Chapter 15

Geology and Nonrenewable Mineral Resources

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Chapter 15

Overview Questions

- What major **geologic processes** occur within the earth and on its surface?
- What are **nonrenewable mineral resources** and where are they found?
- What are **rocks**, and how are they **recycled by the rock cycle**?

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- How do we extract mineral resources from the earth's crust, and what are some harmful environmental effects?
- Will there be enough nonrenewable mineral resources for future generations?
- Is so, can we find **substitutes**?
- How can we use nonrenewable mineral resources more **sustainably**?

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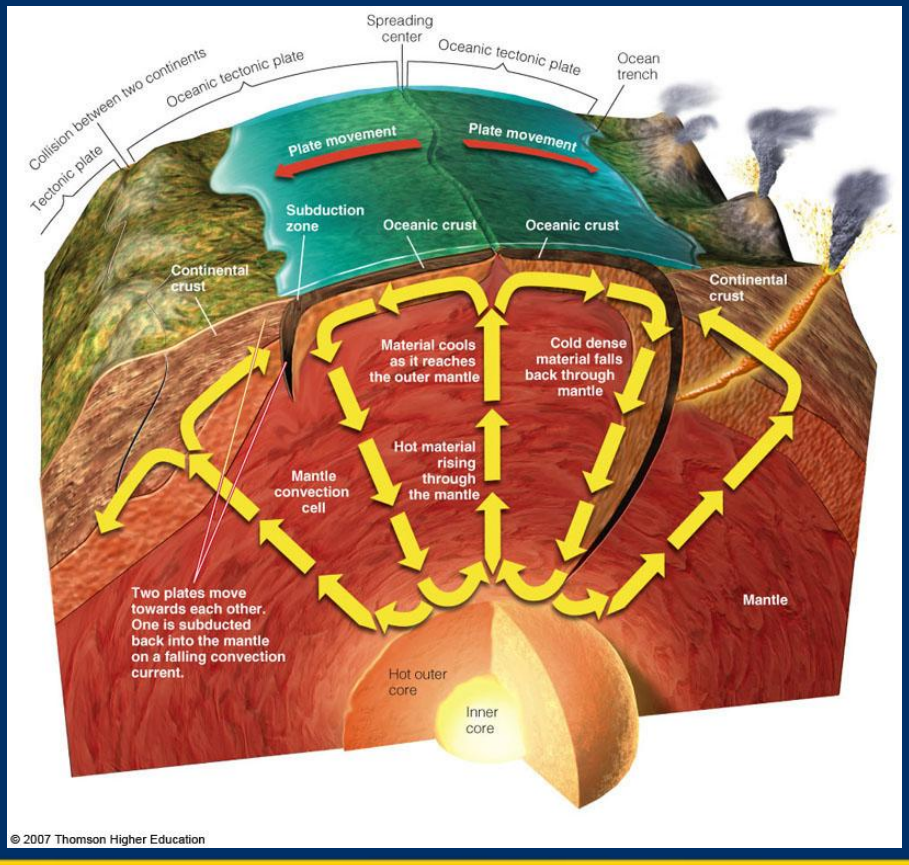
Components of Earth

- The earth is made up of a **core**, **mantle**, and **crust** and is constantly changing.



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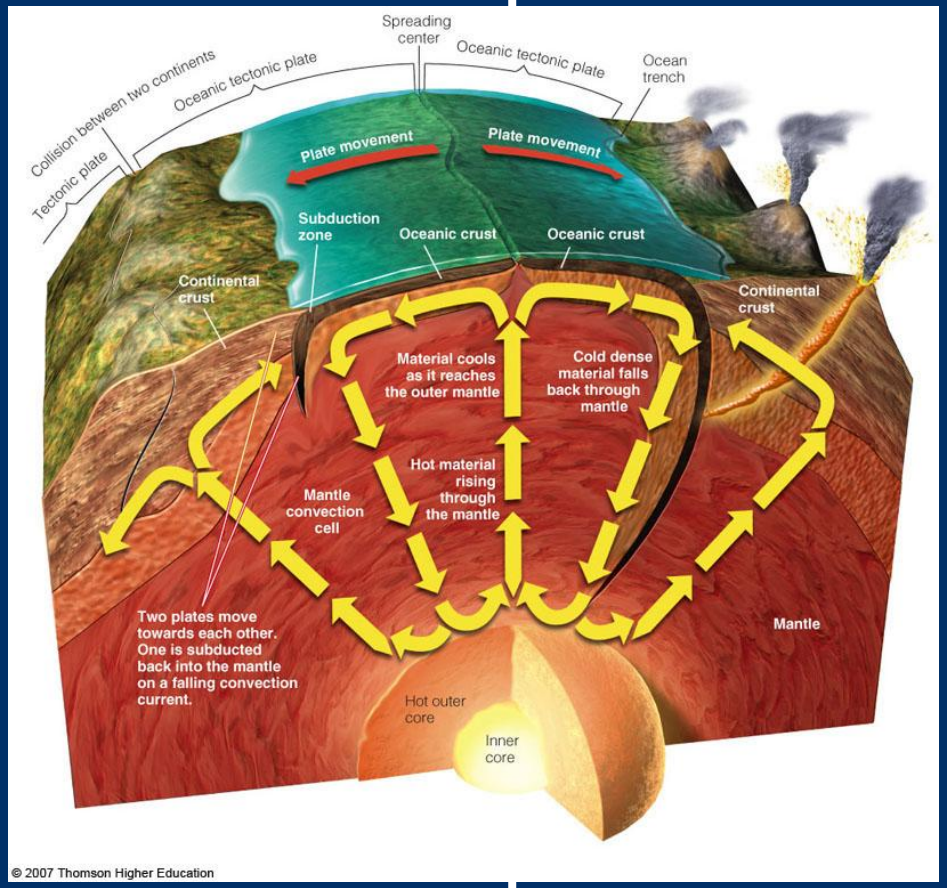

- **Core** – innermost zone with solid inner core and molten outer core; extremely hot.
- **Mantle** – solid rock w/ rigid outer part (**asthenosphere**) that is melted pliable rock
- **Crust** – outermost zone which underlies the continents.

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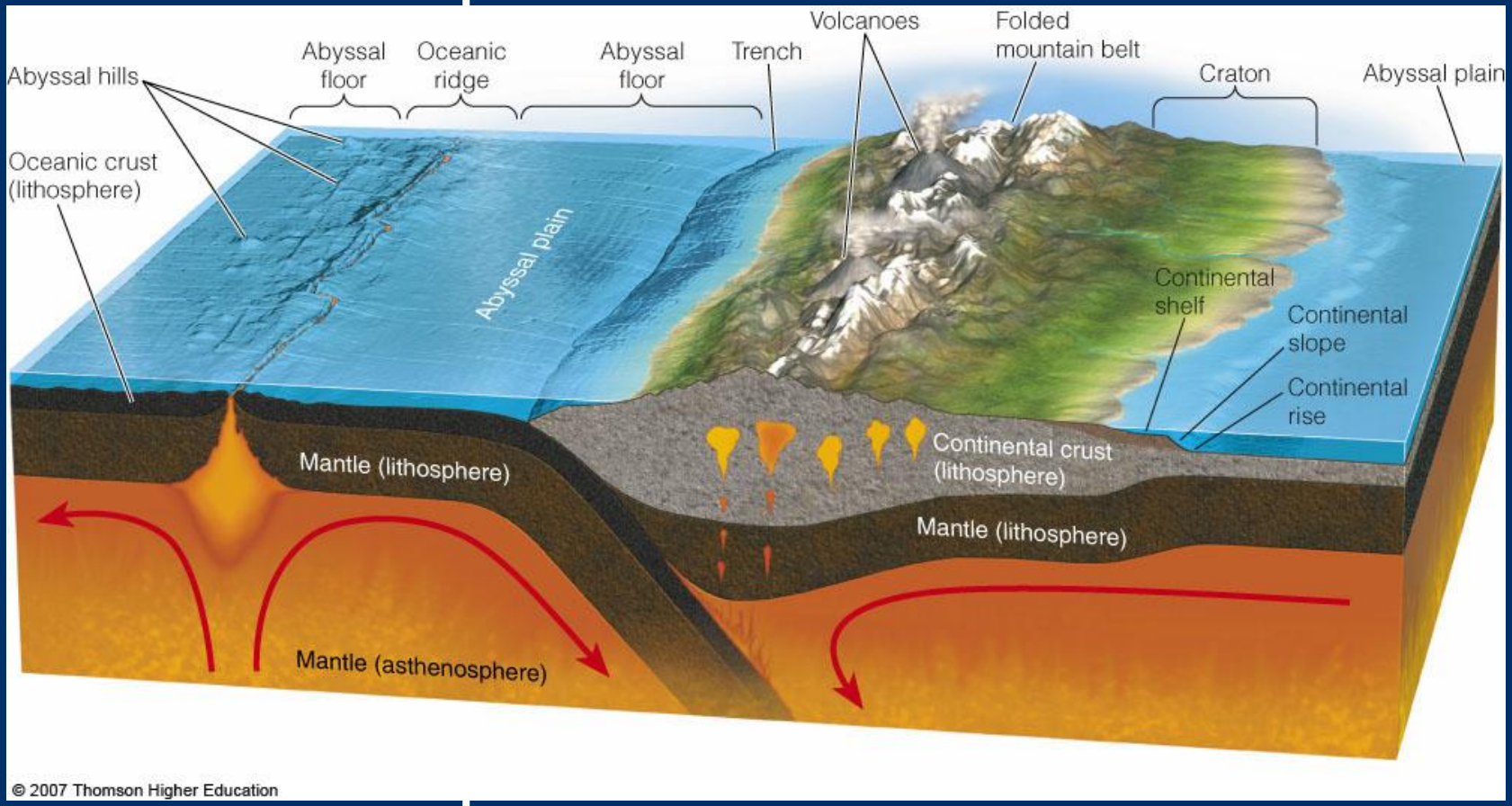
Tectonic Plates



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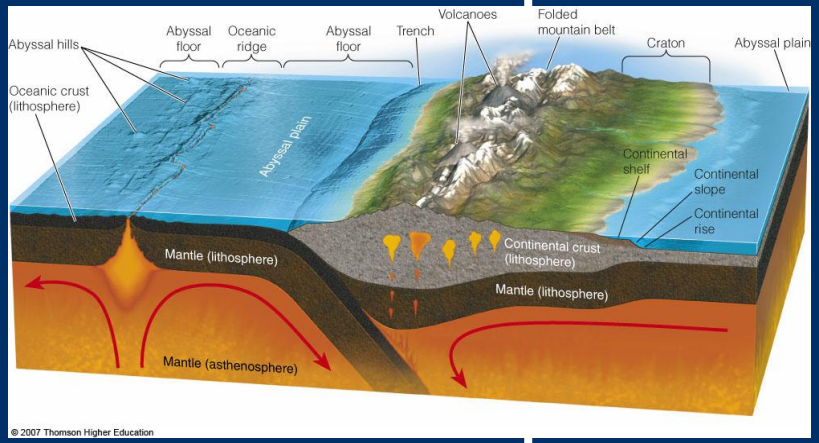

- Huge volumes of heated and molten rock moving around the earth's interior form massive solid plates that move VERY slowly across the earth's surface.
- **Tectonic plates** – huge rigid plates, moved with **convection cells** or **currents** by floating on **magma** (molten rock)

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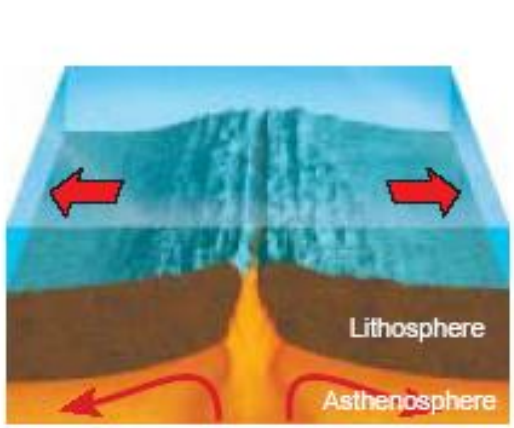
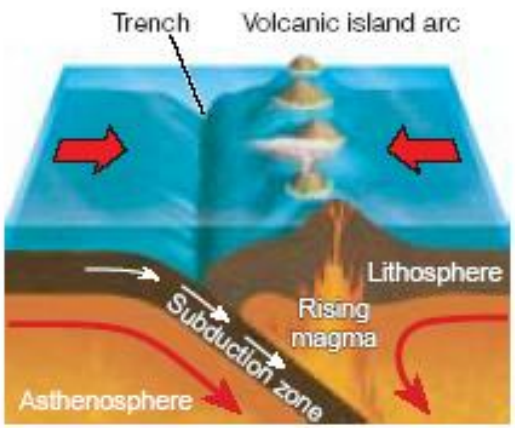
Movement of Tectonic Plates

These plates:

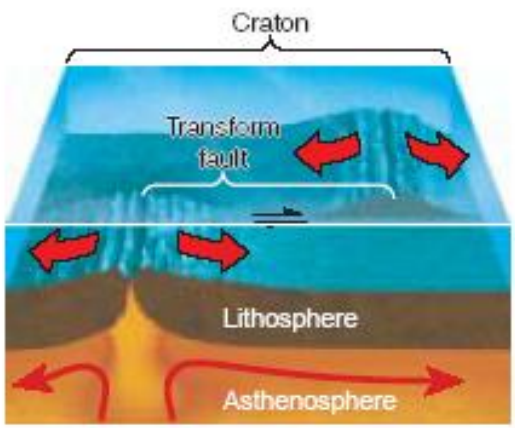
- move apart at **divergent plate boundaries**
- collide w/ another plate at **convergent plate boundaries**
- slide past at **transform fault boundaries**



Divergent plate boundaries



Convergent plate boundaries



Transform faults

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Fig. 15-4, p. 338

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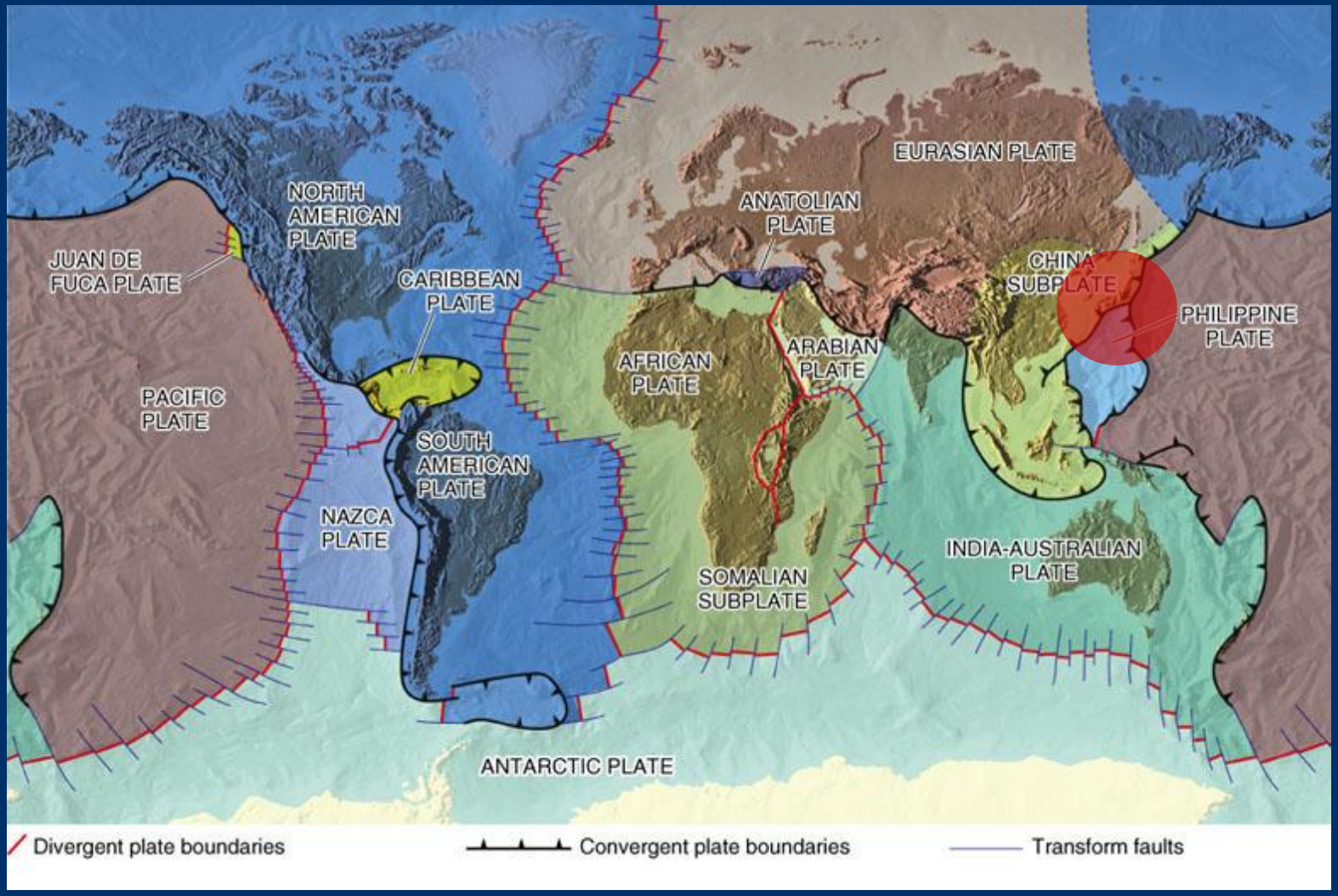

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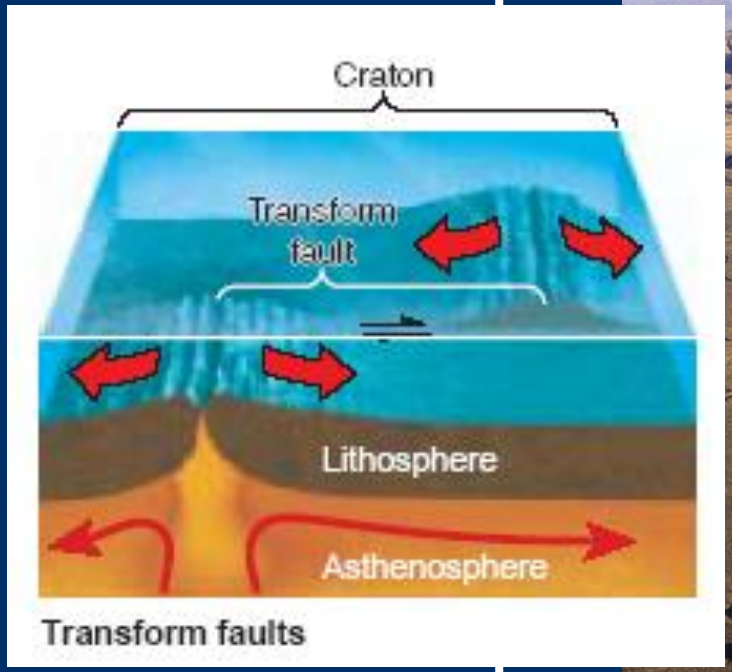

Transform faults


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- Ex: The San Andreas Fault

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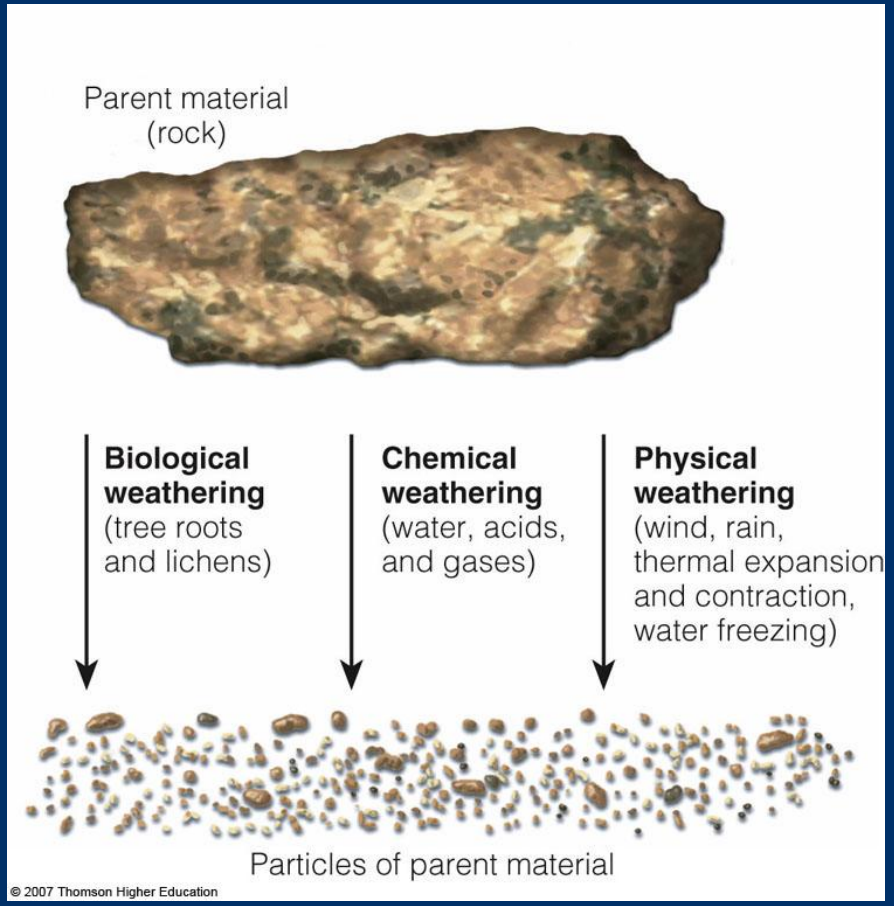
Wearing down Earth's Surface

- **Weathering** – an external process that wears down the earth's surface



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Geologic Processes

- A VERY slow chemical cycle recycles 3 types of rock found in the earth's crust
- **Sedimentary rock** (sandstone, limestone)
- **Metamorphic rock** (slate, marble, quartzite)
- **Igneous rock** (granite, pumice, basalt)

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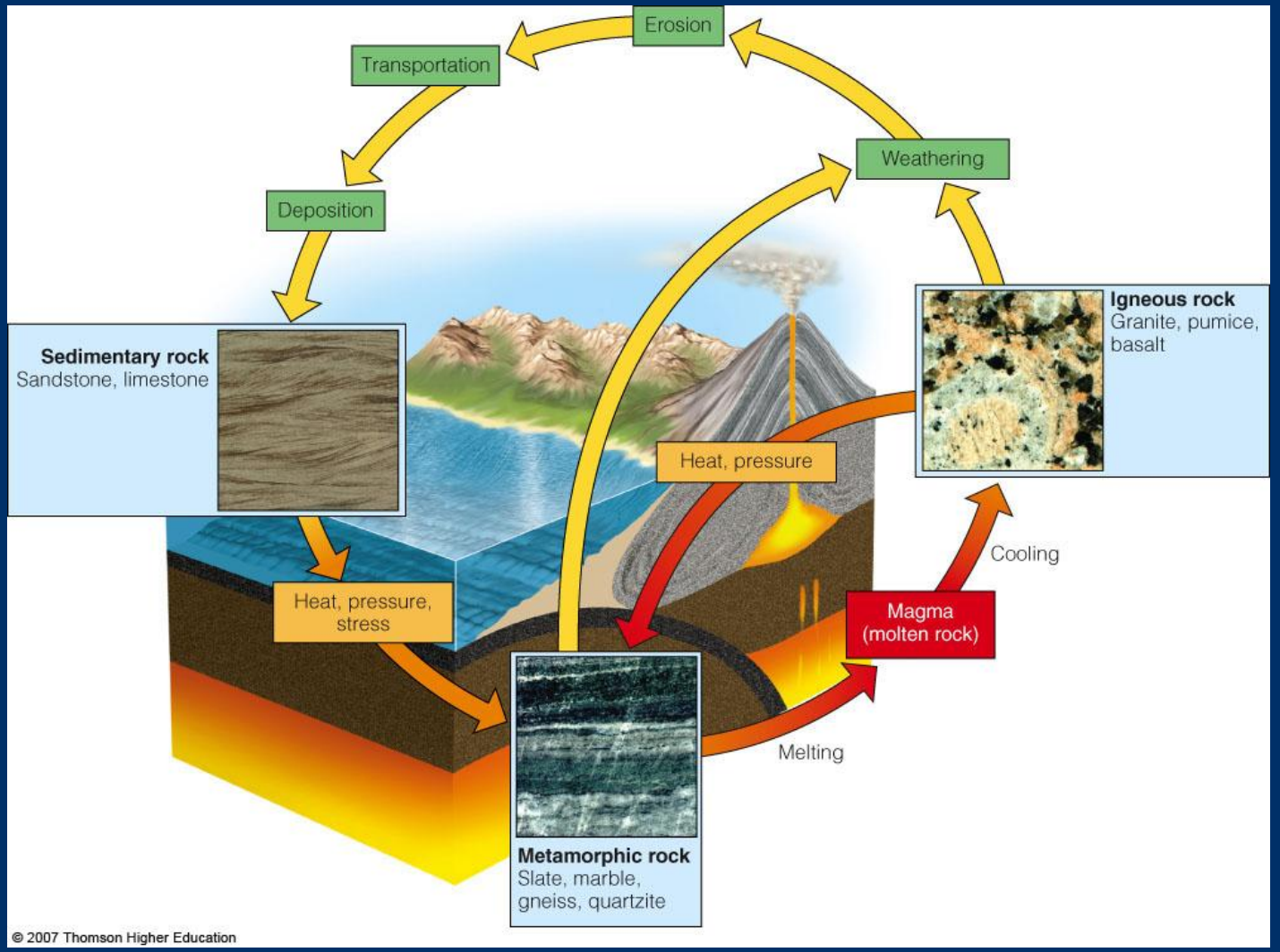
The Rock Cycle



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Economic values

- **Metallic** minerals include are iron, aluminum, manganese, copper, chromium, and nickel.
- **Nonmetallic** minerals include mica, asbestos, limestone, gravel, sand , graphite, diamonds, and other gemstones.

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Environmental costs

- The extraction, processing, and use of mineral resources has a significant environmental impact.
- How much does it cost to make a car?

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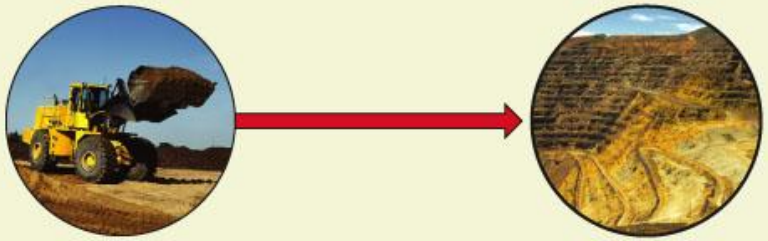
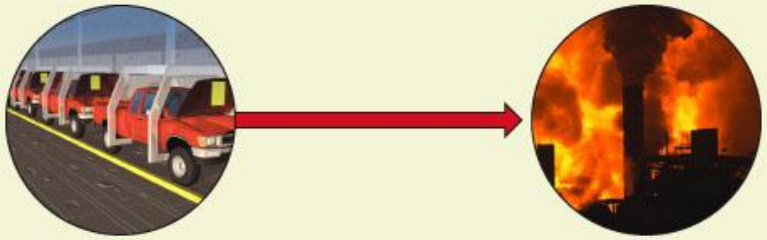
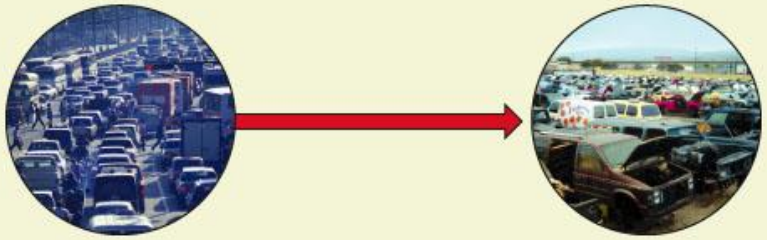
The Rock Cycle

Natural Capital Degradation

Extracting, Processing, and Using Nonrenewable Mineral and Energy Resources

Steps		Environmental effects
Mining Exploration, extraction		Disturbed land; mining accidents; health hazards, mine waste dumping, oil spills and blowouts; noise; ugliness; heat
Processing Transportation, purification, manufacturing		Solid wastes; radioactive material; air, water, and soil pollution; noise; safety and health hazards; ugliness; heat
Use Transportation or transmission to individual user, eventual use, and discarding		Noise; ugliness; thermal water pollution; pollution of air, water, and soil; solid and radioactive wastes; safety and health hazards; heat

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Open-pit Mining

- HUGE holes dug for removal of ores, sand, gravel, and stone.
- Toxic (acidified) water can accumulate at the bottom.

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Strip Mining

- strips away surface rock (**overburden**)
- leaves highly erodible hills of rubble called **spoil banks**
- NO top soil so vegetation is slow to recover

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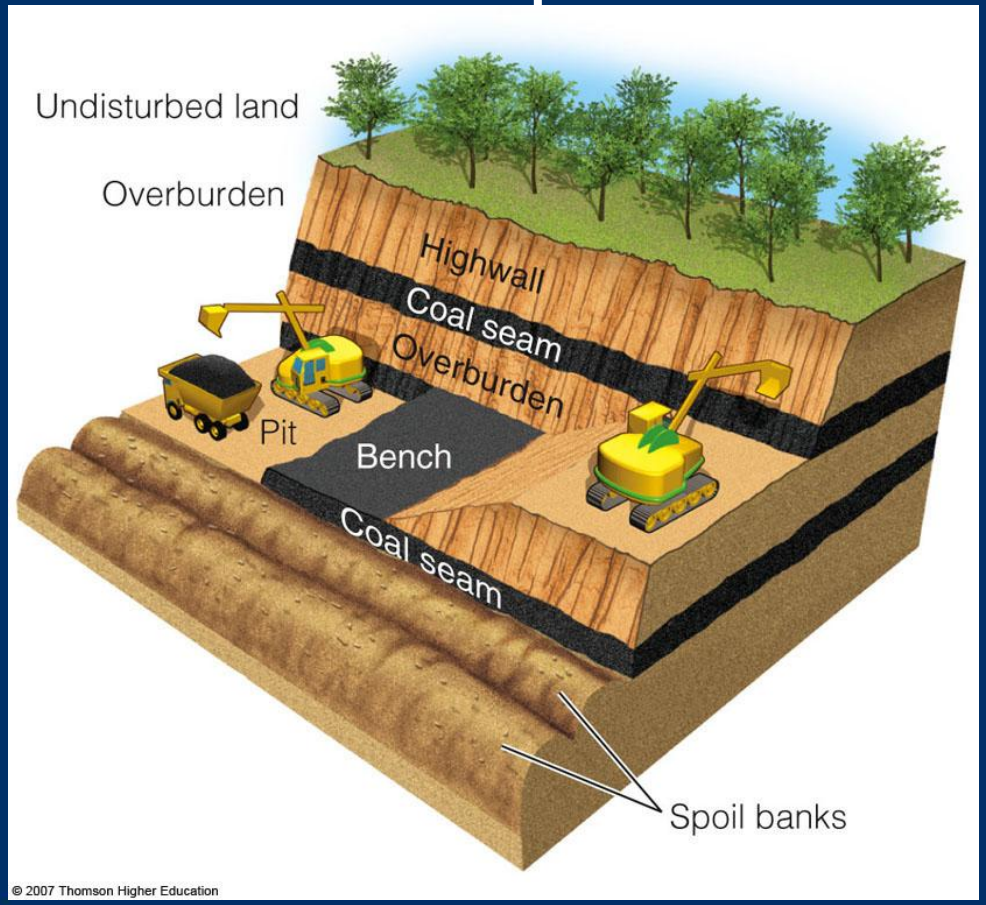
Contour Strip Mining



- Used on hilly or mountainous terrain.
- Unless the land is restored, a wall of dirt is left in front of a highly erodible bank called a **highwall**.

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Mountaintop Removal

- Removes overburden off the tops of mountains to expose coal
- The resulting waste rock and dirt are **dumped into the streams and valleys below**.
- Alters topography of area

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Harmful Effects

- **Air pollution** from **smelting** (heating)
- **Contamination of cyanide and heavy metals** from **heap leach extraction** (spraying ore w/ cyanide solutions to dissolve gold, etc.)
- **Erosion**
- **Altered topography** from mountaintop mining

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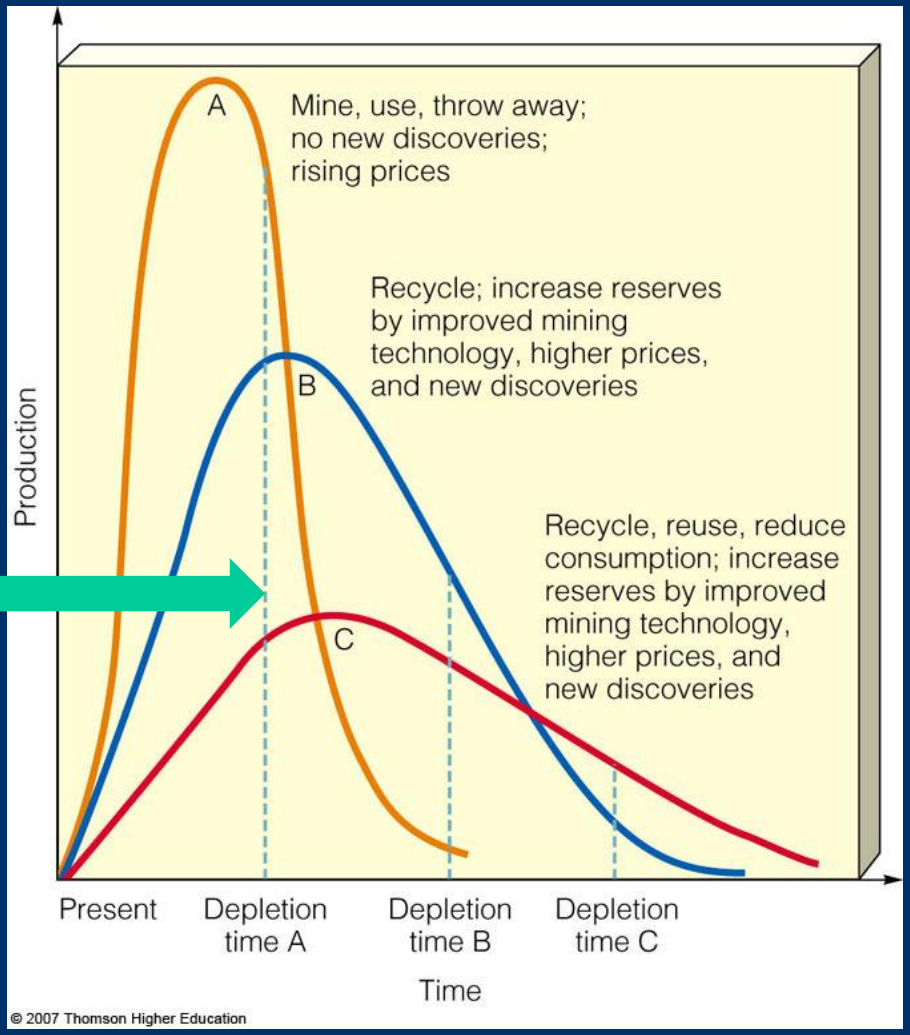
Projected Depletion Rates

- Dashed vertical lines represent times when 80% depletion occurs.



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Using Resources more Sustainably

Solutions

Sustainable Use of Nonrenewable Minerals

- Do not waste mineral resources.
- Recycle and reuse 60–80% of mineral resources.
- Include the harmful environmental costs of mining and processing minerals in the prices of items (full-cost pricing).
- Reduce subsidies for mining mineral resources.
- Increase subsidies for recycling, reuse, and finding less environmentally harmful substitutes.
- Redesign manufacturing processes to use less mineral resources and to produce less pollution and waste.
- Have the mineral-based wastes of one manufacturing process become the raw materials for other processes.
- Sell services instead of things.
- Slow population growth.

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Using Resources More Sustainably

- **Eco-industrial** revolution
- Redesign industrial manufacturing processes to mimic how **nature** deals with wastes
- Industries can interact in complex resource exchange webs in which wastes from manufacturer become raw materials for another.

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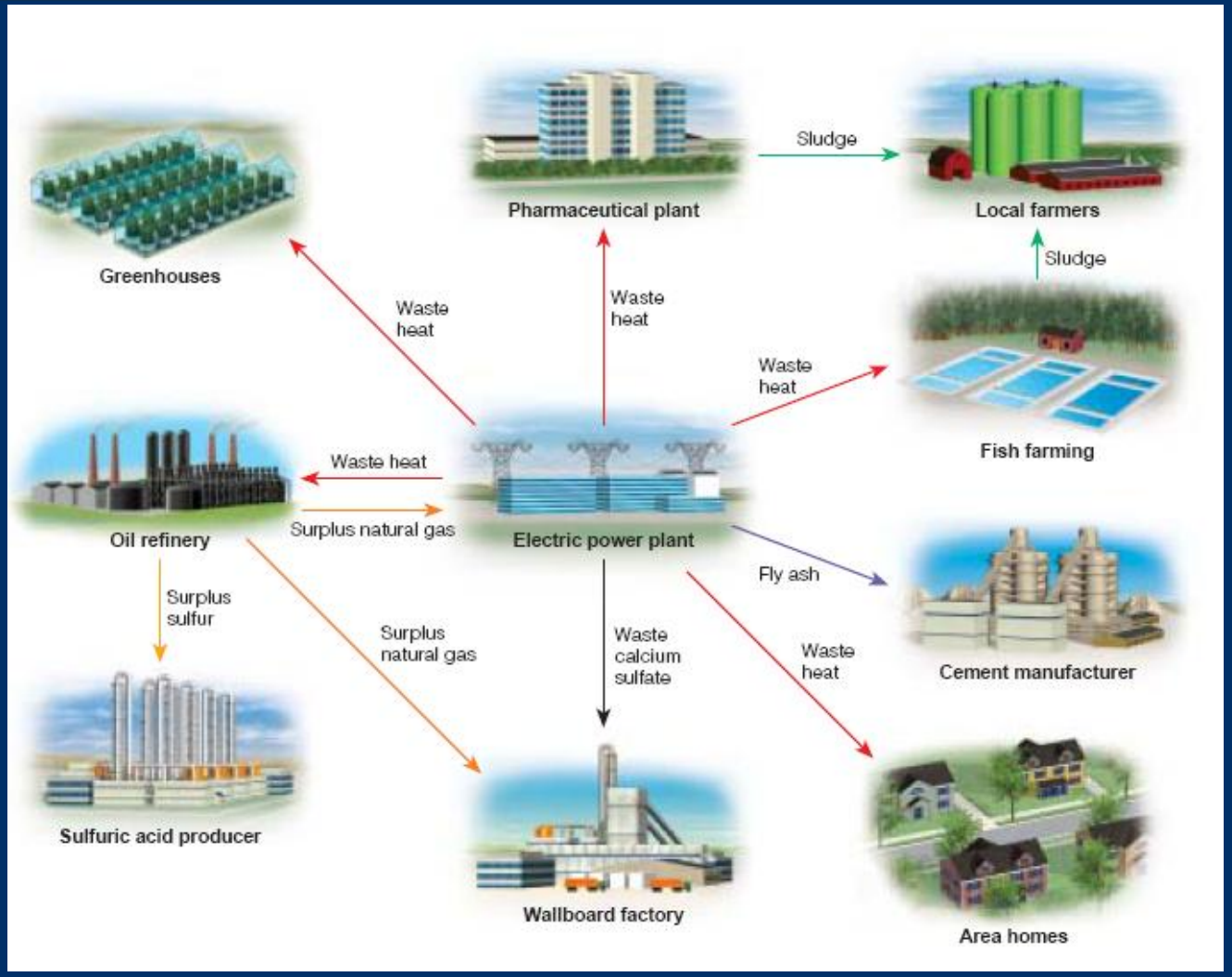

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