

# CARLIN-TYPE GOLD IN BRITISH COLUMBIA?

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RGS Carlin signal

Catchment basin

Porphyry W/Mo

Carbonatite

RGS sample

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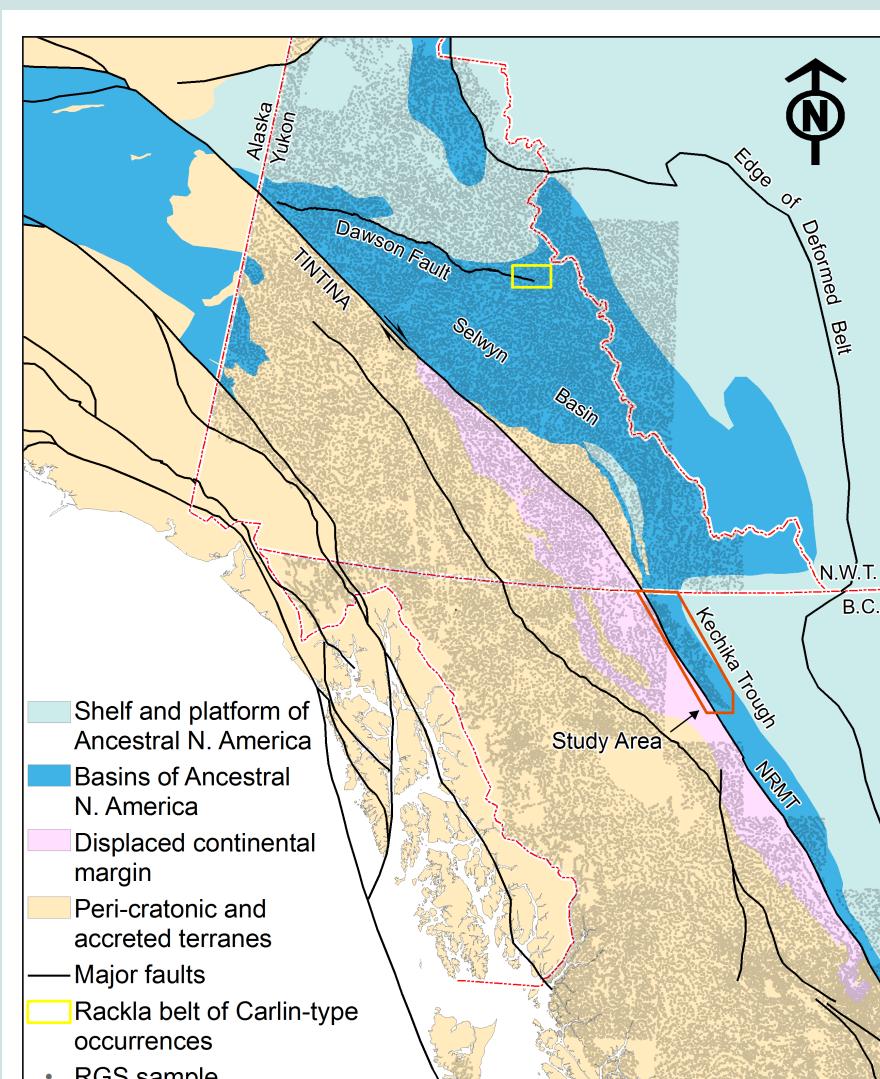
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#### INTRODUCTION

Eocene Carlin-type gold deposits (CTGD) in Nevada constitute the second largest concentration of Au in the world (Muntean et al., 2011). Similar structure-controlled Au and realgar/orpiment showings have recently been discovered in Proterozoic-Paleozoic Selwyn basin strata of the Rackla belt in east-central Yukon (Tucker et al., 2013). These discoveries raise the possibility of similar occurrences in equivalent settings in British Columbia (Poulsen, 1996). This reconnaissance project uses the provincial regional geochemical databases and digital geology to test for Au±As±Hg±Tl±Sb anomalies that may be spatially related to long-lived structures and to platform to deep-water transitions in the Kechika trough (the southward extension of Selwyn basin) of north-central British

#### KECHIKA TROUGH EXTENSION OF SELWYN BASIN AND POSSIBLE GEOLOGICAL CORRELATION WITH THE RACKLA BELT



The Rackla belt of Carlin-type gold mineralization in east-central Yukon straddles the northern edge of Selwyn basin, where Neoproterozoic to Triassic rocks of the basin are juxtaposed across the long-lived Dawson thrust zone against Paleozoic and older slope and shelf rocks of the Ogilvie platform (Fig. 1). The crustalscale structures, combined with favourable carbonate host strata at th shelf-slope transition, localised the replacive mineralization. Neoproterozoic fine-grained siliciclastic and carbonate rocks host most of the Carlin-type gold mineralization discovered to date (Osiris, Isis, Conrad and Pharoah zones: ATAC Resources Ltd., 2013). The ATAC Resources Ltd.'s Anubis zone occurs in Ordovician-Silurian carbonate near the

Lake sediment

Primary stream sediment

Hg by ICPMS (ppb)

media and stream order (symbols as in Fig. 4).

showing location of the study area in north-central B.C. and the Rackla belt of

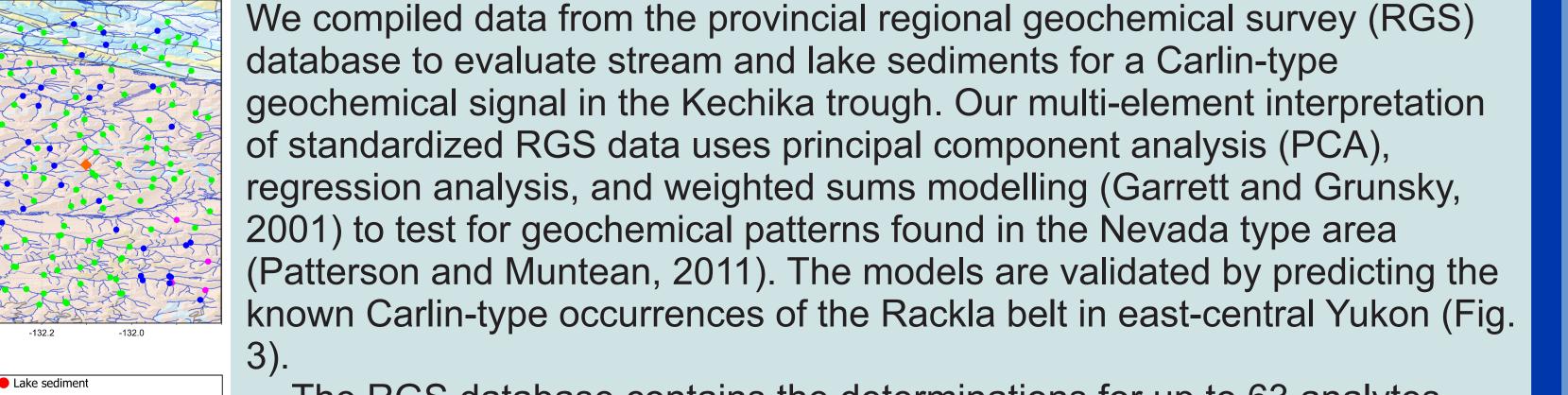
east end of the Paleozoic offshelf belt.

The Kechika trough is the very narrow basin. It shows similar platform to Cretaceous thrust faults that Ordovician to Permian rocks Road River Group and other Cambrian to Ordovician rocks Earn Group strata. Hyland and other Neoproterozoic

southern extension of the Selwyn basin transitions that were probably controlled by penecontemporaneous growth faults (Fig. 2). For instance, the ca. 690 Ma Gataga volcanics, one of the oldest units in the basin, were localized along a syndepositional fault, which was remobilized as one of an array of northeast-verging Jurajuxtaposed the Neoproterozoic rocks against strata as young as Devonian (Ferri et al., 1999). Of the most anomalous samples in this study, several cluster in the immediate footwall of a master thrust that places Neoproterozoic and Cambrian strata on top of younger Paleozoic rocks; others are located centrally within the trough, underlain by Road River and

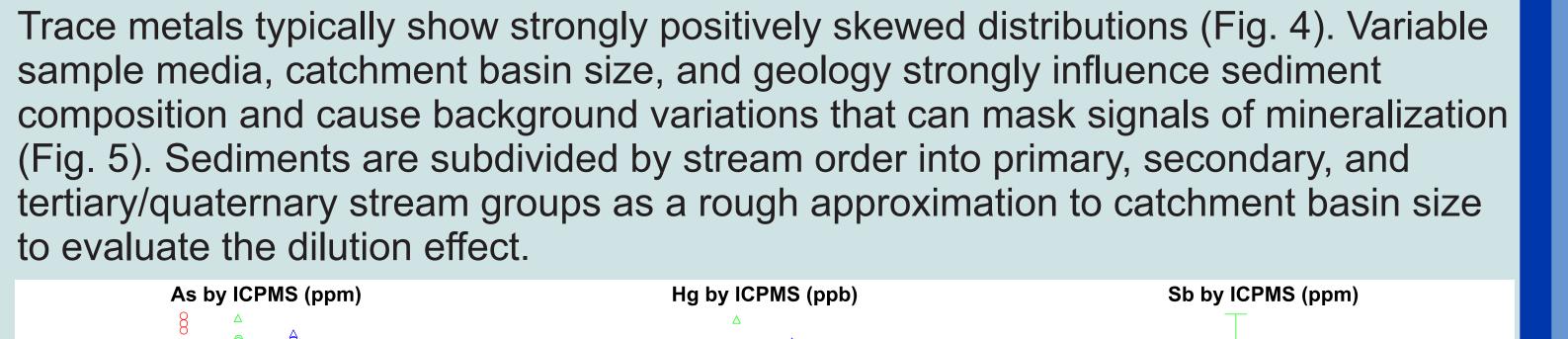
edrock geology and locations of the RGS samples and cross section after Fern et al. (1999). NRMT - Northern Rocky Mountain Trench.

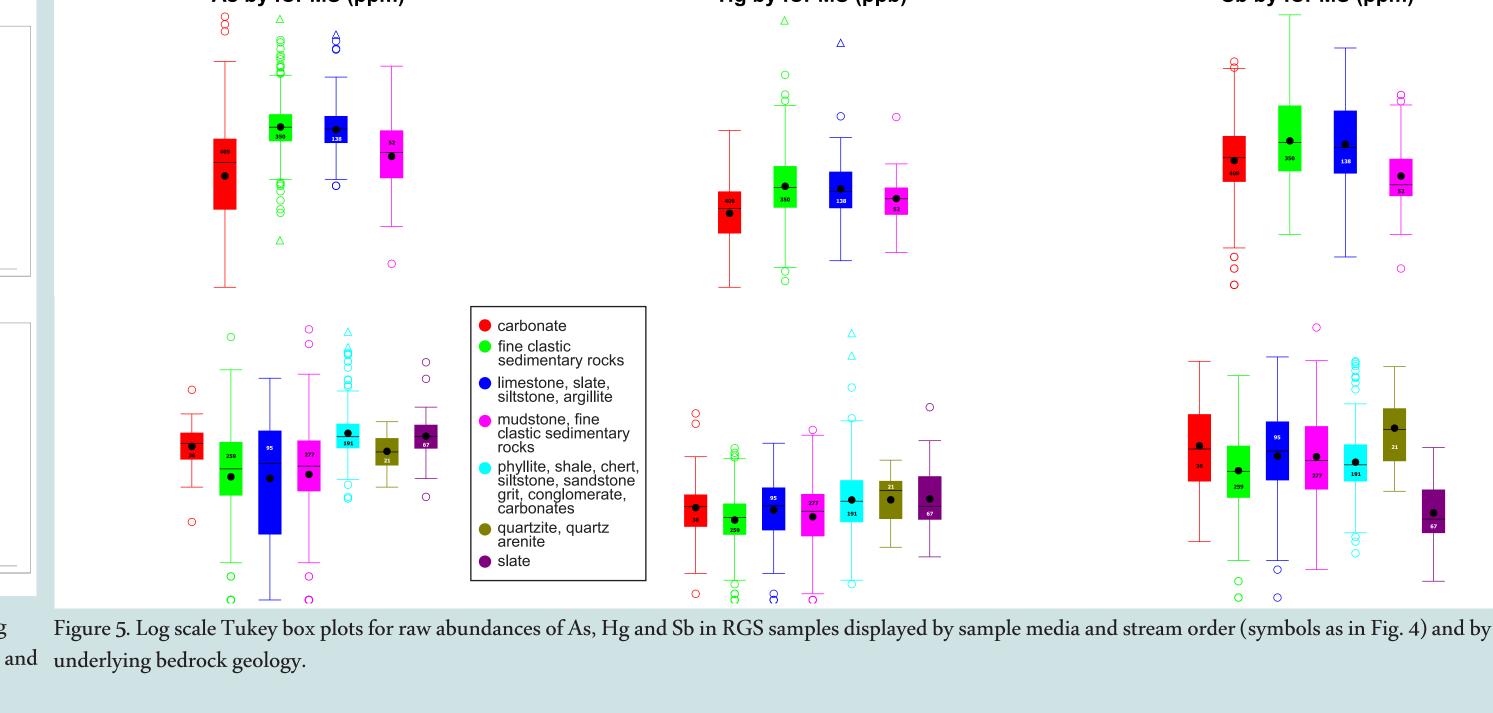
#### REGIONAL GEOCHEMICAL SURVEY DATABASE



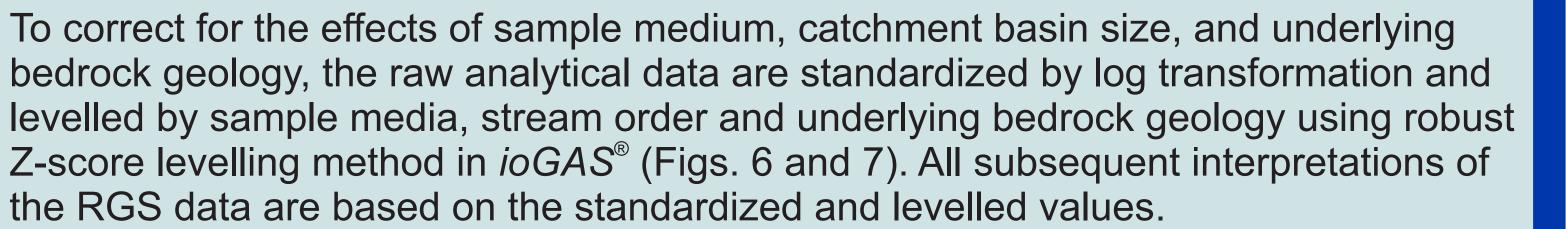
The RGS database contains the determinations for up to 63 analytes, field observations, sample locations, and underlying bedrock attributes obtained from provincial digital geology databases for 100,246 samples. These samples include fine-grained stream and lake sediments and moss collected at an average density of 1 site per 13 km<sup>2</sup> to provide representative geochemical data for the catchment basin upstream from the sample site. The joint federal-provincial RGS programs have been carried out in British Columbia and Yukon since 1976, as part of the National Geochemical reconnaissance program to aid exploration and development of mineral resources. Sample collection, preparation, and analytical protocols are strictly specified and carefully monitored to ensure consistent data regardless of the area and year of survey or the analytical laboratory (Friske and Hornbrook, 1991).

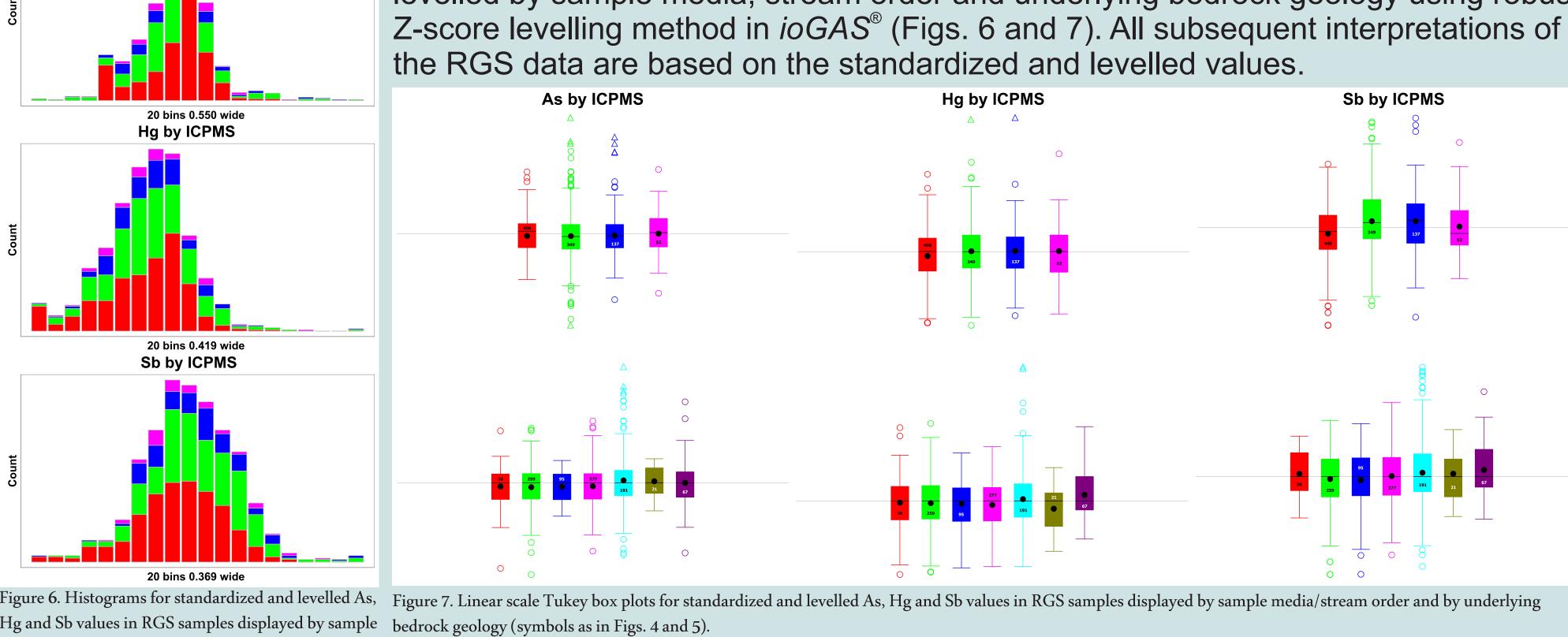
#### SELECTED RGS RAW ANALYTICAL DATA



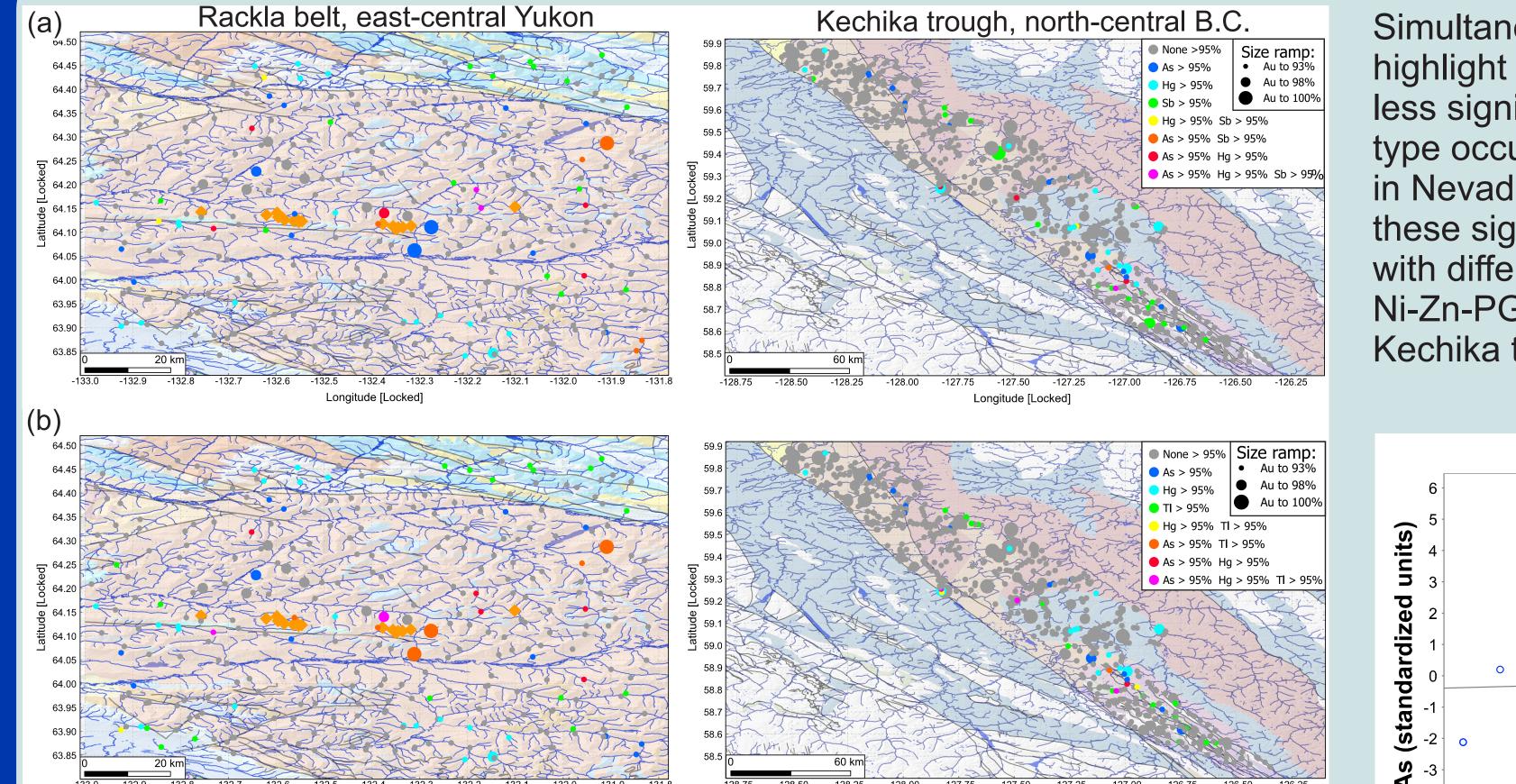


#### DATA STANDARDIZATION AND LEVELLING

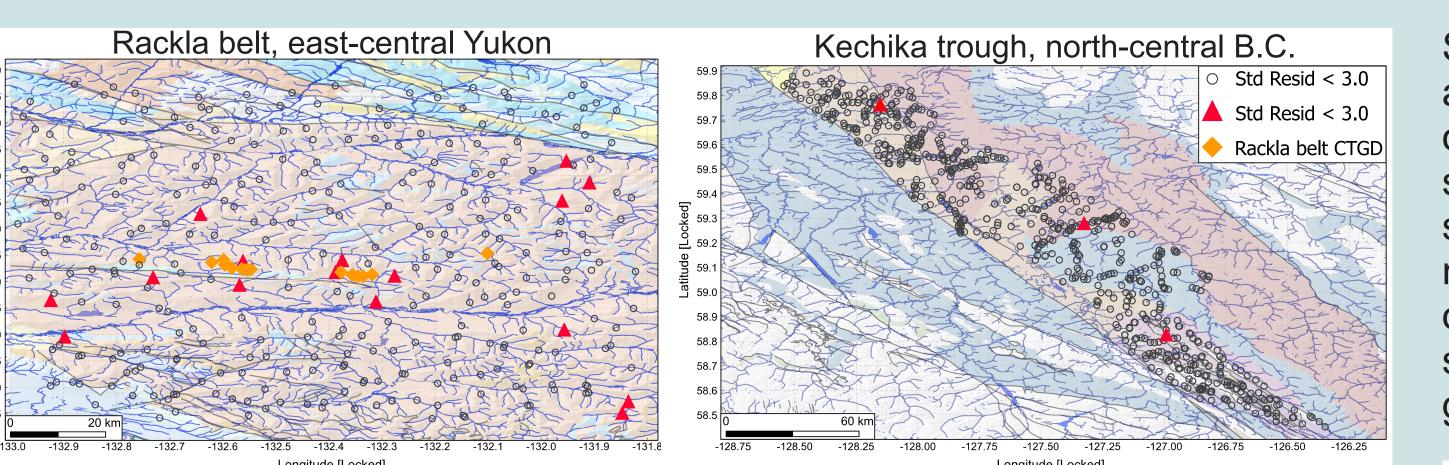




#### MULTI-ELEMENT MODELLING OF CARLIN-TYPE SIGNAL IN RGS SEDIMENTS

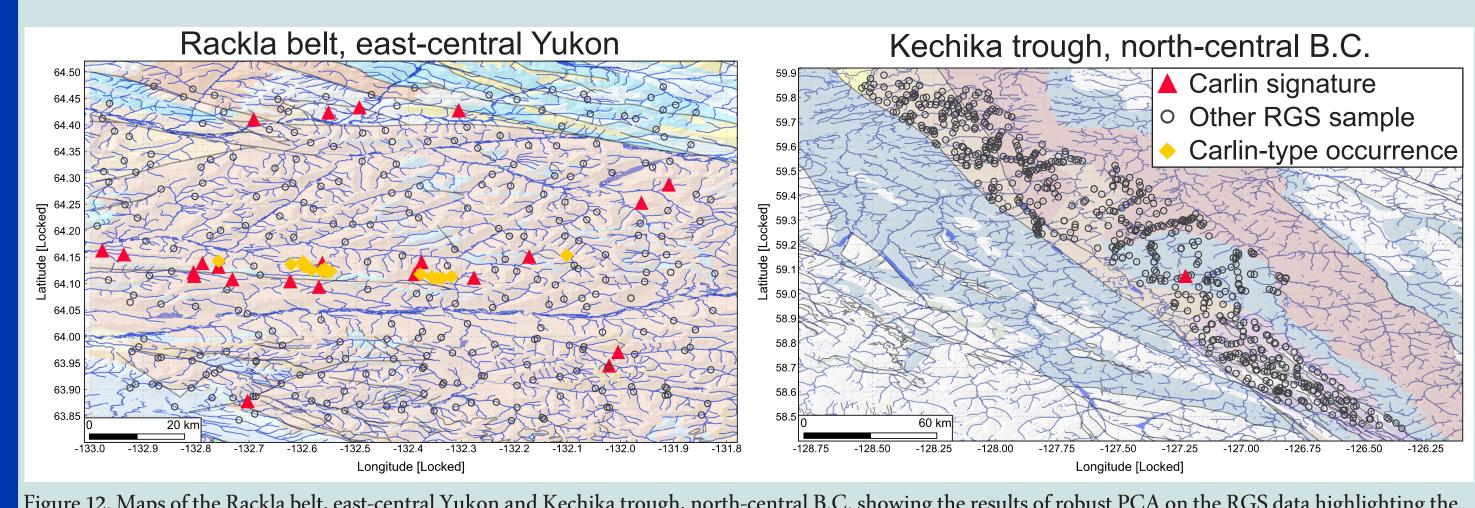


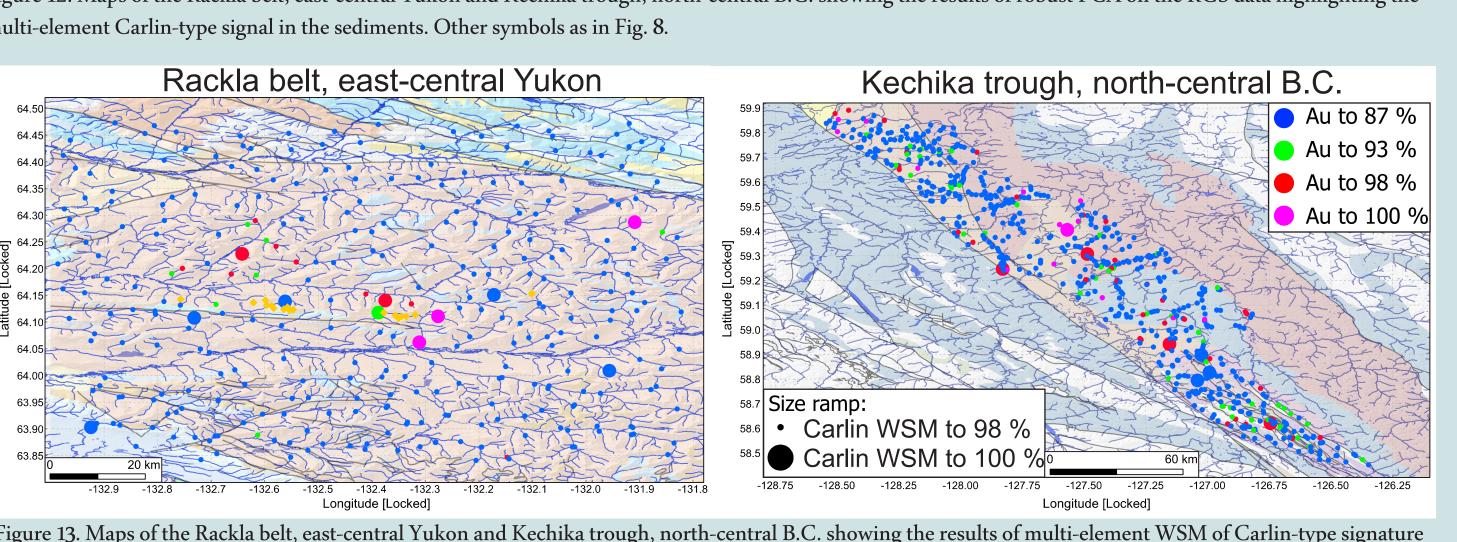
ith Au percentiles by symbol size ramps, for the RGS sediments, locations of the ATAC Resources Ltd.'s Nadaleen Trend of Carlin-type occurrences, and bedro



gure 10. Maps of the Rackla belt, east-central Yukon and Kechika trough, north-central B.C. showing the results of As vs. S robust regression analysis on the RC ata highlighting standardized residuals >3.0 which indicate realgar and/or orpiment in the sediments. Other symbols as in Fig. 8.

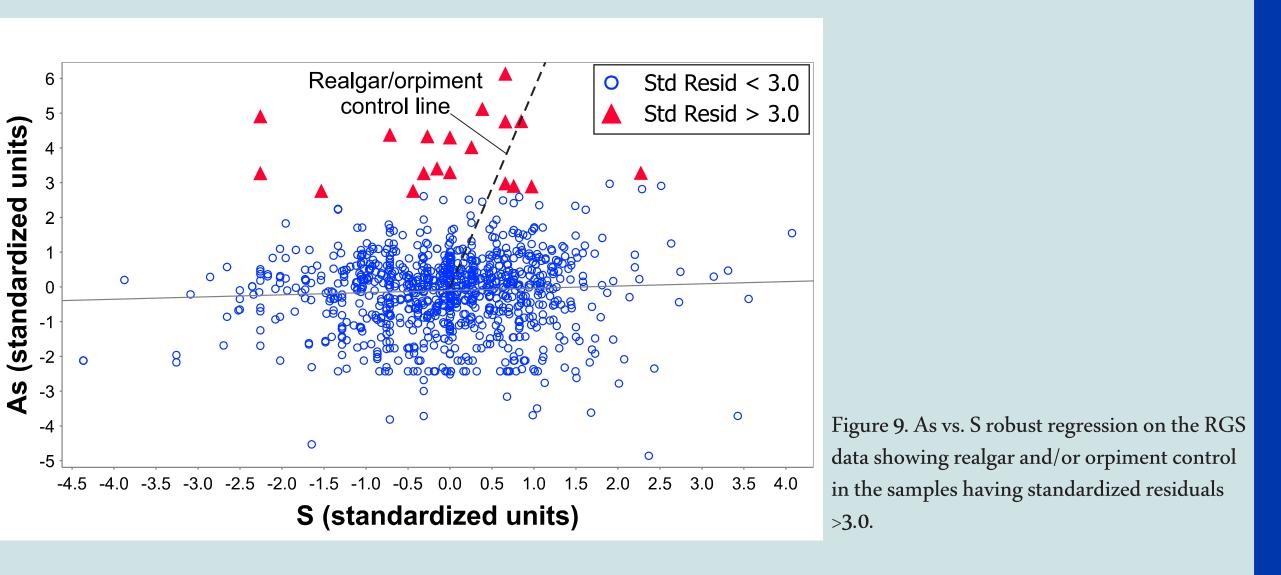
Robust PCA is a powerful multivariate technique that captures the essential variability in the original dataset of many variables with a few derived functions or principal components (PC1, PC2) which are not biased by outliers (Campbell, 1980). Robust PCA on 46-variable correlation matrix best discriminates the RGS samples nearest to the ATAC Resources Ltd.'s CTGD occurrences of the Rackla belt in terms of PC4 vs. PC2, which total to ~17% of variation in the original dataset (Fig. 11). Data points that fall within the narrow field defined by this group of RGS samples have a very similar multi-element Carlin-type signature. They include a number of stream sediments in the Rackla belt area and one lake sediment underlain by Cambrian-Ordovician carbonate and fine-grained siliciclastic strata of the Kechika Group in the project area (Fig. 12).



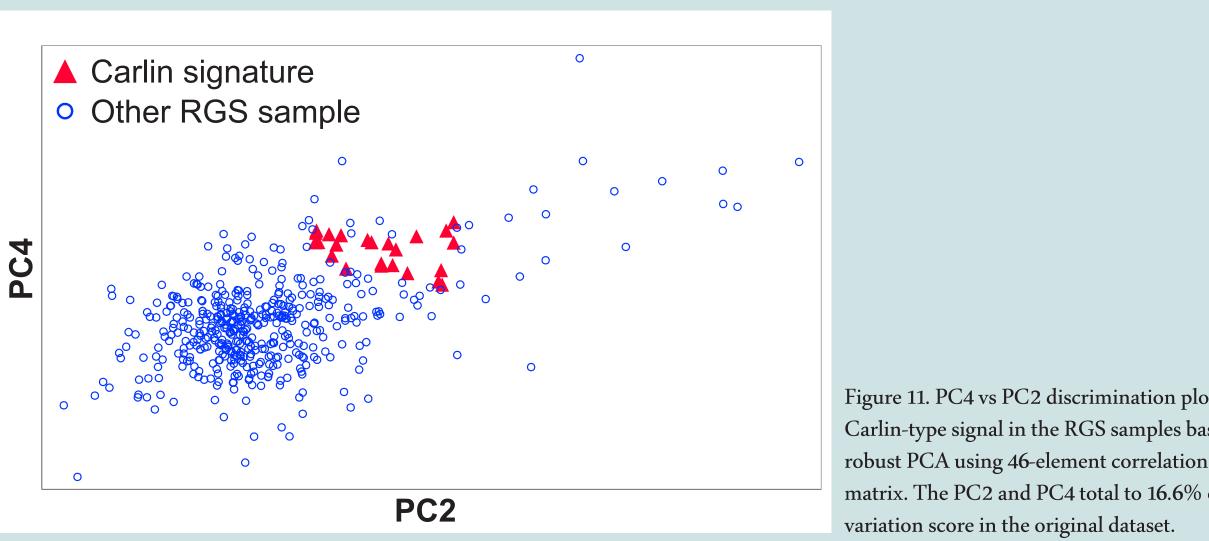


in the RGS sediments using the ERI based on factor analysis of CTGDs in Nevada (Table 1). Other symbols as in Fig. 8.

Simultaneous Au±As±Hg±Tl±Sb elevated values in stream sediments highlight main CTGD clusters of the Rackla belt (Fig. 8). Notably, Sb is less significant in the stream sediment samples nearest to the Carlintype occurrences, similar to the geochemical signature of many CTGDs in Nevada (Patterson and Muntean, 2011). However, interpretation of these signals may be obscured by spatial association of the CTGDs with different mineralization types (e.g., MVT, VMS-SEDEX, stratiform Ni-Zn-PGE) at the shelf-slope transition of the Selwyn basin and Kechika trough (Ferri et al., 1999).



Standardized residual values of >3 from As vs. S robust regression analysis (Rousseeuw and Leroy, 1987) indicate realgar and/or orpiment control and provide another effective way to enhance a Carlin signal in the stream sediments (Fig. 9). These "indicator mineral" standardized residuals highlight the main Rackla belt CTGDs and a number of new targets in the area, along with two lake sediment and one stream sediment samples, underlain by Paleozoic and older siliciclastic and carbonate rocks of the Earn, Road River and Hyland groups, in the Kechika trough (Fig. 10).

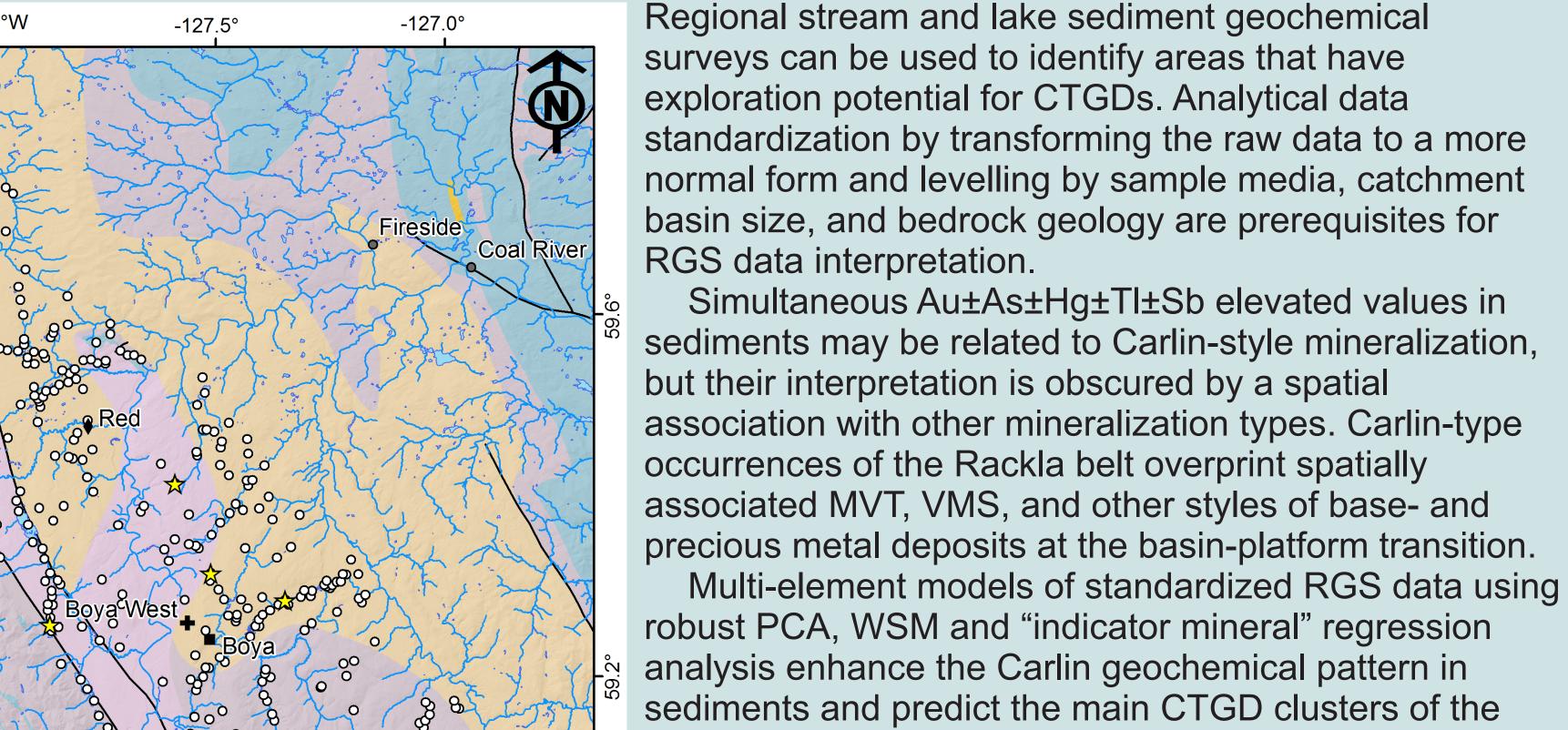


Weighted sums modelling (WSM) is a robust technique that uses a signature with a single function similar to PC1 in PCA, but with the relative scores for each variable assigned by the user, rather than being determined from the covariance or correlation matrix (Garrett and Grunsky, 2001). Using multi-element relative scores based on the factor analysis of lithogeochemical data from CTGDs in Nevada (Table 1; Patterson and Muntean, 2011), the WSM results of >98 percentile predict the main CTGD clusters of the Rackla belt and highlight a few new targets (Fig. 13). In the study area, the Carlin WSM highlights five stream-sediment and three lake-sediment samples underlain by Paleozoic and older fine-grained siliciclastic and carbonate rocks of the Earn, Road River, Kechika and Hyland groups in the Kechika trough and in the footwall of a thrust that juxtaposes the Neoproterozoic-Cambrian strata and the younger Paleozoic rocks.

Table 1. Element relative importance (ERI) used in the WSM of Carlin-type signal based on factor analysis of lithogeochemical data from Jerritt Canvon deposit, Nevada (Patterson and Muntean, 2011). Element | W | Ag | As | Au | Ca | Fe | Hg | La | Sb | Sr | Te | Tl |

The robust regression analysis, PCA, and WSM highlight a Carlin-type signal in a total of 11 stream and lake sediment samples from the Kechika trough (Fig. 14). These samples contain up to 89 ppm As, 1.0 ppm TI, 0.5 ppm Hg, 0.22 ppm Te and 28 ppb Au, comparable to those of mineralized halos at Jerritt Canyon CTGDs in Nevada and of the stream sediments from the Nadaleen Trend of CTGDs of the Rackla

#### BRITISH COLUMBIA HIGHLIGHTS AND CONCLUSIONS



Rackla belt. WSM using the geochemical signature of CTGDs in Nevada (Patterson and Muntean, 2011), combined with As vs. S regression analysis and robust PCA, highlight 11 lake and stream sediment samples from the Kechika trough that show a Carlin-type signature (Fig. 14). These sediment samples are underlain by the Paleozoic and older fine-grained siliciclastic and carbonate rocks of the Earn, Road River, Kechika and Hyland groups in the Kechika trough and in the footwall of a thrust that juxtaposes the Neoproterozoic to Cambrian strata and the younger Paleozoic rocks. Importantly, possible correlation of these strata and this structural setting with the Rackla belt highlight the potential for CTGDs. The outer astern) margin of the Kechika trough is yet to be

MT - Northern Rocky Mountain Trench. Other symbols as in Fig. 2

'S 94L, M and 104P) showing locations of RGS samples with Carlin-type signal and their

#### **EXPLORATION APPLICATIONS AND FUTURE WORK**

A Carlin-type signal in low sample density stream and lake sediments marks new exploration targets in the Kechika trough. Follow up work should include regional catchment basin analysis to evaluate the effects of catchment basin size and bedrock and surficial geology on sediment composition. On the catchment basin scale, multi-media geochemical surveys and bedrock mapping can be used to locate favourable replacement and brecciation zones near long-lived fault zones. Realgar, orpiment and stibnite overprinting auriferous Asrich pyrite are the best indicators of Carlin-type mineralization (Tucker et al., 2013).

Exploration in the prospective northern part of the project area (parts of NTS 94M and 104P) has priori knowledge of mineralization or process to model its multi-element previously been limited by extensive drift cover and poor exposure. Drift prospecting and till indicator mineralogy have been an effective exploration tool in drift-covered areas elsewhere.

> In addition to the new CTGD targets, the Paleozoic and older fine-grained siliciclastic and carbonate rocks in the Kechika trough host numerous SEDEX Pb-Zn-Ba and stratiform Ni-Zn-PGE occurrences, and at least one known intrusion-related W-Mo stockwork-skarn deposit (e.g., Ferri et al., 1999). Further geochemical modelling of these different types of mineralization would help better constrain the geochemical signature of Carlin-type mineralization and identify new exploration targets in the area.

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