

Economics Workshop Topic #0: Relationship between Economics & Regulation

- How should economic or financial model inform ISA decisions
 - Obtain highest value for CHM, while still providing sufficient returns to contractors
 - Cash flow model with IRR goals, but also need to consider the value of selling CHM
 - Is there value to waiting? Tradeoff between value of having CHM in the future versus the foregone economic benefit of exploiting sooner. Even if you exploit now, the metals will still exist through recycling in the future
- What types of hurdle rates or IRR's should be considered
 - 18% proposed in Singapore, others say still higher.
 - Depends on risk
 - Typical threshold rates for new terrestrial mines around 15%, additional needed for higher risk perceived about seabed operations (unproved technology, etc)
- First mover issues
 - Who is first mover? All firms that face higher risk. Possibly consider mine cycle (~10 years)
- Incentives
 - Can/should ISA encourage investments even in metals processor (which is outside their jurisdiction) given that the is crucial for the success of the collectors (and therefore revenue to ISA)
 - There can be no favorable terms for seabed relative to terrestrial mining

Economics Workshop Topic #1: Relative costs for each metallurgical process

- Discuss the relative cost position of the major metals processing routes
 - Leach/Electrowinning, Pyrometallurgy, Hydrometallurgy
 - Instead, we discussed the many process choices, and how to think about the analysis in the economic model.
 - Some consensus on Cuprion plus EMM, but perhaps look at no EMM, but sale of Mn ore.
 - Discussed perhaps Cuprion with pyrometallurgy for extraction of Mn
 - Business case must close and provide IRRs and royalties needed by all parties
 - Economic data on received from 7 contractors, some with different process approaches. Second survey has been sent out to understand more of the economic details on metallurgical processes
 - Considered using comparable land-based metals processors (Cu & Ni) to also understand costs

Economics Workshop Topic #2: Uncertainty associated with each metals process

- Discuss the technical risks associated with each major metal processing route
 - Which technologies are closest to full development?
 - Which have the most risk of not being ready?
 - Cuprion (or hydrometallurgy) seems to be closest to tech readiness
 - EMM is established but not at scale of operations we're considering and so there's still some uncertainty
 - At what level of Engineering Design/Analysis have firms done their cost assessments. Different contractors have done their cost estimates at different levels of detail
 - Perhaps ISA should commission an engineering design firm to develop more details.
- Discuss cost uncertainties associated with each technologies
 - Which technologies are most likely to have major cost overruns?
 - Which might have potential savings due to similarities to existing processes?
 - Uncertainty in cost not likely to be symmetric (much more likely to have cost overruns)
 - Saw some cost overrun data for existing Cu & Ni mines this morning that might provide some insight

Economics Workshop Topic #3: Future of Cobalt & Nickel Prices

- Is Cobalt currently experiencing a price spike or will high prices endure?
- As battery manufacturers attempt to substitute Nickel for Cobalt, will Nickel prices rise?
- Future of electric vehicles
 - Will growth rates meet aggressive expectations?
 - Will other mobility systems replace battery electric vehicles?
 - Use historical averages, expert forecasts or spot prices for revenue calculations?
 - Problem with spot prices could be a local fluctuation and not truly representative
 - External experts spend lots of time and money doing this, we should take their advice???
 - How to consider to uncertainty
 - Messaging to the Council about specific metal grades and average forecasts rather than spot prices

Economics Workshop Topic #4: Impact on Terrestrial Mining

- Discuss potential impacts of seabed nodule mining on terrestrial mining for each metal
 - Depends on the number of contractors
 - For a relatively limited number of contractors, unlikely to affect Cu or Ni prices
 - Mn, particularly EMM most at risk
- Different impact on existing mines vs incentive mines
 - Existing mines likely only affected through price impacts.
 - New/incentive mines may not open if future demand is met by DSM
 - Not necessarily a bad thing if more competitive seabed mines open instead of higher cost terrestrial mines
- Impact on sovereign nations vs. firms vs individual mine sites
 - Limited impact on firms, they can always decide to get into seabed operations
 - Nations may be impacted if fewer new mines open and then country royalty levels are affected
 - Not directly part of the economic model, but the issue still needs to be addressed for the Council