



Critical
Minerals
Mapping
Initiative



Canada
Geological Survey of Canada
Natural Resources Canada



Queensland
Government



Australian Government
Geoscience Australia

Update on the Deposit Classification Scheme for the Critical Minerals in Ores Database

Albert H. Hofstra¹ (ahofstra@usgs.gov)

Douglas Kreiner¹, Matthew Granitto¹, Poul Emsbo¹, Vladimir Lisitsin², Louise Corriveau³, Suzanne Paradis³, Sally Pehrsson³, Jan Peter³, Kathleen Lauzière³, Christopher Lawley³, Michael Gadd³, Jean-Luc Pilote³, Ian Honsberger³, Evgeniy Bastrakov⁴, David Champion⁴, Jonathan Cloutier⁴, Karol Czarnota⁴, Michael Doublier⁴, David Huston⁴, Oliver Raymond⁴, and Simon VanDerWielen⁴

(1)U.S. Geological Survey

(2)Geological Survey of Queensland

(3)Geological Survey of Canada

(4)Geoscience Australia

Critical Minerals Mapping Initiative: Goals

- Compile a global Critical Minerals in Ores (CMiO) Database and serve it to the public via a web-based portal
- Develop a unified Deposit Classification Scheme to sort and use the geochemical data on ores
- Place Critical Minerals in a Tectonic & Systems Framework
- Research Assessment Techniques for Critical Minerals

Critical Minerals of each Country

Critical to the Energy Transition

Critical Minerals	<u>Australia</u>	<u>Canada</u>	<u>United States</u>
Aluminum (Al)		X	X
Antimony (Sb)	X	X	X
Arsenic (As)			X
Barite			X
Beryllium (Be)	X		X
Bismuth (Bi)	X	X	X
Cesium (Cs)		X	X
Chromium (Cr)	X	X	X
Cobalt (Co)	X	X	X
Copper (Cu)		X	
Fluorspar		X	X
Gallium (Ga)	X	X	X
Germanium (Ge)	X	X	X
Graphite	X	X	X
Hafnium (Hf)	X		X
Helium (He)	X	X	
Indium (In)	X	X	X
Lithium (Li)	X	X	X
Magnesium (Mg), Magnesite	X	X	X

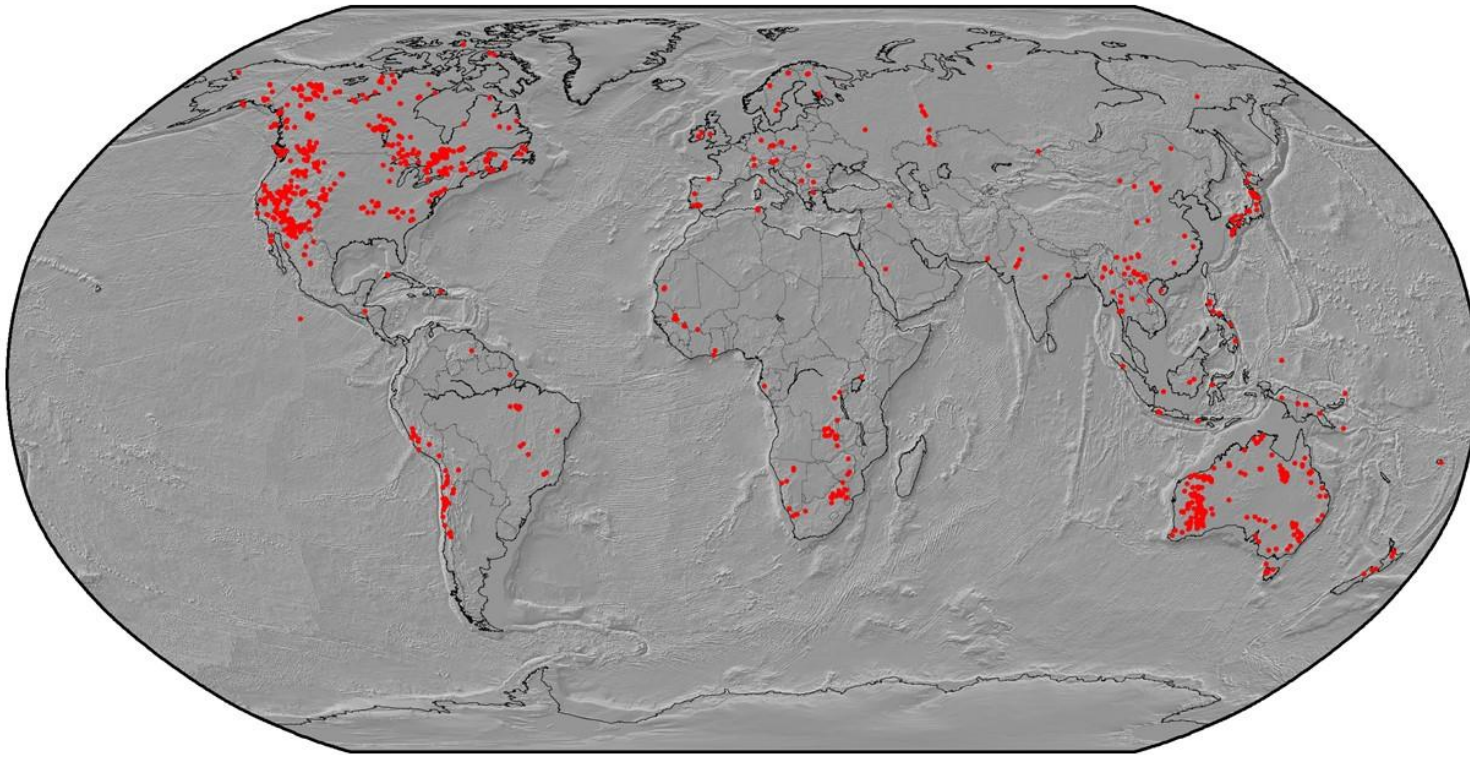
Critical Minerals	<u>Australia</u>	<u>Canada</u>	<u>United States</u>
Manganese (Mn)	X	X	X
Molybdenum (Mo)		X	
Nickel (Ni)		X	X
Niobium (Nb)	X	X	X
Platinum group elements (PGE)	X	X	X
Potash		X	
Rare earth elements (REE)	X	X	X
Rhenium (Re)	X		
Rubidium (Rb)			X
Scandium (Sc)	X	X	X
Tantalum (Ta)	X	X	X
Tellurium (Te)		X	X
Tin (Sn)		X	X
Titanium (Ti)	X	X	X
Tungsten (W)	X	X	X
Uranium (U)		X	
Vanadium (V)	X	X	X
Zinc (Zn)		X	X
Zirconium (Zr)	X		X

38 Critical Minerals

To be useful, ore samples must be analyzed for many elements

Critical Minerals in Ores (CMiO) Database

criticalminerals.org



Ore sample location map

- Geochemical data compiled from GA, GSC, USGS sources
- 7,311 Samples
- 1507 Deposits
- 60 Countries
- Updated annually

Deposit Classification Scheme

Genetically related features / **System type** (N=38)

Linked to samples in 2022

Deposit environment (N=12)

Deposit group (N=52)

Deposit type (N=189)

*Linked to samples in the
CMiO Database*

USGS OFR 2021-1049

<https://doi.org/10.3133/ofr20211049>

Synonyms

Examples

References (N=313)

CMiO Database: Info linked to samples

System type (N=40)

Linked to samples in 2022

Deposit environment (N=12)

Deposit group (N=52)

Deposit type (N=189)

Deposit Classification Scheme

Deposit (name, ID, primary & secondary commodities)

Sample (name & ID)

Sample Location (exact or deposit location, state, country)

Sample source & character (several entries)

Prep & Analytical methods

Results & Detection limits (many elements)

System type

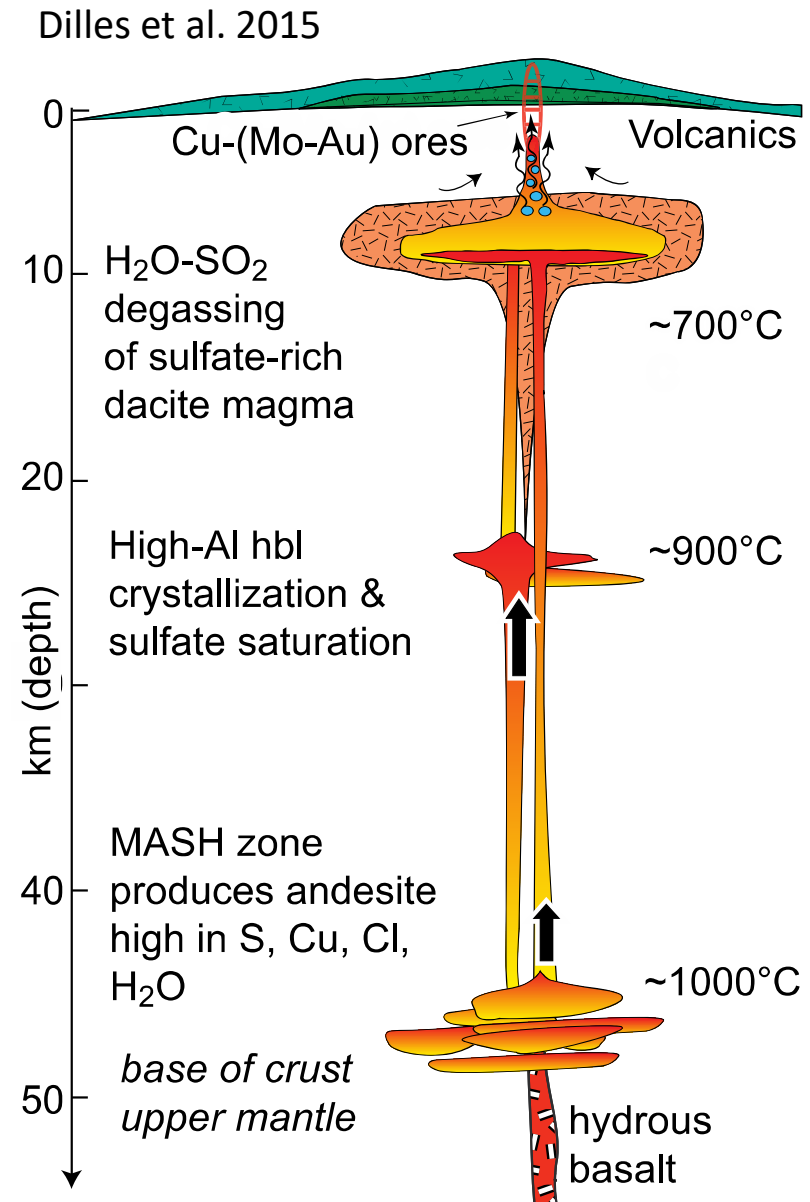
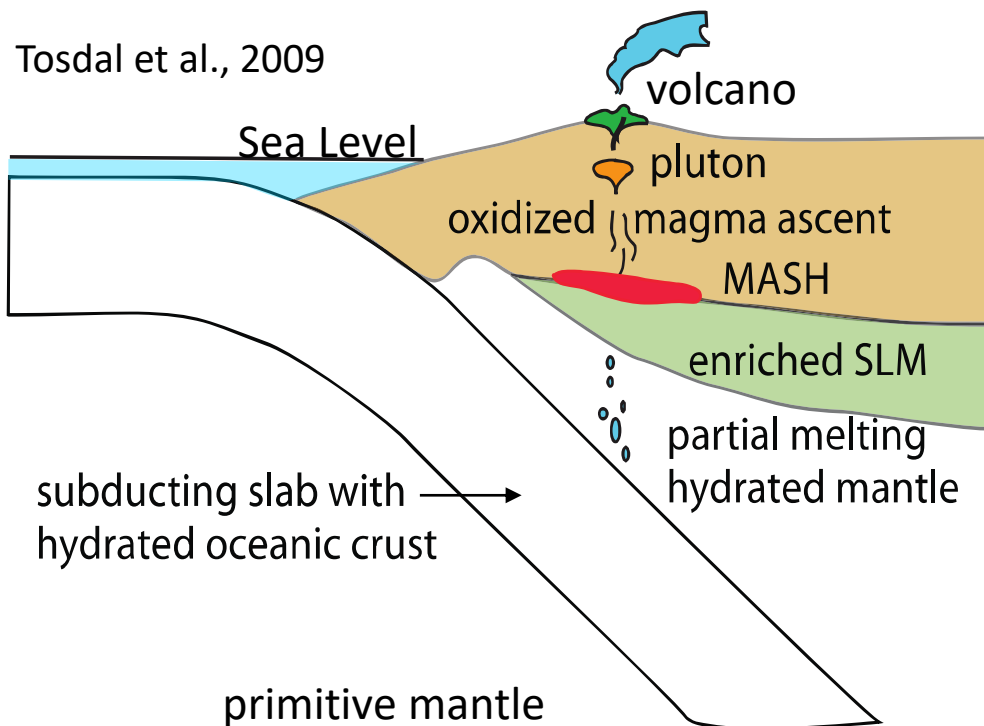
Calc-alkaline porphyry-epithermal system

Porphyry copper system of Sillitoe, 2010

Genetically related features

Arc, magnetite series, calc-alkaline volcano-plutonic center, magmatic fluid, alkali and hydrolytic metasomatism, and myriad deposit types.

Example: *Subduction-related* Calc-alkaline Porphyry-Epithermal System:

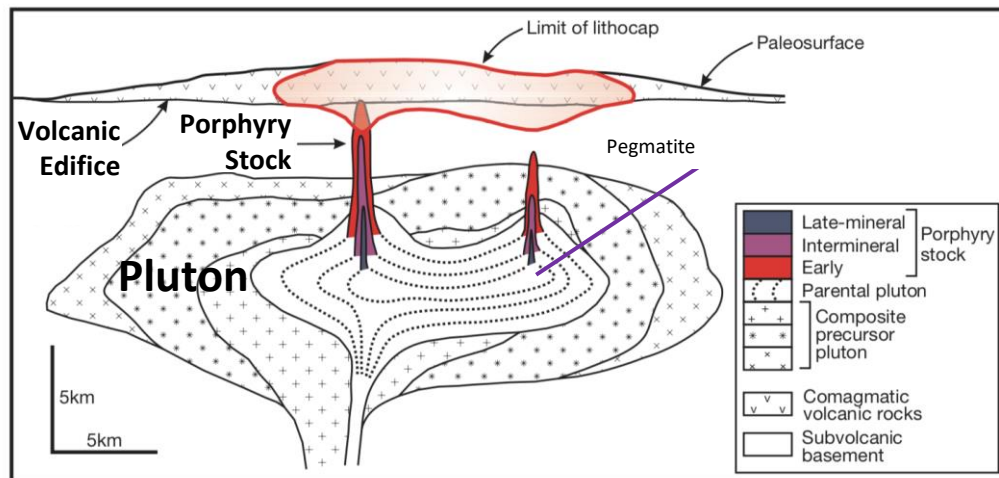


Preliminary information-subject to revision. Not for citation or distribution.

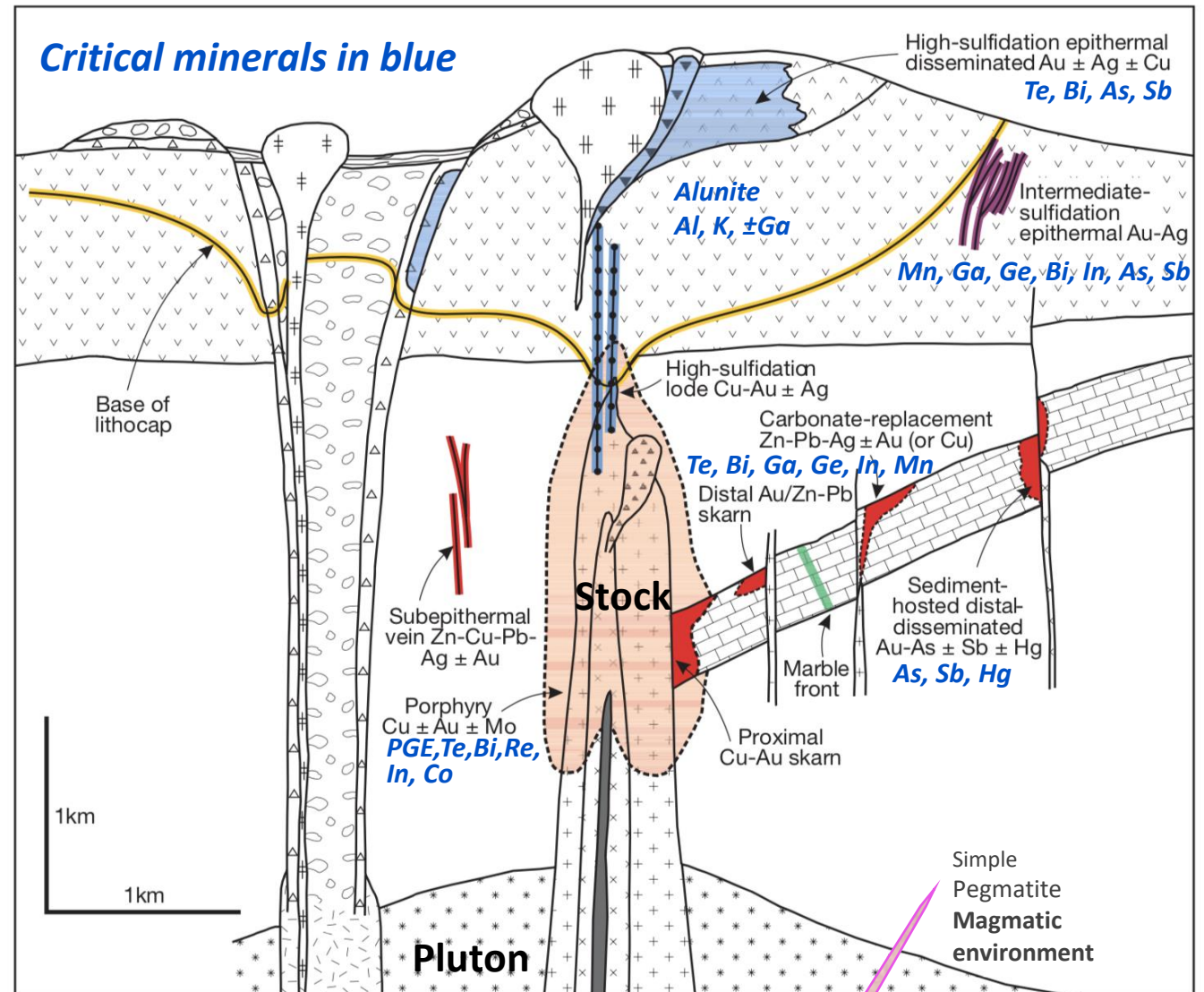
Calc-alkaline Porphyry-Epithermal System:

*Congenetic deposit types
(same time, same place)*

1 System type → many Deposit types
Magmatic hydrothermal environment



Trap part of the system



Adapted from Sillitoe, 2010

Preliminary information-subject to revision. Not for citation or distribution.

System types

Kreiner's working group on Tectonics and Mineral Systems

Placer	Marine Black Shale	Convergence-related mafic-ultramafic
Laterite	Marine Shelf	Plume-related mafic-ultramafic
Saprolite	Superior Fe	Mantle-derived alkaline
Meteoric Infiltration	Superior Mn	Carbonatite
Epithermal	Metamorphic	Alkaline-peralkaline
Lacustrine Redox	Orogenic gold	Alkaline porphyry-epithermal
Lacustrine Evaporite	Orogenic basemetal	A-type high-silica porphyry-epithermal
Marine Evaporite	Hydrogenetic Oceanic	Calc-alkaline porphyry-epithermal
MVT	Seafloor Hydrothermal	Carlin-type gold
Siliciclastic-Carbonate Basinal Brine	Ophiolite	Intrusion-related gold
Siliciclastic-Mafic Basinal Brine	Komatiite	Intrusion-related rare metal
Basin inversion	Impact-related	Metasomatic iron oxide alkali-calcic
Rift-Initiation Basinal Brine		
Epicontinental Basin-Basement Redox		

Deposit environment = *Ore-forming environment*

- Erosional
- Supergene
- Infiltrational
- Basin evaporative
- Basin chemical
- Basin hydrothermal
- Metamorphic
- Metamorphic hydrothermal
- Regional metasomatic
- Volcanic basin hydrothermal
- Magmatic hydrothermal
- Magmatic

Deposit group term = *Key attribute*

*Most of the deposit type names consist of a term that describes a key attribute that is preceded or followed by one or more commodities that are typically recovered from the ore, e.g. **orogenic** gold, **porphyry** copper, iron **skarn***

*In some cases, the deposit group term is preceded by a modifier that describes another characteristic that enables further discrimination, e.g. **epizonal orogenic** gold*

Deposit type naming format

Optional modifier + **Deposit group term** + **Commodity(s)**

Epizonal

Orogenic

Gold

Porphyry

Copper

Skarn

Iron

High sulfidation

Epithermal

Gold-silver

Carlin-type

Gold

Deposit Types form in System Types

Plume-related mafic-ultramafic system

- U-M layered intrusion Cr
- U-M layered intrusion Fe-Ti-V
- U-M layered intrusion PGE
- U-M layered intrusion Ni-Cu-PGE
- U-M intrusion Ni-Cu-PGE
- U-M conduit Ni-Cu-PGE

MVT system

- MVT zinc-lead
- Sandstone zinc-lead
- Non-sulfide zinc-lead \pm Mn
- MVT barite
- MVT strontium
- MVT fluorspar

Deposit Groups share a key attribute

Porphyry Group

- Porphyry Cu \pm Au
- Porphyry Cu-Mo
- Low-fluorine Porphyry Mo
- Climax-type Porphyry Mo
- Porphyry W
- Porphyry Sn

Epithermal Group

- LS Epithermal Au-Ag
- IS Epithermal Ag-Au
- HS Epithermal Ag-Au
- Alkalic Epithermal Au
- Epithermal Sb
- Epithermal Hg
- Epithermal Be
- Epithermal U

System Types operate in Deposit Environments

Magmatic environment

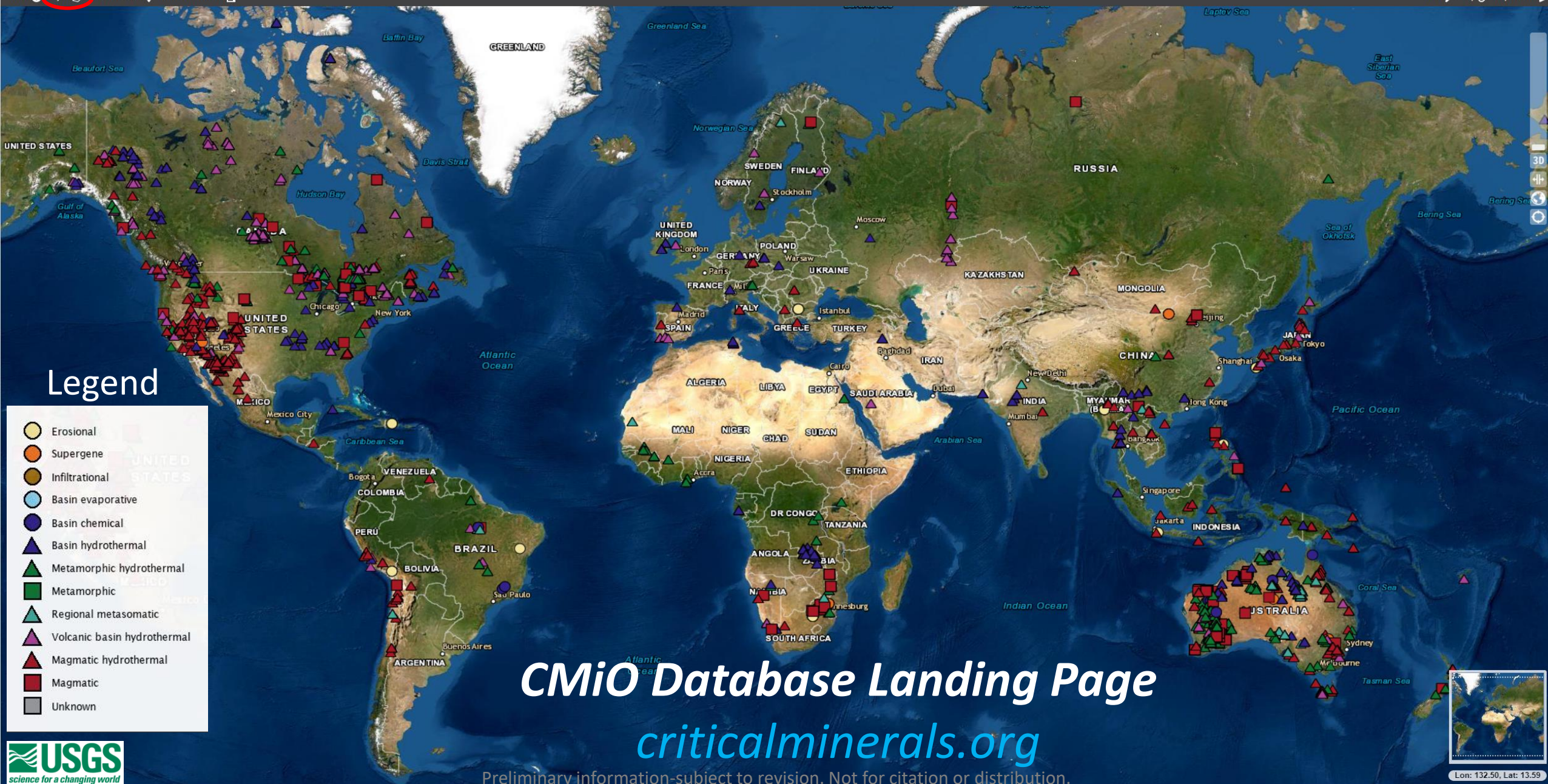
- Mantle-derived alkaline
- Carbonatite
- Alkaline-peralkaline
- Convergence-related mafic-ultramafic
- Ophiolite
- Plume-related mafic-ultramafic
- Komatiite
- Impact-related

Basin hydrothermal environment

- Rift-initiation basinal brine
- Siliciclastic-carbonate basinal brine
- Siliciclastic-mafic basinal brine
- Basin inversion
- MVT
- Epicontinental basin-basement redox



Deposit Environments



Legend

- Erosional
- Supergene
- Infiltrational
- Basin evaporative
- Basin chemical
- Basin hydrothermal
- Metamorphic hydrothermal
- Metamorphic
- Regional metasomatic
- Volcanic basin hydrothermal
- Magmatic hydrothermal
- Magmatic
- Unknown

CMiO Database Landing Page

criticalminerals.org

Preliminary information-subject to revision. Not for citation or distribution.



Deposit Environments



Layers ?

Base Layers >

Map Layers v

Search ...

Geochemistry v

Inorganic Geochemistry v

Critical Minerals - Deposits and Geochemistry -

About | Legend | **Filter (on)** | Fit Extent | Remove

Opacity 100%

Style **Critical Minerals - Deposit Environments** v

	Remove Filter	Include Null Values	Apply Filter
Deposit Name	4	Bingham Canyon	
Deposit Environment	1	Magmatic hydrothermal x	v
Deposit Group	2	Porphyry x	v
Deposit Type	3	Porphyry Cu	





Magmatic Hydrothermal Environment





Porphyry Group





Porphyry Cu Deposits







Bingham Canyon



About **Layers** Location Search Data & Publications

Layers ?

Base Layers >

Map Layers >

Search ...

Geochemistry >

Inorganic Geochemistry >

Critical Minerals - Deposits and Geochemistry

About | Legend | **Filter (on)** | Fit Extent | Remove

Opacity 100%

Style Critical Minerals - Deposit Environments

This layer delivers geochemical analyses of over 7000 samples collected from or near mineral deposits from 60 countries, compiled by the Critical Minerals Mapping Initiative (CMMI), a collaboration between Geoscience Australia (GA), the Geological Survey of Canada (GSC) and the United States Geological Survey (USGS). Data was compiled from a number of publicly-available sources, including federal and provincial government mineral deposit and geochemistry databases, and the ore samples normalised to average crustal abundance (OSNACA) database compiled by the Centre for Exploration Targeting at the University of Western Australia. Geochemical data cover the majority of the periodic table, with metadata on analytical methods and detection limits. Where available, sample descriptions include lithology, mineralogy, and host stratigraphic units. Mineral deposits are classified according to the CMMI mineral deposit classification scheme (Hofstra et al., 2021). Location information includes deposit or prospect name, and sampling location (i.e., mine, field site, or borehole collar). This dataset will be updated periodically as more data become available. Geoscience Australia: D Champion, O Raymond, D Huston, M Sexton, E Bastrakov, S van der Wielen, G Butcher, S Hawkins, J Lane, K Czamota, I Schroder, S McAlpine, A Britt Geological Survey of Canada: K Lauzière, C Lawley, M Gadd, J-L Pilote, A Haji Egeh, F Létourneau United States Geological Survey: M Granitto, A Hofstra, D Kreiner, P Emsbo, K Kelley, B Wang, G Case, G Graham Geological Survey of Queensland: V Lisitsin

Copy WMS Download Metadata

Mineral Occurrences and Resources >

3D Layers >

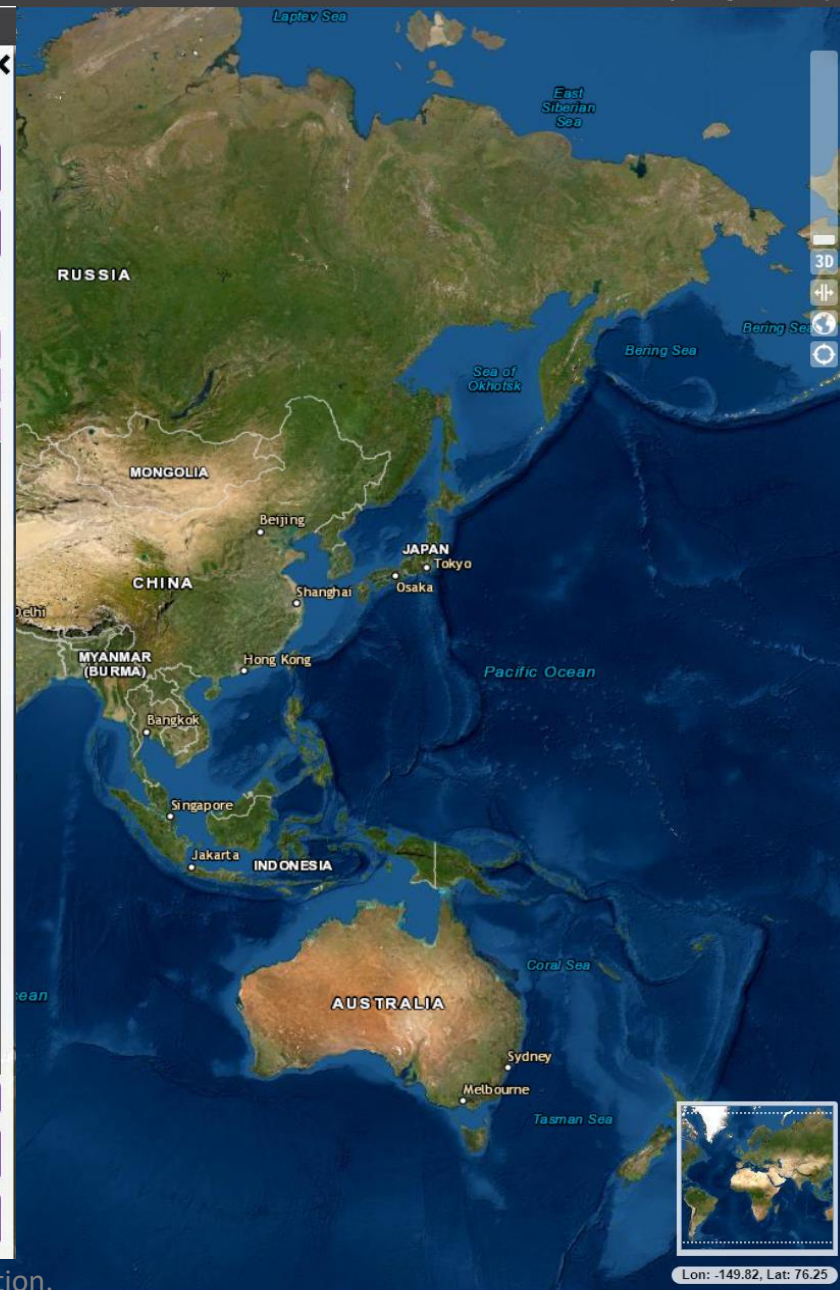
Custom Layers >

CSV

JSON

KML

Shapefile





Bingham Canyon



AutoSave Off BC Geochemistry table - Excel Search

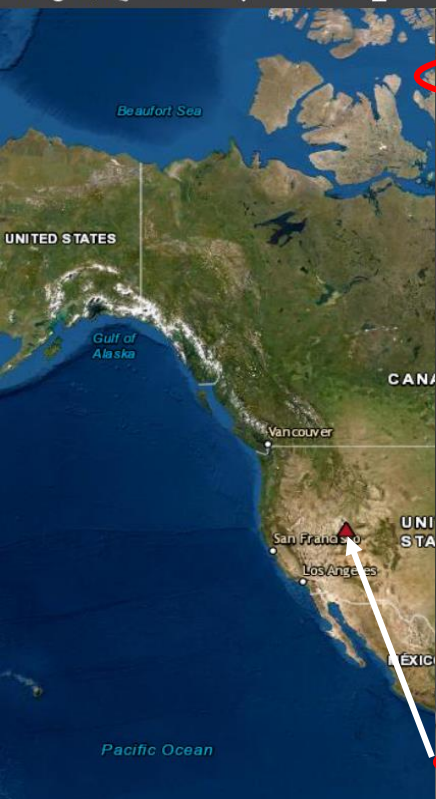
File Home Insert Page Layout Formulas Data Review View Help Nitro Pro

Default Keep Exit New Options Normal Page Break Preview Page Layout Custom Views Ruler Formula Bar Gridlines Headings Zoom 100% Zoom to Selection New Window Arrange All Freeze Panes Split Hide View Side by Side Synchronous Scrolling Reset Window Position Switch Windows Macros

A6	CriticalMineralDepositsGeochemistry.ga.399.7371814.ar								
	A	B	C	D	E	F	G	H	I
1	FID	deposit_uid	deposit_name	deposit_local_id	deposit_environment	deposit_group	deposit_type	primary_commodities	secondary_commodities
17	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.245	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
18	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.246	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
19	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.247	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
20	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.248	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
21	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.249	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
22	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.250	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
23	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.251	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
24	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.252	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
25	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.253	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
26	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.254	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
27	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.255	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
28	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.256	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
29	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.257	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
30	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.258	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
31	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.259	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
32	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.260	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
33	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.261	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
34	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.262	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
35	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.263	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
36	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.264	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
37	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.265	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
38	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.266	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
39	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.267	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
40	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.268	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
41	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.269	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
42	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.270	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
43	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.271	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
44	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.272	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
45	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.273	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
46	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.274	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
47	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.275	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc
48	CriticalMineralDepositsGeochemistry.USA.UT.UT00011.276	USA.UT.UT00011	Bingham Canyon	USA.UT.UT00011	Magmatic hydrothermal	Porphyry	Porphyry Cu ± Au	Cu, Au, Mo	Ag, Re, Pt, Ti, Te, U, Sc



Bingham Canyon



Inorganic Geochemistry

Layers

Critical Minerals - Deposits and Geochemistry

Styles

Critical Minerals - Deposit Environments

+ Filters

Legend

● Critical Minerals - Deposits and Geochemistry

Spatial Search Database Search Import CSV Data

Database Search

Deposit Name:

Bingham Canyon

Search Results

47 results (Page 1 of 5)

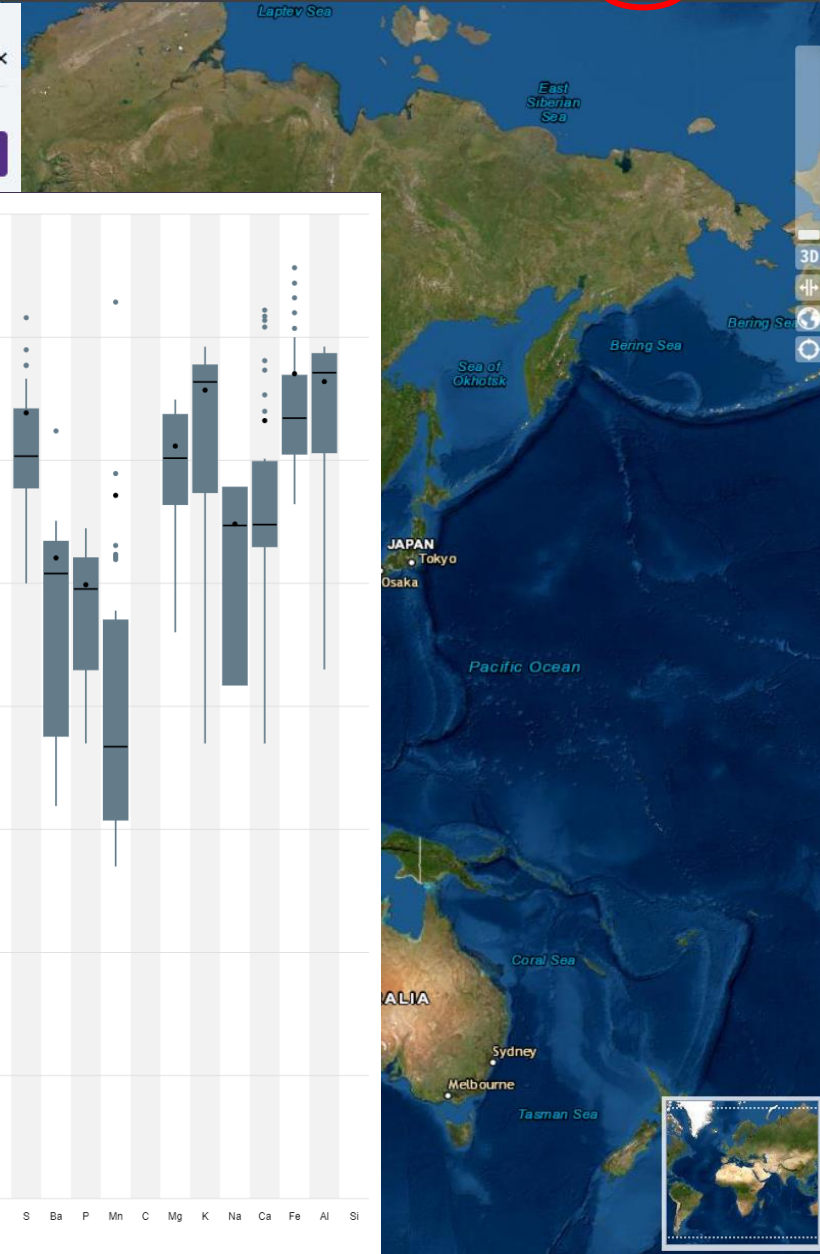
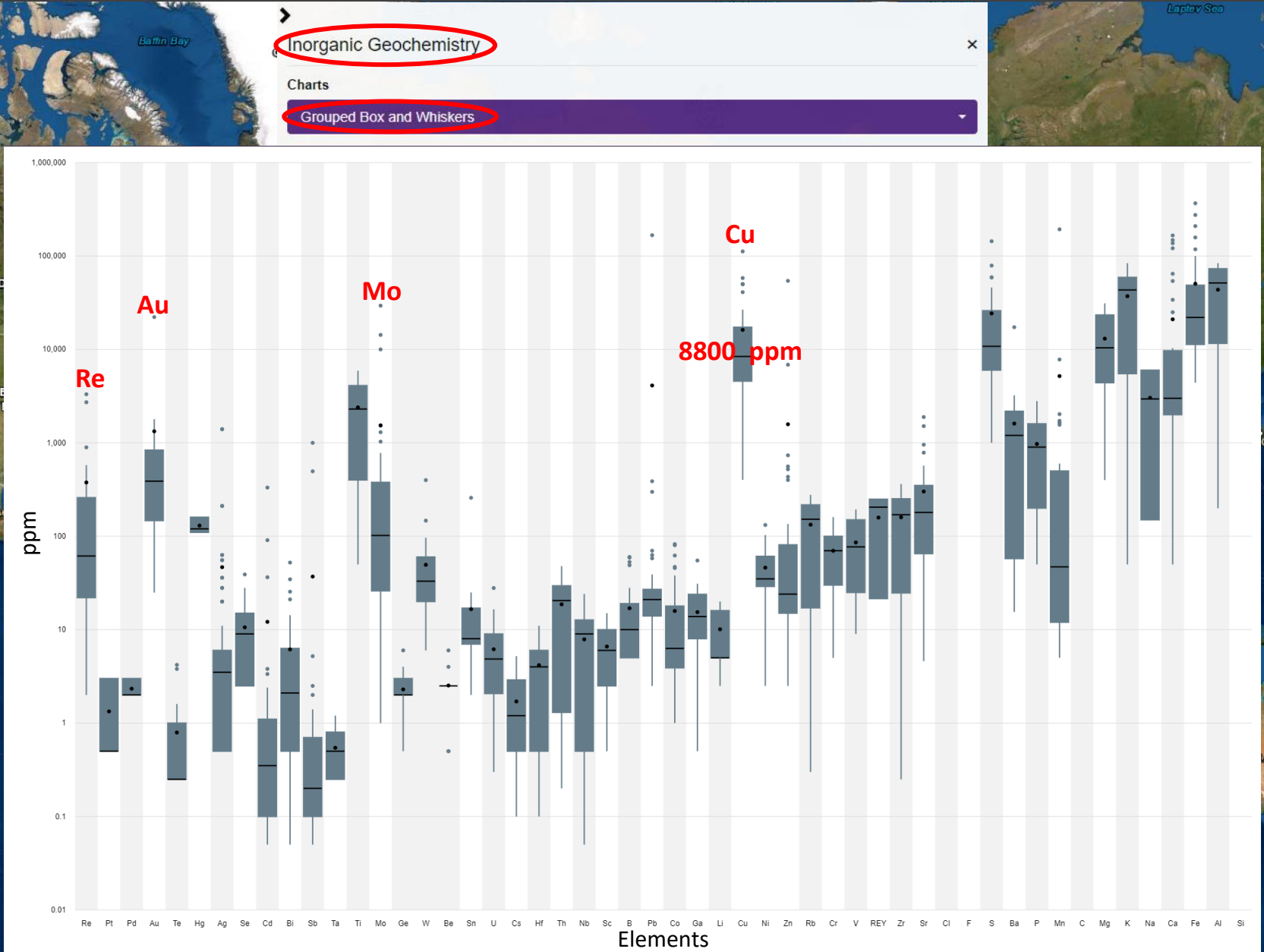
Entity Id	Sample Id	Sample Material	Strat Name	Deposit Name
AU.7371813	7371813	OSNACA_700038	mine sampling	Bingham Canyon
AU.7371813	7371813	OSNACA_700038	mine sampling	Bingham Canyon
AU.7371813	7371813	OSNACA_700038	mine sampling	Bingham Canyon
AU.7371814	7371814	OSNACA_700039	mine sampling	Bingham Canyon
AU.7371814	7371814	OSNACA_700039	mine sampling	Bingham Canyon
AU.7371814	7371814	OSNACA_700039	mine sampling	Bingham Canyon
AU.7371815	7371815	OSNACA_700040	mine sampling	Bingham Canyon
AU.7371815	7371815	OSNACA_700040	mine sampling	Bingham Canyon
AU.7371815	7371815	OSNACA_700040	mine sampling	Bingham Canyon
US.C360786	C360786	RM0054	unknown	Bingham Canyon

First Previous 1 2 3 4 5 Next Last

View Statistics Plot Graphs



Bingham Canyon



Estimated Critical Mineral Endowment of Bingham Canyon

$$[\text{Critical Mineral} / \text{Primary commodity}] \times \text{Primary commodity t} = \text{Critical Mineral t}$$

Pri. Com.	=	Cu 28,500,000 t *	<i>production + resource</i>
		Ti 10,880,342 t *	<i>small amount produced</i>
		W 133,162 t	<i>none</i>
		Sc 24,359 t *	<i>small amount produced</i>
		U 13,121 t *	<i>550 t produced in 1978-1979</i>
		Bi 3,573 t	<i>small amount produced</i>
		Te 812 t *	<i>new plant will produce 20 t/yr</i>
		Re 714 t	<i>small amount produced</i>
		Sb 650 t	<i>none</i>
		In 325 t *	<i>none</i>
		Pt+Pd 32.6 t *	<i>small amount produced</i>

*Energy
Transition

Utility of Critical Mineral/Primary Commodity Ratios

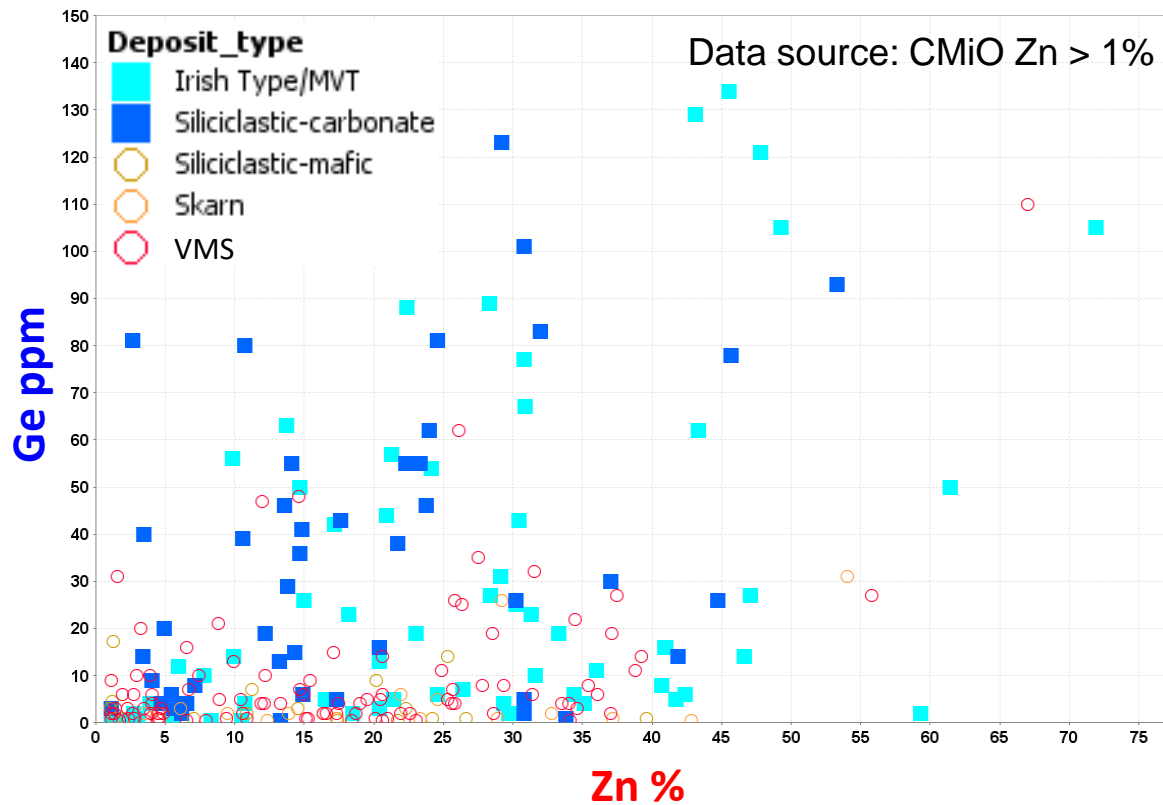
CM/PC in ore x tonnes **PC** in deposit = tonnes **CM** in deposit

Tonnes PC Production: Estimate tonnes **CM** in processed waste
\$ value, Recoverability, Waste as a resource?

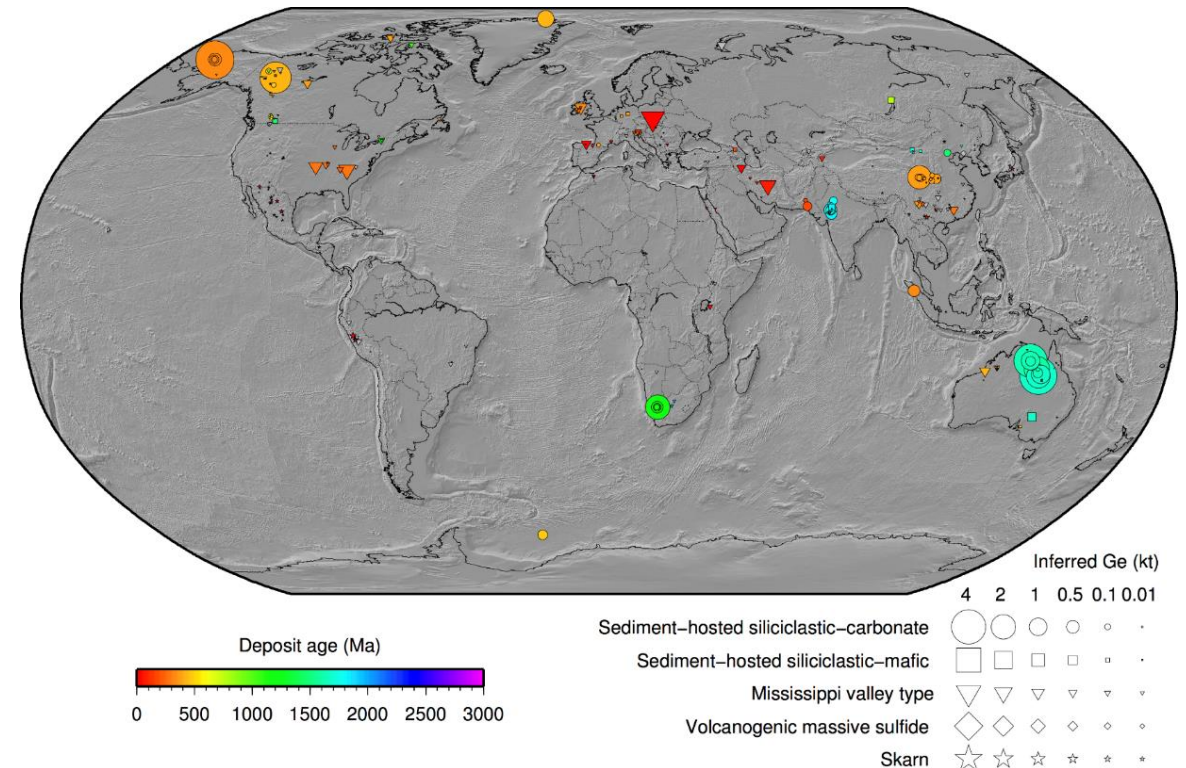
Tonnes PC Resource: Estimate tonnes **CM** future(?) production
\$ value, Recoverability, Incentives?

CM resource maps

Utility of CM/PC ratios: Estimate tonnes of Ge in 5 different Zn deposit types



Ge Resource Map



Results indicative only and require confirmation

From Huston et al., 2021 CMMI Forum

Preliminary information-subject to revision. Not for citation or distribution.

Uses of the CMiO Database: Identify Data Gaps

Deposit environment (12) *data for 10*

2 no data, 1 <5 analyses

Deposit group (52) *data for 42*

10 no data, 7 with < 5 analyses

Deposit type (189) *data for 102*

87 no data, 49 with < 5 analyses

We need more data from CMMI and other sources!

Uses of the CMiO Database

Document the critical mineral signatures of each deposit type.

Improve deposit classifications and Focus exploration

Identify individual systems/deposits that are unusually enriched in critical minerals.

Research to explain why

Compare critical mineral abundances in different deposit types

Mineralogy, Recoverability

Calculate the dollar value of critical minerals in ore.

Foster recovery

Place critical minerals in a systems framework

Resource assessments

Conclusion

By combining forces to fill the knowledge gap on the abundance of critical minerals in ores, classifying the geochemical data by deposit type, and serving it to the public, geochemists and economic geologists now have a powerful tool to address current and future critical mineral resource problems.