Environmental Geology
Chapter 15 MINERAL RESOURCES

If it can’t be grown, it must be mined! Mineral resources are important in people’s daily life as well as in overall economy. Mineral resources are an integral and valuable part of modern society, worth hundreds of billions of dollars per year to the U.S. economy. Mineral Resources are the backbone of modern societies. The availability of mineral resources acts as a measure of the wealth of a society. Processed materials from minerals accounting for 5% of the U.S. GDP.

It’s important to remember that mineral resources are nonrenewable (at least on human timescales), but are recyclable. About 25% of the value of newly mined mineral resources in the U.S. each year is recovered through recycling.

Mineral Resources and Reserves
- **Mineral resources:** Usable economic commodity (profitable) extracted from naturally formed material (elements, compounds, minerals, or rocks)
- **Reserve:** Portion of a resource that is identified and currently available to be extracted – economically recoverable
- **Defining factors:** Geologic, technological, economic, and legal factors

Types of Mineral Resources
Based on how we use them:
- Materials for metal production and technology
- Construction materials
- Agricultural industry (fertilizers)
- Mineral resources for chemical industry
- Others (precious gem stones, cosmetics, food, etc.)
- Energy mineral resources

Mineral resources include:
- Evaporite deposits (e.g. Salt/halite (NaCl))
- Rock and sand
- Limestone for cement
- Gold, Silver, Copper, Platinum
- Mercury
- Iron
- Aluminum
- Zinc, Nickel, other metals

Mineral Resources Problems: They are nonrenewable resources and there is a finite amount of mineral resources with growing demands of the resources. There is a supply shortage due to the growing global industrialization. There is an erratic
distribution of the resources and uneven consumption of the resources. And, highly developed countries use the most of the resources.

**Responses to Limited Availability:** These include finding more sources, finding a substitute, recycling, using less and making more efficient use of what is available, and/or doing without (e.g. Digital photography removes need for large amounts of silver in photographic films)

**Ore** – useful metallic mineral concentrations that can be mined at a profit. Ores are often concentrated via igneous and metamorphic processes, wherein water rich fluids transport and redepit metallic minerals

**Metallic ore**: Useful metallic minerals that can be mined for a profit. Whether or not something is an ore varies depending upon technology, economics, and politics; emphasis on profitability, technological feasibility, and political demands. **Concentration factor**: Concentration necessary for profitable mining. This is variable with types of metals, and over time

**Genesis of Mineral Resources**

**Plate Tectonics and Mineral Resources**
- Plate tectonic boundaries are related to the origins of many ore deposits. Plate tectonic processes (high temp, high pressure, and partial melting) promote the release and enrichment of metals along plate boundaries. Common metal ores along the plate boundaries are Fe, Au, Cu, and Hg, etc.

**Carbonates, Phosphates & Evaporites**

**Carbonate and phosphate deposits** are commonly formed via biological concentration.

**Weathering processes can concentrate minerals – this included evaporites**

**Bauxite** is a mineral resource that yields Aluminum, and is formed by the intense weathering and in wet tropical climates. Leaching can concentrate metallic ores, leaving only insoluble materials at surface.

**Mineral Resources and Environmental Impact**

Environmental impacts result from mineral exploration and testing, mineral mining and refining, mining waste disposal.
Mineral extraction and processing can have a very large environmental impact. Strip mining can scar large areas of the landscape. Abandoned mines and mining waste piles can lead to surface and groundwater contamination, particularly with metals and acidic drainage. The dissolution of gold by cyanide or mercury-bearing solutions used highly toxic substances that can escape and contaminate soil and/or
water. And smelting (refining) can adversely affect air quality, and surface water quality downwind...This used to be a big impact in Arizona.

**Environment Impact of Mineral Development**: The impact depends upon many factors, including mining procedures, hydrologic conditions, climate factors, types of rocks and soils and the topography.

**Impact of Mineral Exploration and Testing**: Generally minimal impact, but more planning and care needed for sensitive areas (arid, wetlands, and permafrost areas). Mineral exploration and testing involves surface mapping, geochemical, geophysical, and remote-sensing data collection and test drilling.

**Impact of Mineral Extraction and Processing**: There is a direct impact on land, water, air, and biological environment, and indirect impacts on the environment: Topographic effect, transportation of materials, etc., and impacts on the social environment: Increased demands for housing and services.

**Some of the impacts from mining operations include:**
- Land disturbances from access, surface mining
- Special mining, e.g., chemical leaching from gold mining
- Mining acid drainage, during mining and post mining
- Smelting emissions, e.g., $SO_2$

**Minimizing the Impact of Mining**
- Environmental Regulations
  - Forbid bad mining practices
  - Clean Air Act
  - On- and offsite treatment of wastes
- Land reclamation: About 50% of land used in mining industry reclaimed
- Use of new biotechnology in mining
  - Bio-oxidation, bioleaching, biosorption, genetic engineering

**Recycling Mineral Resources**: Why recycle? It only takes a few seconds to understand why. Consider the impact of the wastes that are toxic to humans and dangerous to natural ecosystem. And, consider the degradation of air, water, and soil and the use of land for disposal, which is aesthetically undesirable. Recycling helps reduce all of these impacts.

Recycling helps save energy, money, land, raw mineral resources from more mining. Recycling has been proven to be profitable and workable. The recycling of waste materials from mining, human use (direct recycling or “mining” of landfills) significantly reduces need and can reduce contamination by reclaiming the contaminants as resources.
Commonly recycled metals include iron/steel, copper, aluminum, and lead. The most-recycled metals are Iron and steel. One third as much energy needed to produce steel from recycled scrap as from the original ore.

More than $40 billion produced from recycled metals in 1998
Other recycled metals: Lead (63%), aluminum 38%), and copper (36%)

**Mineral Resources and Sustainability**: In order for mineral resources to be brought into a measure of *sustainability*, it is necessary for society to use resources more wisely and efficiently, to develop more efficient means of exploring for and mining resources, and to more efficiently use the available resources. We need to recycle and find substitutes that achieve what mineral resources did in the past.

WSE 8/2012