GEOS 3310 Lecture Notes: Minerals and Environment

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Spring 2010

file:minerals.tex,v (1.19, April 5, 2010), printed April 5, 2010

Introduction

Introduction

Many of the things and almost all of the energy we use are extracted from the Earth. This section discusses the extraction, existing supply, and consequences of mineral and energy resources.

- Categories of resources
  - a *resource* is a naturally occurring accumulation that may be (now or in the future) extracted feasibly [Fig. 14.2, Keller, 2008]
  - a *reserve* is a portion of a resource that is identified and currently available, i.e. can be "counted on" for investing, planning, etc.

- Distribution of resources, e.g. recycling accounts for around

50% of domestic mineral supply [Fig. 14.1, Keller, 2008]

- Mineral resources are tracked in general categories, e.g. metal production, building materials, chemical industry, agriculture

- response to limited availability: *recycling* is crucial [Fig. 14.3, Keller, 2008]

- the *concentration factor* is the ratio of a metals "profitable concentration" and its natural concentration [Tbl. 12.3, Keller, 2005]

Geologic Processes

- Igneous: crystal settling, late magmatic processes, *hydrothermal replacement*, e.g. chromium in Montana, gold veins in Nevada and California. *Kimberlite* diamond ores [Fig. 14.4a, Keller, 2008]. Responsible for Canadian diamond rush since 1990's.

- Metamorphic: usually next to igneous bodies, e.g. many copper deposits in Arizona [Fig. 14.5, Keller, 2008]

- Sedimentary:

  – direct deposition: placer accumulation in streams (e.g. California gold in point bars), [Fig. 14.7, Keller, 2008]

  - Evaporation: closure of inland seaways makes thick salt deposits
    * closure of proto- Gulf of Mexico [Fig. 14.6a, Keller, 2008]
    * drying of Cretaceous inland seaway led to large deposits in western US

- Biological: many copper-zinc deposits in Africa & Australia derived from bacterial mats

- *Plate tectonics* provides a crucial control on distribution of ore types [Fig. 14.A, Keller, 2000] [Fig. 14.B, Keller, 2008] [Fig. 14.C, Keller, 2000]

- post-deposition processes important:

- formation of *salt domes*, important for oil, waste disposal, etc. [Fig. 14.10, Keller, 2000] (see also Zagros Mountains, Iran
- Weathering can make or enhance ore deposits
  * bauxite or aluminum ore in Arkansas [Fig. 14.9a, Keller, 2008]
  * secondary enrichments of sulfides [Fig. 14.9b, Keller, 2008]

Minerals from the Sea

Many deposits are currently in or were formed in the sea

- ocean ridge hydrothermal features [Fig. 14.Aa, Keller, 2008] ("black smokers") [Fig. 14.Ab, Keller, 2008] formed many Cu-Pb-Zn deposits

- sulfur-based ecosystems also found there

Environmental Impacts

Waste Problems/Solutions

- *acid mine drainage* is common in mined-out areas
  - consists of highly acid waters carrying various metals (see USGS Summary or Wikipedia)
  - U.S. examples West Shasta district, CA , Pennsylvania mine drainage
  - these can be remediated using *engineered wetlands* [Fig. 14.14a, Keller, 2008] [Fig. 14.14b, Keller, 2008]
  - *recycling* is highly effective for some expensive or toxic metals [Fig. 14.22, Keller, 2000]

- water supply disruption is also a common problem, e.g.
  - Florida phosphate mining and water impacts

  - water supply for Ajo, Arizona

- subsidence in underground mining areas is common (e.g. Virginia City, NV)

- surface disruption

  - Mountaintop Removal) and EPA
  - also environmental consequences of mountaintop removal
  - EPA to regulate this beginning in 2010

Recycling/Urban Ore

Direct and indirect recycling can be cost-effective, e.g.

- Japanese sewage with higher-than-ore gold content
- unusual commodites like Rare Earths very important in high-tech, may be good recycle targets

Other Resources

Useful Links

This is intended to be an ever-evolving list of useful links on the general topic of this note set.

- charts of metals commodity prices

Bibliography

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