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Editorial

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Contribution of mineral processing and metallurgical technology to sustainable development of world mining industry

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Recent projections by McKinsey & Company[1] warn that "with the deployment of climate technologies accelerating to support the net-zero transition of world economies, the risk increases that materials supply might not keep pace with the increasing demand". The report states that a significant number of new mines will need to be developed at an increasing pace to meet the demand for specialized metals/alloys required for electric vehicle batteries (e.g., Li and V), solar panels, and wind turbines (REE for magnets). To achieve this, it will also be necessary that the first step in the process, i.e., exploration, not only increases dramatically but also adopts a faster pace for the extraction of the desired metals.

The report further predicts that in order to find and extract the required metals for green energy projects, the associated capital and other expenditures for exploration will need to rise from the current levels to approximately $300 billion to $400 billion per year over the next decade. Successful implementation not only relies on finding the relevant resources but also needs, amongst others, available equipment and adequate water resources. Furthermore, acquiring the necessary permits for exploration and mining and having sufficient supply chains are considerations that need to be borne in mind for these expansions. Life cycle assessments also need to be taken into consideration to allow estimations of the required costs for new projects and their environmental impacts.

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The report draws attention to the fact that in technologies necessary for the transition to net-zero, one typically encounters a necessity for a number of different materials, which make such equipment or components thereof materials intensive. For example, the quantity of metals and materials required for an offshore wind turbine is six times greater than that for a gas-based power generation facility on a per megawatt basis. The most popular and required metals for near-zero or low-carbon technologies, namely lithium and rare earth elements, have to date only been produced in low quantities, and their production will need to be increased drastically. It can, therefore, be expected that substantial price increases for certain metals will be experienced as a result of shortages in those metals. Examples are "10% and 20% for nickel and up to 70% for dysprosium". Another complication, which one has to keep in mind, is the geopolitical aspect in the supply of sought-after metals and the strategic vulnerability of countries when dealing with politically unstable or strategically sensitive sources, such as China (rare-earth elements), Indonesia (nickel), and the DRC (cobalt).

While a total of 72 countries, which are responsible for 82% of global emissions, have indicated their commitments to net-zero emissions, several are still outside this agreement and have not given any indication yet of their commitment to and plans for curbing greenhouse gas emissions. It is not surprising that large consuming and producing countries have started to compile inventories and draw up critical minerals lists. The International Energy Agency has even commenced producing a yearly "Critical Minerals Market Review". All of these efforts are focused on reflecting the importance of metals and minerals in the quest to transition to clean energy. The fear exists that a focus on concentrated supplies regionally could limit selected materials to the industrialized regions of the world, e.g., the USA and Europe. This could subsequently result in shortages in many economies worldwide, which would restrict a shift to lower-carbon alternatives. Shortages of materials/metals always lead to volatility in the markets and price fluctuations. In return, These factors reduce further adoption of low-carbon technologies and slow down their implementation, leading to higher costs.

It is foreseen that recovery of metals from secondary resources exceeding historical growth rates will become increasingly necessary, while there should be a simultaneous increase in exploration to unlock the necessary resources of supply beyond 2030. There are several reviews on this topic of metal recovery from secondary resources or wastes, some of which are listed here[2-6]. Regardless of the source, waste material, or secondary origin, all the various reports come to the conclusion that recycling will not only increase in volume and efficiency but is critically important to ensure a sufficient future supply of critical metals. For this to be at all feasible and realistic, Mineral Processing and Metallurgical Technologies will have to find new solutions and processes so that they can play a major role in future sustainable development worldwide. Hopefully, this special edition will contribute in some small measures to these needs.

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