Geology of the Hawaiian Islands
Class 27
20 April 2004

Please finish assignments
- HW #7 – You may turn it in Thursday in class. I will not accept it after that.
- All Virtual Field Trip quizzes. I will accept them until April 29th.

Any Questions?

Natural Resources
Two Kinds:
- Renewable and Non-renewable
Renewable Resources
- Renewed or replenished through natural forces, such as wind or sun
- Other examples include biomass (food, timber, etc.), geothermal, hydroelectric (water power) and heat from the ocean
- Can be replenished as fast as they are consumed

Nonrenewable Resources
- Geologic Resources
- Form so slowly that they cannot be replenished in our lifetimes

Geologic Resources
3 main categories:
- Energy resources – petroleum (oil & natural gas), coal, uranium and geothermal
- Metals – iron, copper, aluminum, gold, silver, platinum, etc.
- Nonmetallic: sand and gravel, limestone (for cement), sulfur, gems, fertilizers, groundwater

Plate tectonic setting of geologic resources
Energy

- Most important category of natural resource
- Coal, petroleum, geothermal, etc.

Energy Mix in the U.S. 1850–1997

Energy Use

Lost energy from:
1. Inefficiency of use

Energy Use

Lost energy from:
2. Realities of physics limit efficiency of any engine and thus the fraction of available energy that can be usefully employed
World Petroleum Demand Currently very close to the level of supply

Petroleum in the U.S.
- Domestic production (Sept., 2002) = 8,870,000 BOPD*
- Total use = 20,000,000 BOPD
- U.S. imports = 11,130,000 BOPD
- Imports = 56%

* Barrels of Oil Per Day

U.S. Petroleum Use
- > 7 billion barrels of oil per year
- This is almost 30% of the earth’s oil use, even though we only have 6% of the earth’s population

How do oil and gas deposits form?
- Production of large amounts of organic material (mainly microscopic plants and bacteria)
- Preservation in a reducing (oxygen-poor) depositional environment (e.g., restricted ocean basin)
- Burial causes increased heat and pressure, resulting in maturation (the physical and chemical breakdown of organic matter into a liquid or gaseous hydrocarbon compounds) in a source rock.
There's more:
- Migration of fluids out of the source rock into a more permeable reservoir rock.
- Trapping of fluids must occur by encountering an impermeable seal.

So, we need:
- Production
- Preservation
- Maturation
- Migration
- Trapping

How much oil is left?
- Proven reserves: 700 billion barrels (over half in Middle East)
- Petroleum resources: 2 trillion barrels
- 1997 consumption: ~70 million barrels per day
- At this rate reserves will last between 25 and 80 years.
This assumes no increase in the rate of consumption, but

- Between 1985 and 1995, consumption of oil in the world increased by 16%.
- The increase in Latin America was 30%.
- The increase in Africa was 40%.
- The increase in Asia was 50%.

Sedimentary basins where large amounts of oil and gas might be found

U.S. reserves of oil

- Amount of oil that we have identified and can produce
- About 25 billion barrels
- If we had to use only our own oil, it would last for only about 4 years

U.S. reserves of oil

- Oil companies adding to the reserves by finding about 3 billion barrels per year
- So the supply would actually last for about 8 years
U.S. Imports of Foreign Oil

- We can exist this way as long as nothing happens to our supply of foreign oil
- Any disruption of the supply of oil could have drastic effects on the U.S. economy

Coal

- Coal is usually formed in swamps
- 1st stage - peat (high C, high H₂O)
- P, T ← loss of gases, toward higher C

Ranks of coal:
- Anthracite
- Bituminous
- Subbituminous
- Lignite

Coalfields of the United States

- High sulfur is bad—H₂SO₄ is produced during burning.
- Principal coal producing areas in United States are Appalachia, Wyoming, New Mexico, and Colorado.
Alternatives to fossil fuels

Nuclear energy

Advantage: Virtually inexhaustible supply

Disadvantage: Dangerous waste

Solar Energy

- MECO has operated a 20-kW photovoltaic system since 1989 at the Kihei High Tech Park
- HECO will install a 18-kW photovoltaic system at Hickam AFB
Wind Energy

- HEI is developing a 10-MW windfarm in North Kohala
- Plans for a 20-MW wind turbine park on Maui

Alternatives to fossil fuels

OTEC
- Ocean Thermal Energy Conversion
- Uses thermal energy stored in the surface layers of the ocean
- Uses mechanical energy available from tides and waves

Uses of OTEC

- Electricity
- Desalination
- Irrigation
- Marine culture
- Alkaline Chlorine Oxidation
- Desalinization
- Energy/heat/steam/ refrigeration
- Building air conditioning
- Waste treatment
As long as the temperature between the warm surface water and the cold deep water differs by about 20°C (36°F), an OTEC system can produce a significant amount of power.

Alternatives to fossil fuels
Geothermal Energy
Thursday’s topic
Selected commodities that the U.S. imports

Mineral deposits
- If deposited in concentrated volume, we get veins or lodes.
- If deposited in large volume, we get disseminated deposit.
- grade: The relative quantity of ore in an ore body (gold ≈0.05 oz/ton)

Mineral deposits
- hydrothermal deposits: minerals deposited from hot waters usually associated with igneous intrusions
- These fluids carry “low temperature ions”; when the fluids cool off (near surface) the solubility goes down and minerals with Pb, Fe, Hg, Cu, Zn, Ag, Au, etc. are precipitated.

Iron Ores
- Magnetite
- Siderite
- Pyrite
- Hematite
Native Gold on a Quartz Crystal

Metal Sulfide Ores
- Galena
- Cinnabar
- Pyrite
- Sphalerite

Copper Ores
- Chalcopyrite
- Malachite
- Chalcocite

Hydrothermal Ore Deposits
- Interbedded, deformed, and/or metamorphosed country rocks
- Fluids rise through fractures and fissures and migrate along bedding planes
- Mineral deposits form by fluids
- Some fluids reach surface as geysers or hot springs
Open-pit Copper Mine, Arizona

Sedimentary mineral deposits

- Banded iron formations
- Placers
- Clays
- Sand and gravel

Major Nonfuel Sub-sea Ore Deposits
Metal Consumption (by Weight) in the United States

Nonrenewable Resources in Hawai’i
- “Fossil” fuels?
- Metals?

Manganese Nodule

Nonrenewable Resources in Hawai’i
- “Fossil” fuels?
- Metals?

Maybe some manganese nodules offshore, but very expensive to produce
Nonrenewable Resources in Hawai`i

- Sand
  - A valuable resource for restoring our beaches
- Rocks and coral
  - Building/construction materials
- Fish, etc.

Questions?

Thursday

- Geothermal resources
- Read Chapter 14