

Weighted Sums Modelling

The application of Weighted Sums Modelling (WSM) to exploration geochemistry was described by Garrett and Grunsky (2001) as a means to model multi-element data using a priori knowledge of the mineralogy and element composition of the sought after mineral deposit (Kane, 1977; Garrett et al., 1980). In this procedure weights or relative importances are assigned to each variable, or a subset of variables, according to some geochemical or mineralogical model of the target mineral deposit type or geological process. Weighted sums (WS) are new variables calculated from the multi-element geochemical results. Like Principal Components Analysis (PCA) or Factor Analysis scores, WS scores have the form of normal or standardized scores with a mean of zero and a standard deviation of one. The main difference between WSM and traditional multivariate statistical methods is that the user assigns the variable weightings rather than determining them with a covariance/correlation matrix for the dataset, as is done in PCA. Furthermore WSM is a robust statistical technique that is not influenced by the presence of outliers (Beckman & Cook, 1983).

The reader is referred to Garrett and Grunsky (2001) for a description of the WS calculation. In summary, relative importance is assigned for each variable. A weighting of 3, for example, means that that particular element is three times more important than an element with a weighting of one. Weighting can be positive or negative. Positive weightings mean that the target model is associated with elevated concentrations of an element. Negative weightings indicate that low concentrations or depletions of an element are important.

Individual relative importance is converted into weights that sum to one by dividing each importance by the sum of the absolute values of importance (i.e. ignoring the negative signs). A requirement of the method is that the sums of the squares of the final weights also equal one. This is achieved by dividing each weight by the square root of the sum of the squares of the weights.

The next step involves calculation of the normal scores for the variables included in the model for each individual sample. To do this, robust estimates of the mean and standard deviation are used. The median (or 50th percentile) is used as a robust estimate of the mean and the inter-quartile range (IQR) multiplied by 0.7413 is used as a robust estimate of the standard deviation. IQR is the difference between the 75th and 25th percentiles of the data distribution and therefore covers a band of data 25% wide (or 0.67449 standard deviation units) on either side of the mean. The constant 0.7413 is used to convert the IQR, which covers a range of 1.3490 standard deviation units to an equivalent standard deviation¹. Weighted sums are then calculated by multiplying the normal scores for each element by the element's corresponding weight and summing for each sample. The high resistance of the median and IQR to outliers mean that it is not usually necessary to trim outlier and far outliers from the dataset before calculation.

¹ For a normal distribution the standard deviation is equal to 0.7413*IQR, where 0.7413 is the reciprocal of 1.349.

Models and Weightings

Six mineral deposit types (SEDEX, Porphyry Cu, W-Skarn, ICG, Polymetallic veins and Carlin) that are either known or believed to occur in the map sheet areas and one geochemical process (hydromorphic dispersion) are modeled using the WS method. Included elements and their relative importance are presented in Table 1.

Data Presentation

Results of each WS model are attached to the corresponding catchment basin polygons using a spatial join in ArcGIS. This process allows for the entire polygon to be assigned a colour based on its WS score. Colours are assigned on the basis of the following percentile breaks:

0-50% Dark blue
50-75% Pale blue
75-90% Pale green
90-95% Yellow
95-98% Orange
98-100% Red

With this scheme, catchment basins with the hotter colours represent samples with geochemical characteristics consistent with the mineralization style being modelled.

Table 1: Table of Relative Importances used to calculate weighted sums models

Deposit Type	Ag	Au	As	Ba	Bi	Cd	Co	Cu	Cs	Fe	Hg	K	Mn	Mo	Ni	Pb	S	Sb	Tl	W	Zn
Polymetallic Veins	4	4	3	3	4	1	2	1	1	1	1	1	1	1	5	3	5				
W-Skarn																					
Porphyry Cu	2	2			1			5	3							3	2				
Intrusive Related Cu-Au	1	2	5		5			2	1	5			1	2	1	1	2				
SEDEX						5	3									1	5	1	5	5	
Carlin	2	1	5	2																	
Hydromorphic Dispersion	2	1			4	5	2	5		4			5	2	4	2	1			1	3

LEGEND

- Regional Geochemistry Sample (RGS) location

National Topographic System grid (1:250 000 scale)

National Topographic System grid (1:50 000 scale)

Yukon-Northwest Territories border

highway, paved

highway, unpaved

local road, unpaved

watercourse

waterbody

wetland

Sb (Levelled)

WSM Percentiles: WSM Score, Number of RGS Samples

0 - 50%: -3.574 - 0.003, 471 samples

50 - 75%: 0.004 - 0.655, 234 samples

75 - 90%: 0.656 - 1.302, 139 samples

90 - 95%: 1.303 - 1.675, 47 samples

95 - 98%: 1.676 - 2.134, 28 samples

98 - 100%: 2.135 - 2.974, 19 samples

QUATERNARY

Q

QUATERNARY: unconsolidated glacial, glaciofluvial and glaciolacustrine deposits; fluvialite silt, sand, and gravel, and local volcanic ash, in part with cover of soil and organic deposits

MID-CRETACEOUS

mKS

mKgS

mKqS

MIDDLE TO UPPER TRIASSIC

TJd

JONES LAKE: brown to buff weathering, calcareous fine-grained sandstone, argillite, and shale; extensive ripple cross-lamination and bioturbation; massive/light grey weathering, fine crystalline, dark grey limestone; minor orange weathering platy limestone

CARBONIFEROUS TO PERMIAN

CPMC

CPT

MISSISSIPPIAN

MK

DEVONIAN AND MISSISSIPPIAN

DME

DME1

DME2

ORDOVICIAN TO LOWER DEVONIAN

ODR

ODR1

ODR2

ODR3

ODR4

CAMBRIAN TO SILURIAN

CSM

CSM1

CSM5

UPPER CAMBRIAN AND ORDOVICIAN

COR1

COR2

LOWER CAMBRIAN

ICG1

ICG2

UPPER PROTEROZOIC TO LOWER CAMBRIAN

PCH

PCH1

PCH2

PCH3

PCH5

MIDDLE DEVONIAN

DH1

DH2

DH4

DL

DN

DA

UPPER LOWER TO LOWER MIDDLE DEVONIAN

DB

LOWER DEVONIAN

IDS

UPPER SILURIAN TO LOWER DEVONIAN

SDD

UPPER CAMBRIAN TO SILURIAN

CSH

UPPER ORDOVICIAN AND SILURIAN

OSK2

OSK4

MIDDLE ORDOVICIAN

OS

UPPER CAMBRIAN AND ORDOVICIAN

COF2

MIDDLE CAMBRIAN

mCH

mCR

LOWER CAMBRIAN

ICS

UPPER PROTEROZOIC TO LOWER CAMBRIAN

uPCV

UPPER PROTEROZOIC TO LOWER CAMBRIAN

PCB1

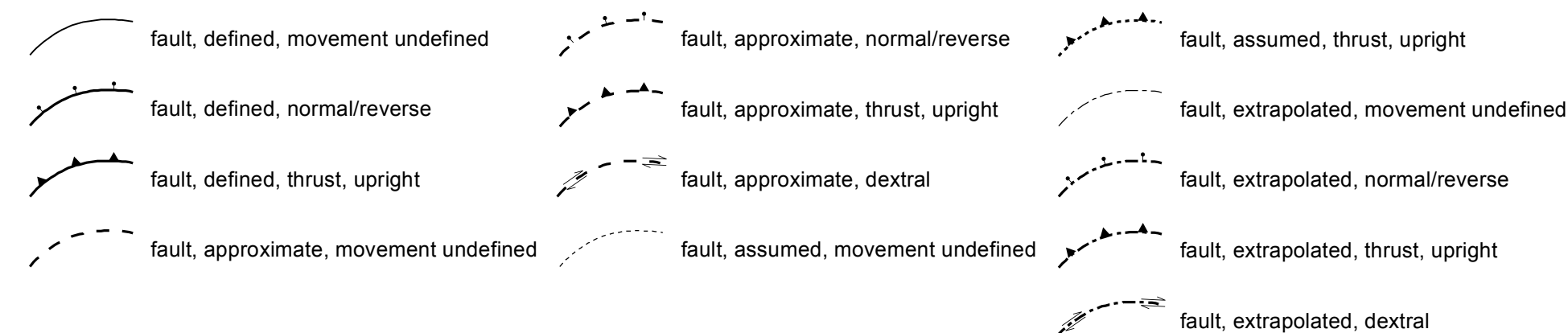


Table 2: List of Mineral Occurrences for NTS map sheets 1050 and part of 105P

OCCURRENCE #	OCCURRENCE NAME	ALIAS(ES)	DEPOSIT TYPE	STATUS	ECONOMIC COMMODITIES	OTHER COMMODITIES
1050 001	TOM		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Deposit	Pb, Ag, Zn, Ba	Sb, barite, Cu
1050 002	MACTUNG		W Skarn	Deposit	W	Cu
1050 003	JEFF		Porphyry Mo (Low F-Type)	Showing		Mo
1050 004	ALP		Au-Quartz Veins	Showing		Au, Ag
1050 005	NIDDERY		Plutonic Related Au	Prospect		barite, Cd, Cu, Au, Ni, Ag
1050 006	SCOT		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Drilled Prospect		Cu, Ni, Ag, Zn
1050 007	ART		Au-Quartz Veins	Prospect		Sb, As, Bi, Au, Pb, Ag
1050 008	KEELE		Porphyry Mo (Low F-Type)	Showing		Mo
1050 009	EMERALD		Porphyry-related Au	Showing		Bi, Cu, Au, Mo, Ag, W
1050 010	HOHN		Cu Skarn	Prospect		Cu, Au
1050 011	BEN		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Showing		Pb, Zn
1050 012	ARROWHEAD		Polymetallic Veins Ag-Pb-Zn+/-Au	Showing		Cu, Pb, Zn
1050 013	RACCOT		Sediment-Hosted Barite	Deposit	barite	Pb, Zn
1050 015	INCA		Polymetallic Veins Ag-Pb-Zn+/-Au	Past Producer	Ag	Pb, Zn
1050 016	STANDARD		Polymetallic Veins Ag-Pb-Zn+/-Au	Showing		Pb, Ag, Zn
1050 018	ODD		Mississippi Valley-Type Pb-Zn (MVT)	Drilled Prospect		Pb, Ag, Zn
1050 019	JASON		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Deposit	Pb, Ag, Zn	barite
1050 020	SAMOVAR	TEA	Sediment-Hosted Barite	Deposit		barite
1050 021	WALT	BAR	Sediment-Hosted Barite	Deposit		barite, Cu, Pb, Ag, Zn
1050 022	TRYALA		Sediment-Hosted Barite	Drilled Prospect		barite, Ba, Cu, Pb, Ag, Zn
1050 023	ORZLE	RAIN	Shale-Hosted Ni-Zn-Mo-PGE (Nick)	Showing		barite, Cu, Pb, Mo, Ni, V, Zn
1050 024	NIDPO		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Drilled Prospect		barite, Ag, Zn
1050 025	BRENNER		Unknown	Drilled Prospect		Cu, Pb, Zn
1050 026	DICKIE		Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Unknown		Cu, Pb, Mo, Zn
1050 027	GARY	GARGANTUA	Deposit	Showing		barite
1050 028	FETCH		Sediment-Hosted Barite	Drilled Prospect		barite, Zn
1050 029	GOW	TH	Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Anomaly		barite
1050 030	GRIZ		Porphyry Mo (Low F-Type)	Showing		Au, Mo, Ag, W
1050 031	VAN ANGEREN		Porphyry Mo (Low F-Type)	Showing		Mo
1050 032	NEVE	BRICK	Au-Quartz Veins	Drilled Prospect		Sb, Au, Ag, Zn
1050 033	KELVIN	BORD	Polymetallic Veins Ag-Pb-Zn+/-Au	Prospect		Sb, Au, Pb, Ag
1050 036	FAN		Unknown	Showing		barite
1050 037	LONER		Barite Veins	Showing		Ba
1050 038	DUET		Unknown	Anomaly		Zn
1050 039	OLD CABIN		Polymetallic Veins Ag-Pb-Zn+/-Au	Showing		Cu, Au, Pb, Mo, Ag
1050 040	URSA		Unknown	Anomaly		Zn
1050 041	FANGO		Polymetallic Veins Ag-Pb-Zn+/-Au	Prospect		Sb, Au, Pb, Ag, Zn
1050 042	FAL		Unknown	Unknown		
1050 043	SIM		W Skarn	Showing		Pb, W, Zn
1050 044	NIT		W Skarn	Showing		Cu, Pb, Ag, W, Zn
1050 045	STROSHIN		Sediment-Hosted Barite	Showing		barite
1050 046	MINORCO		Sediment-Hosted Barite	Showing		barite
1050 048	NUKE		Polymetallic Veins Ag-Pb-Zn+/-Au	Showing		Sb, As, Bi, Au, Cu, Pb, Ag
1050 049	FAENZI		Au-Quartz Veins	Showing		As, Au
1050 050	NORTH MACMILLAN		Barite Veins	Showing		
1050 051	DALL	HARLAN	Au-Quartz Veins	Prospect		Cu, Au
1050 052	BAILES		Unknown	Unknown		Cu, Au, Pb, Ag, Zn
1050 054	ROGUE		Polymetallic Veins Ag-Pb-Zn+/-Au	Prospect		Au, Pb, Ag, Zn
1050 055	CHRISTINA		Subvolcanic Cu-Au Ag (As-Sb)	Showing		Cu, Au, Ag
1050 056	GOLD		Porphyry Mo (Low F-Type)	Anomaly		
1050 057	STUMP	NID	Plutonic Related Au	Showing		As, Cu, Au, Pb, Ag
1050 058	LM		Plutonic Related Au	Drilled Prospect		Cu, Au, Ag
1050 059	SKRONK		Polymetallic Veins Ag-Pb-Zn+/-Au	Showing		Sb, Bi, Cu, Au, Ag, Zn
1050 060	HASTEN		Unknown	Drilled Prospect		Zn
1050 061	FUN		Unknown	Anomaly		Pb, Zn
1050 061	MEHTABEL		Cu Skarn	Drilled Prospect		Au

Mineral Occurrence Deposit Type (Total on map)	Porphyry-related Au (1)
<ul style="list-style-type: none"> Au-Quartz Veins (5) Barite Veins (2) Cu Skarn (2) Mississippi Valley-Type Pb-Zn (MVT) (1) Plutonic Related Au (3) Polymetallic Veins Ag-Pb-Zn+/-Au (9) Porphyry Mo (Low F-Type) (5) 	<ul style="list-style-type: none"> Sediment-Hosted Barite (8) Sedimentary Exhalative Zn-Pb-Ag (Sedex) (7) Shale-Hosted Ni-Zn-Mo-PGE (Nick) (1) Subvolcanic Cu-Au-Ag (As-Sb) (1) Unknown (7) W Skarn (3)

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RECOMMENDED CITATION

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Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey.

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