Mining the Data: Supply and Demand for Critical Minerals

Introduction: Critical minerals like lithium, cobalt, and nickel are the building blocks of the batteries and technologies driving the clean energy transition, but their supply may not keep pace with surging global demand. As renewable energy expands, geoscientists and policymakers are racing to understand where these minerals will come from, how much is available, and what shortfalls might mean for energy future. In this activity, students will analyze real-world supply and demand data and projections for select critical minerals and explore how the battery revolution is reshaping the global minerals landscape.

Materials:

- Computer with internet access
- Copy of or access to:
    - Data: Mineral Supply and Demand (https://bit.ly/AAPG-data-download; automatic download, source: International Energy Agency)
    - Article: Battery Revolution, Renewable Energy Drives Critical Minerals Demand (https://bit.ly/AAPG-battery-revolution)

Steps:

1. Access the "Mineral Supply and Demand" data, which contains the 2024 totals for production and consumption (in kilotons [kt]) for five critical minerals (cobalt, copper, graphite, lithium, and nickel) and a subset of rare-earth elements (REEs). The consumption data focuses on the low emissions energy sector (i.e., renewable energy and energy storage). The data also has projections for supply, estimated through 2040, and demand, estimated through 2050.
    a. Graph the "Total Mineral and Supply and Demand" data on the first tab. Consider: What kind of graph will you use and why? How should each axis be labeled? Does the graph require a key?
        i. Make observations of the graph. What trends do you notice? What data points stand out?
        ii. Use the trend of the data for each mineral to make predictions of their supply in 2045 and 2050.
    b. Look at the data on each tab of the spreadsheet. It may be helpful to graph the data for each mineral as you determine:

   i. What is the most common use in low emissions energy technologies in 2024 (Not including "other uses," as these are outside of the low emissions energy sector)?
   ii. Which use is projected to have the greatest change (increase or decrease) by 2050?

2. Read "Battery Revolution, Renewable Energy Drives Critical Minerals Demand," then consider and discuss the following questions with your classmates:
   a. Critical minerals are used in many technologies, as well as other products and even infrastructure. Why do you think this article focuses on batteries?
   b. Sedimentary basins are mentioned in the article. Why are these basins of interest to petroleum geologists? Why have some geologists suggested these basins might also be of interest to people trying to locate critical minerals?

3. Conduct a battery inventory of your classroom, school, and/or home.
   a. Check anywhere there might be items that contain or use batteries, and record (or research if needed). Don't forget to check less obvious spots, like smoke detectors, clocks, and garage door openers.
   b. Copy the data table below or create your own table to account for the battery types you find. Record the quantity of each battery type that you find. Be sure to include loose batteries you find in your inventory.
   c. Optionally, inspect any batteries you find. Check for corrosion (white or blue-green solid on the outside of the battery), leakage (dried fluid on the battery), or swelling/bulging sides (especially on lithium batteries). **SAFETY NOTE:** Do not handle damaged batteries with your bare hands. Research proper disposal methods.
   d. Tally your totals and share your results with your classmates to create a class dataset.

Battery Type	Found in/ used by which items	Tally	Total
Alkaline (AA, AAA, C, D, 9V)			
Lithium coin cell			
Lithium-ion			
Lithium iron phosphate			
Nickel-metal hydride			

Analysis:

1. Explain the predictions you made for the supply of each mineral in 2045 and 2050.
2. Calculate the expected percent change in supply and demand of each mineral using the following equation:
   (Final mass in kilotons - 2024 mass in kilotons)/(2024 mass in kilotons x 100)
   a. According to the data, which critical mineral has the largest anticipated shortage? Use the data to explain your answer.
3. Lithium coin cell batteries contain approximately 0.17 g of lithium. Use this value to calculate the total amount lithium contained in the lithium coin cell batteries you and your classmates found.
4. Read another article from the American Association of Petroleum Geologists (AAPG) Building Better Batteries (https://bit.ly/AAPG-building-better-batteries) and write an argument on how innovations in batteries could affect the demand for specific critical minerals.

Extension:

Explore additional resources from AAPG to learn more about critical minerals, their use, and their supply chains:

- Building Lithium Supply Chains in the U.S. (https://bit.ly/US-litium-supply-chains)
- Criticality and Energy Minerals (https://bit.ly/AAPG-energy-minerals)
- The State of Energy Innovation According to the International Energy Agency (https://bit.ly/IEA-energy-innovation)