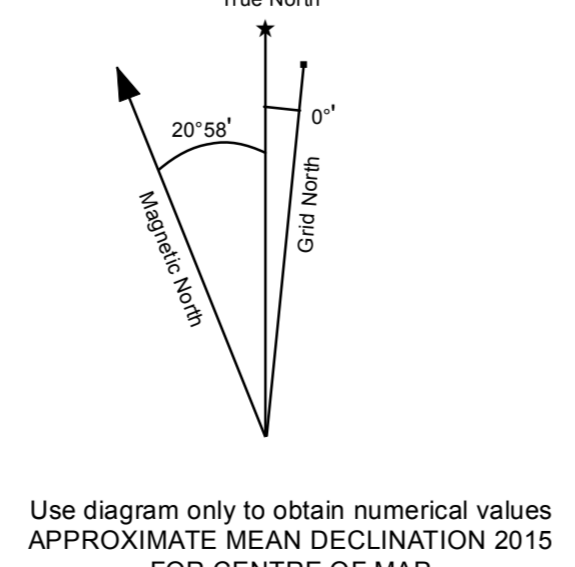


1:250 000-scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA. Copyright Her Majesty the Queen in Right of Canada. ONE THOUSAND METRE GRID Universal Transverse Mercator Projection North American Datum 1983 Zone 9. CONTOUR INTERVAL 100 FEET Elevations in metres above Mean Sea Level

Cu skarn Weighted sums model (Principal Component Residuals) Sheet 8 of 15
SCALE 1:250 000
0 1 2 3 4 5 kilometres



105J SHELDON LAKE	105I LITTLE MAHANNI RIVER	105L GLACIER LAKE
105O FINLAYSON LAKE	105H THIS MAP	105R FLAT RIVER
105B WOLF LAKE	105A WATSON LAKE	105D COAL RIVER

INTRODUCTION

New geochemical data from re-analysis of archived stream sediment samples have been assessed using weighted sums modeling and catchment basin analysis, as described in the methodology report accompanying this map (Mackie et al., 2015). Both commodity and pathfinder element abundances are evaluated to highlight areas that show geochemical responses consistent with a variety of base and precious-metal mineral deposit types. The results of modeling, completed using two approaches, are presented as a series of catchment maps and associated data files. This release is part of a regional assessment of stream sediment geochemistry that covers a large part of Yukon.

SAMPLING AND ANALYSIS PROGRAMS
Stream sediment and water samples from the Frances Lake map area (105H) were collected at a reconnaissance scale in 1987 as part of the Canada-Yukon Mineral Development Agreement (Hornbrook & Friske, 1988). Field descriptions and initial geochemical data for 917 sites were released in Geological Survey of Canada ("GSC") Open File 1649. New geochemical data from the re-analysis of archived sample material were released in GSC Open File 6043 and Yukon Geological Survey ("YGS") Open File 2009-1. The reader is referred to these open files for detailed descriptions of sampling techniques, analytical procedures and quality control measures.

MINERAL OCCURRENCES
A variety of types of base and precious-metal mineralization are known to occur in the Frances Lake map sheet area as shown in Table 1 (YGS MINFILE, 2015). Skarn is dominant style of mineralization documented in the area and includes W (Tai, Woah and Susan deposits), Pb-Zn (Max, Miko, Fir Tree, and Lee deposits) and Cu (Jan Prospect) types. The producing Carlung W-skarn mine, currently operated by North American Tungsten Corporation, occurs in the north-eastern corner of the map area within Northwest Territories. In addition to skarn mineralization, intrusion-related gold mineralization has also been documented within the map area (Justin Deposit). The Finlayson Lake Zn-Pb-Cu-Ag VMS district and the Tintina polymetallic Ag-Pb-Zn deposit occur in the adjacent map area towards the west (105G).

WEIGHTED SUMS MODELLING
As described in the report accompanying this map (Mackie et al., 2015), two approaches have been used to subdue effects related to changes in underlying geology. One uses data levelled by the dominant geology mapped within each catchment. The other uses residuals calculated from regression against principal components interpreted to represent geologic horizons that exhibit a strong influence on the distribution of commodity and pathfinder elements. Weighted sums models (WSM) have been generated using the processed data. Importance rankings used in Weighted Sums Models (WSM) for a variety of deposit types are summarized in Table 2. Each

model is optimized for a target deposit type however other deposit types may be represented in a given model due to similarities in elemental abundances and associations. A WSM is presented for epithermal Au-Ag mineralization, however given the lack of occurrences of this type within the map area the model could not be validated and therefore should be used with caution.

Exploratory data analysis of both raw element data and principal components indicate that the distribution of many commodity and pathfinder elements is strongly influenced by lithological variation. The first principal component shows high positive loadings for Sb, Se, Hg, Ni, Ag, Cu, As, Cd, Ba and Zn; and negative loadings for K, Ti, Na, Al, Bi and U. Respectively, these groupings form geochemical domains that match the transition from sedimentary and volcanic rocks in the west to felsic intrusive rocks in the east. The second principal component shows high negative loadings for Co, Fe, Cr, Ni, Cu and Mg which forms a spatial pattern matching the mapped distribution of the Hyland Group sedimentary rocks. Regression analysis of selected metals against the relevant principal component(s) effectively filters these 'terrace-effects' while preserving responses related to known occurrences. Levelling by the dominant mapped geology has a more subdued effect on filtering the interpreted lithological control for certain (e.g., Ba, Cd, Hg and Ag). In order to reduce the impact these elements had in the WSM they were assigned low importance rankings or were omitted for certain deposit types. Negative rankings were assigned to certain variables to help differentiate deposit types with similar metal associations. For most deposit types the WSM models generated using the two approaches are quite similar.

The effectiveness of historical sampling coverage has been assessed empirically using graphs of WSMs plotted against catchment surface area to determine the ideal maximum catchment size (10 km²). Catchments that cover larger areas are interpreted to have been under-sampled and thus require further sampling to properly evaluate geochemical anomalies. Given the likelihood that a mineralization 'signal' would be progressively diluted with increase in catchment size, marginally high WSM scores for large catchments could also be of interest.

Table 1: List of Mineral Occurrences for NTS map sheet 105H (Yukon MINFILE, 2015)

Number	Name	Type	Commodities
105H 001	JAN	Skarn Cu	Prospect Copper, Lead
105H 002	IMDAS	Skarn Cu	Showing Copper, Zinc, Lead, Silver
105H 003	UNKNOW	Unknown	Unknown
105H 004	COX	Vein Polymetallic Ag-Pb-Zn-Au	Unknown Lead, Silver, Zinc
105H 005	FLP	Skarn Pb-Zn	Drilled Prospect Copper, Lead, Tungsten, Zinc, Silver, Gold
105H 006	DC	Skarn Pb-Zn	Drilled Prospect Copper, Silver, Lead, Zinc
105H 007	VAGAS	Unknown	Anomaly Lead, Zinc
105H 008	MKO	Skarn Pb-Zn	Drilled Prospect Copper, Silver, Zinc, Gold, Lead
105H 009	GLENA	Skarn Pb-Zn	Drilled Prospect Lead, Zinc, Silver
105H 010	STEELE	Skarn Pb-Zn	Showing Copper, Silver, Zinc, Lead
105H 011	MAX	Skarn Pb-Zn	Drilled Prospect Copper, Gold, Lead, Silver, Tungsten, Zinc
105H 012	KLATZA	Unknown	Anomaly Tungsten
105H 013	FRANCES	Vein Cu-Ag-Quartz	Showing Copper
105H 014	LND	Ultramafic Mafic Jade (Nephrite)	Producer Jade/Nephrite
105H 015	DODGE	Vein Cu-Ag-Quartz	Showing Copper
105H 016	TUCHITUA	Ultramafic Mafic Jade (Nephrite)	Past Producer Chrysotile, Gold, Lead, Silver, Zinc, Jade/Nephrite, Copper
105H 017	EAST ARM	Unknown	Unknown
105H 018	GALE	Skarn Pb-Zn	Prospect Copper, Silver, Zinc, Lead
105H 019	MAY	Skarn Pb-Zn	Showing Cobalt, Copper, Molybdenum, Nickel, Zinc, Silver, Gold
105H 020	MAPFEL	Vein Polymetallic Ag-Pb-Zn-Au	Showing Copper, Lead, Silver, Zinc
105H 021	MATT BERRY	Volcanogenic Massive Sulphide (VMS) Kuroko Cu-Pb-Zn	Deposit Gold, Lead, Zinc, Antimony, Silver
105H 022	FLIKE	Skarn Pb-Zn	Showing Lead, Silver, Zinc
105H 023	LUCY	Unknown	Unknown
105H 024	CANYON	Skarn Pb-Zn	Drilled Prospect Gold, Zinc, Lead, Silver
105H 025	STU	Skarn W	Showing Copper
105H 026	TEBBERY	Skarn W	Prospect Tungsten
105H 027	CORRIE	Unknown	Drilled Prospect Bismuth, Zinc, Silver, Nickel, Copper, Gold
105H 028	BLACK JACK	Skarn Pb-Zn	Drilled Prospect Bismuth, Gold, Silver, Zinc, Lead, Cadmium
105H 029	FIR TREE	Skarn Pb-Zn	Drilled Prospect Copper, Zinc, Silver, Gold, Lead
105H 030	MCNITSE	Skarn W	Unknown Tungsten
105H 031	RON	Skarn Pb-Zn	Unknown Cadmium, Lead, Silver, Zinc, Copper, Gold
105H 032	HELEN	Skarn W	Unknown Bismuth, Silver, Tungsten, Gold
105H 033	BROD	Skarn Pb-Zn	Prospect Lead, Zinc, Silver
105H 034	NEEBING	Plutonic Related Au	Showing Gold, Arsenic, Lead
105H 035	JUSTIN	Plutonic Related Au	Drilled Prospect Copper, Gold, Tungsten, Silver, Lead, Molybdenum, Zinc, Bismuth, Arsenic
105H 036	ROAD	Vein Au-Quartz	Drilled Prospect Arsenic, Silver, Gold
105H 037	TOY	Skarn Pb-Zn	Showing Copper, Lead, Silver, Zinc, Gold
105H 040	CRNE	Skarn Mo	Showing Molybdenum
105H 041	BR	Skarn W	Showing Copper, Tungsten
105H 042	TANYA	Skarn W	Drilled Prospect Copper, Silver, Zinc, Tungsten, Lead
105H 043	GUY	Skarn W	Showing Copper, Tungsten
105H 044	RENA	Porphyry Mo (Low F-Type)	Showing Molybdenum, Tungsten
105H 045	FULCHER	Unknown	Anomaly Lead, Zinc
105H 046	TUSTLES	Unknown	Anomaly Copper
105H 047	FIN	Sediment hosted Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Drilled Prospect Barite, Zinc, Lead, Silver
105H 048	TED	Vein Barite	Prospect Barite, Silver, Zinc, Gold, Lead
105H 049	NARCHILLA	Skarn W	Prospect Copper, Silver, Zinc, Gold, Lead
105H 050	LEE	Skarn Pb-Zn	Drilled Prospect Copper, Zinc, Lead, Silver
105H 051	YBESZY	Skarn W	Showing Copper, Tungsten, Zinc, Lead
105H 052	DODGE	Skarn Mo	Showing Molybdenum, Tungsten
105H 053	TILLEI	Porphyry Mo (Low F-Type)	Showing Lead, Molybdenum, Zinc, Tungsten
105H 054	HITCHHIKER	Manto Polymetallic Ag-Pb-Zn	Showing Lead, Zinc, Copper, Silver
105H 055	ZEUS	Skarn W	Showing Copper, Silver, Tungsten, Zinc, Lead
105H 056	CARBIDE	Skarn W	Showing Molybdenum, Tungsten
105H 057	RICHARDO	Unknown	Anomaly
105H 058	ALM	Skarn Pb-Zn	Unknown
105H 059	BUS	Skarn W	Prospect Copper, Molybdenum, Tungsten, Zinc
105H 064	MARHAM	Skarn Pb-Zn	Showing Copper, Zinc, Lead
105H 066	SKCE	Plutonic Related Au	Drilled Prospect Gold, Arsenic
105H 067	GOLDEN CULVERT	Orogenic Au	Showing Gold, Arsenic
105H 068	SUSAN	Skarn W	Drilled Prospect Copper, Silver, Tungsten, Zinc, Lead
105H 070	CALI	Skarn W	Drilled Prospect Copper, Silver, Tungsten
105H 072	WOAH	Skarn W	Drilled Prospect Tungsten
105H 073	TAI	Skarn W	Drilled Prospect Tungsten
105H 075	MAVI	Sediment hosted Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Drilled Prospect Barite, Gypsum, Lead, Silver, Zinc, Copper
105H 077	ZEIT	Skarn W	Showing Tungsten
105H 078	JULIA	Volcanogenic Massive Sulphide (VMS) Besshi Cu-Zn	Drilled Prospect Copper, Gold, Silver, Zinc
105H 079	TINY	Unknown	Unknown
105H 080	KNEIL	Vein Polymetallic Ag-Pb-Zn-Au	Unknown Copper, Silver, Zinc, Lead
105H 081	TYERS	Vein Cu-Ag-Quartz	Showing Antimony, Gold, Silver, Tungsten
105H 082	TUNA	Porphyry Mo (Low F-Type)	Showing Molybdenum, Copper, Arsenic, Bismuth, Zinc, Lead
105H 084	CHAP	Skarn W	Showing Copper
105H 085	BEANS	Unknown	Unknown
105H 086	CERRO	Skarn W	Showing Copper, Tungsten, Molybdenum
105H 087	MG	Unknown	Unknown Zinc
105H 088	BILLINGS	Skarn W	Showing Molybdenum, Tungsten
105H 089	IWO	Skarn Pb-Zn	Showing Lead, Zinc
105H 090	WE	Skarn W	Showing Lead, Zinc, Tungsten
105H 091	PINK	Skarn Cu	Showing Copper
105H 092	SHAW	Skarn Pb-Zn	Showing Lead, Zinc, Tungsten
105H 093	SEBASTIAN	Skarn Pb-Zn	Showing Lead, Tungsten, Zinc
105H 094	MT BILLINGS	Skarn Pb-Zn	Showing Lead, Tungsten, Zinc
105H 095	COME	Sediment hosted Sedimentary Exhalative Zn-Pb-Ag (Sedex)	Showing Zinc
105H 096	MCPHERSON	Skarn Pb-Zn	Showing Copper, Silver, Zinc, Lead
105H 097	TUS	Porphyry Mo (Low F-Type)	Showing Molybdenum, Tungsten
105H 098	ANDERSON	Skarn W	Showing Tungsten
105H 099	BROTEN	Skarn W	Showing Tungsten
105H 100	MINI	Skarn W	Showing Tungsten
105H 102	FER	Vein Au-Quartz	Showing Arsenic, Lead, Zinc, Copper, Gold
105H 103	SPROGGE	Vein Au-Quartz	Prospect Gold, Bismuth, Arsenic, Antimony

Table 2: Importance rankings for weighted sums models using residuals on principal components.

Target Deposit Type*	Other Deposit Types*	Mn	Fe	Co	Ni	Cu	Mo	Pb	Zn	Ag	Au	As	Ba	Cd	Sn	Sb	Te	Hg	Tl	Bi	F	W	
Pb-Zn skarn	VMS, SEDEX MVT, Polymetallic Ag-Pb-Zn							3	4	2					1						1		
VMS (Zn-rich)	SEDEX Pb-Zn skarn, MVT, Polymetallic Ag-Pb-Zn				-2	2	4	2	1				1						2	1	-2		
Cu skarn	Porphyry Cu, Cu-Ag dtz vein					3				3								1					1
W skarn	Porphyry Mo					1																	4
Porphyry Mo	Porphyry Cu, W skarn					2	3																1
Intrusion-related Au	Epithermal Au-Ag									4	2							1					1
Epithermal Au-Ag	Polymetallic Ag-Pb-Zn					-1	-1	4	3	2								1					

* VMS = volcanic hosted/associated massive sulphide; SEDEX = sedimentary exhalative; MVT = Mississippi Valley Type; Polymetallic Ag-Pb-Zn type includes both vein and manto styles.
* Raw data following a log₁₀ transformation.

LEGEND

Town
▲ Mineral Occurrence
— Road
— Contour
— River
— Water Body
— Wetland
• Sample Location
— Catchment
— Catchment > 10km²

Weighted sums model (PC residuals)
Cu skarn deposits
■ incomplete element suite
■ 0-50th percentile
■ 50-75th percentile
■ 75-90th percentile
■ 90-95th percentile
■ 95-98th percentile
■ 98-100th percentile

RECOMMENDED CITATION

MACKIE, R., ARNE, D. AND PENNIMPEDE, C., 2015. Weighted sums model for Cu skarn deposits using principal component residuals. In: Enhanced interpretation of stream sediment geochemical data for NTS 105H. Yukon Geological Survey, Open File 2015-27, scale 1:250 000, sheet 8 of 15.

Catchment basin polygons generated by the Yukon Geological Survey (J. O. Bruce). 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 the Yukon Geological Survey, Energy, Mines and Resources, Government of Yukon, Room 102-300 Main St., Whitehorse, Yukon, Y1A 2B5. Ph. 867-667-3201, Email geology@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>.

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Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2015-27

Weighted sums model for Cu skarn deposits using principal component residuals (NTS 105H) Sheet 8 of 15

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