Partner Events of EcoBalance 2022
Critical minerals for carbon-neutrality and circular economy
(summary report)

Critical minerals, such as rare earths, cobalt, lithium, nickel, copper, and aluminium, are used for advanced applications, related to renewable energy and generally face supply risks and vulnerability of the supply chain because of minor and biased occurrences in the world. Therefore, maintaining a circular flow of critical minerals is expected to achieve a circular economy and sometimes national security.

This event, as a support event of EcoBalance 2022, provided the latest related research, standardization and rulemaking situation about a criticality assessment, traceability system for carbon footprint, and established value networks.

■Date/ Time: 13：30-16:30 (JST:UMT+9), **3** November, 2022

■Venue: Fukuoka International Congress Center, Fukuoka, Japan

■Sponsorship: Circular Economy Association (CEA)
Circularise
International Round Table on Materials Criticality (IRTC)
Mining and Materials Processing Institute of Japan - Committee of Comprehensive resource use system (MMIJ)
Minviro
Rare Earth Industry Association (REIA)

■Participants: About 80 persons (registration: 101 persons)

■Agenda:

13:30～13:35 Opening Remark

Vice president, Rare Earth Industry Association/
Director, Circular Economy Association/ Chief analyst, Mitsubishi UFJ R&C (MURC)
Kotaro Shimizu

13:35～14:00 Critical Materials, the Circular Economy, and Carbon Neutrality

Professor of Economics and Business and Coulter Foundation Chair in Mineral Economics,
Colorado School of Mines / Deputy Director, Critical Materials Institute (CMI)
Roderick G. Eggert

14:00～15:00 Discussion- Expected circular business ecosystem from the critical minerals' aspect

Moderator: Guido Sonnemann （Bordeaux University）
Panelists: Roderick Eggert（Colorado School of Mines／CMI）
Alessandra Hool（IRTC）
Shinsuke Murakami（The University of Tokyo）

Keld F. Rasmussen（Grundfos）
Kotaro Shimizu（REIA／CEA／MURC）

15:25～15:45　Critical raw materials and their circular management - an international perspective
International Round Table on Materials Criticality
Alessandra Hool

15:45～16:05　Criticality assessment of mineral resources for the Japanese economy
Chair, Committee of Comprehensive resource use system,
the Mining and Materials Processing Institute of Japan/
Professor, Dept. of Tech. Mgnt. for Innovation, Grad. Sch. of Eng., the University of Tokyo
Shinsuke Murakami

16:05～16:25　A Journey Towards Transparency and Sustainability
President, Rare Earth Industry Association/ Grundfos
Badrinath Veluri

16:25～16:30　Closing Remark
Chair, Committee of Comprehensive resource use system,
the Mining and Materials Processing Institute of Japan/
Professor, Dept. of Tech. Mgnt. for Innovation, Grad. Sch. of Eng., the University of Tokyo
Shinsuke Murakami

1. Critical Materials, the Circular Economy, and Carbon Neutrality

Professor of Economics and Business and Coulter Foundation Chair in Mineral Economics, Color
ado School of Mines / Deputy Director, Critical Materials Institute
Roderick G. Eggert

- A material is deemed “critical” if it has essential functionality (i. e., it is indispensable), if substitution is difficult, and if it is subject to supply-chain risks. The United States government defines more than 50 minerals as critical minerals in 2022. The list is long because what is critical depends on who you are, where you are, and when you ask – and most elements are critical to someone. In addition, each

material has its own story about the reason why it is critical. For example, some materials face a lack of supply chain diversity and others face geographic risks.

- The global demand for some critical minerals will increase along with the progress of carbon neutrality. For example, the demand for materials for solar applications and power electronics (Ga, In, Se, Ag, Te, Sn), for magnets and motors (Nd, Pr, Gd, Dy, Tb), for energy storage and batteries (Li, Ni, Co, Mn), for fuel cells and electrolyzers (platinum group elements, rare earths), and for nuclear (Co, Dy, Gd, Hf, In) are expected to increase. Copper, essential for electrification with no good substitutes, is not defined as a US critical mineral because the United States is a significant producer of copper and copper's supply chain is more diverse than the supply chains of most other minerals on the US list.
- "Produce more", "Waste less" and "Use less" are three fundamental approaches to managing critical minerals. A circular economy is an approach that satisfies the three aspects. Therefore, a circular economy is an important approach to managing critical minerals.
- In an era of growing material demand, recycling of materials in end-of-life products will struggle to satisfy a significant share of the supply. What determines recycling's share of total supply are the rate of final demand growth, average product lifetime, and percent of available end-of-life scrap that is actually recycled. These factors should be considered to promote recycling.
- The time dimension cannot be ignored in thinking about supply risks and criticality. In the short to medium term, the lack of diversity in supply leads to supply risks. The lack of production capacity leads to supply risks in the medium to long term.

2. Discussion- Expected circular business ecosystem from the critical minerals' aspect

Moderator: Guido Sonnemann （Bordeaux University）

Panelists: Roderick Eggert（Colorado School of Mines／CMI）
Alessandra Hool（IRTC）
Shinsuke Murakami（The University of Tokyo）
Keld F. Rasmussen（Grundfos）
Kotaro Shimizu（REIA／CEA／MURC）

- The relationship between criticality and a circular economy was discussed in the panel discussion. The panelists argued that recycling is one of the important approaches to solving supply risks and sustainability issues. The panelists noted that ensuring the amount and quality of recycling is one of the challenges and political measures are needed to promote recycling.
- The panelists stressed that criticality could be used as an indicator to prioritize circular economy activities. The panelists noted that security issues would be a strong driver to promote circular economy activities because manufacturers are more interested in supply risks, but appropriate rules such as international standards are necessary to promote such behaviors from the perspective of sustainability.
- The panelists mentioned that the evaluation of the specific features of critical minerals is needed in the future. Recycling, refurbishing, and reusing are important actions for electric vehicle's battery materials because large amounts of materials are included per vehicle and the materials can be collected more efficiently. However, recycling some of the electronic materials cannot be pursued because very small amounts of materials are included per product.
- The panelists referred to developing common languages about circularity, enhancing cost competitiveness (e.g., tax measures), and establishing frameworks and platforms for information sharing as drivers for the implementation of circular strategies for critical minerals.
- The panelists also referred to difficulties in collecting some end-of-life products, the lack of incentive for recovery, and the cost of using secondary materials as barriers to the implementation of circular strategies for critical minerals. The panelists highlighted that the creation of incentives that make circular activities profitable is necessary.

3. Critical raw materials and their circular management - an international perspective

International Round Table on Materials Criticality

Alessandra Hool

- Circular economy contributes to mitigating the criticality of critical raw materials (CRMs). For the implementation of the circular business models for CRMs, we have common challenges such as small amounts of raw material per product, CRMs often not captured or targeted in circularity metrics, low value of raw material per product, difficult logistics, lacking standardization, and limited recycling capacity. However, there are some good practices of circular business in the world.

- Hitachi group has achieved rare earths recovery from hard disk drives (HDDs). In this practice, efficient automatic disassembly of HDDs, collection infrastructure, and vertical integration of manufacturing, collection, disassembly, and end-of-life recycling enables both to secure the supply of critical raw materials and to gain economic benefits.
- H.C. Starck Tungsten has realized tungsten recycling in Germany. Recycling multiple types of elements in a single plant setup is one of the success factors in this practice.
- Rolls-Royce and General Electric have constructed a system for closed-loop recycling of rhenium from jet engine turbine blades and lifetime extension of turbines via repairs and replacement of parts. The success factors of this practice are high-quality and well-defined scrap properties, innovative repair practices, providing turbines as "product as a service", and a B2B relationship between product suppliers and product users.
- CircuBAT project, which is in progress in Switzerland, aims to construct a system for circular EV batteries. The drivers of this practice are massive demand increase for EV batteries, a high value of battery materials, impacts on company reputation, and political attention.

4. Criticality assessment of mineral resources for the Japanese economy

Chair, Committee of Comprehensive resource use system,
the Mining and Materials Processing Institute of Japan/
Professor, Dept. of Tech. Mgnt. for Innovation, Grad. Sch. of Eng., the University of Tokyo
Shinsuke Murakami

- Japan has a really limited domestic supply of metal ores and the Japanese economy depends on manufacturing industries. Therefore, securing a stable supply of materials for the industries has been essential for Japan. The Japanese government defines 31 elements as "rare metals" and promotes recycling them in the Japanese resource policy. The criticality assessments in terms of supply risks and economic importance have been conducted in Japan to decide the minerals to stockpile and where to put the research and development funds.
- The Japanese government published "Circular Economy Vision" in 2020 and promoted activities for the circular economy. The government has also tried to achieve carbon neutrality. Recycling will contribute to reducing greenhouse gases (GHGs) in the material industry in the long run. However, recycling can sometimes increase GHGs emissions, which is called a backfire.
- In Japan, we cannot supply 100% of our inputs from domestic scraps when we promote recycling. Japan will have to import scraps to promote recycling in the future. We, however, will face the challenge with scope 3 of the carbon footprint calculation for imported scrap recycling.
- A council of the Japanese government has proposed the concept of "Resource Autonomous Economy" as one of its future goals of economic policy. The background concerns are increasing supply risks, a strong emphasis on national security, and building a more resilient supply structure. Circular economy is regarded as one of the approaches to achieving "Resource Autonomous Economy". In such circumstances, we assess the criticality, including more downstream materials for manufacturing and other industries.

5. A Journey Towards Transparency and Sustainability

President, Rare Earth Industry Association (REIA)/ Grundfos

Badrinath Veluri

- The demand for rare earths will increase in the future and the rare earths industry needs to construct a transparent and sustainable value chain to address the ESG disclosure.
- However, the current rare earths value chain has big problems, which are the lack of transparency and volatility. The lack of standards and methodologies in the rare earths industry causes these problems. For example, evaluating the carbon footprint of rare earths products is difficult in transparency. It causes unclear or ambiguous definitions and quantification methodologies throughout the value chain, no framework and no system definition for the collection of data and modeling, no factual data, risk of data tempering or manipulation, and insufficient collaboration and consensus within the industry.
- The Rare Earth Industry Association (REIA) works on activities to construct a transparent and sustainable value chain. We are developing common languages, standards and guidelines, data security and protocol, transparency systems, methods for quantification of sustainability, and traceability systems.
- We, REIA, are supporting CsyARES which is a framework to certify the sustainability of rare earths products. This framework focuses on the environmental footprint. We are also making the product category rules (PCR) for rare earth products. In addition, we are developing a digital twin system for ensuring traceability and enabling data analytics throughout the value chain.