Additional Questions & Answers from the Asia & Oceania Session

Looking ahead 30 to 40 years, are the members of the panel optimistic that the global mining and mineral industry will be able to satisfy the exploding demand for critical minerals?

There are reasons to be optimistic if one considers that industrial-scale mining has been around for millennia. A lot has changed in the mining methods and the tools from 1000s of years ago, but the industry has persisted through major societal events. The major unknowns are probably related to the potentially devastating effects of climate change. How that will impact industry and society in the next 30 to 40 years is difficult to predict.

"Exploration is really the essence of the Human Spirit" (Astronaut Borman). Do we need to invest in mineral exploration boots on the ground when we have so much untapped data asset?

Geologists working in the field are essential for the foreseeable future. Even advanced machine learning methods require boots on the ground for model training and validation.

Is it possible to incorporate geological uncertainty/challenges into mineral criticality assessment?

This is a very important point. The first challenge is defining the different types of uncertainty. Each datasets is associated with its own source of uncertainty (e.g., all measurements are associated with uncertainty); whereas model methods are simplifications of the underlying data and thus introduce additional uncertainty. The impact of these different sources of uncertainty can be tested by systematically leaving out datasets and comparing the results, nudging datasets to test the sensitivity of the output, re-sampling methods to calculate confidence intervals, and a whole range of other mixed qualitative and quantitative approaches that are part of the model validation process. Methods for communicating model uncertainty effectively seems to be lagging behind the ability to create more and more complex models.

I am from the Mongolian University of Science and Technology. Thank you very much for the presenters and the presentations are very interesting. Is there an opportunity to cooperate as our laboratory is implementing a project on this topic (Critical minerals and Battery metals)?

This forum brought together a number of researchers working on critical minerals. Please feel free to get in touch with any of the speakers if you would like to find out more or to propose opportunities for collaboration.

What are the types of bacteria that can be used for bioleaching in REE extraction?

That will depend on the mineralogy of the REE-hosting material(s) you want to leach. Bacteria are active catalysts in a wide range of mineral weathering reactions, and generally appear to be able to catalyse any reaction that has a negative Gibbs Free Energy. The type(s) of bacteria then, ‘simply’ need to be aligned with your targeted geochemical weathering reactions. The

more bacteria you're able to grow, employing your desired geochemistry, the better your bioleaching outcome will be.

Answer from Gordon Southam, the University of Queensland.

Rose mentioned the issue of funding in critical minerals research. How can geoscience research better articulate its value-add and contribution to critical minerals discovery to better secure funding?

This question comes up a lot as geoscience programs request funding for renewal. The challenge is that there is a long delay between pre-competitive geoscience and the return on investment (i.e., mining). A lot of information goes into the decision to start mining and the pre-competitive data that may have been important early on is only one of the datasets that gets considered in the end. That means that government geoscience needs to work closely with industry to provide support at the different stages of the decision making process. Geoscience Australia provided several compelling examples of how small government investment can generate big returns. Geological surveys should try and track these success stories closely to see how and when geoscience was used. Creating decision support systems online, as is currently being developed at Geoscience Australia, could help too and is an exciting area for future work.