

Workshop on CO₂ Mineralization for ENERGY RELEVANT MINERAL EXTRACTION

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Base assumptions

▶ CO₂ price

– Equation of costs:

[CO₂ Mineralization expenses] + [Metal Extraction] - [CO₂ credits] ≤ [Existing Process Cost/ton]

– We've estimated mineralization expenses to be \$15-20 with no improvement in yield

▶ CO₂ availability

– Point

– On-site DAC/DOC

– Pipelines where warranted

– Enhanced CO₂ concentration – mining doesn't need 100% purity

Known Unknowns beyond chemistry

▶ Ore Bodies

- Subterranean mapping
- Compositional analysis for trace metals
- Predicting ore reactivity and CO₂ capacity

▶ Deployment

- Measurements and protocols for extrapolation to scale
- LCA
- TEA
- Fate of impurities

Potential Metrics - Mining

- ▶ Pretreatment of ore *in situ* or *ex situ*
 - >80% of deployed CO₂ should result in mineralization
 - Maximum extent of reaction should take place within 90 days for in-situ and 1 day for ex-situ
 - Energy of comminution should be reduced by 50%
- ▶ Incorporation of CO₂ mineralization into metal extraction or concentration steps.
 - Feed for this process could be extracted ore or existing mine tailings that contain recoverable energy relevant minerals
 - >90% of deployed CO₂ should result in mineralization
 - CO₂ reaction can take place during comminution, floatation, sorting and separation
 - IF CO₂ is generated during the process (for example – reduction of siderite into Fe) it has to be either captured or offset within the overall process.
- ▶ Reaction of process tailings before land disposal
 - Feed for this process would be residuals from the active metal extraction steps.
 - >90% of deployed CO₂ should result in mineralization
 - Maximum extent of reaction should be achieved PRIOR to moving to tailings storage and not take more than 24 hours

Potential metrics – *In situ* disposal and phytomining

▶ PHYTOMINING

- Carbon negative LCA
- Annual or more frequent harvests of plants or sap
- Energy of comminution should be reduced by >90%
- Feed for this process could vary from unprocessed rock to existing mine tailings that contain recoverable energy relevant minerals
- Processed metal costs are lower than conventional mining, including value-added products that result (e.g. biochar, carbon credits)