Yukon Geological Survey

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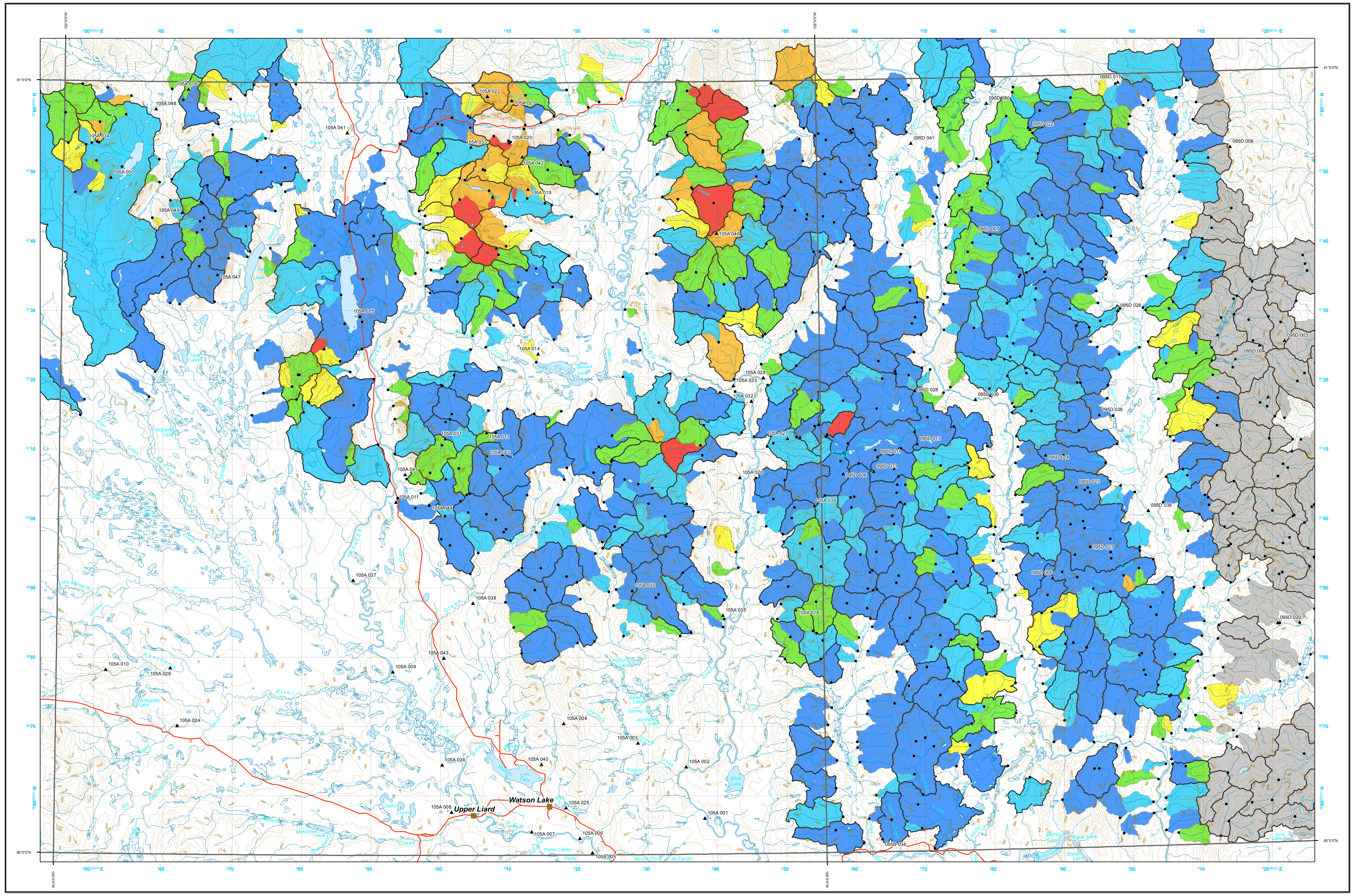


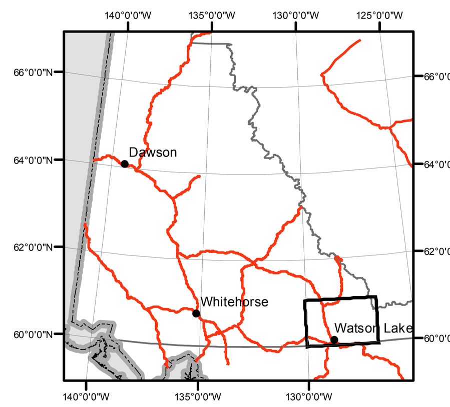


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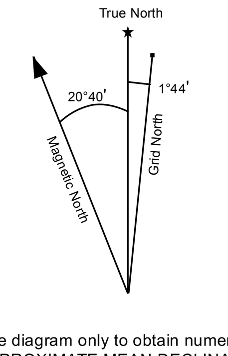
ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 9

CONTOUR INTERVAL 100 FEET
Elevations in metres above Mean Sea Level

**Porphyry Mo deposits**
**Weighted sums model**
**(Principal Component Residuals)**
**Sheet 9 of 12**

SCALE 1:250 000

0 1 2 3 4 5
kilometres




Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 2015
FOR CENTRE OF MAP

| | | |
|---|---|---|
| 105G FINLAYSON LAKE | 105H FRANCES LAKE | 095E FLAT RIVER |
| 105B WOLF LAKE | 105A THIS MAP | 095D THIS MAP |
| 104P MCDAME | 094M RABBIT RIVER | 094N TOAD 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 that accompanies 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 Watson Lake and Coal River areas (NTS 105A and 95D, respectively) were collected at a reconnaissance scale in 1995 as part of the Canada-Yukon Mineral Resource Development Cooperation Agreement (Friske *et al*., 1996). Field descriptions and initial geochemical data for 1117 sites were released in Geological Survey of Canada (GSC) Open File 3293. New geochemical data from the re-analysis of archive sample material from 824 sites were released in Yukon Geological Survey (YGS) Open File 2012-10 (Jackaman, 2012). The reader is referred to these reports for detailed descriptions of sampling techniques, analytical procedures, and quality control measures. The current assessment includes only those samples that have been re-analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and as such, the eastern half of NTS map sheet 95D is excluded.

## MINERAL OCCURRENCES

A variety of types of base and precious-metal mineralization are known to occur in the Watson Lake and Coal River area as shown in Table 1 (Yukon MINFILE, 2015). The most significant deposits are classed as intrusion-related gold (Hyland Deposit), Polymetallic Ag-Pb-Zn manto (past producing Mt. Hundere Mine & McMillan deposit) and W-Skarn (Bailey deposit). Other types of mineralization include various Pb-Zn deposits and prospects such as the Ritco (Skarn), Balon (SEDEX), Jeri and Jeri-North (SEDEX or MVT), and Sambo (VMS). The volcanic and sedimentary package that hosts VMS mineralization in the Finlayson Lake district extends into the Watson Lake map area indicating a high prospectivity for this style of mineralization.

## WEIGHTED SUMS MODELING

As described in the methodology report (Mackie *et al*., 2015), two approaches have been used to subdue the influence of background lithological variation and secondary absorption on the composition of stream sediments. One uses data levelled by the dominant geology mapped within each catchment, while the other uses residuals calculated from regression against selected principal components. Weighted sums models (WSM) have been generated using the processed data. The importance rankings used in WSMs 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.

Weighted sums models were not generated for porphyry Cu-Mo and epithermal Au-Ag deposit types because no such deposits are known to exist in the region and exploratory data analysis revealed no obvious anomalies in the expected commodity and pathfinder elements. Similarly, given a lack of evidence for scavenging of metal ions by secondary Fe or Mn-oxides a WSM for hydromorphic anomalies was also not produced.

Exploratory data analysis using 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 accounts for ~27% of the total geochemical variation and shows high positive loadings for Cd, Se, Sb, Ba, Hg, Zn and Ag; and negative loadings for, amongst other elements, Rb, Al, Sn, La, Ce and K. Respectively, these groupings form spatial patterns that match the distribution of chert and clastic sedimentary rocks of the Rabbitkettle Formation and intermediate intrusive rocks of the Hyland Suite. The second principal component, accounting for ~13% of the total variation, shows high positive loadings for Co, Fe and Cu, and high negative loadings for Tl, Nb, Ca, Ti, Na and Sr, and forms domains matching the mapped distribution of clastic sedimentary rocks of the Hyland Group and the carbonate rocks of the Rabbitkettle Formation, respectively. Regression analysis of selected metals against the relevant principal component(s) effectively filters these terrane-effects while preserving responses related to known occurrences. Levelling by mapped geology has a more subdued effect on filtering the interpreted lithological control on the distribution of certain pathfinder elements (*e.g.,* Sb, Ba and Cd). In order to reduce the impact this has on the WSM using this approach, certain elements were given low importance rankings or, in some cases, were omitted for certain deposit types.

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 (15 km$^2$). Catchments that cover larger areas (shown on the map with bold outlines) are interpreted to have been under-sampled and thus require further sampling to properly evaluate the area for geochemical anomalism. Given the likelihood that a mineralization 'signal' would be progressively diluted with increasing catchment size, marginally high WSM scores in large catchments may also be of interest.

**Table 1: List of Mineral Occurrences for NTS map sheet 105A/95D (Yukon MINFILE, 2015)**

| Number | Name | Type | Status | Commodities |
|---|---|---|---|---|
| 095D 001 | TOOBALLY | Unknown | Anomaly | |
| 095D 002 | GUSTY | Volcanogenic Sulphide - type not determined | Showing | Copper |
| 095D 003 | RA | Unknown | Unknown | |
| 095D 004 | AR | Unknown | Unknown | |
| 095D 005 | MEL | Sediment hosted Mississippi Valley-Type Pb-Zn (MVT) | Deposit | Barite, Zinc, Lead, Copper |
| 095D 006 | MCMILLAN | Manto Polymetallic Ag-Pb-Zn | Deposit | Lead, Zinc, Silver |
| 095D 007 | CHU | Skarn Pb-Zn | Showing | Lead, Zinc |
| 095D 008 | GABE | Volcanogenic Sulphide - type not determined | Showing | Copper |
| 095D 011 | HYLAND GOLD | Plutonic Related Au | Deposit | Gold, Silver, Bismuth, Lead, Arsenic |
| 095D 012 | SOWDEN | Unknown | Unknown | |
| 095D 013 | HULSE | Manto Polymetallic Ag-Pb-Zn | Prospect | Lead, Silver, Zinc |
| 095D 014 | WATSIT | Unknown | Anomaly | Zinc |
| 095D 016 | ASBURY | Unknown | Anomaly | Zinc, Lead |
| 095D 017 | SPORK | Unknown | Unknown | |
| 095D 018 | OUDDER | Skarn W | Anomaly | Tungsten |
| 095D 019 | SERAPHIM | Unknown | Anomaly | Zinc |
| 095D 020 | LOOTZ | Volcanogenic Sulphide - type not determined | Anomaly | Lead, Zinc |
| 095D 021 | KRONIG | Unknown | Anomaly | Barite, Zinc, Lead |
| 095D 022 | HERPES | Skarn W | Unknown | Tungsten |
| 095D 023 | QUO | Unknown | Anomaly | Gold |
| 095D 026 | SULPETRO | Coal | Deposit | Coal |
| 095D 027 | JONI | Sediment hosted Mississippi Valley-Type Pb-Zn (MVT) | Showing | Barium, Lead, Zinc, Silver |
| 095D 028 | PLAY | Unknown | Unknown | |
| 095D 032 | JERI | Sediment hosted Sedimentary Exhalative Zn-Pb-Ag (Sedex) | Drilled Prospect | Zinc, Lead |
| 095D 033 | CUZ | Vein Au-Quartz | Showing | Antimony, Arsenic, Bismuth, Gold |
| 095D 034 | JP | Unknown | Anomaly | Lead, Silver |
| 095D 035 | JERI-NORTH | Sediment hosted Mississippi Valley-Type Pb-Zn (MVT) | Drilled Prospect | Zinc |
| 095D 036 | ZIEL | Unknown | Anomaly | Lead, Zinc |
| 095D 037 | GUSTY | Unknown | Anomaly | |
| 095D 038 | BLOOD | Unknown | Anomaly | |
| 095D 039 | FERRICRETE | Unknown | Anomaly | |
| 095D 040 | ARGIL | Unknown | Anomaly | Copper, Molybdenum, Nickel, Manganese |
| 095D 041 | TOE-IN | Skarn | Anomaly | |
| 105A 001 | HY | Unknown | Unknown | |
| 105A 002 | IT | Unknown | Unknown | |
| 105A 003 | GARDEN | Unknown | Unknown | |
| 105A 004 | WINDFALL | Unknown | Unknown | |
| 105A 005 | WATSON | Vein Polymetallic Ag-Pb-Zn±Au | Drilled Prospect | Lead, Zinc, Silver |
| 105A 006 | NAZO | Vein Polymetallic Ag-Pb-Zn±Au | Drilled Prospect | Barite, Copper, Zinc, Silver, Lead |
| 105A 007 | CAROL | Coal | Drilled Prospect | Coal |
| 105A 008 | ALBERT | Coal | Drilled Prospect | Coal |
| 105A 009 | SAWMILL | Coal | Showing | Coal |
| 105A 010 | RANCH | Unknown | Unknown | |
| 105A 011 | CARNEGIE | Unknown | Anomaly | |
| 105A 012 | MT. HUNDERE | Manto Polymetallic Ag-Pb-Zn | Past Producer | Lead, Zinc, Silver, Fluorite |
| 105A 013 | SA DENA HES | Skarn Pb-Zn | Past Producer | Lead, Zinc, Silver |
| 105A 014 | RALPH | Unknown | Unknown | |
| 105A 015 | SIMPSON | Unknown | Staked - No Work Recorded | |
| 105A 016 | HEISZ | Unknown | Unknown | |
| 105A 017 | BAILEY | Skarn W | Deposit | Tungsten, Tungsten Trioxide, Copper, Molybdenum |
| 105A 018 | BALON | Sediment hosted Sedimentary Exhalative Zn-Pb-Ag (Sedex) | Prospect | Cadmium, Zinc, Lead, Copper, Gold |
| 105A 019 | CANADA | Skarn W | Showing | Tungsten |
| 105A 020 | MURRAY | Porphyry Mo (Low F-Type) | Showing | Gold, Molybdenum, Tungsten |
| 105A 021 | NOTT | Vein Polymetallic Ag-Pb-Zn±Au | Drilled Prospect | Copper, Lead, Gold, Zinc, Tungsten, Silver |
| 105A 022 | BOURGET | Unknown | Anomaly | Copper, Tungsten |
| 105A 023 | WARBURTON | Vein Polymetallic Ag-Pb-Zn±Au | Showing | Copper, Silver, Gold, Lead |
| 105A 024 | OLGA | Unknown | Unknown | |
| 105A 025 | MYMRYK | Unknown | Unknown | |
| 105A 026 | HYLAND | Unknown | Anomaly | Zinc |
| 105A 027 | ANGUS | Unknown | Anomaly | Zinc |
| 105A 028 | SHALE | Unknown | Unknown | Zinc |
| 105A 029 | ALLEGRETTO | Unknown | Unknown | |
| 105A 030 | LINGFISH | Unknown | Anomaly | Lead, Zinc |
| 105A 031 | PLAN | Unknown | Unknown | |
| 105A 032 | GREEN | Vein Polymetallic Ag-Pb-Zn±Au | Showing | Copper, Gold, Lead, Silver |
| 105A 033 | KLUNK | Unknown | Unknown | |
| 105A 034 | HOWARD | Unknown | Unknown | |
| 105A 035 | TILL | Unknown | Anomaly | |
| 105A 036 | DODO | Coal | Prospect | Coal |
| 105A 037 | MIDDLE CANYON | Coal | Showing | Coal |
| 105A 038 | SHELL | Unknown | Anomaly | |
| 105A 039 | AURUM | Manto Polymetallic Ag-Pb-Zn | Anomaly | Copper, Zinc, Gold, Silver |
| 105A 040 | SKIHILL | Unknown | Unknown | |
| 105A 041 | PUG | Unknown | Unknown | |
| 105A 042 | SLEET | Unknown | Unknown | |
| 105A 043 | GLIMMER | Unknown | Anomaly | |
| 105A 044 | HIGHWAY | Unknown | Anomaly | |
| 105A 045 | JEWEL | Unknown | Unknown | |
| 105A 046 | TAFFIE | Porphyry Mo (Low F-Type) | Anomaly | Molybdenum |
| 105A 047 | SAMBO | Volcanogenic Massive Sulphide (VMS) Kuroko Cu-Pb-Zn | Prospect | Copper, Zinc, Gold, Silver, Lead |
| 105A 048 | ITCH | Unknown | Anomaly | |
| 105A 049 | LITTLE JIMMY | Volcanogenic Sulphide - type not determined | Showing | Copper, Zinc, Lead, Silver |
| 105A 050 | BART | Unknown | Anomaly | Copper, Zinc, Gold, Lead |

**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 | Zn | Pb | Ag | Au[1] | As | Ba | Cd | Sn | Sb | Te | Hg | Tl | Bi | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polymetallic Ag-Pb-Zn | SEDEX, VMS (Zn-rich), MVT, Pb-Zn skarn | | | | | | | 2 | 4 | 2 | | 1 | | | 1 | 1 | | | -2 | | |
| VMS (Zn-rich) | SEDEX, Pb-Zn skarn, MVT, VMS (Cu-rich), Polymetallic Ag-Pb-Zn | | | | | 2 | | 4 | 3 | 1 | | | 1 | 1 | | | | | 1 | | |
| VMS (Cu-rich) | Cu skarn | | | 2 | | 3 | | -1 | -1 | | | | | | | | | | | | |
| Porphyry Mo | Porphyry Cu | | | | | 2 | 4 | -1 | | 1 | | | -2 | -1 | | | | | | 1 | 1 |
| W skarn | Porphyry Mo | | | | | | 2 | | | | | | | | | | | | | 1 | 3 |
| Intrusion-related Au | Epithermal Au-Ag | | | | | | | | | | 3 | 3 | | | | 1 | | | | 1 | |

[a]Polymetallic Ag-Pb-Zn type includes vein and manto styles; SEDEX = sedimentary exhalative Pb-Zn-(Ag); VMS = volcanic-hosted/associated massive sulphide deposits; MVT = Mississippi Valley-type Pb-Zn deposits

[1]Raw data following a $\log_{10}$ transformation

## LEGEND

- Town
- Mineral Occurrence
- Road
- Contour
- River
- NTS map sheet
- Water Body
- Wetland
- Sample_Location
- Catchment
- Catchments >15 km$^2$

**Weighted sums model (PC residuals)**

**Porphyry Mo 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 Porphyry Mo deposits using principal component residuals. In: Enhanced interpretation of stream sediment geochemical data for NTS 95D and 105A. Yukon Geological Survey, Open File 2015-30, scale 1:250 000, sheet 9 of 13.

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) 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 2015-30


# Weighted sums model for Porphyry Mo deposits using principal component residuals (NTS 95D and 105A) Sheet 9 of 13


by

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