

1  **Energy and Mineral Resources**

Earth 9th Edition – Chapter 23

2  **Energy & Mineral Resources: summary in haiku form**

Petroleum, gas,
coal, uranium, et al.
There's only so much...

3  **Key Concepts**

- Renewable and nonrenewable resources.
- Energy resources: "Fossil fuels."
- Energy resources: Environmental effects of burning fossil fuels.
- Energy resources: Alternate energy sources.
- Mineral resources: Igneous and metamorphic processes.
- Mineral resources: Weathering and ore deposits.
- Mineral resources: Nonmetallic mineral resources.

4  **Copper mine, Morenci, Arizona**

5  **Renewable & nonrenewable resources**

- Renewable resources
 - ☒ Can be replenished over relatively short time spans
 - ☒ Examples include:
 - ◆ Plants
 - ◆ Animals for food
 - ◆ Trees for lumber

6  **Renewable & nonrenewable resources**

- Nonrenewable resources
 - ☒ Significant deposits take millions of years to form
 - ☒ Examples:
 - ◆ Fuels (coal, oil, natural gas)
 - ◆ Metals (iron, copper, uranium, gold)
 - ☒ Some resources, such as groundwater, can go into either category depending on how they are used

7  **Houston, Texas**

8  **Annual
per-capita
consumption, U.S.**

9  **Population Growth**

10  **U.S. Energy Consumption, 2004**

11  **Consumption of energy in the USA**

12  **Energy Resources**

- Coal
 - ☒ Formed mostly from plant material
 - ☒ Along with oil and natural gas, coal is commonly called a fossil fuel
 - ☒ The major fuel used in power plants to generate electricity
 - ☒ Problems with coal use include environmental damage from mining and air pollution

13  **Coal fields of the United States**

14  **U.S. Coal Fields**

15 

16 

17  **Gas Hydrates**

18  **Volatile at the surface**

19  **Energy Resources**

- Oil and natural gas
 - ☒ Oil and natural gas, consisting of various hydrocarbon compounds, are found in similar environments
 - ☒ Derived from the remains of marine plants and animals
- 20  **Drilling platform, North Sea**
- 21  **Titusville, Pennsylvania, 1859**
- 22  **Energy Resources**
 - Oil and natural gas
 - ☒ A geologic environment that allows for economically significant amounts of oil and gas to accumulate underground is termed an oil trap
 - ☒ Examples of traps:
 1. Anticlinal traps
 2. Fault traps
 3. Salt Dome traps
 4. Stratigraphic traps
- 23 
- 24 
- 25 
- 26 
- 27  **Energy Resources**
 - Oil and natural gas
 - ☒ When the cap rock is punctured by drilling, the oil and natural gas, which are under pressure, migrate from the pore spaces of the reservoir rock to the drill hole
- 28  **Energy Resources**
 - Environmental effects of burning fossil fuels
 - ☒ Urban air pollution
 - ◆ Air pollutants are airborne particles and gases that occur in concentrations that endanger the health of organisms and disrupt the orderly functioning of the environment
- 29  **Energy Resources**
 - Environmental effects of burning fossil fuels
 - ☒ Two types of pollutants
 - ◆ Primary pollutants – emitted directly from identifiable sources
 - ◆ Secondary pollutants – formed when chemical reactions take place among primary pollutants
- 30 
- 31  **Energy Resources**
 - Environmental effects of burning fossil fuels
 - ☒ Carbon dioxide and global warming
 - ◆ Greenhouse effect
 - atmosphere is transparent to incoming short-wavelength solar radiation
 - outgoing long-wavelength radiation emitted by earth is absorbed in the lower atmosphere, keeping the air near the ground warmer
- 32  **Heating of the atmosphere**
- 33  **Energy Resources**
 - Environmental effects of burning fossil fuels
 - ☒ Carbon dioxide and global warming
 - ◆ It appears that global temperatures have increased (global warming) due to a rising level of atmospheric carbon dioxide
- 34  **Energy Resources**
 - Tar sands and oil shale
 - ☒ Tar sands

- ◆ Mixtures of clay and sand combined with water and bitumen (a viscous tar)
- ◆ Several substantial deposits around the world
- ◆ Obtaining oil from tar sands has significant environmental drawbacks

35 **Tar Sands**

36 **Athabaska Tar Sands**

37 **Tar Sands**

38 **Figure 23.9B**

39 **Tar Sands**

40 **Energy Resources**

● **Tar sands and oil shale**

☒ **Oil shale**

- ◆ Contains enormous amounts of untapped oil
- ◆ Currently, because of world markets and with current technologies, not worth mining

41 **Oil shale in the United States**

42 **Oil shale in the Green River Formation**

43 **Energy Resources**

● **Alternate energy sources**

☒ **Nearly 90 percent of world's energy needs are derived from nonrenewable fossil fuels**

☒ **Possible alternate energy sources**

- ◆ Nuclear energy
- ◆ Solar energy
- ◆ Wind energy
- ◆ Geothermal energy

44 **Energy Resources**

● **Alternate energy sources**

☒ **In U.S., most important alternate energy source is nuclear**

- ◆ About 7% of total

☒ **Hydroelectric is next**

- ◆ About 5% of total

☒ **Others, locally important (~1% of total)**

- ◆ Solar, geothermal, wind, tidal

45 **Alternate energy sources - nuclear**

46 **Diablo Canyon (near S.L.O.)**

47 **Alternate energy sources - solar**

48 **Solar One (near Barstow)**

49 **near Sacramento**

50 **Alternate energy sources - wind**

51 **Still Pumping...**

52 **Crowley, Alberta**

53 **Table 23.1**

54 **U.S. Installed Wind Power**

55 **Alternate energy sources - hydroelectric**

56 **Alternate energy sources - hydroelectric**

57 **Figure 23.16 (top b)**

58 **Figure 23.16 (top a)**

59 **Southwestern Iceland**

60 **The Geysers, California**

61 **Alternate energy sources - geothermal**

62 **Alternate energy sources - geothermal**

63 **Table 23.2**

64 **Alternate energy sources - tidal**

65 **Tidal Power**

- 66  **Annapolis Royal, Nova Scotia**
- 67  **Mineral resources**
- The endowment of useful minerals ultimately available commercially
 - ☒ Mineral resources include
 - Reserves – already identified deposits from which minerals can be extracted profitably
 - Include known deposits that are not economically or technologically recoverable
- 68  **Mineral resources**
- Mineral resources
 - ☒ Ore – refers to useful metallic minerals that can be mined at a profit and in common usage to some nonmetallic minerals such as fluorite and sulfur
 - ☒ To be considered of value, an element must be concentrated above the level of its crustal abundance
- 69  **Bingham Canyon, Utah**
- 70 
- 71  **Pegmatite in the Black Hills, South Dakota**
- 72  **Mineral resources**
- Mineral resources and igneous processes
 - ☒ Some of the most important accumulations of metals are produced by igneous processes that concentrate the desirable materials
- 73  **Mineral resources**
- Mineral resources and igneous processes
 - ☒ Examples of igneous mineral resources
 - ☒ Magmatic segregation
 - Separation of heavy minerals that crystallize early or enrichment of rare elements in the residual melt
 - ☒ Diamonds
 - Originate at great depths
 - Crystals are disseminated in ultramafic rock called kimberlite
- 74  **Mineral resources**
- Mineral resources and igneous processes
 - ☒ Hydrothermal solutions
 - Among the best-known and important ore deposits
 - Majority originate from hot, metal-rich fluids that are remnants of late stage magmatic processes
 - Move along fractures, cool and precipitate the metallic ions to produce vein deposits
- 75  **Hydrothermal deposits often occur with igneous rocks**
- 76  **Native Copper**
- Keweenaw Peninsula, Michigan**
- 77  **Diablo Lake Overlook**
- North Cascades National Park**
- 78  **Yellowstone Park, Wyoming**
- 79  **Figure 23.24**
- 80  **Black smoker,**
- East Pacific Rise**
- 81  **Mineral resources**
- Mineral resources and metamorphic rocks
 - ☒ Many of the most important metamorphic ore deposits are produced by contact metamorphism
 - Sphalerite (zinc)
 - Galena (lead)
 - Chalcopyrite (copper)

- 82  **Mineral resources**
- Mineral resources and metamorphic rocks
 - ☒ Regional metamorphism can also generate useful deposits
 - ◆ Talc
 - ◆ Graphite
- 83  **Mineral resources**
- Weathering and ore deposits
 - ☒ Secondary enrichment – concentrating metals into economically valuable concentrations
 - ☒ bauxite
 - ◆ Principal ore of aluminum
 - ◆ Forms in rainy tropical climates from chemical weathering and the removal of undesirable elements by leaching
- 84  **Bauxite – the principal ore of aluminum**
- 85  **Mineral resources**
- Weathering and ore deposits
 - ☒ Other deposits, such as many copper and silver deposits, result when weathering concentrates metals that are deposited through a low-grade primary ore
- 86  **Uranium Exploration**
Lingle, Wyoming, 1977
- 87  **Talc Exploration**
Dillon, Montana, 1979
- 88  **Mineral resources**
- placer deposits
 - ☒ Placers – deposits formed when heavy metals are mechanically concentrated by currents
 - ☒ Involve heavy and durable minerals
 - ☒ Examples include:
 - ◆ Gold
 - ◆ Platinum
 - ◆ Diamonds
- 89  **"sourdough" in 1850**
(how old do you think he is???)
- 90  **Gold Dredge near Nome, Alaska**
- 91  **Gold Dredging in Colorado**
- 92  **Mineral resources**
- Nonmetallic mineral deposits
 - ☒ Use of the word "mineral" is very broad
 - ☒ Two common groups
 - ◆ Building materials
 - Natural aggregate (crushed stone, sand and gravel)
 - Gypsum (plaster and wallboard)
 - Clay (tile, bricks, cement, "kitty litter")
- 93 
- 94  **Aggregate in action**
- 95  **Mineral resources**
- Nonmetallic mineral deposits
 - ☒ Two common groups
 - ◆ Industrial minerals
 - Fertilizers
 - Sulfur
 - Salt
- 96  **Phosphate Mining in Florida**

97  *End of Chapter*