11.3: The Geosphere as a Source of Natural Capital

The geosphere is an immense source of natural capital, providing a living environment for most humans, minerals required by modern civilizations, and room for disposal of wastes. One of the greatest concerns with regard to sustainability is the acquisition of essential elements from the geosphere in ways that sustain to the maximum extent possible supplies of these irreplaceable resources. As technology advances priorities for specific geospheric resources change. In recent years, numerous uses have emerged for the **rare earth elements** consisting of the fifteen lanthanides (elements with atomic numbers 58 through 71 in the periodic table shown in Chapter 3) plus scandium and yttrium, transition elements with atomic numbers 21 and 39. The chemical properties of the lanthanides are generally quite similar making their separation difficult and the properties of scandium and yttrium are similar to those of the lanthanides, so they are commonly classified as rare earths.

The uses that have emerged for the rare earths are varied and for different ones include making metal alloys, superconductors, phosphors that glow various colors in light-emitting diodes(LEDs), electrodes, electrolytes, electronic filters, lasers, specialty (colored) glasses, X-ray tubes, mercury vapor lamps, computer memory, oxidizing agents, and reducing agents. Rare earth's are widely used in hybrid automobiles and in wind turbines. Each Toyota Prius hybrid automobile reportedly requires 1 kg of neodymium for its electric motor with terbium and dysprosium added in smaller quantities to preserve magnetic qualities and 10-15 kg of lanthanum for its electric motor.

Lithium has emerged as an important element because of the emergence of high-powered lithium storage batteries capable of storing and releasing large quantities of energy per unit mass of battery. These have largely been used in computers and other electronic devices, but will certainly find growing applications in electric and hybrid automobiles.

With the rather sudden development of new applications for rare earth elements and lithium, questions of supply have become important. China has had a near monopoly on rare earth elements and, with the advancement of high-tech industries in China which may consume available supply, other countries have become alarmed regarding availability. China is also a source of lithium, although Bolivia is the main supplier. Fortunately, rare earths are not very rare and the vast U.S. deposit in Mountain Pass, California, was the largest supplier until the facility was closed due to competition from China where labor costs are very low. Now the mine is being modernized in preparation for production to resume. Rare earth deposits also occur in Canada and even Vietnam.

In June 2010, U.S. military officials and geologists revealed that war-torn Afghanistan was a treasure trove of desired minerals including rare earths with a total value of all mineral resources estimated at around 1 trillion dollars. The most abundant and valuable of these is iron (estimated at $420 billion), copper ($274 billion), niobium ($81 billion), cobalt ($51 billion), gold ($25 billion), molybdenum ($24 billion), and rare earths ($7.4 billion). Other minerals of commercial value in Afghanistan likely include silver, potash, aluminum, graphite, fluorite, phosphorus, lead, zinc, mercury, strontium, sulfur, talc, magnesite, and kaolin clay. There are also believed to be lithium deposits in dry lake beds of Afghanistan's eastern province of Ghazni. The lithium deposits may in fact be equal to those of Bolivia, which currently produces most of the lithium used in battery manufacture. Development of these mineral sources has the potential to help move the economy of the troubled country of Afghanistan from dependence on the opium trade (and U.S. military expenditures) to an economy based upon mineral resources.