Critical Mineral Resources

Position Statement. Mineral resources are essential to modern civilization, and a thorough understanding of their distribution, consequences of their use, and the potential effects of mineral supply disruption is important for sound public policy.

Purpose. This position statement (1) summarizes the consensus view of The Geological Society of America on critical mineral resources; (2) advocates better understanding of their distribution, the potential for disruption of their supply, and the consequences of their use; (3) encourages educational efforts to help the general public, lawmakers, and other stakeholders understand that mineral resources are used in almost every aspect of their daily lives, including modern technology, housing, transportation, information systems, and defense; (4) recommends enhanced assessment of critical mineral resources and the potential for disruption of their supply, scientific investigation of non-conventional resources, better understanding of the full life-cycle consequences of their use, and international collaboration; and (5) provides a communications tool for geoscientists and general GSA member use.

Rationale

Demand for a variety of mineral resources, such as rare earth elements (REEs), platinum group elements (PGE), cobalt, beryllium, lithium, and iodine has increased with the continued consumption in developed economies and the emergence of Brazil, China, India, and other developing economies[1]. Such elements are crucial to a variety of manufacturing, high-tech[2], and military applications[3,4]. Demand for energy-related minerals has increased as global energy production diversifies beyond carbon- and nuclear-based sources. For example, rare earth elements are used in many renewable energy devices, including high-strength magnets for wind-power generators; lithium is used in electric car batteries. In addition, photovoltaics, computers, cell phones, phosphors, liquid crystal displays (LCD), and other components crucial to a high-tech, low-carbon, sustainable future require increased production and/or recycling of REE, PGE, lithium, tellurium, gallium, and other elements[5]. A stable supply of mineral resources is essential for economic prosperity and national security.

The mineral production that supplies many of these elements is concentrated in certain countries. For example, China produces >95% of the global rare earth element supply[6]; the United States produces >85% of the world beryllium supply[7]; and nearly 80% of global platinum production is in South Africa[8]. Furthermore, reserves of some elements are often concentrated in one location; e.g., platinum in South Africa and lithium in South America[9]. The tenuous nature of the mineral supply chain was highlighted in 2010 when China stopped exporting REE to Japan for almost two months[10]. The U.S. Geological Survey publishes annual summaries for more than 80 mineral commodities documenting global production and U.S. import reliance.[7]

Geoscientists have a prominent role in the exploration for, management of, and environmentally safe handling of critical mineral resources. To provide a solid base for the future, it is necessary to identify the global distribution, potential for supply disruption, and environmental consequences of the production and use of these resources. Meeting global demands will become more challenging as the world's population and standards of living continue to increase and as proven developed reserves of critical minerals are depleted.

In 2008, the National Research Council issued a report[2] defining a critical mineral as one that is both essential in use and subject to the risk of supply restriction. Subsequently, this has been expanded to include other factors, such as environmental impacts.[11] However, the concept of criticality is context-specific and dynamic. For example, what is critical for a specific manufacturer or product may not be critical for another, what is critical for a state may not be critical for a country, and what is critical for national defense may be different than what is necessary to make a television brighter or

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less expensive. Nonetheless, the notion that minerals are critical to society is valid and has important implications for our economic prosperity.

Conclusions and Recommendations

Government, educational, and private sector organizations, individually as well as collectively, should address the following critical resource challenges:

- *Assessment of mineral resources* — There is a vital need to understand the abundance and distribution of critical mineral resources, both within the United States and globally. It is also necessary to understand the geologic processes that form mineral deposits. Sufficient funding should be provided to ensure that these tasks are met by federal agencies.
- *Life-cycle assessment* — Governments need to devote sufficient resources to define critical elements and support research and development that allows for economically efficient and environmentally sound mineral discovery and development, mineral processing technology advances, and materials manipulation — including recycling — to meet national needs.
- *Sustainability* — The adequacy of mineral resources at a given moment in time is important but should not substitute for a longer-term view of finite global resources in the context of population growth, rising standards of living, and the environmental consequences of use. The world is not likely to run out of mineral resources in a broad sense, but shortages of particular resources at a specific time and place are likely. Advances in technology will create demand for new resources and make many marginal resources economic, and price changes will alter the use and desirability of some elements. Substitution and recycling will also affect the need for newly mined mineral resources.
- *Education* — Although there is growing awareness of the importance of energy to our nation's future, there is less appreciation of the impact of mineral resources on the nation's health and wellbeing and the fundamental role of minerals in industrial development. Efforts to ensure a better-educated public in regard to mineral resources are important, including the teaching of economic geology at the university level to maintain an adequate workforce of exploration and production geologists.
- *International collaboration* — Modern society depends on critical minerals. However, such resources are unevenly distributed across the planet. Open communication and collaboration across borders may reduce the most common supply risks for critical minerals.

About the Geological Society of America

The Geological Society of America, founded in 1888, is a scientific society with more than 25,000 members from academia, government, and industry in more than 100 countries. Through its meetings, publications, and programs, GSA enhances the professional growth of its members and promotes the geosciences in the service of humankind. GSA encourages cooperative research among earth, life, planetary, and social scientists, fosters public dialogue on geoscience issues, and supports all levels of earth science education. Inquiries about the GSA or this position statement should be directed to GSA's Director for Geoscience Policy, Kasey S. White, at +1-202-669-0466 or kwhite@geosociety.org.

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Opportunities for GSA and GSA Members to Help Implement Recommendations

To facilitate implementation of the goals of this position statement, The Geological Society of America recommends that its members take the following actions:

- Support funding for geoscience organizations (federal, state, and provincial governments) and academic institutions involved in understanding the genesis and global distribution of mineral resources.
- Encourage companies and governments to collaborate internationally and share information that helps society understand the limitations and potentials of mineral resource development.
- Encourage research and data-gathering to determine which mineral resources are "critical" from different private sector and governmental perspectives.
- Encourage research on the consequences of exploiting resources in different environments and on new opportunities for substitution, recycling, and discovery of new types of resources.
- Promote the inclusion of mineral-resource information (global distribution, use and criticality for society, consequences of use, etc.) in educational materials at the K–12 and college levels and for popular media.