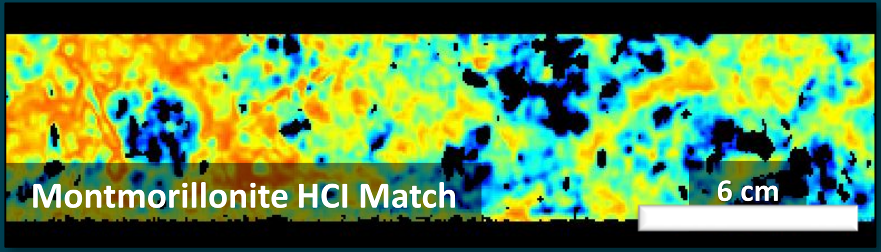
Procemin·GEOMET 2019

15th International Mineral Processing Conference
6th International Seminar on Geometallurgy

Geometallurgical Considerations: Processing Mineralogy vs Alteration Footprints



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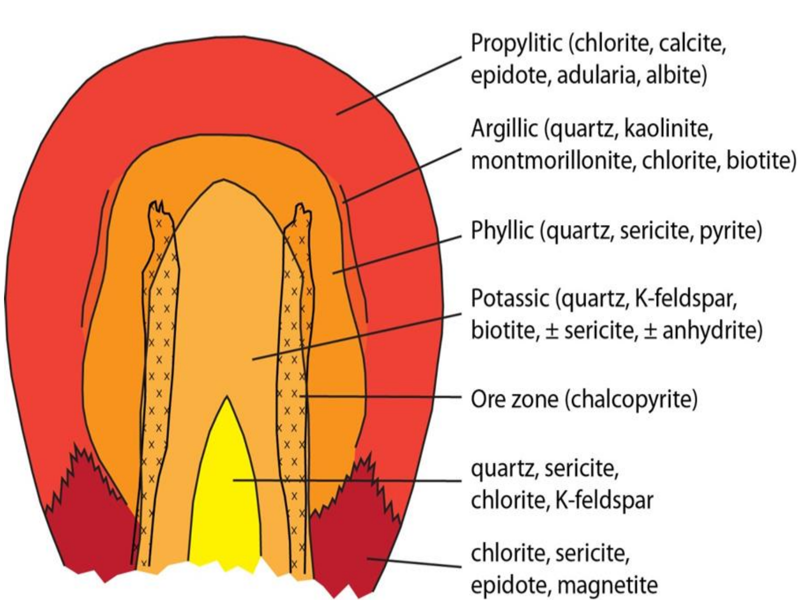
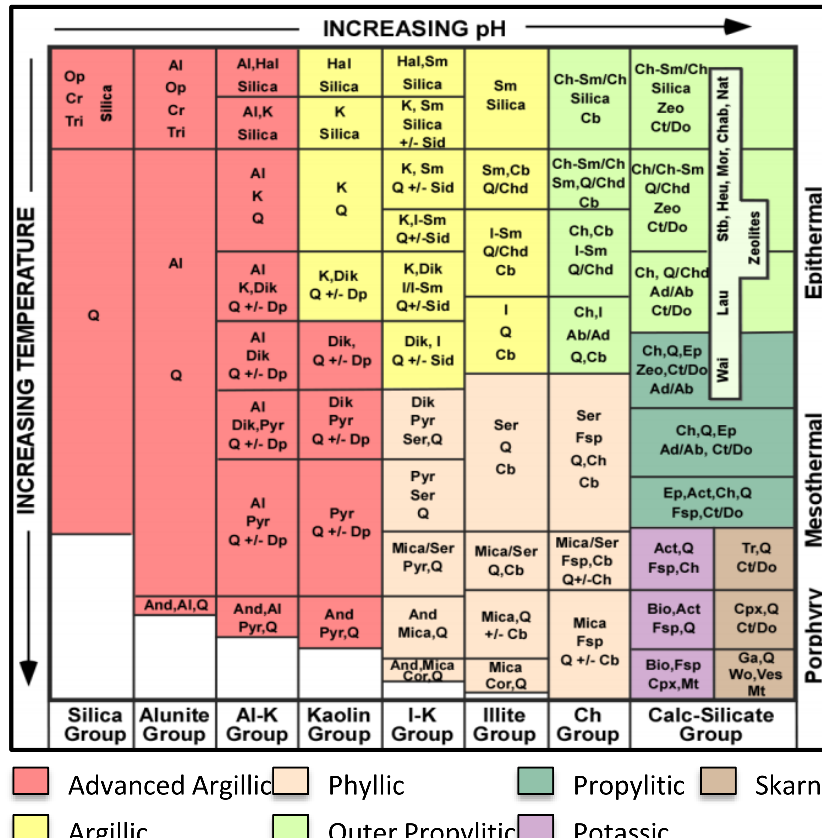
Geological Alteration Mineralogy

- Mineralogy provides temp-pH information that can be used to guide explorers
- Example: porphyry copper



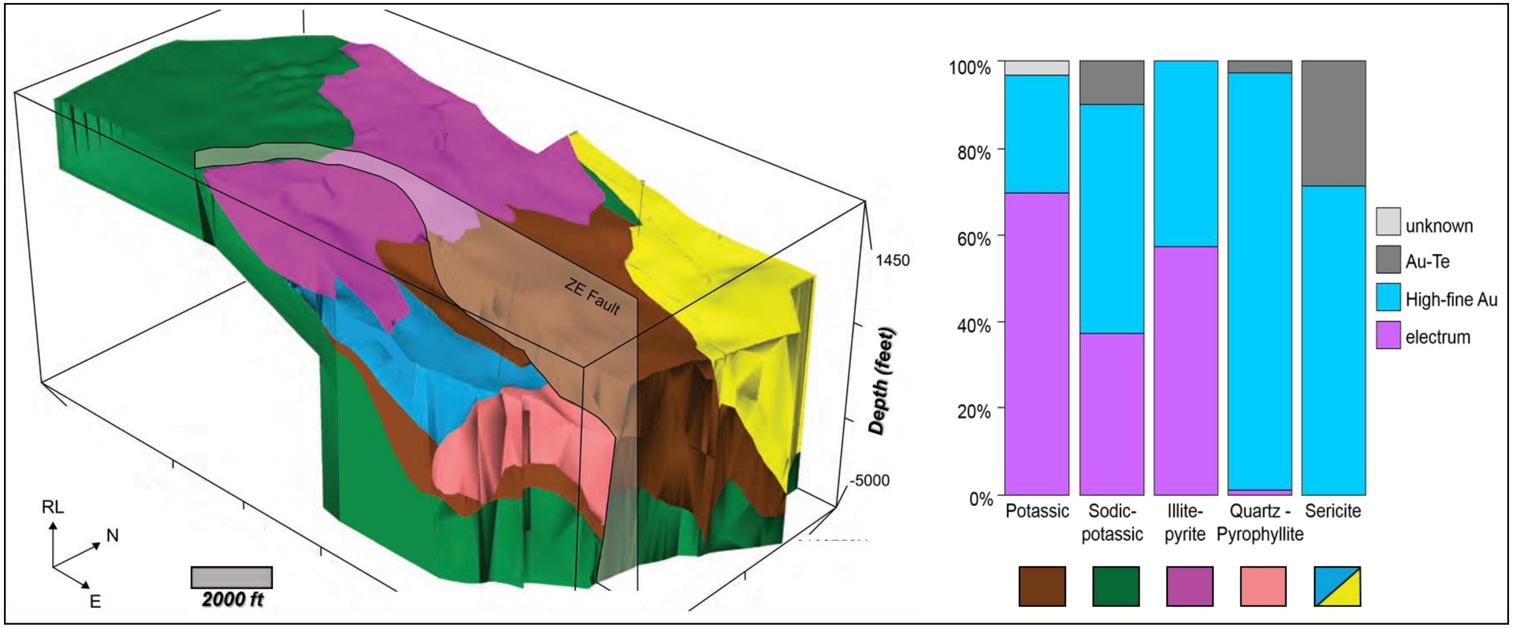
(from Lowell and Guilbert, 1970)



(from Leach, 1995)

Geometallurgical Mineralogy

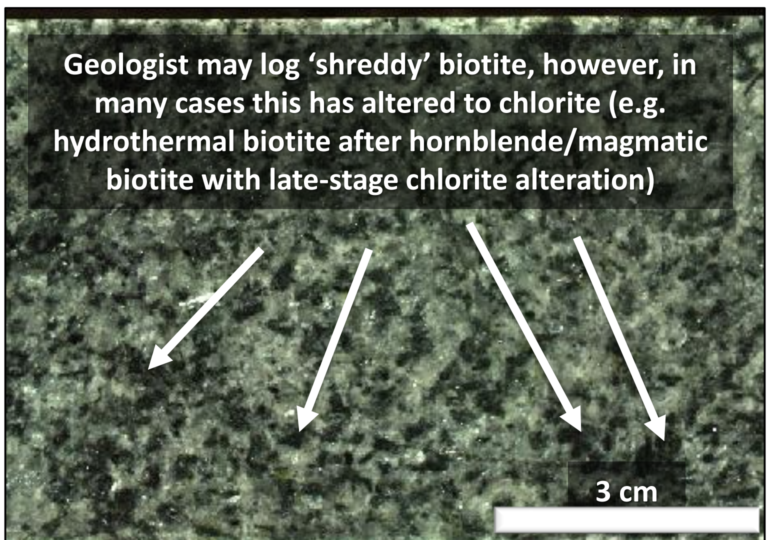
- Represent variability of an ore deposit by correlating geology and mineralogy with metallurgical testwork data
- Identify minerals present and model how mineralogy relates to processing behavior (e.g. comminution, deportment, etc.)

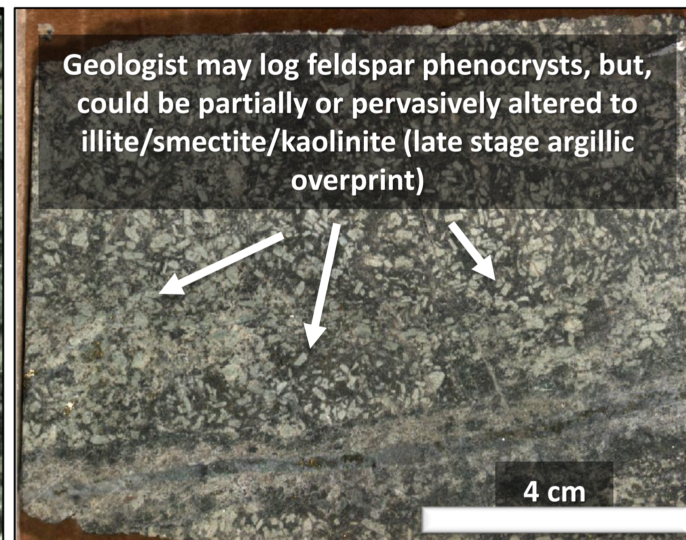


(from Gregory et al., 2013 and Harraden et al., 2013)

Geology vs Geometallurgical Models

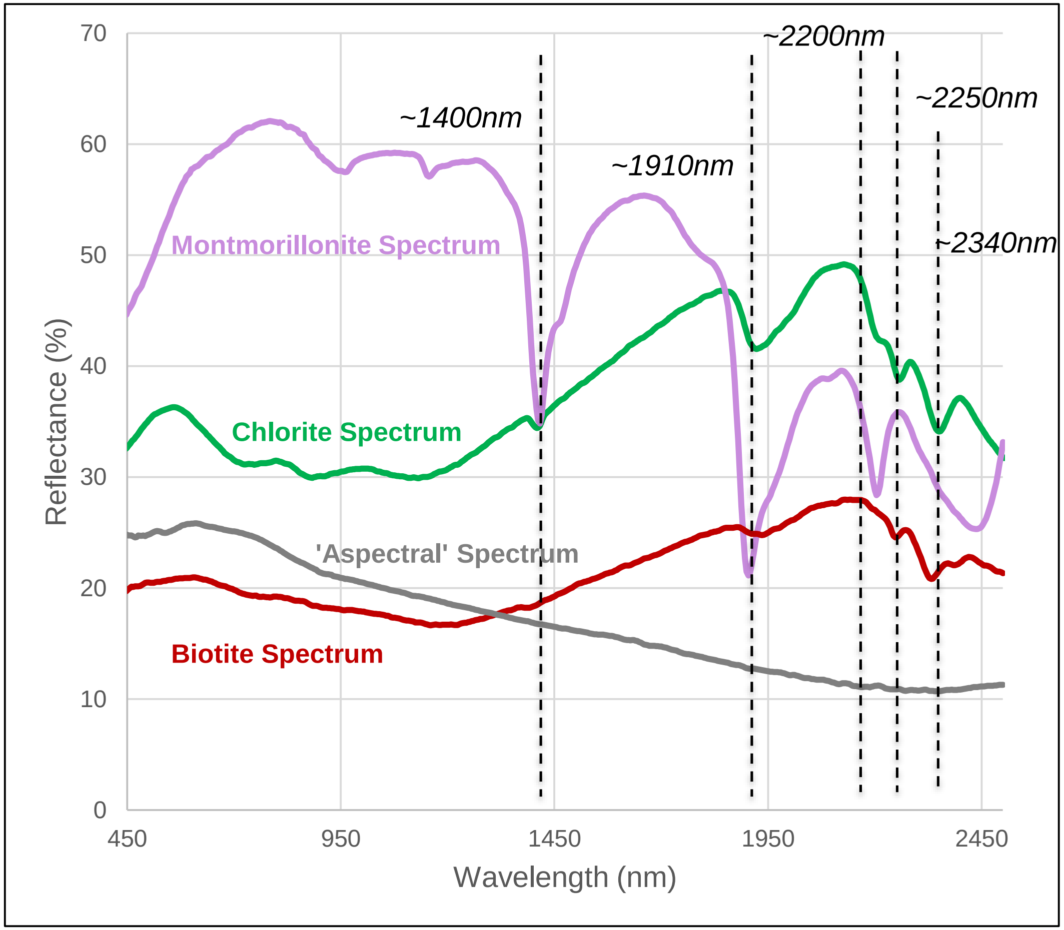
- Both primarily focused on distribution of clay minerals, but different types of information necessary for exploration vs mineral processing
- Geomet models consider mineralogy and processing behavior





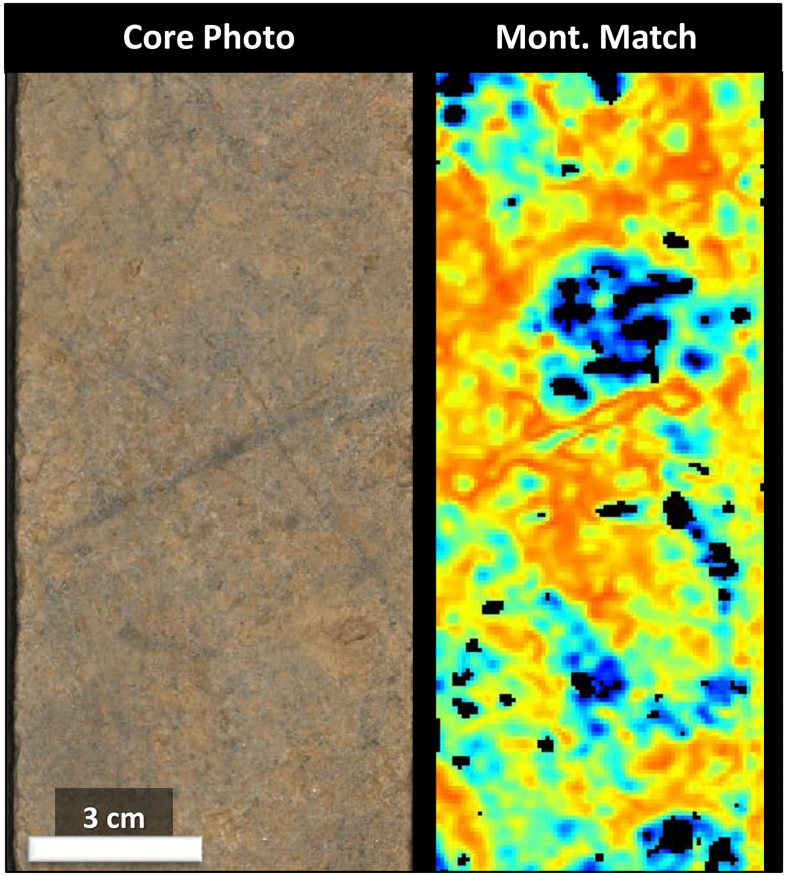
Mineral Mapping by VNIR-SWIR

- Montmorillonite, chlorite, and biotite are easily distinguished by VNIR-SWIR hyperspectral analysis
- Quartz and feldspar have no diagnostic absorption features in the SWIR – lack of features can be tracked as a separate mineral category ('aspectral')



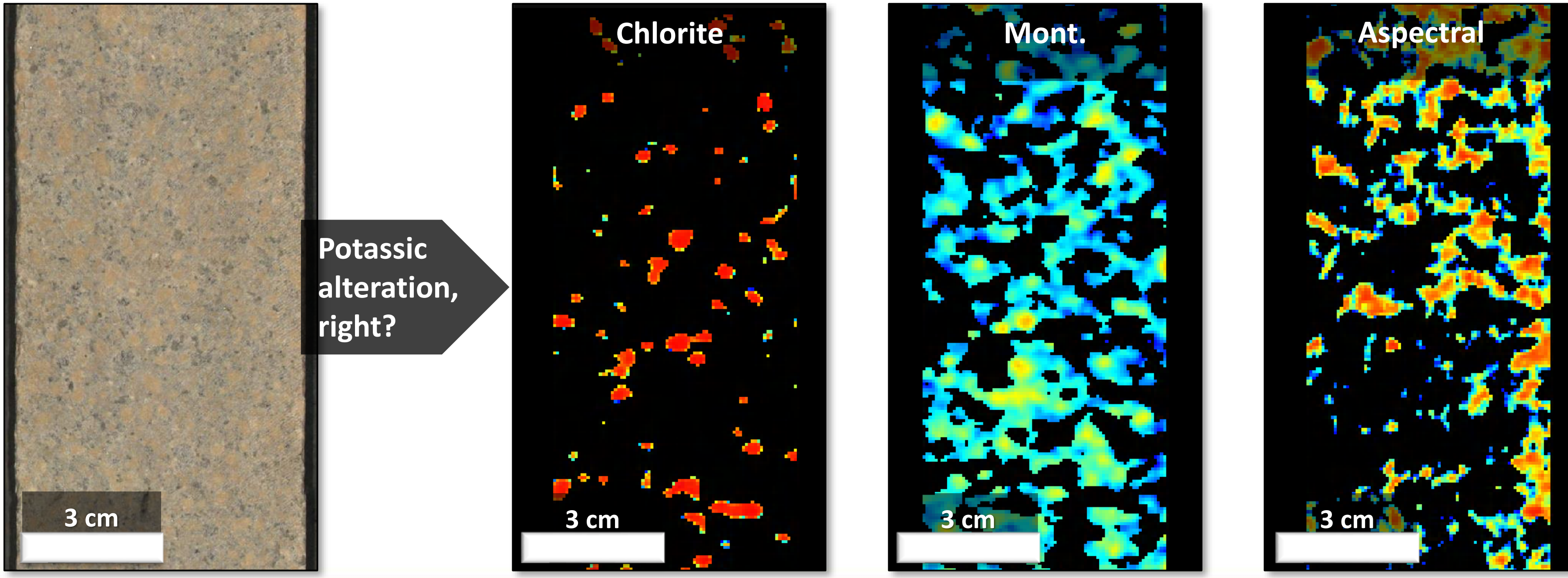
Case Study: Chilean Porphyry

- ~8,500 meters of hyperspectral data from an operating Chilean porphyry copper deposit
- VNIR – SWIR spectra collected at 500 µm pixel resolution
- ~200,000 pixels per meter of drillcore
- VNIR – SWIR advantages:
  - ability to see minerals not obvious or distinguishable visually
  - increased sampling statistics

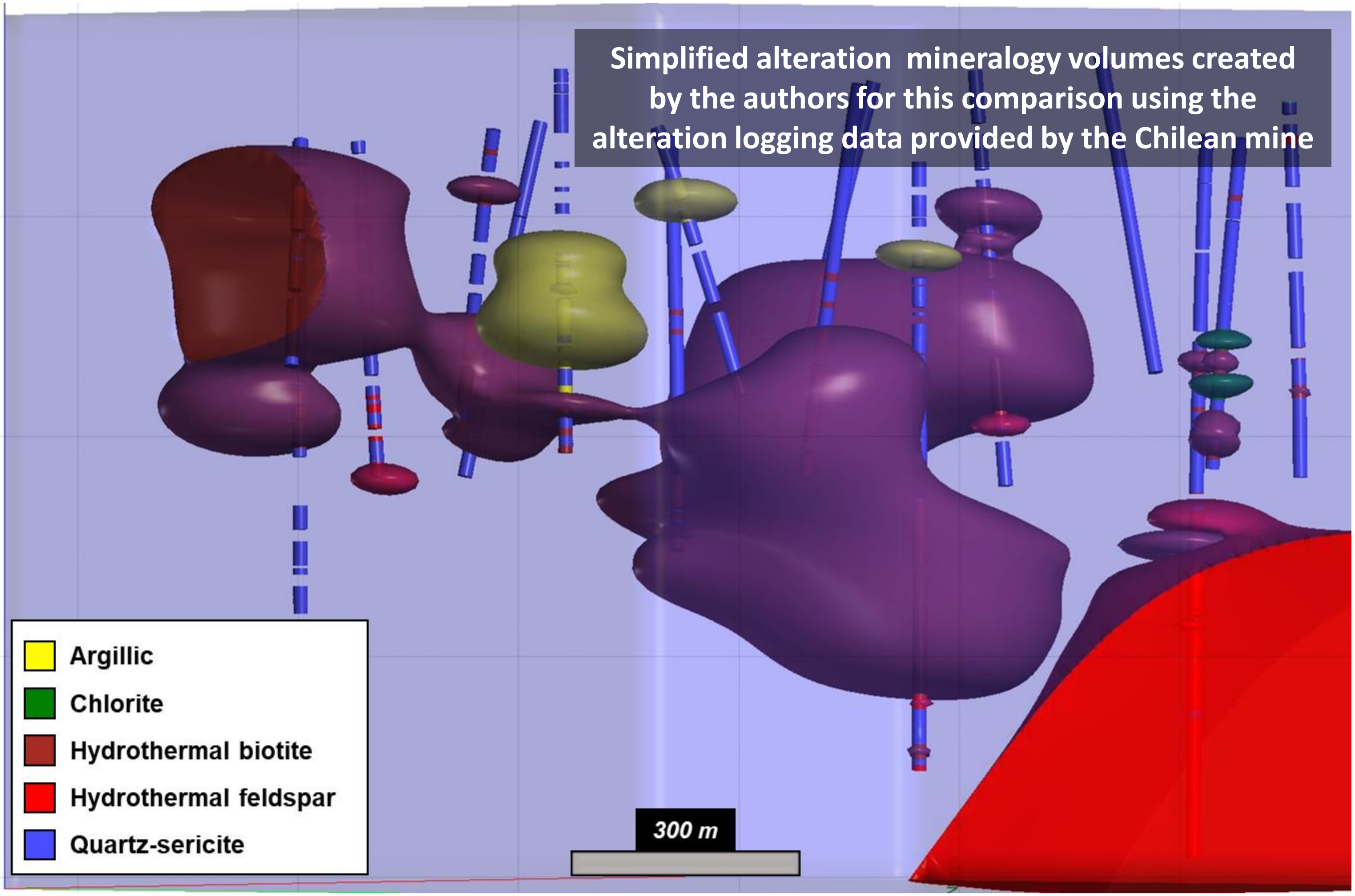


Case Study: Methods

- Compared distribution of mineralogy in the deposit using:
  1. geological alteration mineralogy as logged on site
  2. mineralogy detected by hyperspectral core imaging

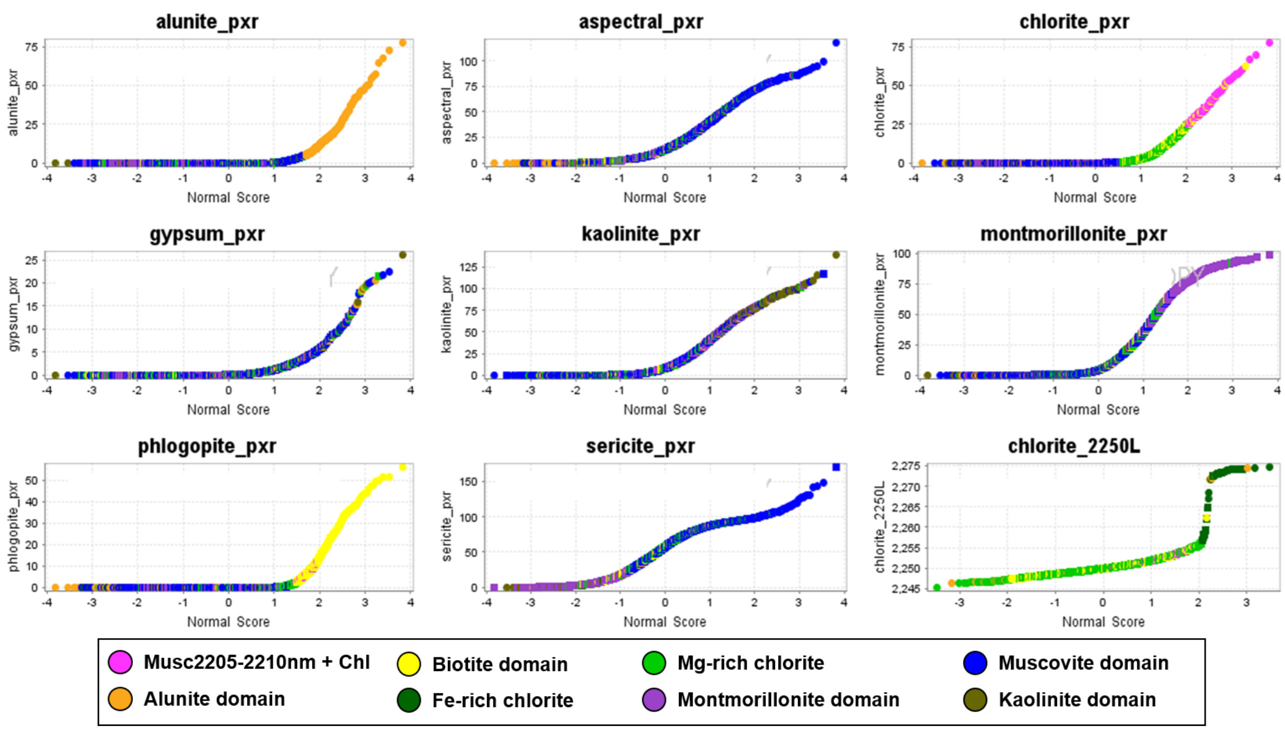


Geological Alteration Mineralogy



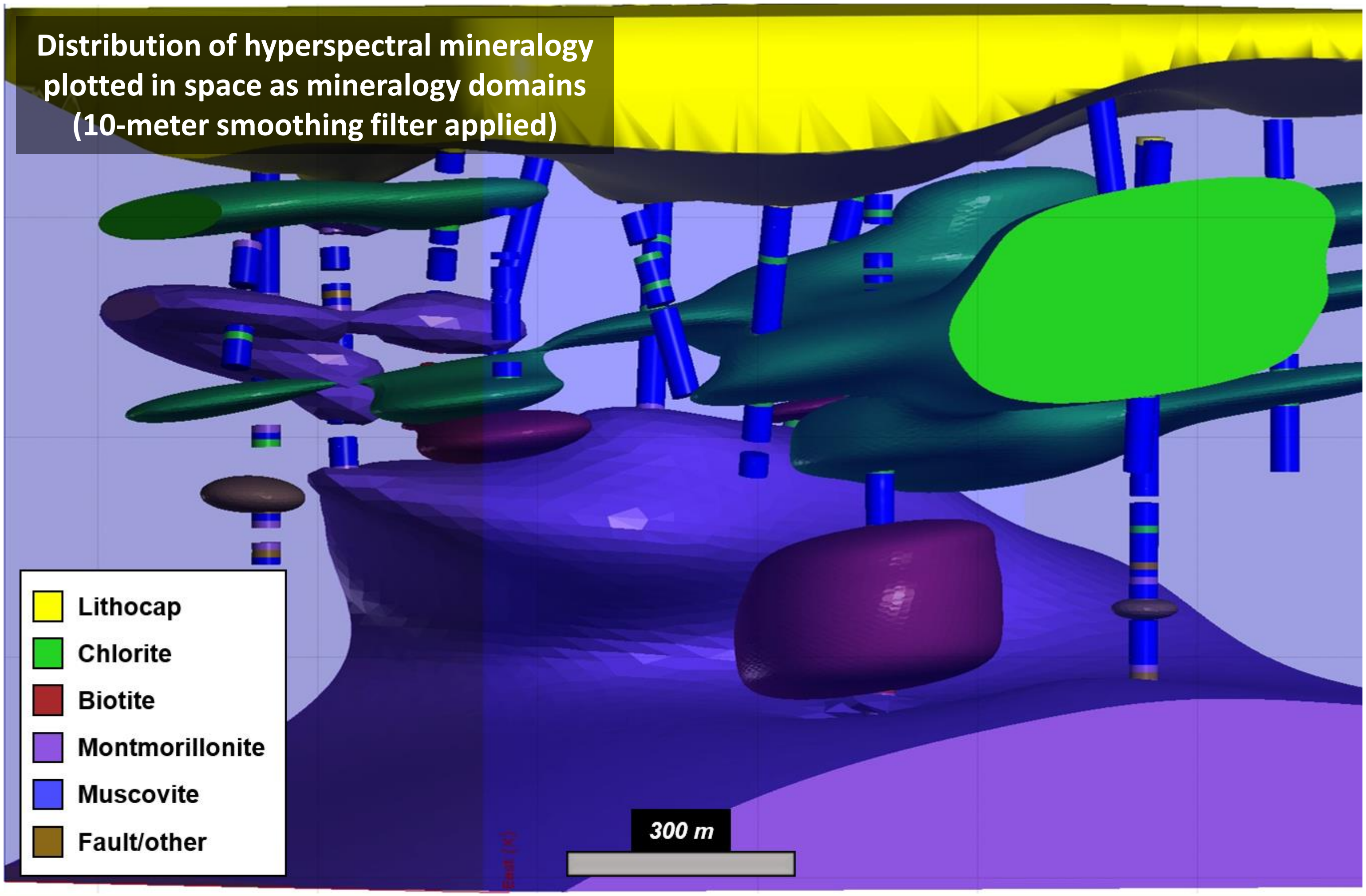
Hyperspectral Mineralogy

- Statistical approach to define mineral predominance domains
- Domains defined by presence of a mineral >20%*: biotite, chlorite, alunite, kaolinite, montmorillonite, and muscovite



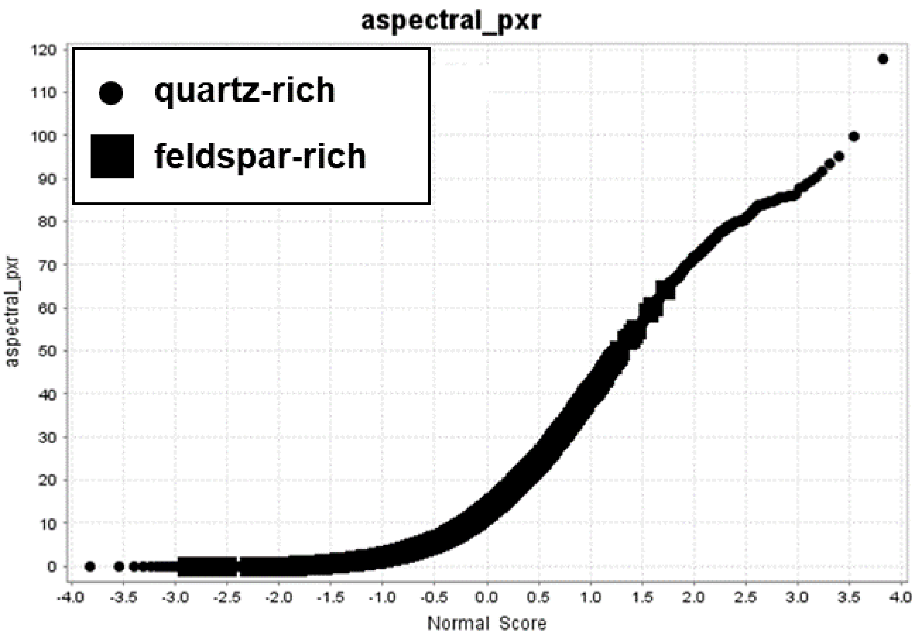
*semi-quantitative, surface analysis of IR-active minerals

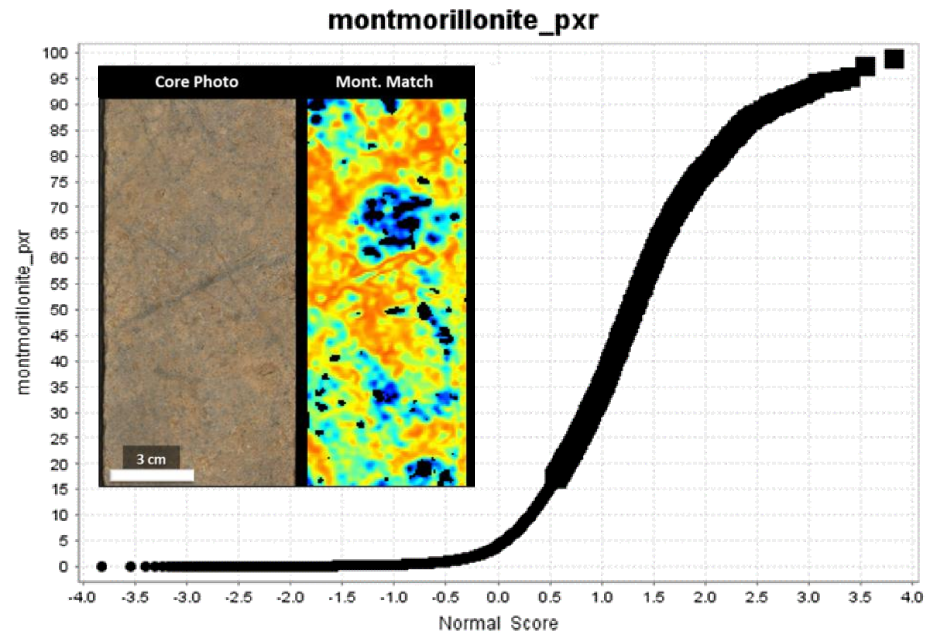
Hyperspectral Mineralogy



Hyperspectral Mineralogy

- Montmorillonite-bearing (>15%*) samples selected
- Variations in abundance of aspectral mineral class used to further subdivide into feldspar-rich and quartz-rich domains





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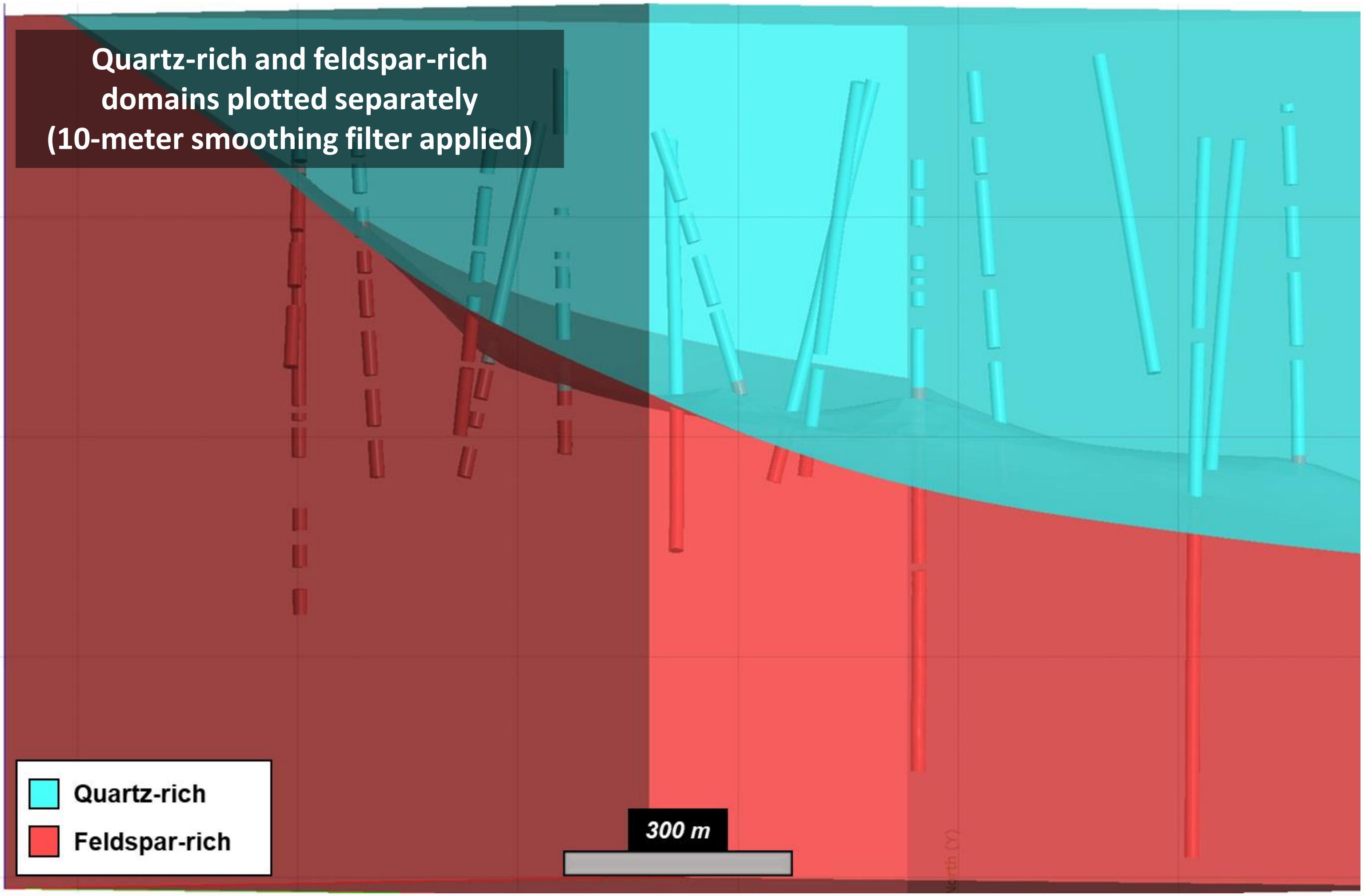
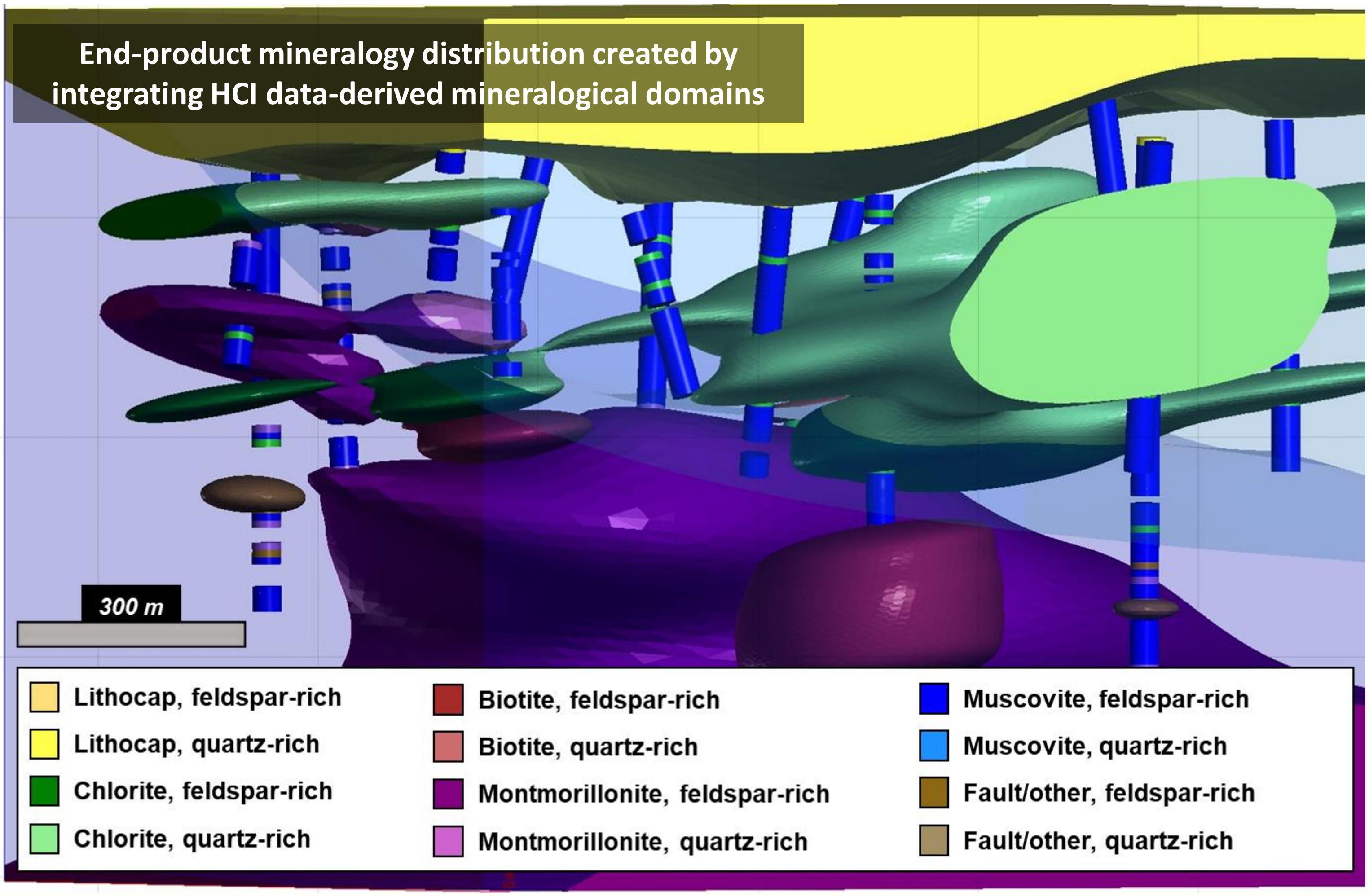
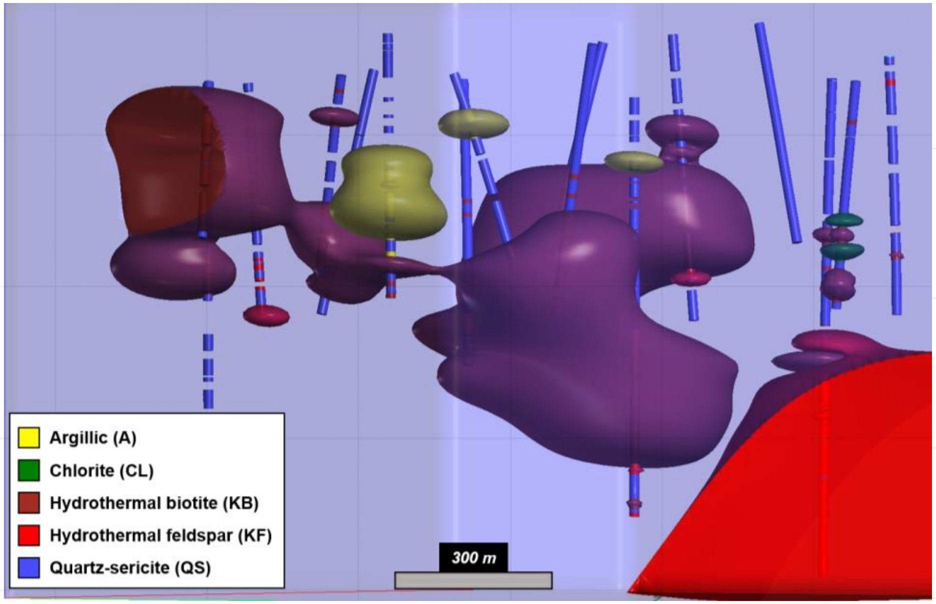
Hyperspectral Mineralogy

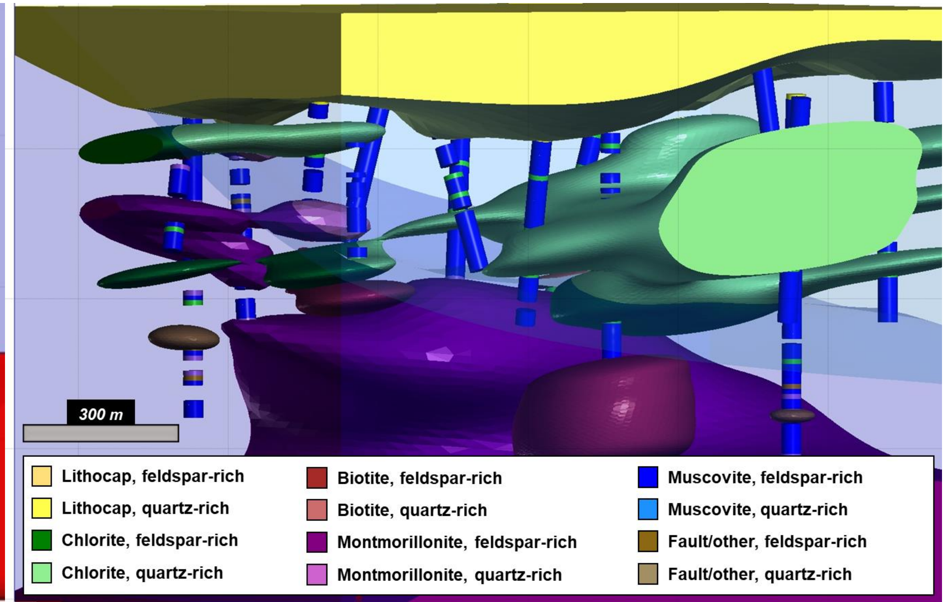


Integrated Hyperspectral Mineralogy



Geological vs Integrated Hyperspectral





Primary differences:

1. strong reliance on textures (i.e. hydrothermal biotite and feldspar) in the geological domains compared to HCI detection of present mineralogy

2. geological volumes successfully map the distribution of large concentrations of these minerals, but the overall underestimates the presence of post-ore deposition minerals

Geological vs Integrated Hyperspectral

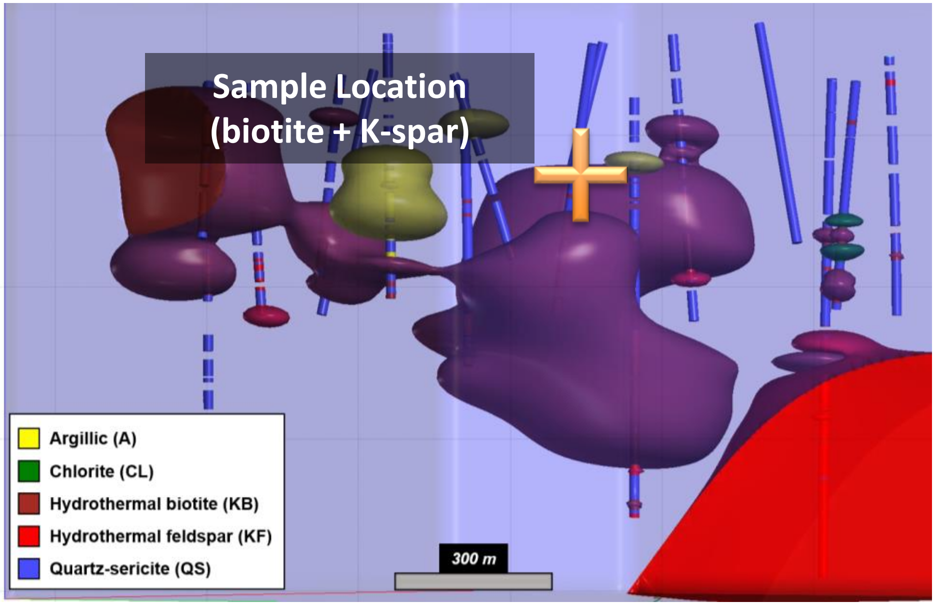
- Inherent complexities to a direct comparison, but illustrates relative differences (upwards of 200%) of a volume that identifies geologically relevant mineralogy and one that attempts to map domains containing the mineralogy present
- Integrated HCI mineralogy volume accounts for metallurgically important mineralogy (e.g. chlorite and montmorillonite can increase reagent consumption and change flotation viscosity, affecting recovery)

Alteration Logged on Site	HCI Mineral Assemblage	Geological Model Vol.*	Mineralogy Model Vol.*	Rel. Difference (%)
Argillic	Lithocap	6,192.8	319,560.0	98%
Chlorite	Chlorite	219.8	135,670.0	100%
Biotite	Biotite	131,980.0	38,751.0	241%
K-feldspar	Montmorillonite	186,170.0	690,310.0	73%
Quartz-sericite	Muscovite	2,326,100.0	1,465,400.0	59%
Not included	Fault/other	-	960.8	100%

*km^3

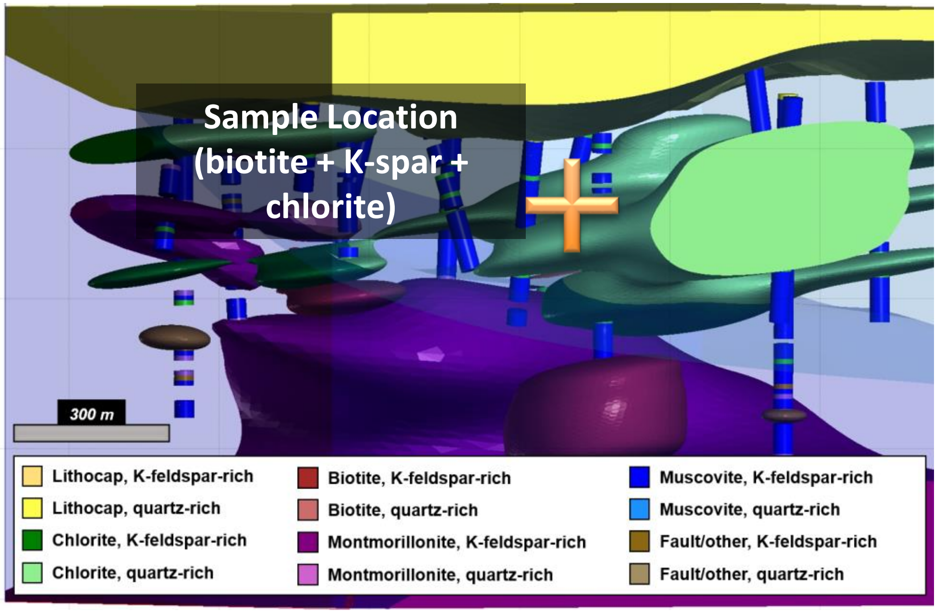
Geological vs Integrated Hyperspectral

- If testwork samples are selected using the geological mineralogy alone, feldspar and biotite represent dominant mineralogy



Geological vs Integrated Hyperspectral

- If testwork samples are selected using the geological mineralogy alone, feldspar and biotite represent dominant mineralogy
- Hyperspectral domaining better captures present-day mineralogical variability of the deposit
  – Integrated hyperspectral domains map distribution of chlorite, muscovite, and montmorillonite



Conclusions

Current, physical mineralogy is critical for accurately determining processing response and can be assisted by hyperspectral methods

Integrated, fit-for-purpose mineralogical data is key to developing successful geometallurgical models and testwork programs

By integrating physical mineralogy with geological alteration information, geometallurgical models will better capture deposit variability

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Muchas Gracias!

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