ATLAS OF GOLD COMPOSITIONS FOR BRITISH COLUMBIA

Developing a New Tool for the Exploration Community

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Geoscience BC

BONANZA GEOSCIENCES

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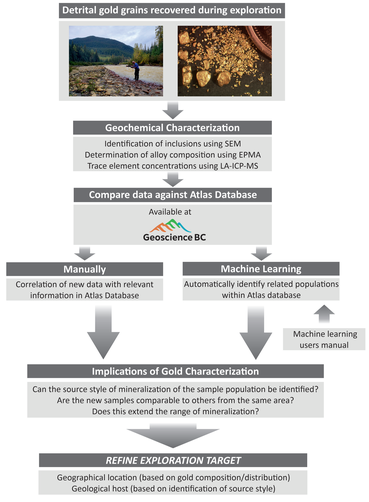
1. Project Objectives

- Gold particles are commonly recovered during exploration but are not currently used as an indicator mineral.
- Gold particle geochemistry is a function of the source mineralization style and may be used to infer deposit type.
- We are building an "atlas" of gold compositions in BC - a comprehensive geochemical database which characterizes gold from different source mineralization styles.
- Atlas will be publically available, and provide a template against which new composition data can be compared.
- We will develop a machine learning approach to facilitate interrogation of new sample populations of gold particles against the Atlas database.
- The new tool will be suitable for exploration projects of all sizes.

Projected completion by Roundup 2021

2. Using the Atlas Database

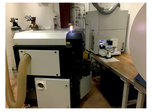


3. Building the Atlas

Analytical Techniques Employed

SEM
Mineral inclusions

EPMA
Major elements in alloy



LA-ICP-MS
Trace elements in alloy

Existing Data

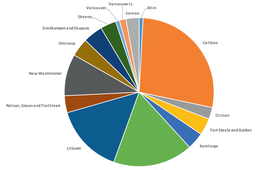
UoL Collection

- Published alloy composition data for Au, Ag, Cu, Hg and Pd and inclusion mineralogy (EPMA, SEM)[1][2]
  [68 localities, 3868 gold particles]
- Trace elements (e.g. Cu, Hg, Pd, Sb, Pb, Bi, Te) (LA-ICP-MS)[3]
  [25 localities, 884 gold particles]

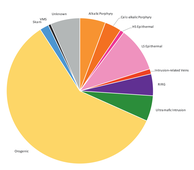
UBC Collection

- Published + unpublished composition data for Au, Ag, Cu and Hg (EPMA)
  [148 localities, 5364 gold particles]

Summary of Regions and Mineralization Styles Represented



BC Mining Divisions



Mineralization Styles

New Data

Full Analysis of New samples

- Donations
- Additional samples from UoL/UBC collections

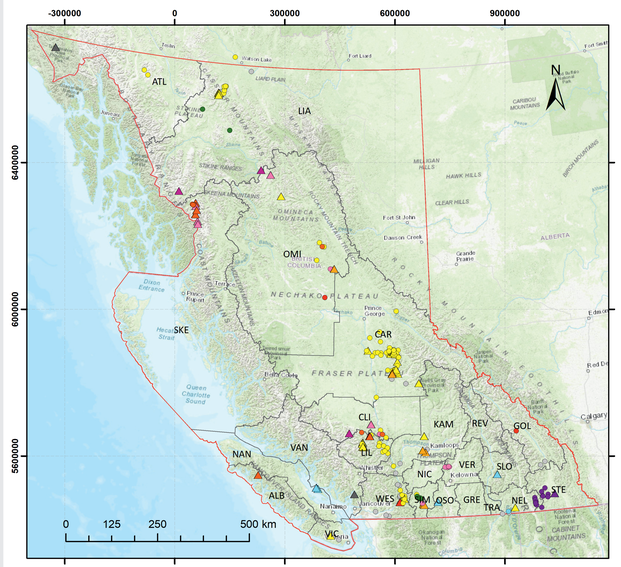
Additional data from existing samples

- Mineral inclusion data from UBC samples, (2945 particles to date)
- Trace element data (first of two sessions) 385 gold grains, 20 localities.

Projected size of initial database

12509 PARTICLES from 353 LOCALITIES

4. Map of Sampled Locations



Legend

Sample Type
Hypogene
Detrital

Mineralization Style
Orogenic
VMS
Skarn
Unknown

Porphyry
Alkalic
Calc-alkalic

Epithermal
Low Sulfidation
High Sulfidation

Intrusion-related
Intrusion-related (inferred)
Reduced Intrusion-related Gold
Ultramafic Intrusion-related

Mining Divisions
Division Boundary

ALB	Alberni	LIA	Liard	REV	Revelstoke
ATL	Atlin	LIL	Lillooet	SIM	Similkameen
CAR	Cariboo	NAN	Nanaimo	SKE	Skeena
CLI	Clinton	NEL	Nelson	SLO	Slocan
STE	Fort Steele	WES	New Westminster	TRA	Trail Creek
GOL	Golden	NIC	Nicola	VAN	Vancouver
GRE	Greenwood	OMI	Omineca	VER	Vernon
KAM	Kamloops	OSO	Osoyoos	VIC	Victoria

Acknowledgements

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References

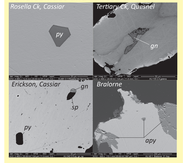
[1] Chapman, R.J. and Mortensen, J.K. (2016) Characterization of gold mineralization in the northern Cariboo Gold District, British Columbia, Canada, through integration of compositional studies of lode and detrital gold with historical placer production: a template for evaluation of orogenic gold districts. Economic Geology, 111 (8). pp. 1321-1345.
[2] Chapman, R., Mileham, T., Allan, M. and Mortensen, J. (2017) A Distinctive Pd-Hg Signature in Detrital Gold Derived from Alkalic Cu-Au Porphyry Systems. Ore Geology Reviews, 83. pp. 84-102.
[3] Banks DA, Chapman RJ, Spence-Jones C. 2018. Detrital Gold as a Deposit-specific Indicator Mineral by LA-ITS-MS Analysis. In: *Geoscience BC Report* 2018-21.

5. Interesting Discoveries

Orogenic Gold

Key localities/regions:
Bralorne, CGD, Atlin, Cassiar

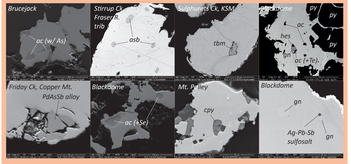
Signature
Binary Au-Ag alloy, with small range of trace elements at low concentrations.
Inclusions mainly simple sulfides, sulfarsenides and sulfosalts.



Porphyry and Epithermal Gold

Key localities/regions:
Calc-alkalic porphyries and LS epithermal: *KSM, Blackdome, Brucejack.*
Alkalic porphyries: *Mt Milligan, Mt Polley, Copper Mountain, Afton*

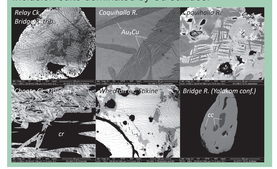
Signature
Variable, often with Bi-Ag-Pb-Te-Sb-S-As inclusion mineralogy. Alkalic porphyries exhibit Pd-Hg in alloy.



Orthomagmatic Gold :

Key localities/regions:
Bridge R., Wheaton Ck, Coquihalla R
Formed in Alaskan-type intrusions assosciated with PGEs.

Signature
Complex alloy textures from exsolution of intermetallic Au,Cu out of Cu-rich Au.
Inclusion suite dominated by Cu sulfides.

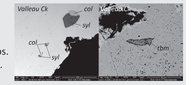


Unknown Origins...

In some cases, inclusion mineralogy indicative of magmatic-hydrothermal system, though definitive source is unclear.

Example: Valleau Ck, Omineca.

- Flows through alkalic granites and ultramafic-mafic gabbros.
- Inclusion mineralogy dominated by Au-Ag-Bi-Hg-tellurides.
- Currently undrilled.



Key Comments

- Compositional features indicative of mineralization style can be readily identified from single samples, but their interpretation is difficult without sufficient knowledge of gold grain geochemistry.
- In order to make classification and interpretation more widely accessible, we are developing a multivariate approach to interrogating and classifying the geochemical data.

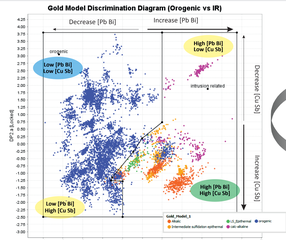
6. Ongoing Work: Development of Exploration Tool

Atlas Generation

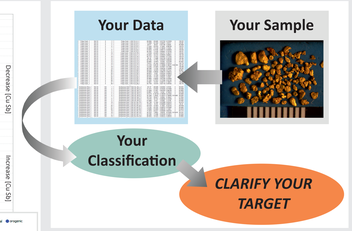
The database will be published in a format suitable for direct importation into *ioGas* software

Exploratory Data Analysis

- Identifying compositional features to indicate different mineralization styles.
- Data assessed in *ioGas* to identify parameters which co-vary according to source style.
- Data grouped into known Gold Model groups based on expert domain knowledge.
- Linear Discriminant Functions calculated to maximize the between-group separation and minimize the within-group separation.
- Discriminant Functions visualized using XY biplot.
- Discriminants recorded so that mineralization style can be identified from unknown populations.



- Each point represents data for one gold particle.
- Pb-Bi variation discriminates gold from orogenic and magmatic hydrothermal systems.
- Cu-Sb variation in high Pb-Bi gold differentiates low and intermediate sulfidation epithermal, alkalic and calc-alkalic sources.
- Further interrogation of data required to constrain signatures for individual magmatic sources and variations in orogenic deposits.



As new data is added to the database it will become increasingly powerful.

Further interpretation of the data will enhance our understanding of gold metallogeny across BC.