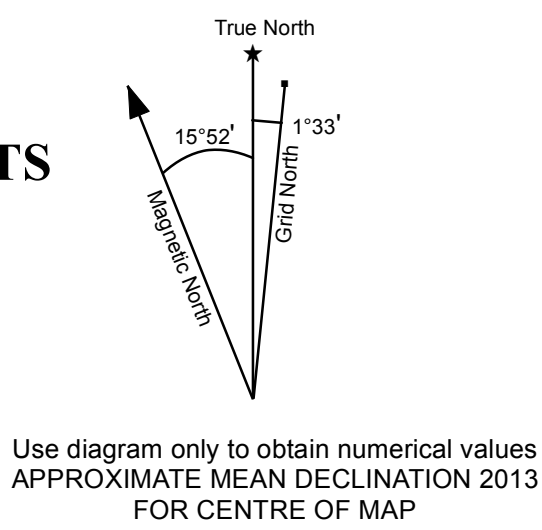
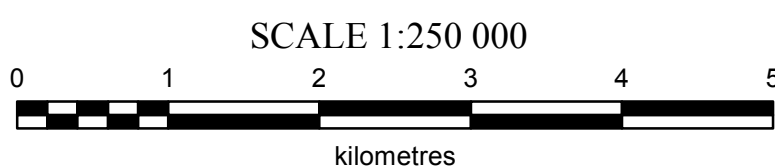


1:250 000-scale topographic base data
produced by
CENTRE FOR TOPOGRAPHIC
INFORMATION,
NATURAL RESOURCES CANADA

ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 8

CONTOUR INTERVAL 100 FEET
Elevations in metres above Mean Sea Level

WEIGHTED SUMS MODEL IRON-RELATED COPPER-GOLD DEPOSITS YUKON



116A LARSEN CREEK	106D NASH CREEK	106C NADALEEN RIVER
115P MCQUESTEN	105M THIS MAP	105N LANSING RANGE
115I CARMACKS	105L GLENLYON	105K TAY RIVER

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 deviation. 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, IRCG, 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	Ti	W	Zn
Polymetallic Veins	4	4	3			4	1	2		1	1	1	1	1	5		3				5
W-Skarn			3		3					1	3		3								5
Porphyry Cu	2	2			1		5	3					3		1	2					
Intrusive Related Cu-Au	1	2	5			2				1	5		1	2	1	5			1	5	5
SEDEX				5		3															
Carlin	2	1	5	2						4			5	2	4	2			1		3
Hydromorphic Dispersion	2		1			4	5	2					5	2	4	2			1		3

LEGEND

- Regional Geochemistry Sample (RGS) location
- National Topographic System grid (1:250 000 scale)
- National Topographic System grid (1:50 000 scale)
- highway, paved
- highway, unpaved
- local road, paved
- local road, unpaved
- contour
- watercourse
- waterbody
- wetland

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

OCCURRENCE #	OCCURRENCE NAME	ALIAS(S)	DEPOSIT TYPE	STATUS	ECONOMIC COMMODITIES	OTHER COMMODITIES
105M001	KENO HILL	BELLEKNO, ELISA, KENO 200, LUCKY QUEEN, ONEK, SILVER KING	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag, Zn	Cu, Au, Sn
105M002	FAITH		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Au, Pb, Ag, Zn
105M003	QUANAN		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M004	GOLDEN QUEEN		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Sn, Pb, Ag
105M005	SILVER BASIN		Polymetallic Veins Ag-Pb-Zn/Au	Prospect	Ag	Au, Pb
105M006	MAISON		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Au, Pb, Ag
105M007	MONUMENT	LAURASSIE, RUMA TUM	Polymetallic Veins Ag-Pb-Zn/Au	Prospect		Au, Pb, Ag
105M008	COMETICKA	PORCUPINE VEIN	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag, Zn	
105M009	APPEX		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag, Zn
105M010	VAROGLAND		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M011	HOMESTAKE		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Au, Pb, Ag, Zn
105M012	CHRISTINE		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag
105M013	MO		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer		Au, Pb, Ag
105M014	MAYBURN		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Ag, Pb	
105M015	HOGAN		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag
105M016	BLUNDER	MT. KEND	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M017	WERNESKE	RAULADAD	Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Au, Pb, Ag, Zn
105M018	FORMO	VALEND	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag, Zn	
105M019	NOMAD		Porphyry W	Anomaly		
105M020	PADIP		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag, Zn	
105M021	EAGLE		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Pb, Ag, Zn
105M022	FISHER		Polymetallic Veins Ag-Pb-Zn/Au	Anomaly		Au, Pb, Ag, Zn
105M023	PARIENT		Unknown	Anomaly		
105M024	CREAM AND JEAN		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M025	NEIRO		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Au, Pb, Ag, Zn
105M026	GRUBTCH		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Pb, Zn, Ag
105M027	TITAN		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Pb, Ag, Zn
105M028	SHANGHAI	NORTH LUMB	Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Cu, Pb, Ag, Zn
105M029	MCQUESTEN	WAYNE	Plutonic Related Au	Past Producer	Au, Pb, Ag, Zn	
105M030	ARGENT		Unknown	Anomaly		
105M031	STRECHURK	JOURMIRA	Porphyry Sn	Prospect		Au, Cu, Pb, Ag, Sn, W, Zn
105M032	MT. HALDANE	LOOKOUT	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M033	LAVENDER		Polymetallic Veins Ag-Pb-Zn/Au	Anomaly		Au, Pb, Ag
105M034	COBALT		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M035	PATTERSON		Unknown	Anomaly		Au, Cu, Au, Pb, Ag, Zn
105M036	ETTA		Unknown	Anomaly		
105M037	GORDON		Silicic Veins & Disseminations	Prospect		Au, Pb, Ag, Zn
105M038	TWO BUTTES		W Skarn	Drilled Prospect		W, As, Bi, Au, Hg, Ag
105M039	SHEEP SLIP		Cu Skarn	Showing		Cu
105M040	GRAT KORN		W Skarn	Prospect		Cu, W, Zn
105M041	RAM		Unknown	Anomaly		
105M042	MCQUESTEN		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag
105M043	LOST WERNESKE COPPER		Unknown	Anomaly		Cu
105M044	ROOP		W Skarn	Showing		Pb, Ag
105M045	ARL		Unknown	Anomaly		
105M046	ANDON		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Au, Pb, Ag, Zn
105M047	MT. ALBERT		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag
105M048	ARMON		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Ag
105M049	VAGA		Unknown	Anomaly		
105M050	NEIRO		Polymetallic Veins Ag-Pb-Zn/Au	Anomaly		Pb, Ag
105M051	FRIESEN		W Skarn	Showing		Cu, Au, Pb, Mo, Ag, W
105M052	MT. HINTON		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Au, Ag
105M053	AVONUE		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag
105M054	CHANCE		Silicic Veins & Disseminations	Showing		Sn
105M055	YONK		Unknown	Anomaly		Au, Bi, Au, Pb, Ag, Sn, W
105M056	SUNDOWN		Plutonic Related Au	Showing		
105M057	GUSTAVUS		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Au, Bi, Au, Pb, Ag, Sn, W
105M058	HALLWAY	SNISTER	Unknown	Drilled Prospect		Au, Hg, W
105M059	RANKIN		Unknown	Anomaly		
105M060	NEWBY	ALEX	W Skarn	Drilled Prospect		Pb, Bi, Cu, Au, Pb, W, Zn
105M061	CHRISTAL	DOROTHY	Polymetallic Veins Ag-Pb-Zn/Au	Showing		Pb, Ag, Zn
105M062	SESSWORTH	CARIBOU HILL	Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M063	IRON CLAD		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		
105M064	KALZAS		W Veins	Drilled Prospect		Be, Pb, Mo, Ag, Sn, W
105M065	CONRICH	ELSO	Unknown	Anomaly		
105M066	WIASSEL		Unknown	Anomaly		
105M067	GAMBLER		Polymetallic Veins Ag-Pb-Zn/Au	Past Producer	Pb, Ag	
105M068	HAYTERNAK		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Zn, Pb, Ag
105M069	DRILL		W Veins	Showing		W
105M070	BELLY		Polymetallic Veins Ag-Pb-Zn/Au	Drilled Prospect		Pb, Ag, Zn
105M071	BEMA		Polymetallic Veins Ag-Pb-Zn/Au	Showing		Au, Ag
105M072	WHITETANK		Unknown	Anomaly		
105M073	THYSLAND		Unknown	Prospect		
105M074	GORDON		Sediment-Hosted Barite	Prospect		barite
105M075	BELEKNO		Polymetallic Veins Ag-Pb-Zn/Au	Prospect	Pb, Ag, Zn	Cd, Sn
105M076	ELSA TAILINGS		Tailings Reprocessing	Deposit	Au, Pb, Ag, Zn	
105M077	ONEK		Polymetallic Veins Ag-Pb-Zn/Au	Deposit	Ag, Pb, Au, Zn	
105M078	LUCKY QUEEN		Polymetallic Veins Ag-Pb-Zn/Au	Deposit	Ag, Pb, Zn, Au	
105M079	BERMINGHAM		Polymetallic Veins Ag-Pb-Zn/Au	Deposit	Pb, Zn, Ag, Au	
105M080	FLAME & SNOT		Unknown	Deposit	Au, Pb, Ag, Zn	

- Mineral Occurrence Deposit Type (Total on map)**
- ◆ Sediment-Hosted Barite (1)
 - Cu Skarn (1)
 - ▼ Plutonic Related Au (2)
 - ◇ Polymetallic Veins Ag-Pb-Zn/-Au (49)
 - Porphyry Sn (1)
 - Porphyry W (1)
 - ◆ Stibnite Veins & Disseminations (2)
 - ▲ Tailings Reprocessing (1)
 - Unknown (15)
 - W Skarn (5)
 - ◆ W Veins (2)

REFERENCES

- Beckman, R.J. and Cook, R.D., 1983. "Outliers," Technometrics, vol. 25, no. 2, p. 119-149.
- Garrett R.G. and Grunsky, E.C., 2001. Weighted sums – knowledge based empirical indices for use in exploration geochemistry. Geochemistry: Exploration, Environment, Analysis, vol. 1 2001, p. 135-141.
- Garrett, R.G., Kane, V.E. & Zeigler, R.K., 1980. The management and analysis of regional geochemical data. Journal of Geochemical Exploration, vol. 13, no 2.3, p. 115-152.
- Jackaman, W., 2011. Regional stream sediment geochemical data Mayo area, central Yukon (105M). Yukon Geological Survey Open File 2012-8.
- Kane, V.E., 1977. Geostatistics Symposium on Hydrogeochemical and Stream-Sediment Reconnaissance for Uranium in the United States. United States Department of Energy Report, GJX-77(77), p. 203-222.

RECOMMENDED CITATION

HEBERLEIN, D., 2013. Yukon Geochemistry Weighted Sums Model for NTS 105M: Iron-related Copper-Gold Deposits. Yukon Geological Survey, Open File 2013-16, 116 sheets. Scale 1:250 000.

Digital cartography and drafting by J.O. Bruce, Yukon Geological Survey.

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

Paper copies of this map and the accompanying report may be purchased from Yukon Geological Survey, Energy, Mines and Resources, Government of Yukon, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5. Ph. 867-667-3201, Email geosales@gov.yk.ca.

A digital PDF (Portable Document File) file of this map may be downloaded free of charge from the Yukon Geological Survey website: <http://www.geology.gov.yk.ca>.

Funding for this project was provided by the Canadian Northern Economic Development Agency (CanNor) through their Strategic Investments in Northern Economic Development initiative.

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2013-16

Yukon Geochemistry Weighted Sums Model for NTS 105M: Iron-related Copper-Gold Deposits (1:250 000 scale)

by

David Heberlein



Canadian Northern Economic
Development Agency

Agence canadienne de
développement économique du Nord