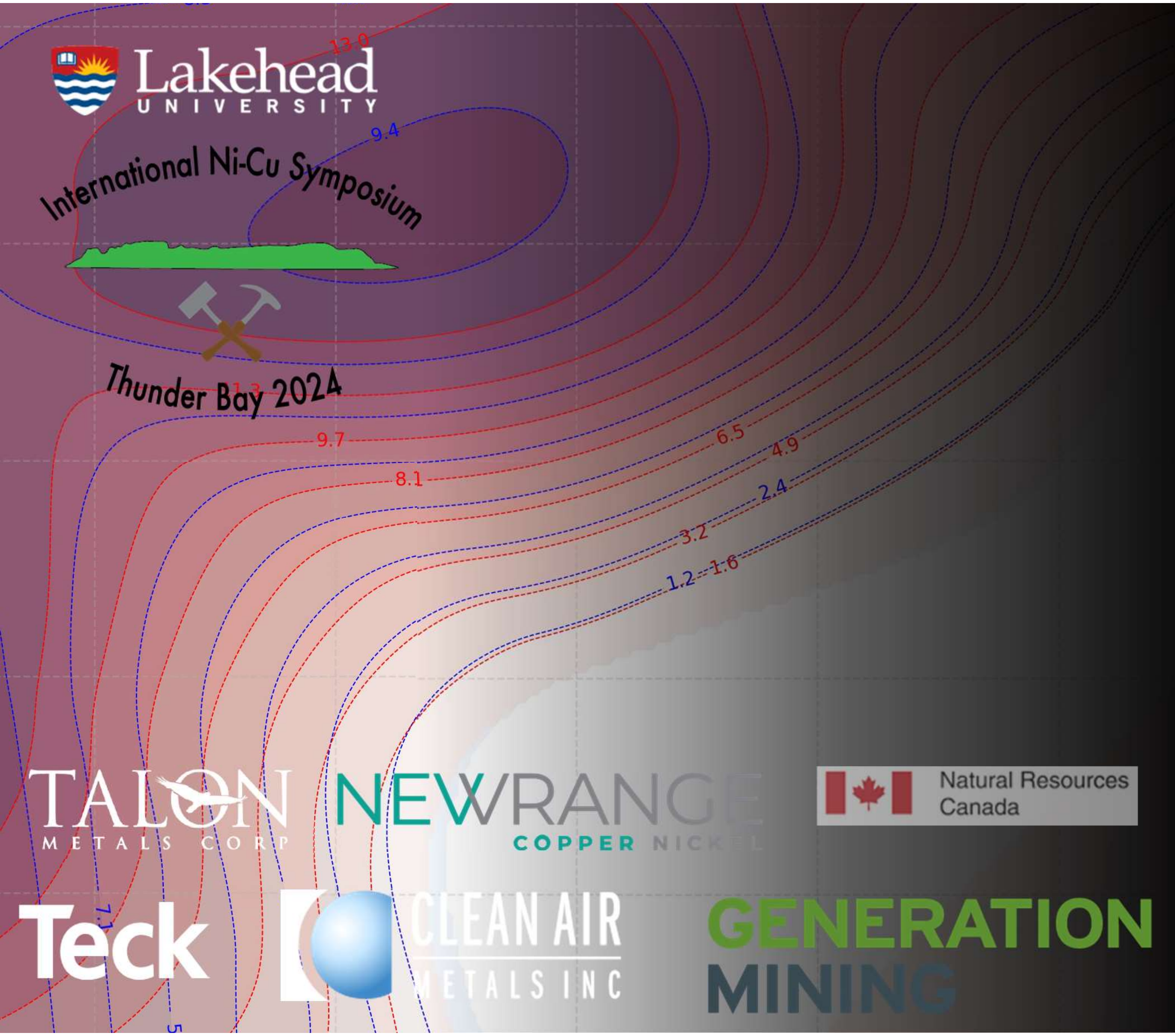

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Thermodynamic constraints on the generation of cubanite-rich magmatic sulfides

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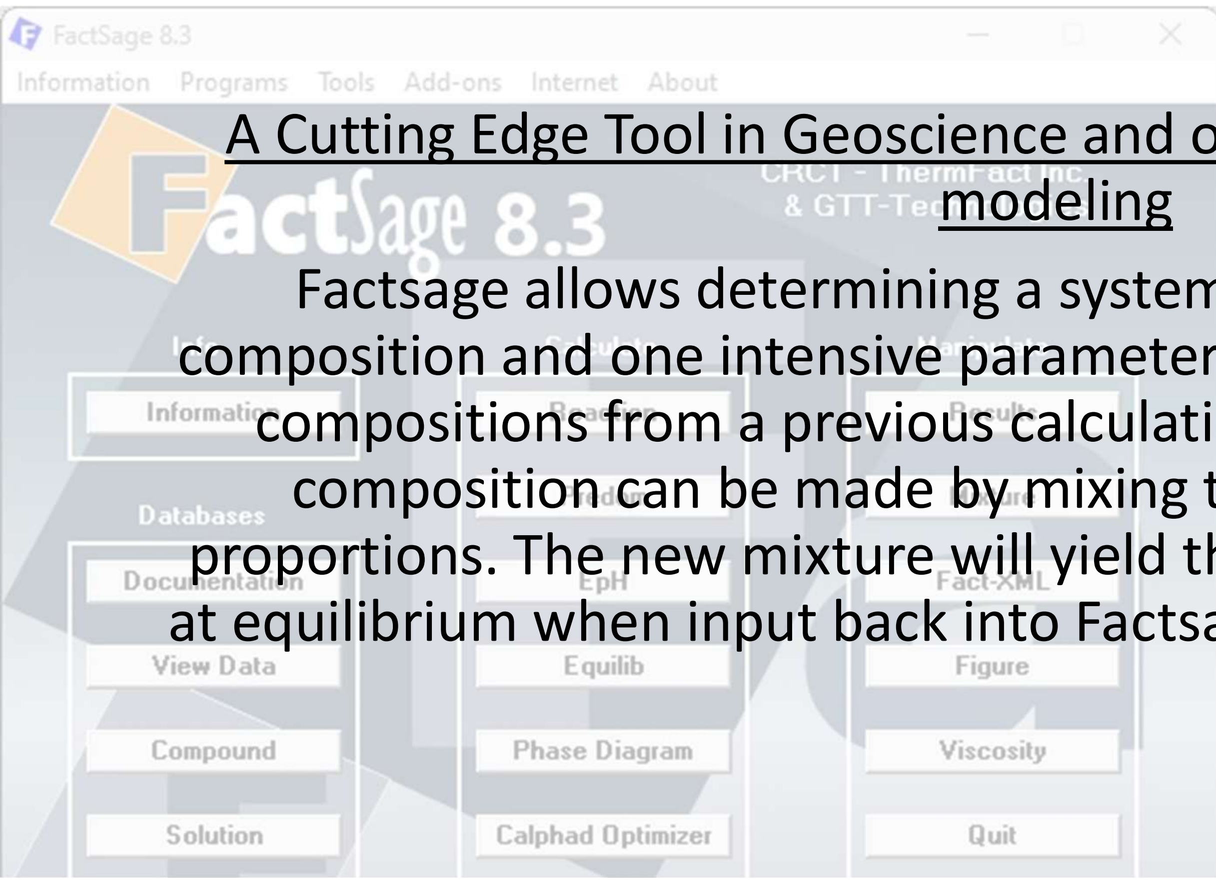
Introduction and Statement of the Problem:

- Nickel (Ni) and Copper (Cu) are important for the green transition, but their extraction is challenging in the presence of cubanite.
- Cubanite separates slowly in flotation circuits, making circuit optimization necessary.
- Cubanite is common in Ni-Cu deposits from the MCR, so identifying the cubanite-bearing geometallurgical domains in these deposits is essential, and this is currently being done through petrography.
- What if we could pinpoint cubanite rich zones without costly petrographic analyses? That’s where thermodynamic models come in, offering a pathway to more efficient extraction

Research question

- What are the specific magmatic conditions that lead to the formation of cubanite, and how does its ratio to chalcopyrite and other sulfide phases vary under these conditions?

Tools



<u>A Cutting Edge Tool in Geoscience and our tool for thermodynamic modeling</u>

Factsage allows determining a system's state by defining bulk composition and one intensive parameter (e.g., temperature). If phase compositions from a previous calculation are known, a new bulk composition can be made by mixing those phases in different proportions. The new mixture will yield the same phase compositions at equilibrium when input back into Factsage at the same temperature.

Modeling Approach

1- Focus on Low-Temperature

Cubanite Stability in Low-Temperature Sulfide Assemblages

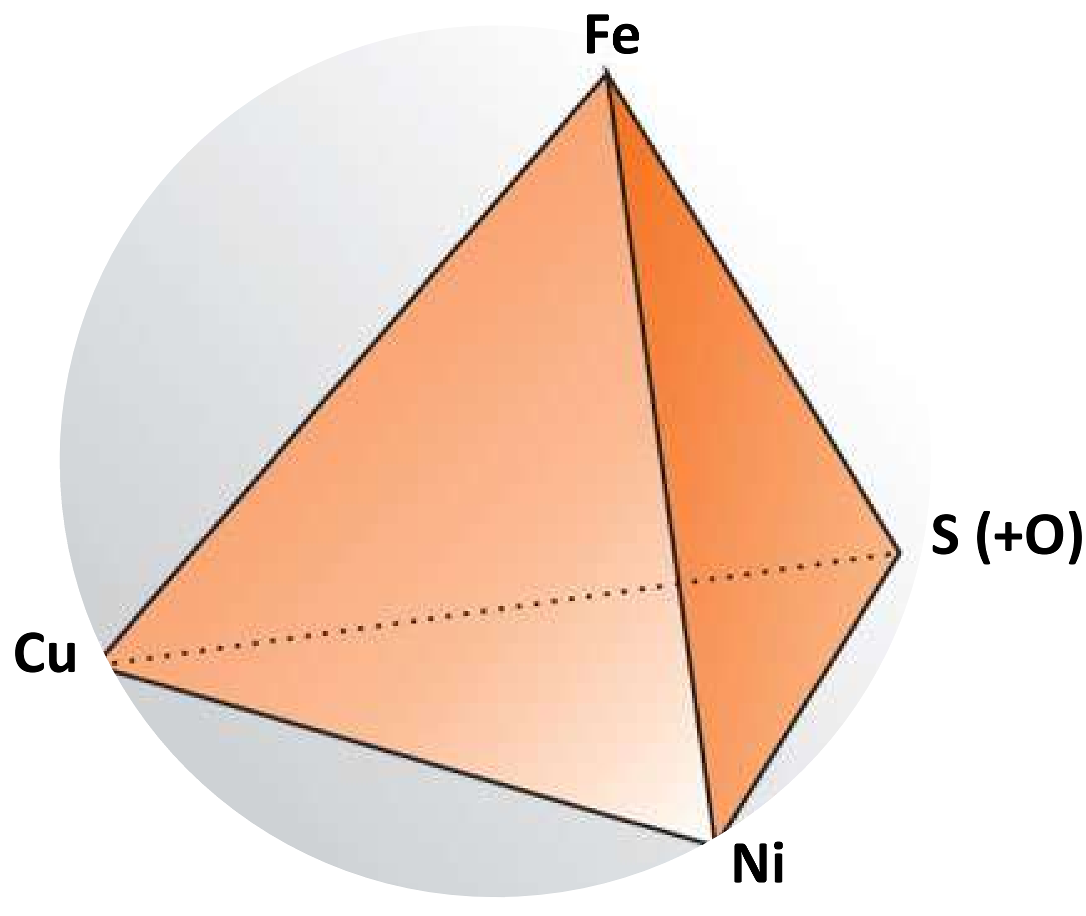
Function of $X_{(Fe\text{-}Ni\text{-}Cu\text{-}S\text{-}O)}$ which control fO_2, fS_2,

2- Focus at High-Temperature

Cubanite Stability in Cooling Products of Equilibrated Silicate-Sulfide Melts at High Temperature

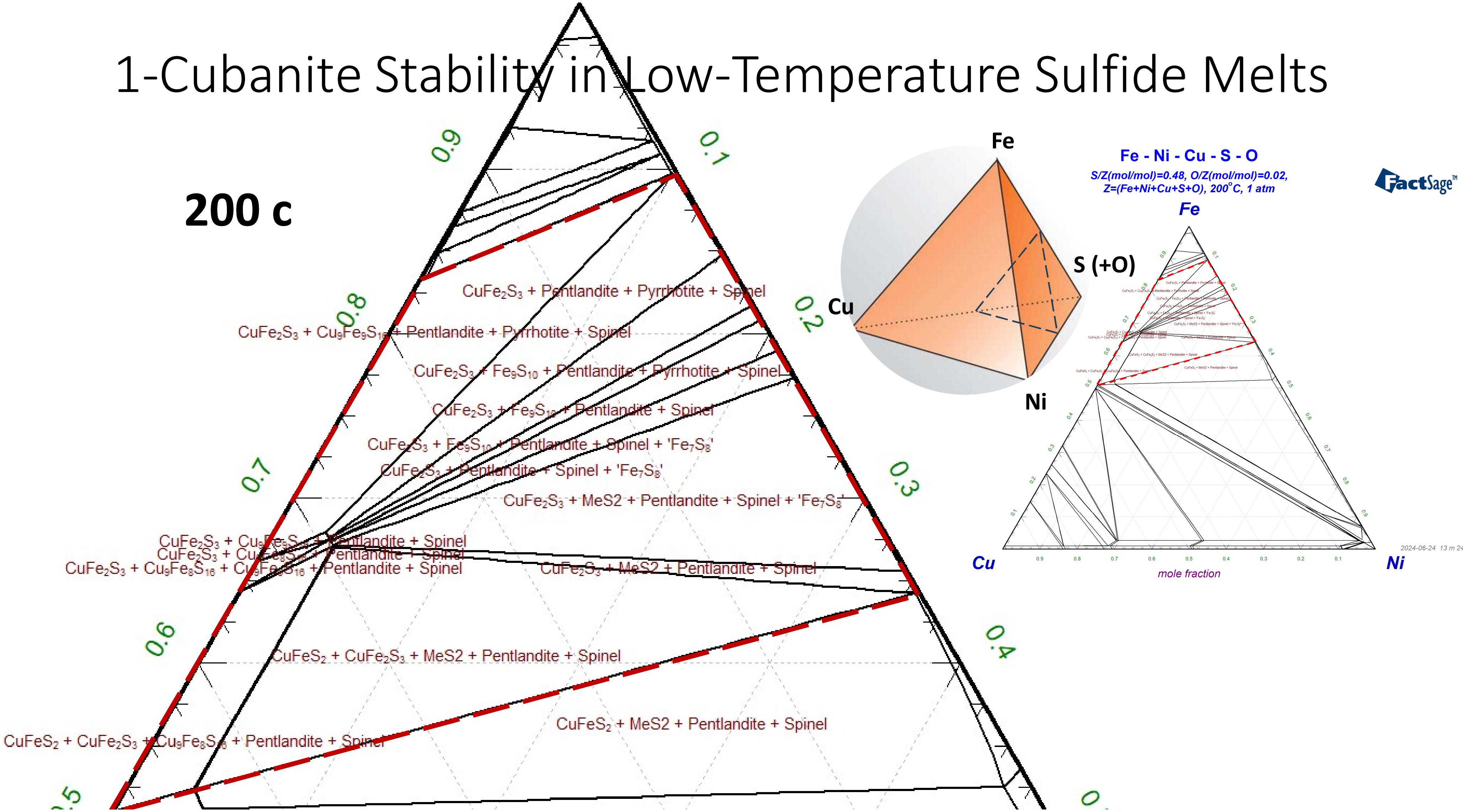
In a system where silicate melt and sulfide melt are in equilibrium at elevated temperatures, what intensive variables would be required to ensure the stability of cubanite when the system subsequently cools down to lower temperatures?

1-Cubanite Stability in Low-Temperature Sulfide Melts



1-Cubanite Stability in Low-Temperature Sulfide Melts

200 c



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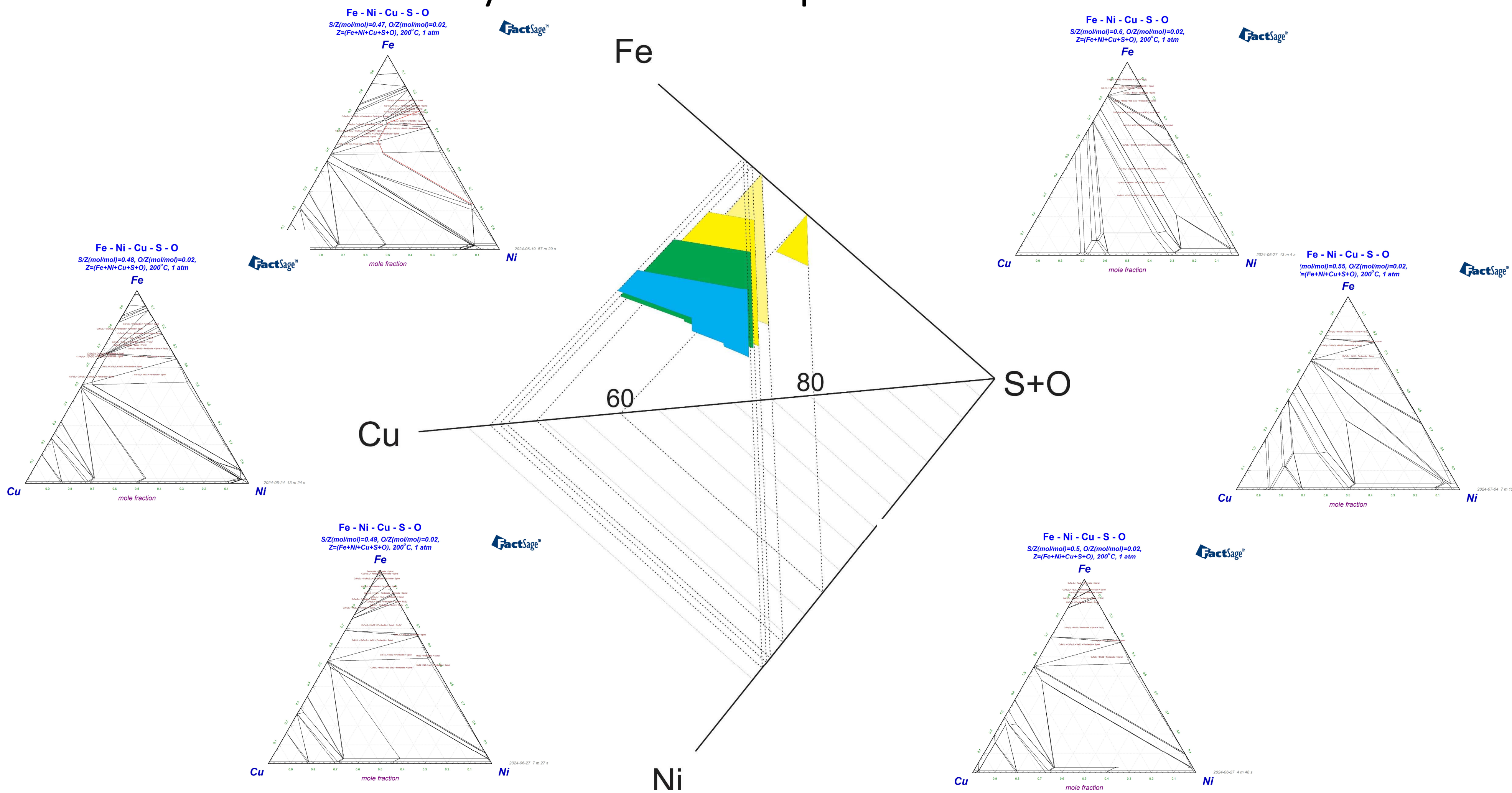

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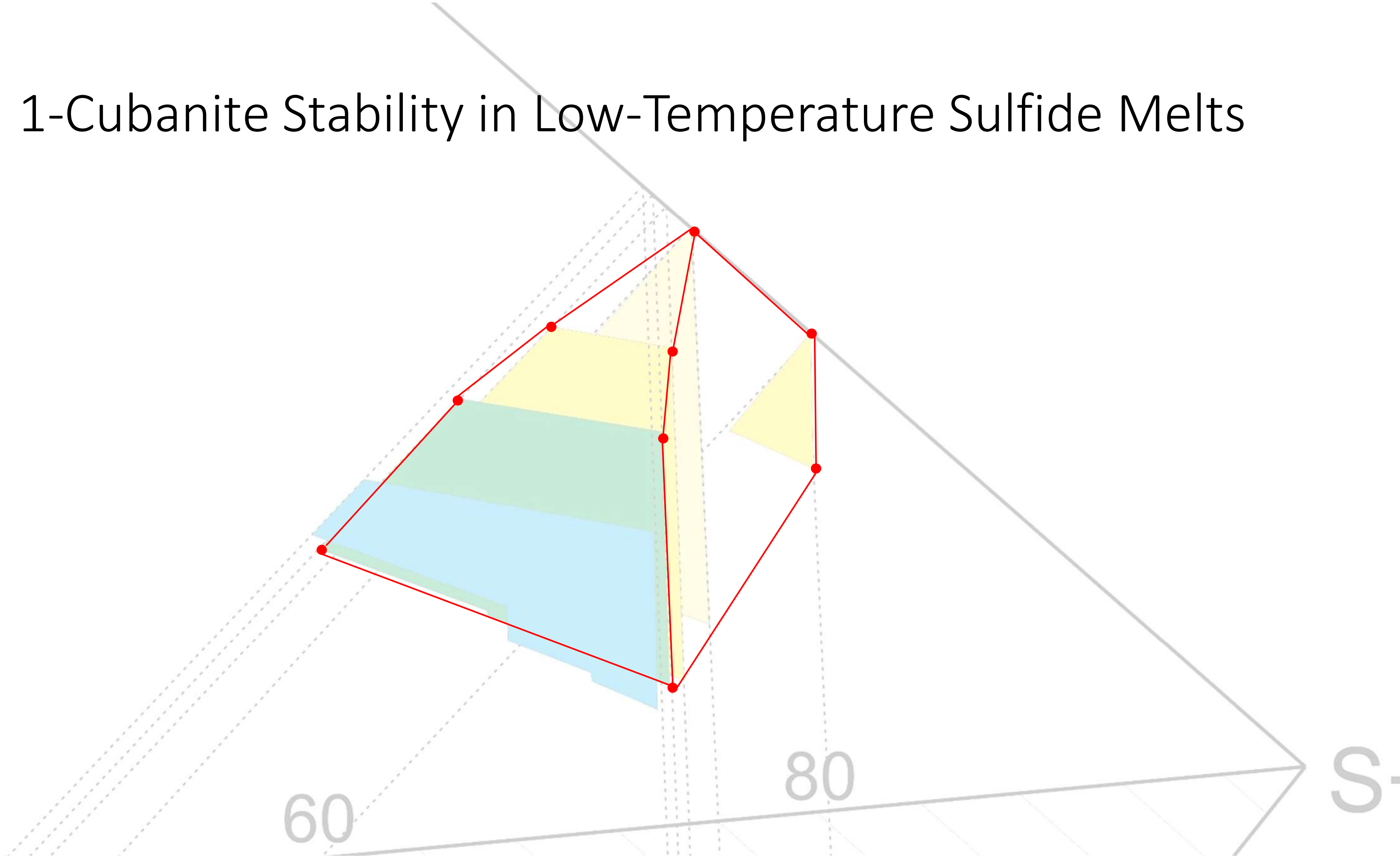


2-Cubanite Stability in Equilibrated Silicate-Sulfide Melts at High-Temperature

Simulating Net-textured sulfide

R-factor:

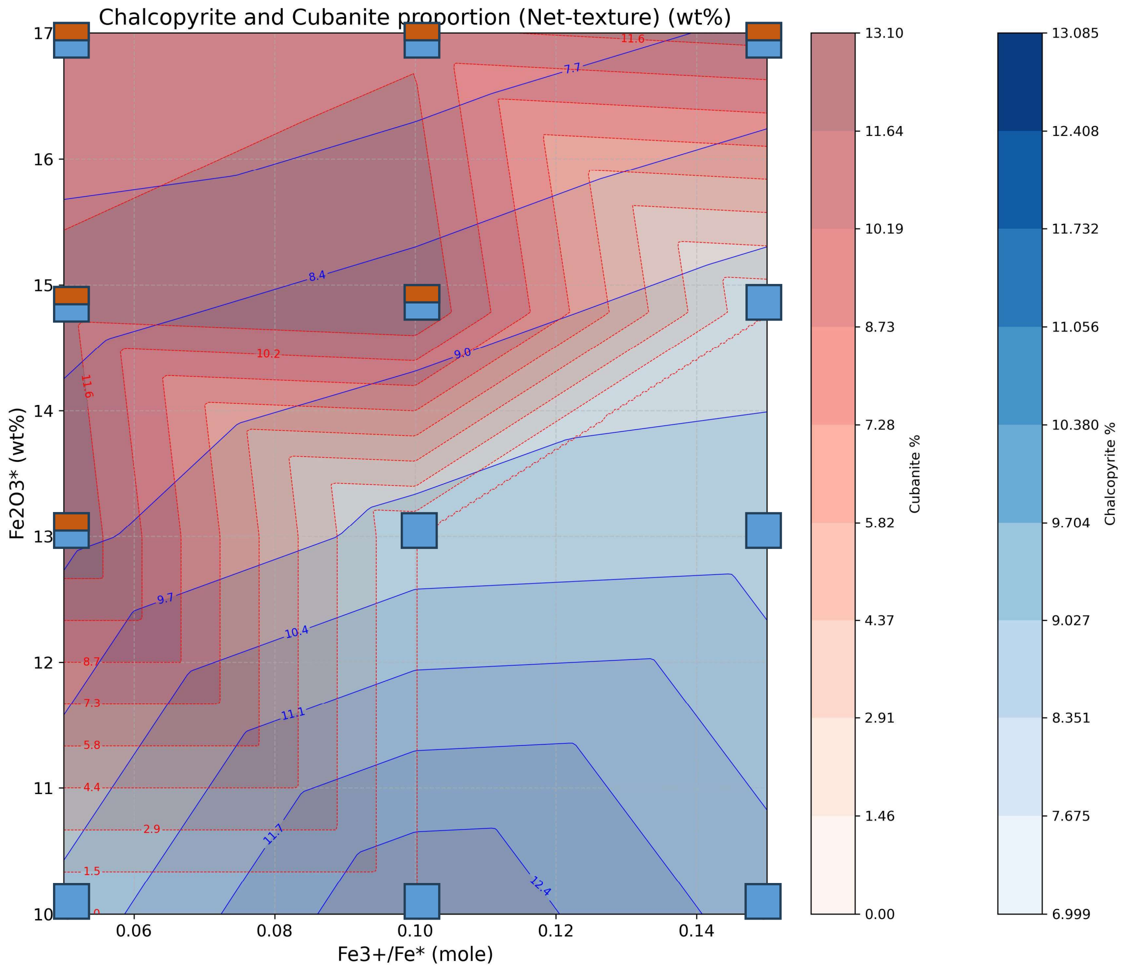
- Approximately 700 (0.143 wt% matte, 99.857 wt% slag)

Procedure:

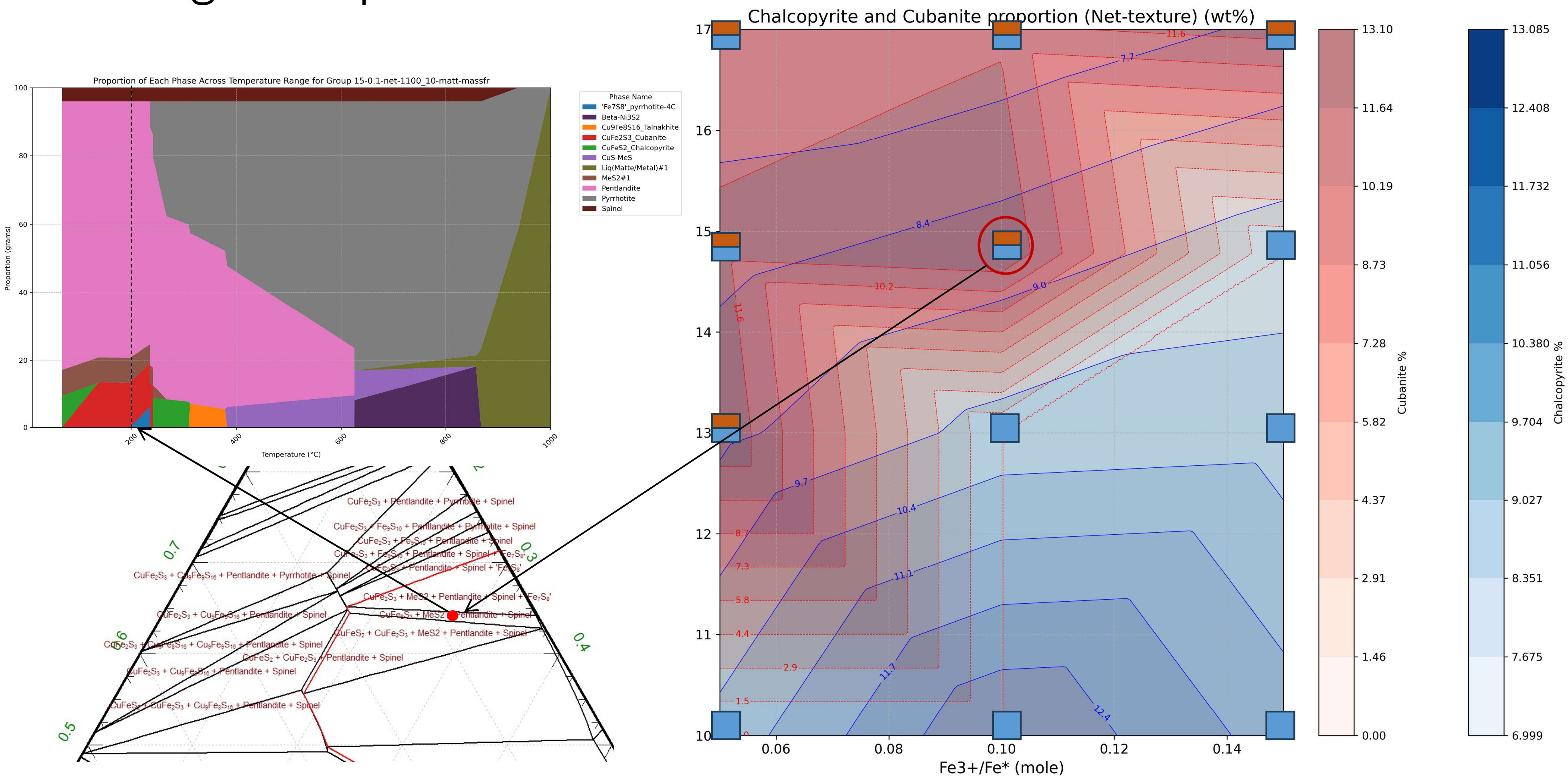
- Initial system: 99.857% slag, 0.143% matt.
- Cooled to slag solidus and liquidus temperature.
- Recorded compositions: slag, olivine, matte and intensive variables (at liquidus and solidus).
- Created cumulate rock: 60% olivine, 30% matte, 10% slag melt.
- Cooled system: recorded matte composition at slag solidus.
- Equilibrated matt across temperature

2-Cubanite Stability in Equilibrated Silicate-Sulfide Melts at High-Temperature

Results of the simulation of Net-textured sulfide with different bulk Fe_2O_3 and Fe^{3+}/Fe^{2+} ratio



2-Cubanite Stability in Equilibrated Silicate-Sulfide Melts at High-Temperature



Summary

- Cubanite stable at low T in sulfides generated from magmas with
  - High Fe_2O_3*
  - Low fO_2
- Possibly due to presence of reduced ferropicrites
- Alternatively due to assimilation of reduced Fe-rich silicate iron formation – most consistent with Augustin's and Brzozowski's models for Tamarack and Current Lake

Future works

3- Compare these conditions with natural settings
What would have to happen to a natural magma to achieve such condition? Wall-rock assimilation is working hypothesis.

4- Identifying Proxies
What are the trace elements or ratios in the assimilant that correlate with cubanite or chalcopyrite saturation?

5- Validation and Application
Validate the identified proxies in samples provided by industry partners

6- Implementation in Mining Operations
Apply the validated proxies to map cubanite-bearing/barren domains.

7- Continuous Improvements
Use machine learning techniques to enhance predictive accuracy over time.

Thanks for your attention

Insights and Questions?

با سپاس از توجه شما

Acknowledgments

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