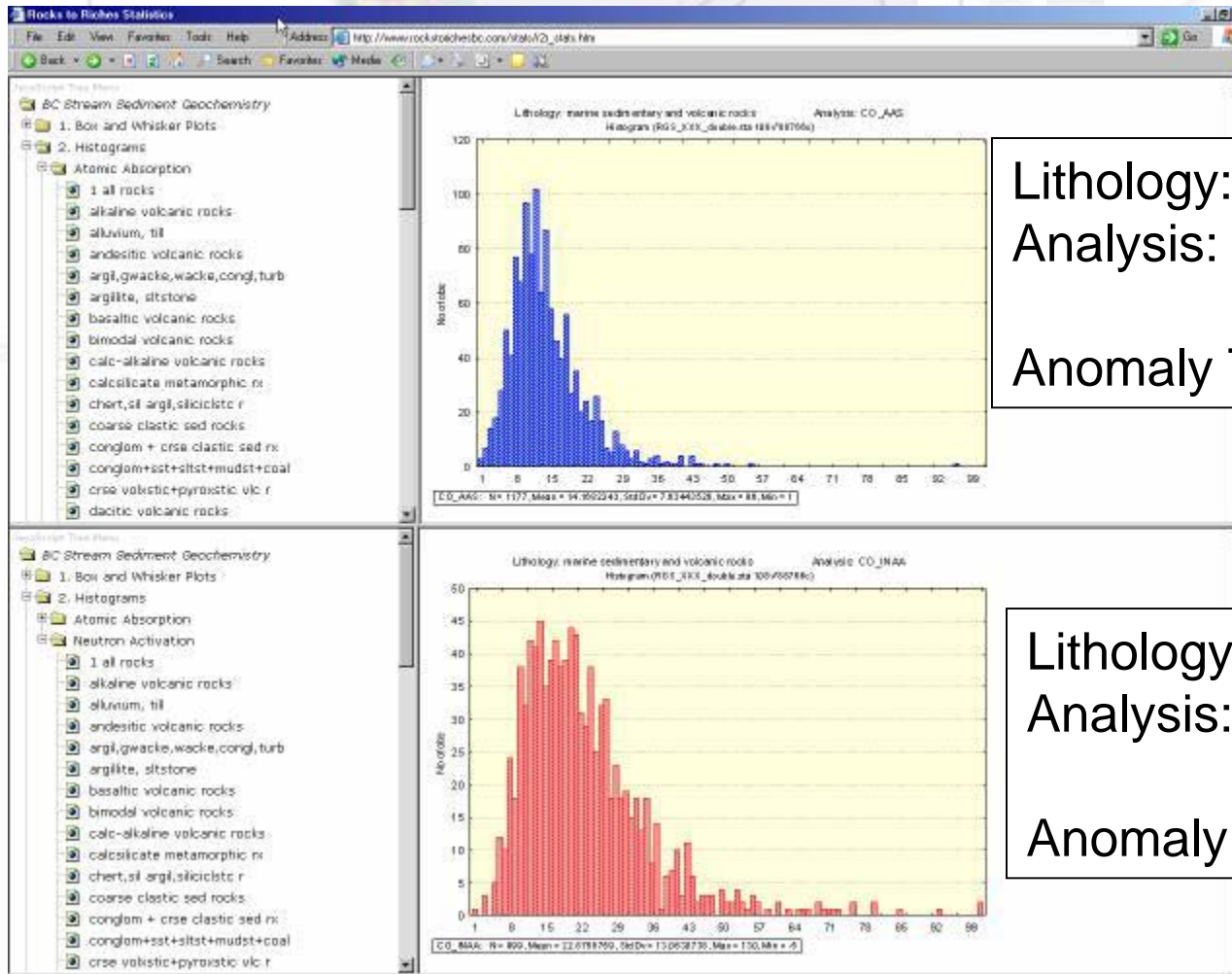


Lithology: **Tonalite**  
 Analysis: Cobalt INAA  
 Anomaly\* Threshold: **38 ppm**

Lithology: **Ultramafic**  
 Analysis: Cobalt INAA  
 Anomaly\* Threshold: **190 ppm**

\* Anomaly => 99<sup>th</sup> Percentile

## Analysis-specific Anomaly Thresholds



Lithology: Marine sediments  
 Analysis: Cobalt by **Atomic Absorption**  
 Anomaly Threshold: **41 ppm**

Lithology: Marine sediments  
 Analysis: Cobalt by **Neutron Activation**  
 Anomaly Threshold: **72 ppm**



## Mineral Deposit Models: Porphyry Co ± Mo ± Au

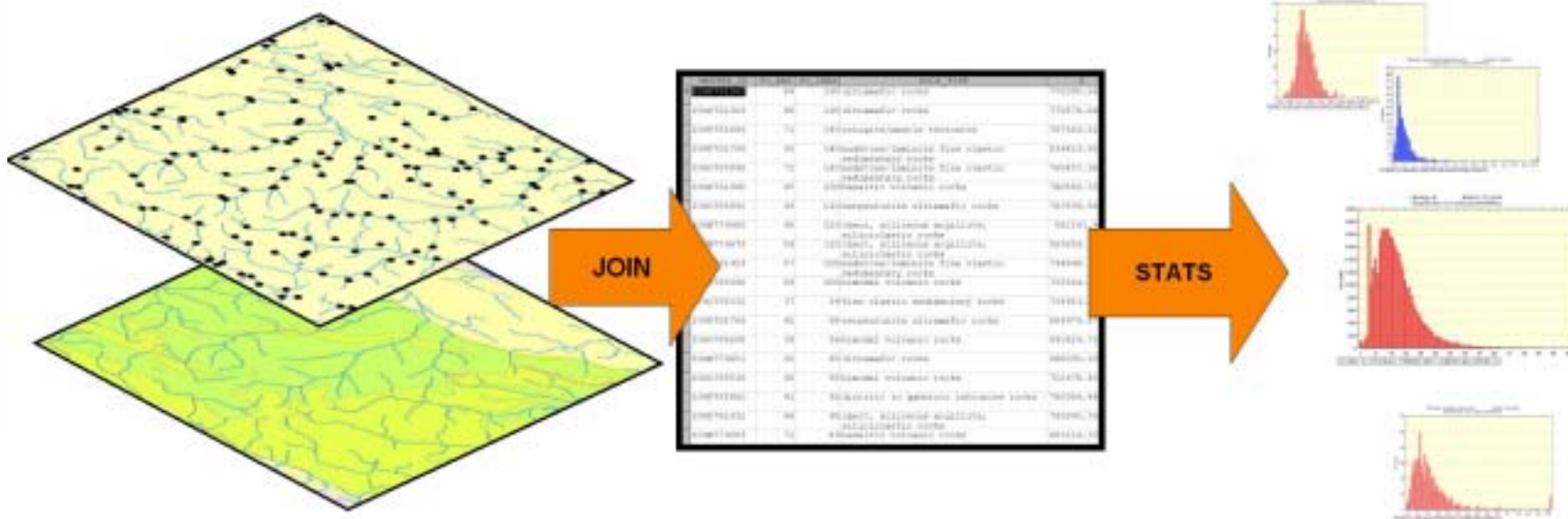
Model Name	Expected Frequency	Date Added	Reference
Mineralization - stockwork 1 - c	always	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
DisseminatedFeldspar - zone 1 - c	always	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
DisseminatedFeldspar - zone 2 - c	usually	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
DisseminatedFeldspar - zone 3 - c	sometimes	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
DisseminatedFeldspar - zone 4 - c	rarely	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
AlterationType - albic	rarely	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
AlterationType - intermediate argillic	rarely	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
AlterationType - propylitic	sometimes	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
AlterationType - potassic	usually	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
ElementEnhanced - Ag	rarely	10/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
ElementEnhanced - Au	rarely	10/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
ElementEnhancedToOre - Au	sometimes		
ElementEnhancedToOre - Cu	always		
ElementEnhancedToOre - Mo	usually		
FormMineralisation - breccia-filling	sometimes		
FormMineralisation - stockwork	sometimes	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
FormMineralisation - contact zone	sometimes	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
FormMineralisation - fracture	usually	27/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
LocationForm - stock	sometimes	27/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
LocationForm - stock			SUBSTRATE
MineralEnhanced - Pyrite	always		
MineralEnhancedToOre - bornite	rarely		
MineralEnhancedToOre - chalcopyrite	always		
MineralEnhancedToOre - Gold	sometimes		
MineralEnhancedToOre - molybdenite	usually		
LocPriorityImportance - primary	always		
RedLine - quartz-concrete	usually	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
RedLine - quartz-feldspar porphy	sometimes	11/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au
RedLine - quartz-feldspar porphy	rarely	10/02/2000	Andre Panteleyev (1995), Porphyry Cu-Mo-Au

**CAPSULE DESCRIPTION:** Stockworks of quartz veinlets, quartz veins, closely spaced fractures and breccias containing pyrite and chalcopyrite with lesser molybdenite, bornite and magnetite occur in large zones of economically bulk-mineable mineralization in or adjoining porphyritic intrusions and related breccia bodies. Disseminated sulphide minerals are present, generally in subordinate amounts. The mineralization is spatially, temporally and genetically associated with hydrothermal alteration of the host rock intrusions and wallrocks.

**BC EXAMPLES:** Brenda (092HNE047), Berg (093E046), Huckleberry (093E037), Schaft Creek (104G015)

Andre Panteleyev (B.C. Geological Survey Branch Open File 1995-20)

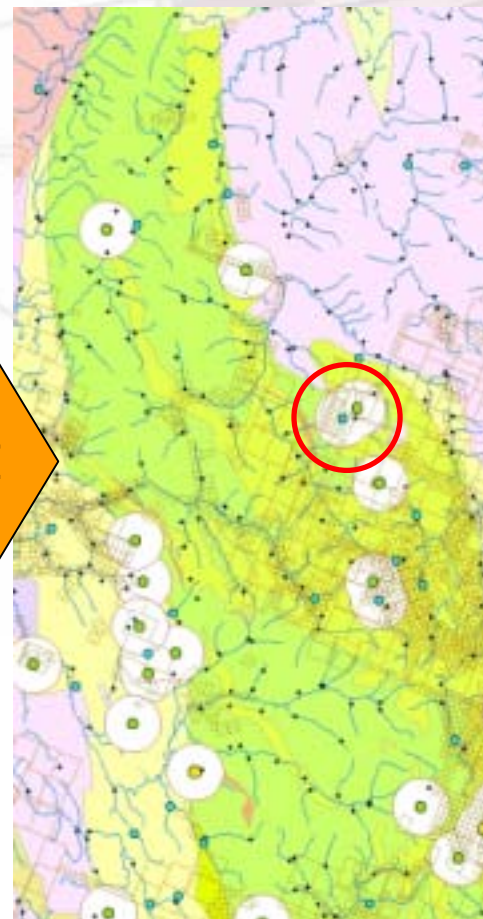
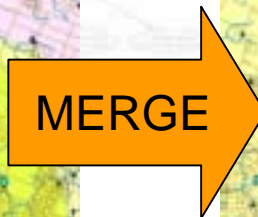
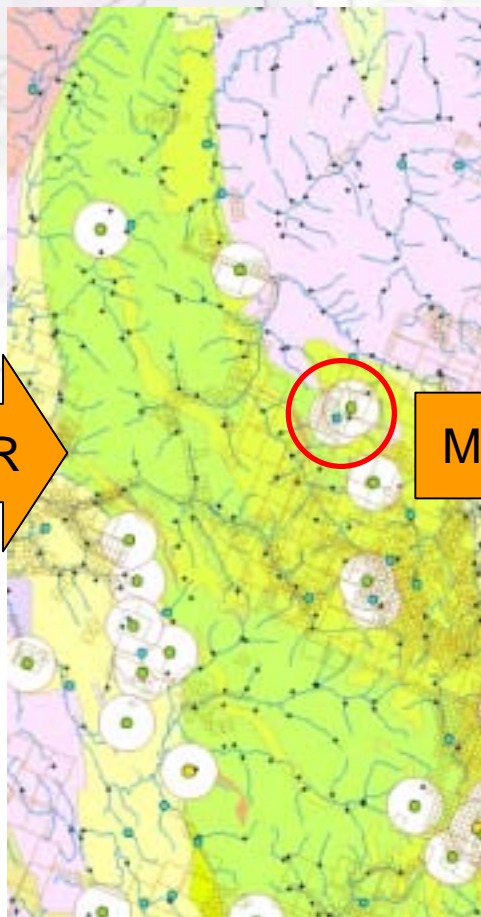
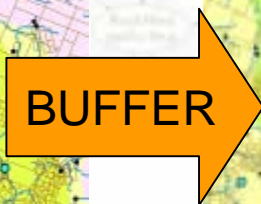
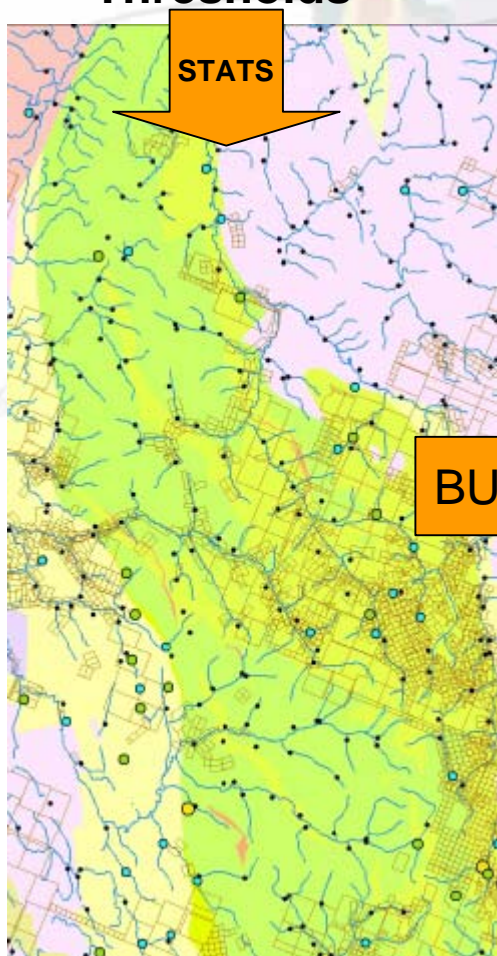
## Workflow #1



**Geochemical Anomaly  
Thresholds**

## Geochemical Anomaly Thresholds

## Workflow #2

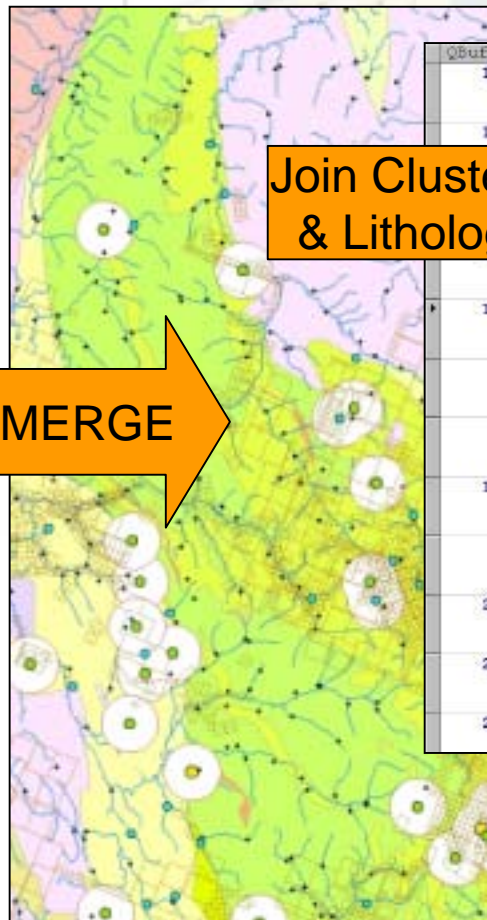


Select only samples with anomalous geochemistry

Find other anomalous samples within 2.5km radius

Merge into clusters, eliminate duplicates.

## Workflow #3



Join Clusters  
& Lithology

QBuE_ID	QMASTER_ID	ROCK_TYPE	AG	BA	YE	EN
1985	82M775408	quartzite, quartz arenite	0	0	0	0
143	7771289	sedimentary rocks	0	1	0	0
	775	granodioritic intrusive rocks	0	0	0	0
	65189	granodioritic intrusive rocks	0	0	0	0
		syenitic to monzonitic intrusive rocks	0	0	0	0
161	82K775274	granodioritic intrusive rocks	1	0	0	0
67	104B871293	andesitic volcanic rocks				
685	104J003057	alkaline volcanic rocks				
1228	104P781863	eclogite/mantle tectonite	1	0	0	0
318	1031781155	quartz monzonitic intrusive rocks	0	0	0	0
2966	94C975154	greenstone, greenschist metamorphic rocks	0	0	0	0
2112	92H813226	granodioritic intrusive rocks	1	0	0	1
2948	94C973136	argillite, greywacke, wacke.	0	0	1	0

TRANSLATE

GeoReference MineMatch Instance Module

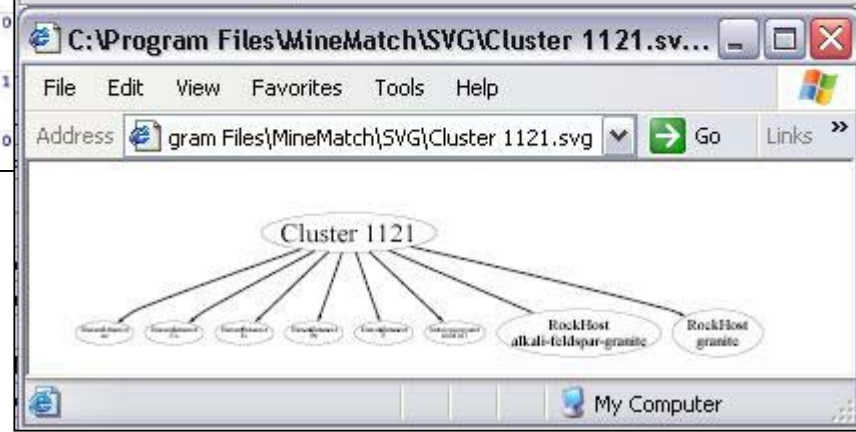
File Edit View Options Help

Instances

- Cluster 1114
- Cluster 1115
- Cluster 1117
- Cluster 1119
- Cluster 112
- Cluster 1121
- Cluster 1127
- Cluster 1128
- Cluster 1129
- Cluster 113
- Cluster 1130

Description

Description	Presence
Cluster 1121	instance
ElementEnhanced - As	present
ElementEnhanced - Co	present
ElementEnhanced - Fe	present
ElementEnhanced - Sb	present
ElementEnhanced - V	present
InstanceAssociated - 104M 027	present
RockHost - alkali-feldspar-granite	present
RockHost - granite	present



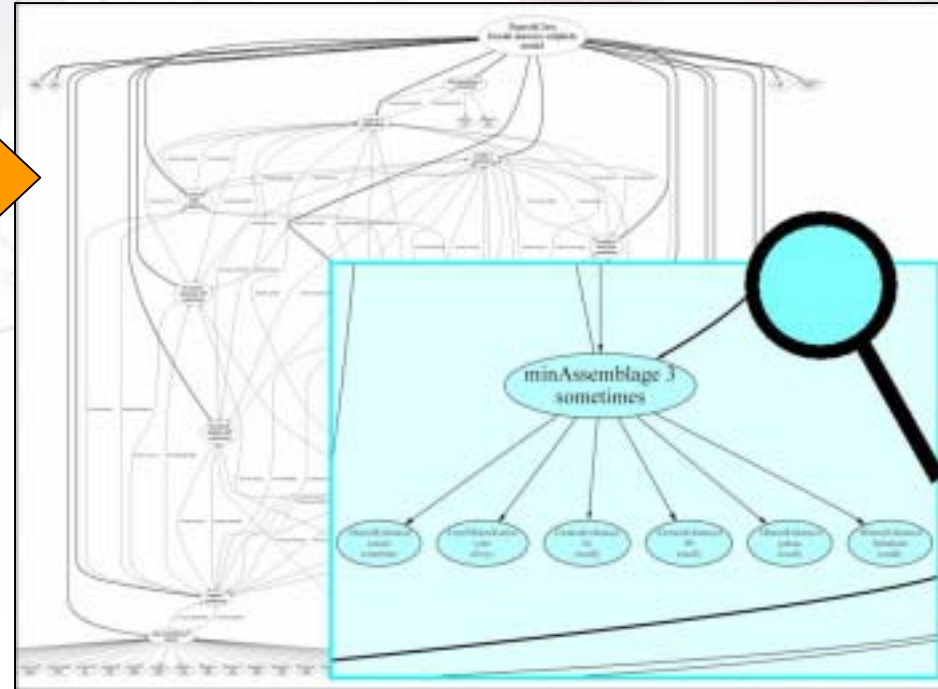
## Workflow #4

TRANSLATE

The screenshot shows the 'GeoReference MineWatch Instance Module' interface. It features a table with columns for 'Instances', 'Description', and 'Presence'. The 'Instances' column lists clusters 1114 through 1130. The 'Description' column shows 'Cluster 1121' expanded to show elements like 'ElementEnhanced - As', 'ElementEnhanced - Co', 'ElementEnhanced - Fe', 'ElementEnhanced - Sb', 'ElementEnhanced - V', 'InstanceAssociated - 1046 027', 'RockHost - alk-alk-feldspar-granite', and 'RockHost - granite'. The 'Presence' column indicates 'present' for all. Below the table is a tree view of 'Cluster 1121' with several child nodes.

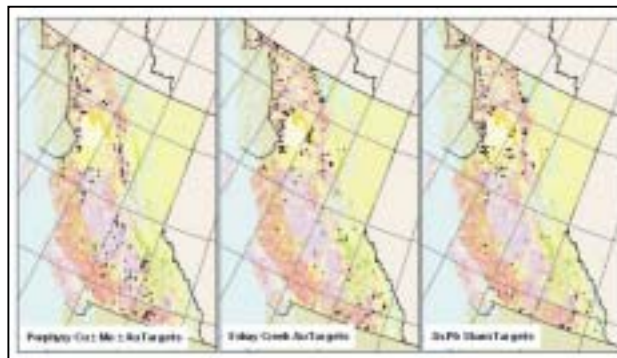
COMPARE

Similarity  
Rankings  
yield  
Target  
Maps



Deposit Models

Anomaly Clusters  
(Instances)



Target

Maps

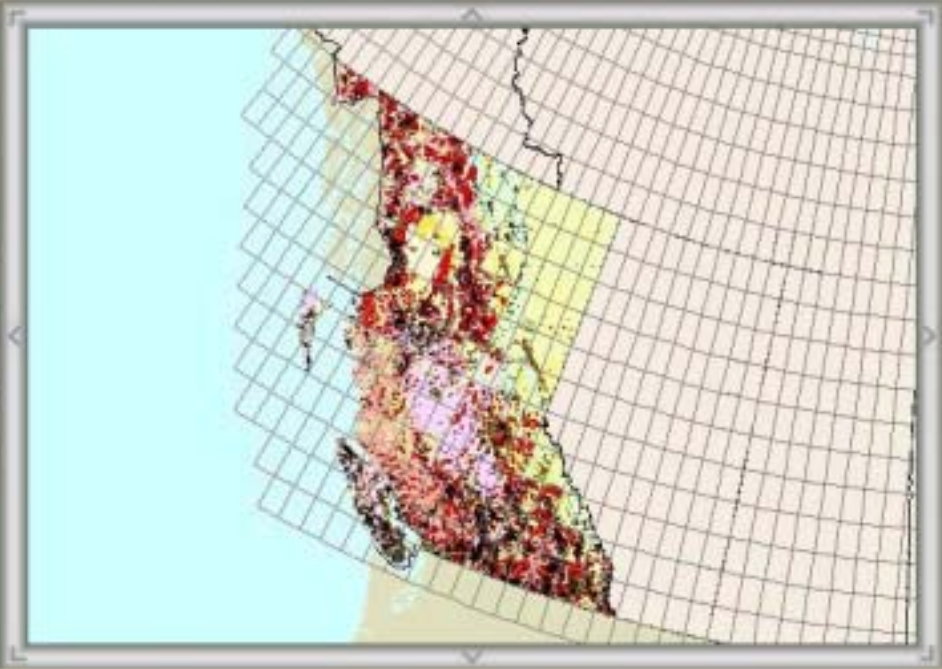
More than 2000 Targets Meriting Evaluation were Identified from ~40000 Stream Sediment Samples, and Published on the Internet

Rocks to Riches MineMatch Geochemistry Project - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites History Links

### Rocks to Riches: MineMatch Geochemistry Project



**Using the Anomaly Clusters Map**

This map shows all the Anomaly Clusters identified by the MineMatch Geochemistry Project.

**MAP APPEARANCE AT 1600% ZOOM**

- Anomaly Cluster outline
- Background samples
- Claim outlines
- Known mineral occurrences

3222: N55.07, W124.5

Rest the mouse over an Anomaly Cluster to view its Cluster Number and latitude and longitude. Click an Anomaly Cluster and links to its mineral deposit-type similarity rankings will appear below the map. Links to detailed comparisons with the two best-matching deposit-types also appear.

**IMPORTANT:** Claim boundaries were sourced from [The MapPlace](#) in October 2003, and may be up to one year out of date. Click [here](#) for more.

To browse the map, choose an

Click [here](#) to request **Anomaly Cluster** details.  
Click [here](#) to go to **Target Maps**  
Click [here](#) to view stream **Sediment Sample Statistics**  
Click [here](#) to view the **Discussion Forum**

Click on map to display attributes

Designed by GeoReference Online Ltd [www.georeferenceonline.com](http://www.georeferenceonline.com)

Opening page <http://rockstoricheisbc.com/maps/minematch/map/m10000.html>

Internet

## Clicking on any Anomaly Cluster brings up Hyperlinks to MineMatch Reports on the Anomaly Cluster

**Rocks to Riches: MineMatch Geochemistry Project**

Using the Anomaly Clusters Map

This map shows all the Anomaly Clusters identified by the MineMatch Geochemistry Project.

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To browse the map, choose an

Cluster_ID	3207
Best_Match	<a href="http://www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Match_1.htm">www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Match_1.htm</a>
Next_Match	<a href="http://www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Match_2.htm">www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Match_2.htm</a>
Rankings	<a href="http://www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Rankings.htm">www.rockstorichesbc.com/mmhtml/Cluster_3207_-_Rankings.htm</a>

Links to MineMatch reports for selected occurrence

Click [here](#) to request **Anomaly Cluster** details.  
 Click [here](#) to go to **Target Maps**  
 Click [here](#) to view tream **Sediment Sample Statistics**  
 Click [here](#) to view the **Discussion Forum**

Designed by GeoReference Online Ltd [www.georeferenceonline.com](http://www.georeferenceonline.com)

## Best Match Comparison Report



Rocks to Riches MineMatch

File Edit View Favorites

Back

Rocks to Riches

ZOOM  
100  
200  
400  
800  
1600  
%  
+

Legend

Cluster\_ID 3207  
Best\_Match [www/](#)  
Next\_Match [www/](#)  
Rankings [www/](#)  
Designed by GeoReferen

Comparison Rankings for Cluster 3207 against Mineral Deposit Types - GeoReference Online Ltd. - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Online Ltd  
GEOREFERENCE

### Comparison Rankings for Cluster 3207 against Mineral Deposit Types

Match Object	Rank	Overall Score	Penalties	Rewards
Porphyry Cu + Mo + Au	1	36.3	258	11000
W Skarn Deposits	2	33.7	9	7000

Cluster 3207 Matching Against Porphyry Cu + Mo + Au - GeoReference Online Ltd. - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Online Ltd  
GEOREFERENCE

### Cluster 3207 Matching Against Porphyry Cu + Mo + Au

Cluster 3207: Attribute	Cluster 3207's Value	Cluster 3207: Present or Absent	Porphyry Cu + Mo + Au: Attribute	Porphyry Cu + Mo + Au's Value	Porphyry Cu + Mo + Au: Expected Frequency	Match Type	Cluster 3207's Comment	Porphyry Cu + Mo + Au's Comment
RockHost	granitic-rock	<a href="#">present</a>	RockHost	quartz-monzonite	<a href="#">sometimes</a>	maybeAKD	-	most common intrusive hostrock for mineralization in Canadian Cordillera
RockHost	volcaniclastic igneous rock (undifferentiated)	<a href="#">present</a>	RockHost	volcaniclastic-igne	<a href="#">usually</a>	exactAKD	-	commonly andesitic rocks; volcanic flow rocks are locally dominant
RockHost	monzonite	<a href="#">present</a>	RockHost	breccia	<a href="#">usually</a>	unmatched	-	hydrothermal breccia
RockHost	quartz-diorite	<a href="#">absent</a>	RockHost	porphyry	<a href="#">usually</a>	-	-	commonly granitic plutonic rocks and dyke in





## Target Maps Published for 30 Deposit Types (Additional Target Distribution Maps possible for any additional Models)

Targets - Microsoft Internet Explorer

Address <http://www.rockstorichesbc.com/go/ge.html1.html>

Mineral Wealth for All in British Columbia

RocksToRichesBC

### Targets

Targets

For each of the deposit types listed below, maps have been produced which show the 250 Anomaly Clusters which best match the deposit type. Clicking on the deposit type will bring up the map, and clicking on any cluster in the map will bring up links to further information about the cluster.  
[For more information about Anomaly Clusters and how to work with information about Anomaly Clusters, please read the [introduction.](#)]

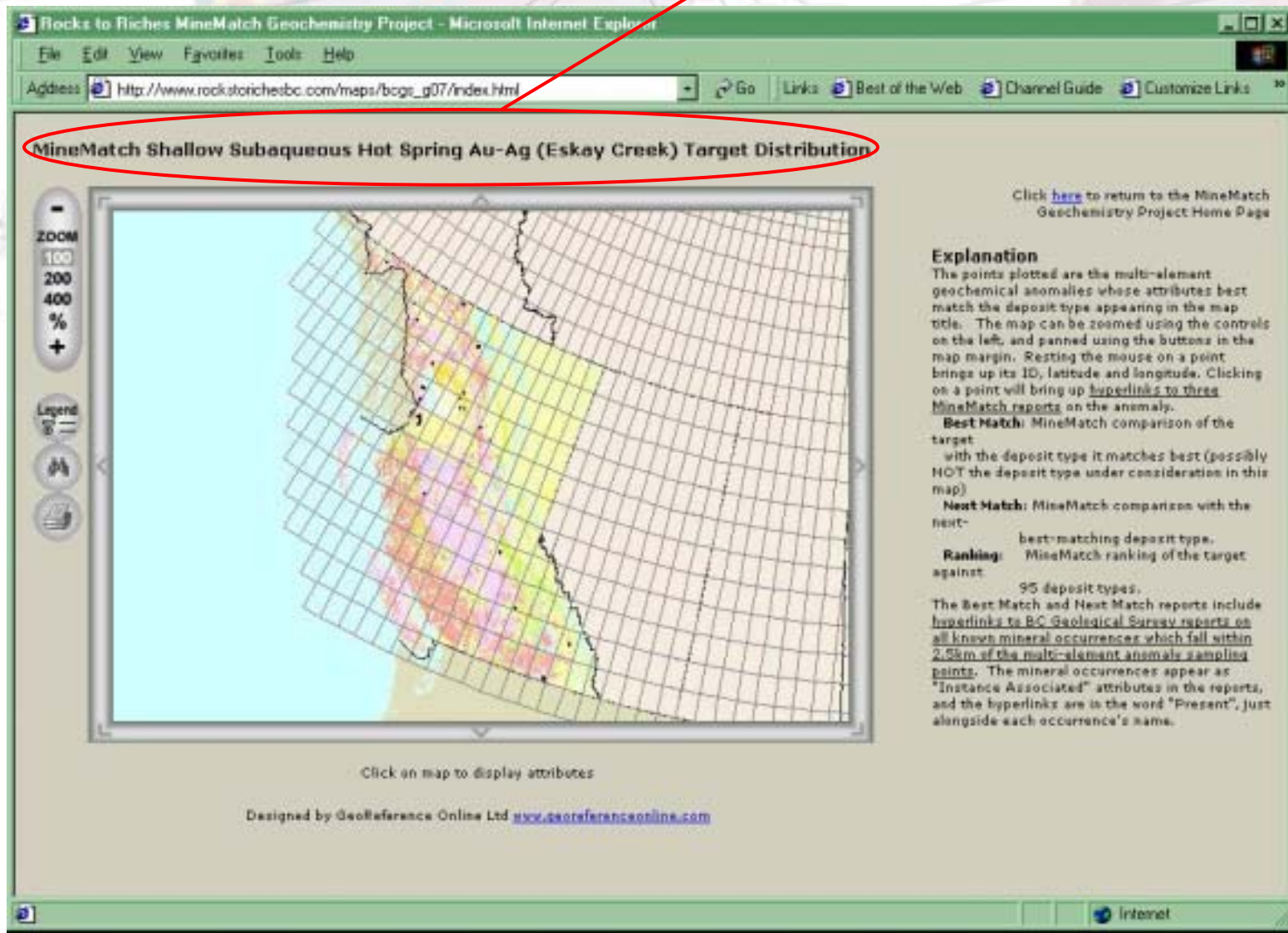
**Deposit Type (No)** (Cluster Ranking) (best match comparison) (second-best match comparison)

- [Phanerozoic IOCG \(BCGS D07\)](#) (Ranking) (best) (second)
- [Shallow Subaqueous Hot Spring Au-Ag-Eskay Creek \(BCGS G07\)](#) (Ranking) (best) (second)
- [Epithermal Au-Ag-Cu High Sulphidation \(BCGS H04\)](#) (Ranking) (best) (second)
- [Cu Skarn \(BCGS K01\)](#) (Ranking) (best) (second)
- [Zn-Pb Skarn \(BCGS K02\)](#) (Ranking) (best) (second)
- [Fe skarns \(BCGS K03\)](#) (Ranking) (best) (second)
- [Sn skarns \(BCGS K06\)](#) (Ranking) (best) (second)
- [Mo skarns \(BCGS K07\)](#) (Ranking) (best) (second)
- [Subvolcanic Cu-Au-Ag \(As-Sb\) \(BCGS L01\)](#) (Ranking) (best) (second)
- [Porphyry Cu-Au Alkalic \(BCGS L03\)](#) (Ranking) (best) (second)
- [Porphyry Cu + Mo + Au \(BCGS L04\)](#) (Ranking) (best) (second)
- [Porphyry W \(BCGS L07\)](#) (Ranking) (best) (second)

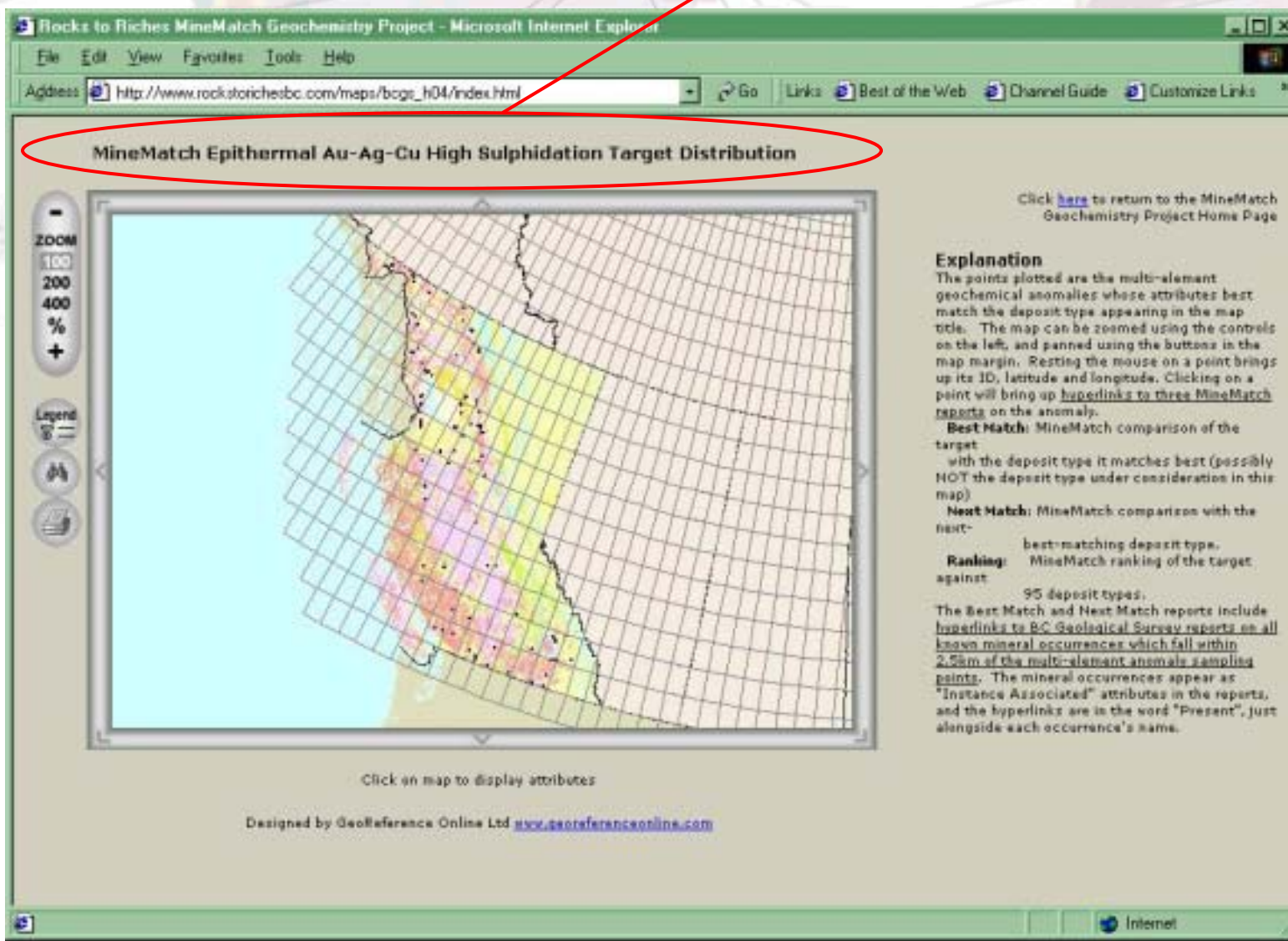
Targets

Porphyry Cu ± Mo ± Au Model

## Example 1: Subaqueous Hot-Spring Au-Ag (Eskay Creek) Targets



## Example 2: Au-Ag-Cu High Sulphidation Targets



LegendBurster is an ESRI-based system.

It is available as an Add-In to ArcGIS 8 or as a Stand-Alone application.

The screenshot displays the ArcMap interface with the LegendBurster add-in. The main map shows a geological map with various colored regions. The LegendBurster tool windows are open, showing the following data:

**LegendBurster Query Net Editor:**

Description	Frequency
Complex3	query
Complex1	query
Map_Unit - (any value)	always
RockName - (any value)	always
Composition - Silicate	always
Texture - Clay Supported	none
Texture - Granular	always
RockName - (any value)	always
Texture - Silt Size	always
Member	query

**LegendBurster Map Object Net Editor:**

Description	Presence	mapObject
Map Object 112	present	mapObject
Map_Unit - "Quaternary sediments"	present	
RockName - alluvium	present	
Composition - Silicate	present	
Genesis - Nonmarine	present	
Texture - Homogeneous	present	
RockName - colluvium	present	
Composition - Silicate	present	
Genesis - Sub-aerial	present	
Texture - Granular	present	
RockName - silt, lacustrine	present	
Composition - Intermediate	present	
Genesis - Nonmarine	present	
Texture - Silt Size	present	
RockName - silt	present	
Map Object 113	mapObject	
Map Object 114	mapObject	

**Attributes of Export01:**

GQCOMPLEX4	GQSTJOHN	GQCOMPLEX1	CONCEPTNAM	FID	Shape*
33.00000	49	D Toad Fin		108	Polygon
33.00000	49	D Toad Fin		109	Polygon
67.00000	49	100 Lard Fin		110	Polygon
100.00000	49	100 "Quaternary sediments"		111	Polygon
67.00000	49	D Durrvegan Fin		112	Polygon

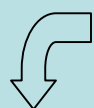
**Identify Results:**

Field	Value
FID	111
Shape	Polygon
CONCEPT_1	507
CONCEPTID	507
CONCEPTNAM	"Quaternary se"

**LegendBurst**  
is an ESRI-  
based system.

It is available  
as an Add-In  
to ArcGIS 8 or  
as a Stand-  
Alone  
application.

ESRI  
(ArcGIS 8 /  
MapObjects LT)



Query Scores

Queries

Legend-  
Burst

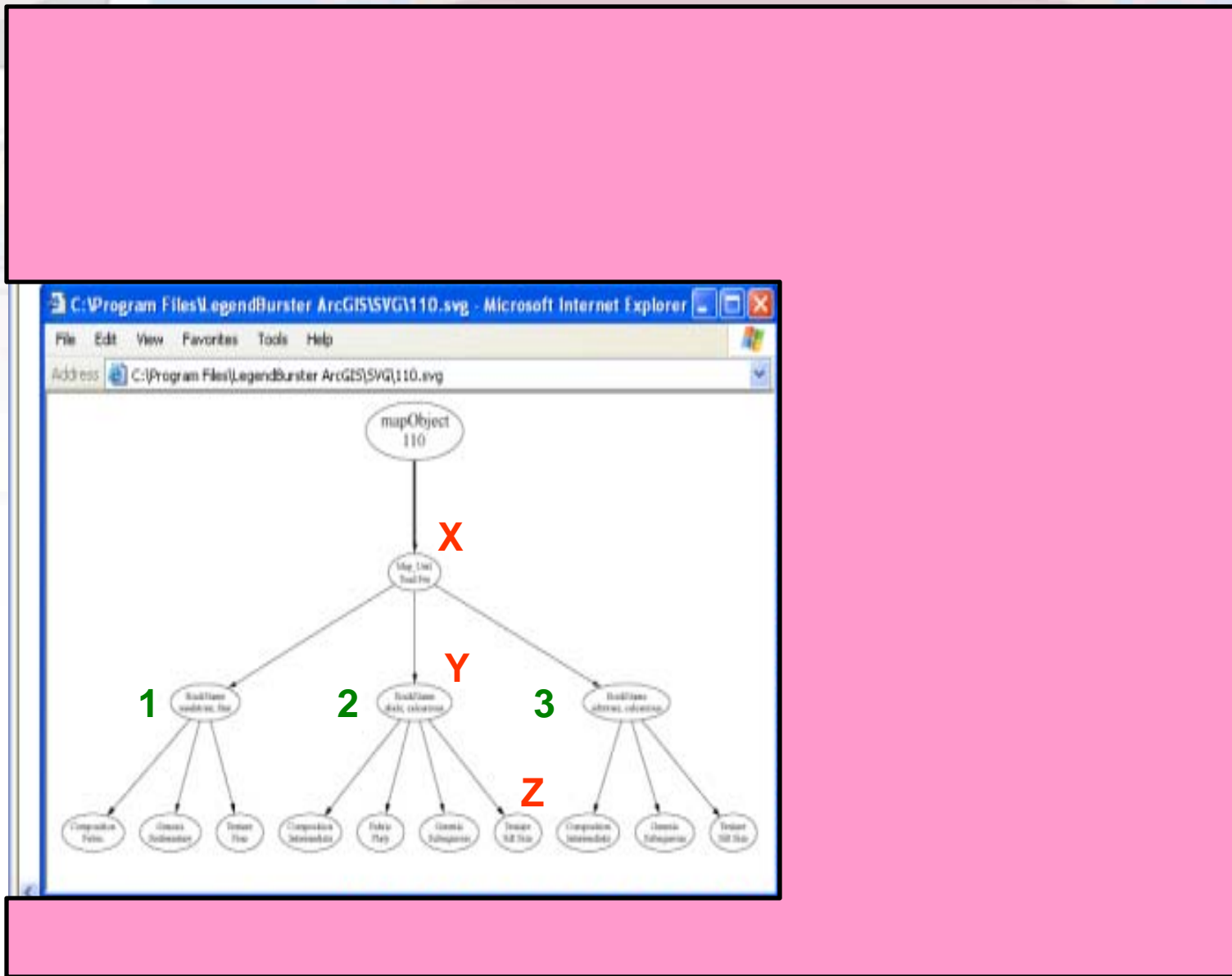
Instance  
Descriptions

**LegendBurster** solves two significant data representation problems by storing data in semantic nets:

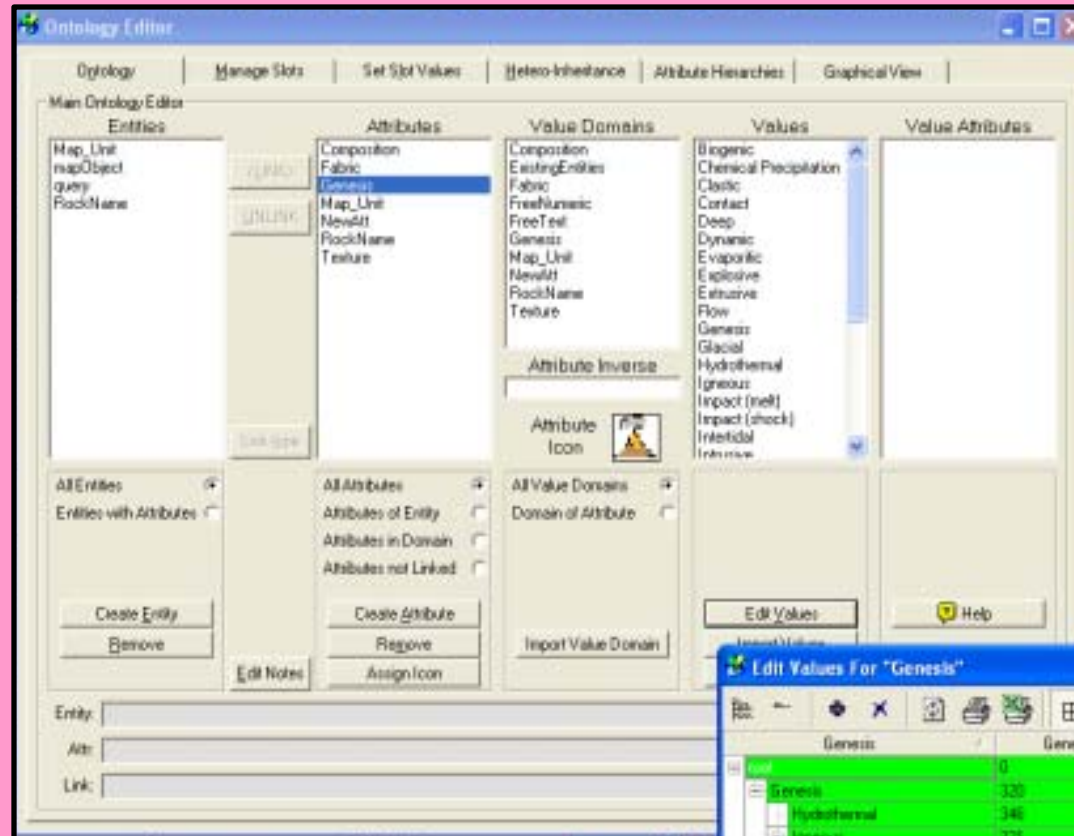
(1) “cardinality > 1” issues

(2) nested attribute issues.

There is no limit to the numbers of, or nesting of, attributes in **LegendBurster**.



**LegendBurster** provides the user with a powerful **Ontology Editor** to formally structure the language for describing map objects. Internationally recognised standard vocabularies are easily imported, and exported for use in other projects.



Genesis	GenesisCos	GenesisInc
Genesis	320	<input checked="" type="checkbox"/>
Hydrothermal	346	<input checked="" type="checkbox"/>
Igneous	321	<input checked="" type="checkbox"/>
Explosive	326	<input checked="" type="checkbox"/>
Extrusive	325	<input checked="" type="checkbox"/>
Flow	327	<input checked="" type="checkbox"/>
Intrusive	322	<input checked="" type="checkbox"/>
Deep	324	<input checked="" type="checkbox"/>
Shallow	323	<input checked="" type="checkbox"/>
Impact (met)	328	<input checked="" type="checkbox"/>

LegendBurster easily manages hierarchical data, and deals explicitly with negation.

Hierarchies are referenced during query resolution, so that “kind-of” relationships are automatically taken into account. (“Granite” will score a “match” if “Igneous Rocks” are in the query.)

The screenshot displays the GeoReference MapObject Net Editor interface. The main window shows a hierarchical tree of map objects. The tree structure is as follows:

- Map Object 112
  - Map\_Unit - "Quaternary sediments"
    - RockName - alluvium
      - Composition - Silicate
      - Genesis - Non-marine
      - Texture - Homogranular
    - RockName - colluvium
      - Composition - Silicate
      - Genesis - Sub-aerial
      - Texture - Granular
    - RockName - silt, lacustrine
      - Composition - Intermediate
      - Genesis - Non-marine
      - Texture - Silt Size
    - RockName - till
  - Map Object 113
  - Map Object 114
  - Map Object 115
  - Map Object 116
  - Map Object 117
  - Map Object 118

The 'Add Attribute & Value...' dialog box is open, showing the following configuration:

- Target Entity: Map\_Unit - "Quaternary sediments"
- Entity Class: Map\_Unit
- Attribute: RockName
- Value(s) & Frequency:
  - P1: chert
  - Ab: coal
  - P1: [empty]
  - P1: [empty]
  - P1: [empty]
  - P1: [empty]
- Entity: [empty]
- Attribute: [empty]
- Link: [empty]
- Comment: Coal absence tested by drilling to 50m.

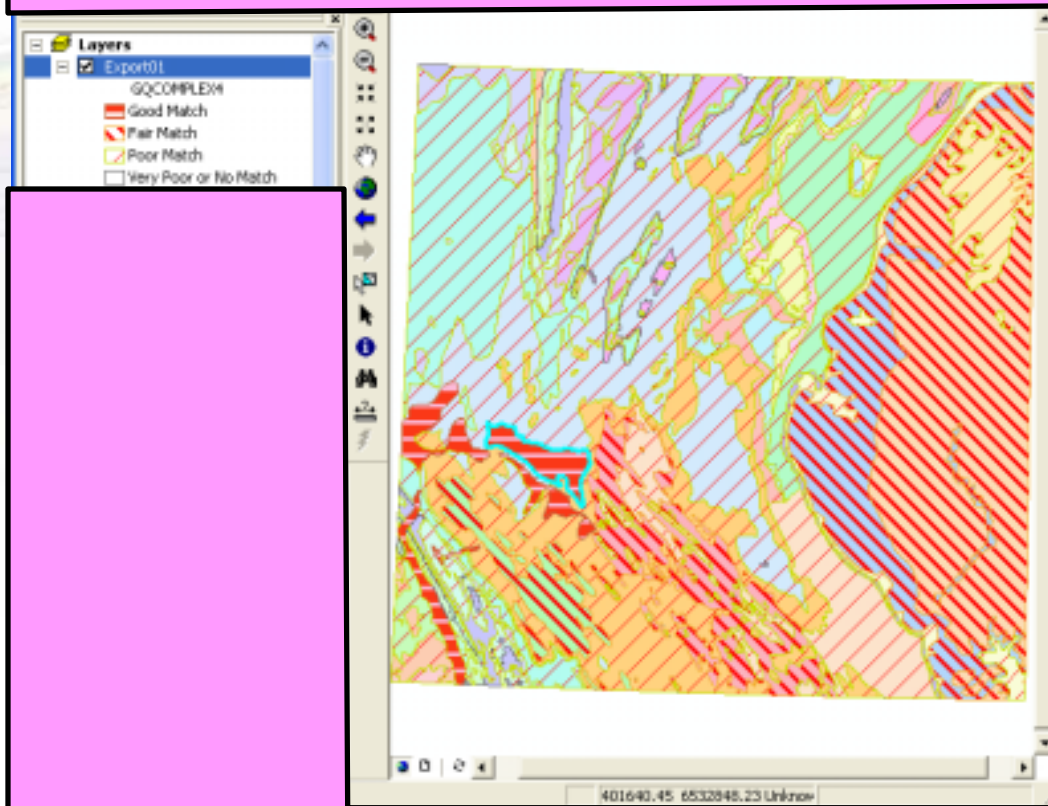
On the right side of the dialog, a table titled 'RockName' is visible, showing a list of rock types and their counts:

RockName	Co..
root	0
Rock Type	465
alluvium	468
calcarenite	469
chert	470
coal	471
colluvium	472
conglomerate	473
conglomerate, coarse	474
conglomerate, massive	475
dolostone	476
limestone	481
mudstone	484
orthoquartzite	485
sandstone	486
shale	494
silt, lacustrine	500
siltstone	501
solution breccia	505
till	506



**LegendBurster** has a powerful query engine which records partial matches as well as perfect matches during query resolution.

Query results are always stored and are therefore available for highly informative adornment of maps.



LegendBurster can provide detailed explanations of how matches and conflicts were recognised between query attributes and map object attributes.

This provides an invaluable audit trail for mission-critical data evaluation projects.

Complex4 Attribute	Complex4's Value	Complex4's Match Type	MObj 36 Attribute	MObj 36's Value	MObj 36's Match Type	Match Type
Map_Unit	<any value>	always	Map_Unit	Dunvegan Fin	present	exact
RockName	<any value>	always	RockName	conglomerate, massive	present	exact
Composition	Silicate	always	Composition	Silicate	present	exact
			Fabric	Massive	present	
			Genesis	Clastic	present	
Texture	Clast supported	never	Texture	Clast supported, rounded	present	highNO
Texture	Granular	always				unmatched
RockName	<any value>	always	RockName	shale	present	exact
			Composition	Intermediate	present	
			Fabric	Platy	present	
			Genesis	Subaqueous	present	
Texture	Silt Size	always	Texture	Silt Size	present	exact
			RockName	sandstone, carbonaceous	present	alreadyMatch

**Individual Match Item Information**

This is a mismatch because Complex4 never has Texture Clast Supported, but MObj 36 does have clast supported, rounded, and clast supported, rounded is a kind of clast supported.

OK

# Successful Standards

- For standards to succeed, their adoption has to be a rewarding experience for their users.



**LegendBurster** rewards GIS users by recognising hierarchical and multiple attribute values, & by providing close and intermediate matches as well as exact matches to queries – with explanations.

## Reference:

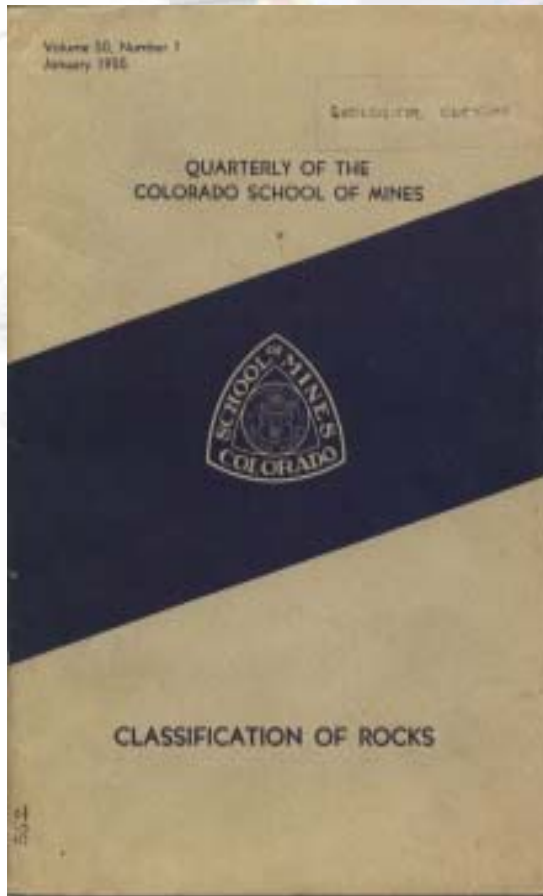
“Qualitative Probabilistic Matching with Hierarchical Descriptions”, Smyth C.P. and Poole D. (2004)  
<http://www.georeferenceonline.com/ref/KR2004SmythPoolePaper.pdf>

## Last Word .....

“Geologists owe it to themselves and to workers in other sciences to use standard nomenclature.”

R. B. Travis

Preface to “Classification of Rocks”,  
Quarterly of the Colorado School of  
Mines, Volume 50, Number 1, (1955)



2004 ESRI User Conference  
San Diego, California

Clinton Smyth, Janice Denovan & Tony Huynh  
June, 2004

[www.georeferenceonline.com](http://www.georeferenceonline.com)

Thank you.