

## Chapter 11

### Resources & Energy

## 11.1 Mineral Resources

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- ▶ Mineral resources can be either *metals*, such as gold, Au, silver, Ag, and aluminum, Al, or *nonmetals*, such as sulfur, S, and quartz,  $\text{SiO}_2$ .
- ▶ Metals can be identified by their shiny surfaces, as good conductors of heat and electricity, and they tend to bend easily when in thin sheets.
- ▶ Most nonmetals have a dull surface and are poor conductors of heat and electricity.

## Ores

**ores** a natural material whose concentration of economically valuable minerals is high enough for the material to be mined profitably

Metallic minerals such as gold, silver, and copper, Cu, are called *native elements* and can exist in Earth's crust as nuggets of pure metals.

Most other minerals in Earth's crust are *compounds* of two or more elements.

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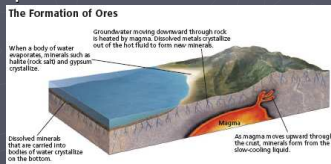
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## Ores Formed by Cooling Magma

- Some ores, such as chromium, Cr; and nickel, Ni, form as the magma cools and the dense metallic minerals sink.
- As the minerals sink, layers of these minerals accumulate at the bottom of the magma chamber to form ore deposits.



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## Ores Formed by Contact Metamorphism

**lode** a mineral deposit within a rock formation.

- Heat and chemical reactions with hot fluids from the magma can change the composition of the surrounding rock. This process is called *contact metamorphism*.
- Some ores, such as copper, Cu; and zinc, Zn, form by *contact metamorphism*.
- Contact metamorphism also occurs when hot fluids called *hydrothermal solutions* move through small cracks in a large mass of rock.
- When the minerals from the surrounding rock dissolve into the hydrothermal solution, new minerals will precipitate from the solution and form narrow zones of rocks called *veins*.

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## Ores Formed by Moving Water

**placer deposit** a deposit that contains a valuable mineral that has been concentrated by mechanical action

- ▶ The movement of water helps to form ore deposits.
- ▶ Tiny fragments of native elements, such as gold, Au, are released from rock as it breaks down by weathering.



- ▶ Streams carry the fragments until the currents become too weak to carry these dense metals, which collect in placer deposits.

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## Uses of Mineral Resources

**gemstones** a mineral, rock, or organic material that can be used as jewelry or an ornament when it is cut and polished

- ▶ Metallic ores are sources of valuable minerals and elements, like gold, Au, platinum, Pt, and silver, Ag.
- ▶ Some nonmetallic minerals display extraordinary brilliance and color when they are specially cut for jewelry.
- ▶ Other nonmetallic minerals, such as calcite and gypsum, are used as building materials.

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## 11.2 Fossil Fuels

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## Fossil Fuels

**nonrenewable resource** a resource that forms at a rate that is much slower than the rate at which it is consumed

**fossil fuel** a nonrenewable energy resource that formed from the remains of organisms that lived long ago; examples include oil, coal, and natural gas

- ▶ Much of the energy humans use every day comes from the burning of the hydrocarbons that make up fossil fuels.

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## Formation of Coal

- ▶ Coal is the most commonly burned fossil fuel, formed during a complex process called *carbonization*.
- ▶ Carbonization occurs when partially decomposed plant materials is buried in swamp mud and becomes peat.
- ▶ As bacteria consume some of the peat and release the gases methane,  $\text{CH}_4$ , and carbon dioxide,  $\text{CO}_2$ , the contents of peat gradually change until mainly carbon remains.
- ▶ Peat remains if conditions are not optimal for carbonization. Peat may be burned as fuel.

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## Types of Coal Deposits

- ▶ The partial decomposition of plant remains forms a brownish-black material called *peat*.
- ▶ Peat is buried by other sediment. As heat and pressure increase peat becomes *lignite*. Lignite is also called brown coal.
- ▶ Increased temperature and pressure compacts the lignite and forms *bituminous coal*. Bituminous coal is made of 80% carbon.
- ▶ *Anthracite*, the hardest form of coal, is produced when bituminous coal is under high temperatures and pressures. Anthracite coal is made of 90% carbon.

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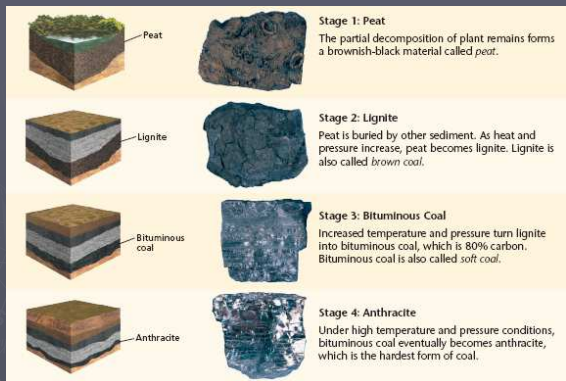
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## Types of Coal




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## Formation of Petroleum & Natural Gas

- Petroleum and natural gas are mixtures of hydrocarbons.
- These fossil fuels formed when heat and pressure caused chemical changes to the remains of microorganisms and plants.

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## Petroleum & Natural Gas Deposits

- Petroleum and natural gas are very important sources of energy for transportation, farming, and many other industries.
- They are mined from permeable sedimentary rocks.
- Petroleum accumulates beneath *cap rock* and fill the space to form an oil reservoir. Natural gas rises above petroleum, because it is less dense than both oil and water.

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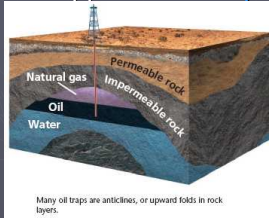
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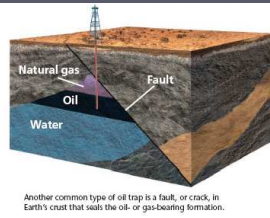
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## Oil Traps

The diagram below shows how oil becomes trapped under *cap rock*.



Many oil traps are anticlines, or upward folds in rock layers.



Another common type of oil trap is a fault, or crack, in Earth's crust that seals the oil- or gas-bearing formation.

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## Oil Traps

- ▶ When a well is drilled into an oil reservoir, the petroleum and natural gas often flow to the surface.
- ▶ After the pressure of the overlying rock is removed, fluids rise up and out through the well.

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## Fossil Fuel Supplies

- ▶ Fossil fuels are one of the main sources of energy, but are nonrenewable resources.
- ▶ *Crude oil*, or unrefined petroleum, is also used in the production of plastics, synthetic fabrics and rubber, medicines, waxes, chemical fertilizers, detergents, shampoos, and many other products.
- ▶ *Coal* is the most abundant fossil fuel in the world. Two-thirds of the known deposits of coal occur in the United States, Russia, and China.
- ▶ *Oil shale* is a relatively abundant material that contains petroleum. But the cost of mining oil from shale is far greater than the present cost of recovering oil from other sedimentary rocks.

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## 11.3 Nuclear Energy



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## 11.3 Nuclear Energy

- ▶ The energy that is produced from nuclear reactions is called *nuclear energy*.
- ▶ Scientists discovered that atoms had smaller fundamental parts.
- ▶ These parts could be split by creating nuclear reactions with nuclear technologies.



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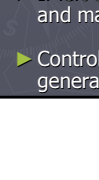
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## Nuclear Fission

**nuclear fission** the process by which the nucleus of a heavy atom splits into two or more fragments; the process releases neutrons and energy

- ▶ When the nucleus splits, it releases more neutrons as well as energy.
- ▶ The newly released neutrons begin a chain reaction by striking nearby nuclei, which causes those nuclei to split and release more neutrons and more energy.
- ▶ If left uncontrolled, a fission reaction will escalate quickly and may result in an explosion (bomb).
- ▶ Controlled reactions produce heat that can be used to generate electricity (reactor).



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## How Fission Generates Electricity

- ▶ A *nuclear reactor* is a specialized equipment in which controlled nuclear fission is carried out.
- ▶ Currently, *uranium-235*, or  $^{235}\text{U}$ , is the only naturally occurring element used for nuclear fission.
- ▶ This ore is mined and processed into fuel pellets with high  $^{235}\text{U}$  content.
- ▶ These uranium-enriched pellets are placed into rods to make *fuel rods*. Bundles of these fuel rods are then bombarded by neutrons to induce a nuclear reaction.

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## How Fission Generates Electricity, *continued*

- ▶ The resulting chain reaction from nuclear fission causes the fuel rods to become very hot.
- ▶ Water is pumped around the fuel rods to absorb and remove heat energy.
- ▶ The hot water becomes steam and turns the turbines that provide power for electric generators.
- ▶ So, *nuclear reactors are a way to create lots of steam to run turbines for generating electricity.*

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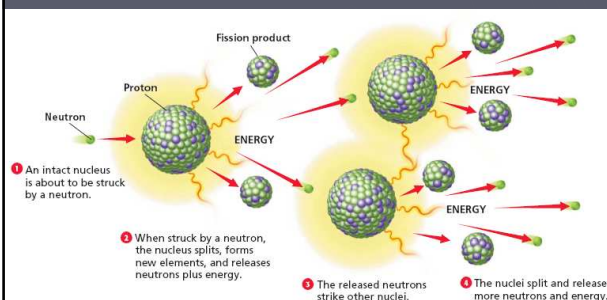
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## Nuclear Fission



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## Advantages and Disadvantages of Nuclear Fission

- ▶ Nuclear power plants burn no fossil fuels and produce no air pollution. (good)
- ▶ However, they produce harmful radioactive materials that have very long half-lives, wastes must be stored for thousands of years. (bad)
- ▶ These waste products give off harmful doses of radiation that can destroy plant and animal cells and can cause harmful changes in the genetic material of living cells. (bad)

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## Nuclear Fusion

**nuclear fusion** the process by which nuclei of small atoms combine to form new, more massive nuclei; the process releases energy

- ▶ All of the energy that reaches Earth from the sun is produced by nuclear fusion.
- ▶ Fusion reactions only occur at temperatures of more than 15,000,000°C.
- ▶ The only byproduct of fusion are helium nuclei, which are harmless to living cells.

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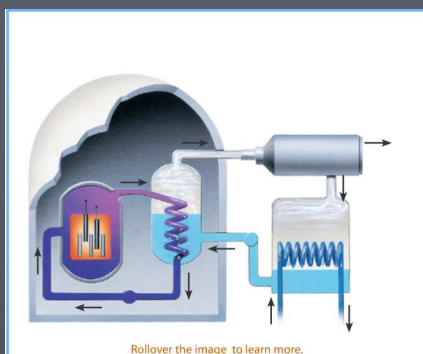
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## Parts of a Nuclear Reactor



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## 11.4 Alternative Energy Sources

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### Solar Energy

**solar energy** the energy received by Earth from the sun in the form of radiation

- ▶ Solar energy can be converted to heat energy in many different ways.
- ▶ In a *passive system*, sunlight enters the house and warms the building materials, which stores some heat for the evening.
- ▶ An *active system* includes the use of solar collectors and photovoltaic cells to collect heat or convert solar energy into electricity.

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### Geothermal Energy

**geothermal energy** the energy produced by heat within Earth

- ▶ The resulting steam from water passing by nearby magma or hot gases related by magma, deep in the earth, produces a large amount of geothermal energy.
- ▶ Engineers and scientists have harnessed geothermal energy by drilling wells to reach the hot water.
- ▶ The steam and hot water are used as a source of heat and as sources of power to drive turbines, which generate electricity.

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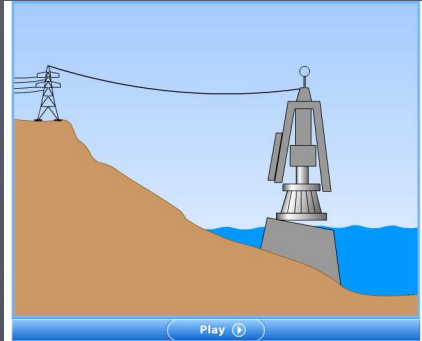
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## Tidal Energy




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## Energy from Running Water

**hydroelectric energy** electrical energy produced by the flow of water

- Moving water is one of the oldest sources of energy. Energy can be harnessed from the running water of rivers and streams or from ocean tides.
- Today, 11% of the electricity in the United States comes from hydroelectric power plants.
- At a hydroelectric plant, massive dams hold back running water and channel the water through the plant. Inside the plant, the water spins turbines, which turn generators to produce electricity.

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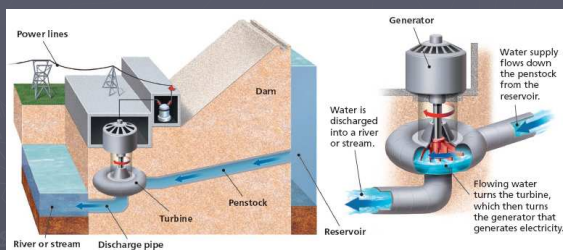
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## How a Hydroelectric Dam Generates Electricity

- The diagram below shows how dams generate electricity.




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## Energy from Wind

- ▶ Wind energy is now being used to produce electricity in locations that have constant wind.
- ▶ *Wind farms* may have hundreds of giant wind turbines that can produce enough energy to meet the electricity needs of entire communities.
- ▶ Wind generators are not practical everywhere. Because the wind does not always blow, wind energy cannot be depended on as an energy source for every location.

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