# History of Resource Use

Myths

* Superabundance
  + Resources so abundant it didn’t matter how they were treated
  + Would never run out
  + Supplanted by…
* Scientific Supremacy
  + Trusting that science will provide answers to any environmental crisis
  + Problem: Nature is not only more complex than we know, its much more complex than we can know

Humans and Metals, a history

* Early availability of native metals
  + Cooper most widely distributed
    - Harder and stronger than others
    - Advantages apparent, used in Neolithic times
* Shift to bronze
  + Copper alloyed with tin
  + Problem: Tin was rare
    - Only known large deposits of tin in western great Britain
    - Establishment of tin trade routes led to bronze age
* Bronze into Iron Age
  + Iron began to be worked around 1300 BC
    - First iron came from meteorites
  + Bronze age ended ~800 BC
  + Iron requires more energy
    - Could not be smelted easily, just heated enough to be reworked
    - Must be smelted in a very hot fire, requiring charcoal
      * Wood cooked in low oxygen environment
      * Process burns off volatiles
  + Blast furnace (1340 CE)
    - Major breakthrough
    - Large amounts of iron could be produced
  + Environmental crisis:
    - Demand for iron lead to energy crisis and forests were cut down to produce charcoal

Global Exploration

* As Europe grew, sought new sources of resources
* Portugal and Spain fight over “New Worlds”
  + 1494: Pope intervened and divided world in halves
  + Spain got the world west of Cape Verde islands (in north atlantic)
    - Exploits Americas

Need for new energy

* By 1700s, England’s forests depleted, threatened economy
* Price index of charcoal quadrupled from 1560 to 1660 while everything else doubled
* Solution: coal
  + Developed as new source of fuel for iron
  + Allowed more and larger iron production furnaces
  + Close to a single coal seam

Steel

* Cast iron no longer sufficient –
* Coke made by heating coal in absence of air
* 1740 – carbon steel
  + Blow air through molten iron
  + Lowers carbon content less than 1%
* Steel not only stronger and easier to work, more flexible
  + Flexibility was critical
  + Allowed use in construction (eg bridges)

Industrial Age

* Fueled by population growth
* Implications:
  + People migrated to cities
  + Environmental degradation accerated
  + Coal demand leads to railroads and canals
* Impact on working conditions
  + Child labor
  + Dangerous conditions
* New metals:
  + Nickel -> Ni-Steel
    - 1889
    - Military applications (armor, shells)
    - Alloys
      * 70% of nickel goes to stainless or other alloys
      * Nickel adds strength and corrosion resistance
  + Aluminum (1827, but hard to extract)
  + Other metals combined with steel:
    - Cobalt
    - Titanium
    - Molybdenum
* Technology changes:
  + Spurred by development of internal combustion engine, aircraft, weaponry
    - Aircrafts -> aluminium and titanium
    - Jet engines need high strength, light, heat resistance

Paved way for modern age

* Energy and Weapon use of uranium and thorium
* Medicine:
  + Barium dyes for x-rays
  + Radioactive elements for cancer treatments
* Electronics:
  + Gallium and germanium in transducers
  + Rare Earth Elements in color TV
    - Phosphores
* Catalysts in chemical (oil) processes
* Car catalysts – platinum, rhodium or palladium

Relationship status between wealth and resources

* Majority of human wealth comes from agricultural, manufacturing, or mineral resources
* Modern society built around exploitation and use of mineral and natural resources

Consumption Growth

* Economic growth
  + In order to grow, we must keep consuming
  + Requires:
    - Population growth, and/or
    - Productivity growth
* US mineral consumption
  + Shift to nonrenewable
    - 1900 -> almost half of materials from reneweables
    - 1995 -> 8% of total consumption
    - Why?
      * Combination of new products and markets and replacements in established markets
      * Natural fibers -> synthetic fibers
      * Wood -> plastics
      * Natural oils -> synthetic oils
  + Total minerals consumed by since WW2 more than all other consumption
  + 5% of world population uses 30% of world’s resources
  + Important trends:
    - Rate of mineral resource use has risen more rapidly than population growth
    - Percentage of mineral resource being supplied domestically decreased

# Resource Conflict and Control

Countries rich in minerals are often marred by corruption, authoritarianism, militarization, and civil war. Rebel groups, governments, and mining resources exploit mineral resources, fueling civil and interstate conflict as players vie for control over riches

* Smuggled diamonds have been used to fund armed rebel groups involved in civil wars in states such as Sierra Leone, Angola, and the Democratic Republic of the Congo

Resource curse

* Countries rich resources have worse economic development than countries with fewer resources
* Resource wealth : Corruption
  + Instability
  + No sustainable development
* Example: Coltan mining and the Congo
  + Columbite-tantalite is a dull metallic ore found in eastern Congo
    - Becomes metallic tantalum, heat-resistant powder that can hold high electrical charge
    - Vital for capacitors
    - Used in almost all computers
      * Recent tech boom caused price of coltan to skyrocket to $400/kg at one point
  + In order to mine for coltan, rebels overran Congo’s national parks, clearing large forests
  + Poverty and starvation caused by the war drove miners and rebels to hunt the parks endangered elephants and gorillas for food
  + International community failed to tackle link between exploitation and conflict in the Congo
  + War-related death toll in east congo at 2 million as result of two year war over resources by 2000

Oil in Middle East

* 1908 – Millionaire D’Arcy struck oil in Western Persia, first discovery
  + Britain negotiated oil contracts with Iran in 1911
* 1920s – American oil involved with Saudis
  + 1930s, Oil Well #7 was first to turn Saudi’s fortunes when SoCal geologists got permission to drill
* 1950s – Boom time for international oil companies in the middle east
  + Import quotas introduced in US to protect domestic production
  + Lower revenues from ME countries, upset ME countries

Resource Cartels

* Group of entities who collude control production and price of commodity
* OPEC – Oil
  + Up to 1960s, companies slashing prices for Venezuelan and ME crude
  + Formed OPEC to:
    - Get larger share of revenues produced by western oil companies
    - Get greater control over production levels
  + 1970s – greater than half of worldwide oil production
  + Today:
    - 15 nations,
    - 44% of oil production
    - 82% of proven reserves

Yom Kippur War and 1973 Oil Embargo

* Arab OPEC nations (OAPEC) enacted production costs and an oil embargo against irael-friendly nations
* Embargo lasted 5 months from October ’73 to March ‘74
  + 400% increase in OPEC revenue
* Rationing and panic
  + UK imposed 3-day workweek
  + 7 countries banned non-essential Sunday driving
  + US gas stations closed on Sundays and restricted days gas could be purchased
  + Global recession, increased unemployment, inflation surged
* Post-mortem international response:
  + International Energy Agency
    - Promotes alternate energy sources, rational energy sources, multinational energy technology cooperation
    - Member countries required to maintain total oil stock levels equivalent to 90 days of previous year’s net imports
  + Oil conservation efforts
    - Lower speed limits
    - Energy efficiency
    - Mass transit improvements
    - Alternate energy emphasis

Success of OPEC

* Much can be attributed to Saudi Arabia’s world oil supply dominance
  + Has tolerated cheating on part of other cartel members
  + Cut its own production to compensate for other members exceeding quotas
* 1972 - $23 billion from exports
* 1977 - $140 billion

Strategic Reserves

* Petroleum
  + Emergency crude stored in Strategic Patroleum Reserve in salt caverns along TX and LA coastline
* Minerals strategic reserves particularly essential to defense and civilian industries
  + Chromium
  + Cobalt
  + Manganese
  + Platinum group metals

Defense and the Environment

* Debate over critical and strategic minerals also brought up issue of mining on public lands
* Example: Absaroka-Beartooth Wilderness in Montana
  + Chromium and platinum-palladium reserves
  + 70% of domestic reserves of platinum group metals

DeBeers

* Founded in 1888 to establish control over diamond market
  + Only release enough stones meet demand
* Diamond price largely arbitrary
* Until the start of 21st century, DeBeers had total control over market
  + Convinced independent producers join
    - If that didn’t work, flooded market with comparable diamonds
  + Bought diamonds when prices fell considerably
  + Competition has since dismantled the monopoly
* Kept expenses low via explitative labor policies
  + Strict worker control
  + Migrant workers on limited contracts
  + Poor working conditions

# Metals

Abundances:

* Abundant -- >0.1% of crust’s weight
  + Iron, Aluminum, Magnesium, Manganese, Silicon, Titanium
  + Future availability never in doubt
* Scarce -- < 0.1% of crust’s weight
  + Ferro-alloy metals
    - Nickle, Chromium
  + Base
    - Copper, Lutetium
  + Precious
    - Gold, Silver, Platinum
  + Special
    - Gallium, Germanium, rare-earth elements

Iron

* 94% of all metal consumed
* Abundant, easy to smelt, low cost, strong, durable, easy to work
* Minerals:
  + Hematite
  + Magnetite
* Banded iron formations

Aluminum

* 2nd most abundant metal after silicon
* Very difficult to free from mineral forms
  + Only been mined for 125 years
* 2nd most widely used metal after iron
* Use today
  + America uses 44 lbs/person/year
* Bauxite
  + Easy to mine the ore
  + Processing very energy intensive
    - Much higher than other common metals
    - Much less needed to recycle aluminum
  + Tropical
* History:
  + Growth coincided with development of major power networks
  + Leveled off after 1973 energy embargo

Titanium

* Used large scale for 50 yrs
* Alloys – high strength to weigh ratio, melting point, and corrosion resistance
* White titanium oxide pigment
  + White, opague, permance of color, low toxicity
  + Principal pigment in paint, paper, plastic, rubbers and more
* Processing
  + Mining pretty low impact
  + Processing produces large amount of toxic sulfate and sulfuric acid waste

# Mining

Surface mining

* 2/3 of mineral production
  + Sand and gravel, crushed stone, phosphates, coal, copper, iron, and aluminum
* Open pit and strip mining
  + Open pits economical where:
    - Large reserves involved
    - High rates of production desired
    - Overburden is thin enough to be removed
* Advantages:
  + Safer
  + Fewer complications

Underground mining

* Extracts solid min3w