UTAH OFFICE OF
ENERGY DEVELOPMENT

Utah Copper

Grade/Subject: 8th-grade Integrated Science

Strand/Standard 8.4.2 Engage in an argument supported by evidence about the effect of per capita consumption of natural resources on Earth's systems. Emphasize that these resources are limited and may be non-renewable. Examples of evidence include rates of consumption of food and natural resources such as freshwater, minerals, or energy sources. (ESS3.A, ESS3.C)

Lesson Performance Expectations: Students will write an argument related to the per capita consumption of copper and its effect on the Earth's Systems.

Materials: Student computers

Time: Depending on the length and depth the teacher assigns to the argument paper.

Teacher Background Information:

- Copper Mining and Production Wastes (EPA)
- How Metal Mining Impacts the Environment
- World Atlas
- The Environmental Impact of the Mining Industry
- Copper Alliance Copper Recycling
- Sustainable Copper
- RioTinto Kennecott

Student Background Knowledge:

- Students should be familiar with copper in the form of pennies, but you may need to remind them of other places copper is used. Copper is one of the oldest metals ever used and has been one of the critical materials in the development of civilization. Because of its properties, singularly or in combination, of high ductility, malleability, thermal and electrical conductivity, and its resistance to corrosion, copper has become a primary industrial metal, ranking third after iron and aluminum in terms of quantities consumed. Electrical uses of copper, including power transmission and generation, building wiring, telecommunication, and electrical and electronic products, account for about three-quarters of copper use. Building construction is the single largest market, followed by electronics and electronic products, transportation, industrial machinery, and consumer and general products. Copper byproducts from manufacturing and obsolete copper products are readily recycled and contribute significantly to copper supply. (USGS)
- Today, roughly 700 million metric tons of copper have been produced worldwide. This would fit into a cube measuring about 430 meters on each side.

- Identified deposits contain an estimated 2.1 billion metric tons of additional copper, which brings the total amount of ***discovered*** copper to 2.8 billion metric tons. This would fit into a cube measuring 680 meters on a side, the size of seven football fields. It is also estimated that ***undiscovered*** resources contain about 3.5 billion metric tons of copper, which would mean that there are roughly 6.3 billion metric tons of copper on Earth. This would fit into a cube measuring about 890 meters on each side.
- Of the identified copper that has yet to be taken out of the ground, about 65% is found in just five countries on Earth -- Chile, Australia, Peru, Mexico, and the United States.
- Copper is usually found in nature in association with sulfur. Pure copper metal is produced from a multistage process. Beginning with mining and concentrating low-grade ores containing copper sulfide minerals, followed by smelting and electrolytic refining to produce a pure copper cathode. An increasing share of copper is produced from acid leaching of oxidized ores (USGS).

Teacher Step by Step: A 3-D lesson should insist that students think deeply. Provide time and space for the students to experience the phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

Introduce *Phenomenon:* *Observation of event, data, or other evidence of activity.*

The photo below shows the Bingham Canyon Copper mine in Salt Lake County, Utah. This is one of the world's largest copper mines.

https://farm4.staticflickr.com/3764/13613808365_effbb88d73_b.jpg

1. Ask students to record what questions they have about the phenomenon on their student sheets.
2. You can enlarge the background information on the student sheet into classroom sets rather than on student pages. Use it for classroom discussion to help students understand the ideas of per capita consumption and the concept of more and less developed countries.
3. Students will need help developing their claims. You might wish to limit the claims to one Earth system and check their claims before they proceed to write their argument. Most claims will state that copper mining is disruptive

to Earth Systems, and the evidence is easy to find. What is more important is the reasoning portion. Insist that students present reality-based solutions to the problem. The Rio Tinto Kennecott site has some excellent examples of this being done. Ideally, students will also address the per capita consumption of copper and ways that could be reduced.

4. Students can share arguments, read aloud, publish them, or send them to copper companies or senators.

Assessment of Student Learning.

A rubric for the argument might include the number of evidence statements required, documentation of sources, and the sophistication of the solutions presented.

Standardized Test Preparation:

1. Which of the following statements shows a "per capita" relationship?
    a. Students collect as many pennies as they can.
    b. Students in a class have a total of 423 pennies.
    c. Students in a class have a range of 20 to 8 pennies.
    d. Students in a class have an average of 14 pennies each.*

2. Less developed countries use less copper per capita than developed countries, yet their demand for copper is predicted to rise quickly. Choose two reasons for this:
    a. Lack of copper available for all countries.
    b. Reduced demand by developed countries.
    c. High population growth in less developed countries.*
    d. Increasing demand for products in less developed countries.*
    e. Overconsumption of resources by less developed countries.

3. Which of the following are problems most likely found in a large copper mine like the Bingham Canyon Mine? Choose two.
    a. Difficulty finding copper.
    b. Groundwater pollution.*
    c. Disposal of rock wastes.*
    d. Increased wildlife populations.
    e. Tourists wish to see the mine.

4. Which of the following are practical methods to reduce the effect of a mine on a community?
    a. Refilling the hole created by the mine.
    b. Closing the mine to reduce the impact.
    c. Resurfacing and replanting the waste rock piles.*
    d. Finding new uses for the product in the community.
    e. Purifying water before it is allowed back into the groundwater.*

Extension of Lesson: Teachers could extend this lesson plan with different minerals or energy sources. Iron, magnesium, silver, oil, and coal are all mined in Utah.

Career Connections: Careers in mining are varied. Not just the mining engineers but the smelting, transporting, marketing, employment, environmental consultants, and public relations personnel are possibilities for further research. Representatives from one of these careers can come and speak to the class. Have students read over the list of possible careers in mining from the University of Utah College of Mines and Earth Sciences and research any they find interesting.

Utah Copper

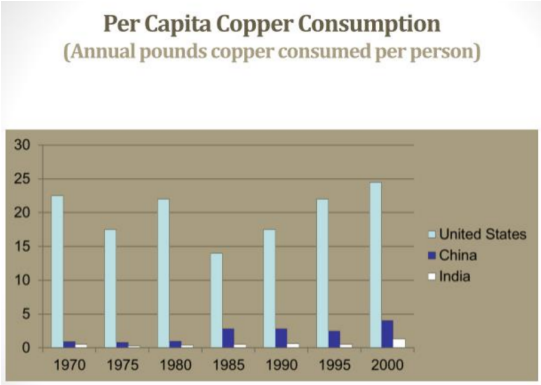
Name_____

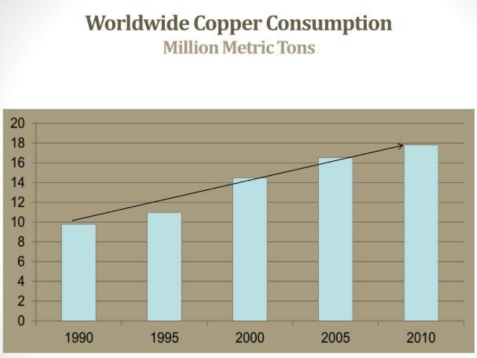
Phenomenon: Study the phenomenon pictured. Ask three questions about what you see.
1.

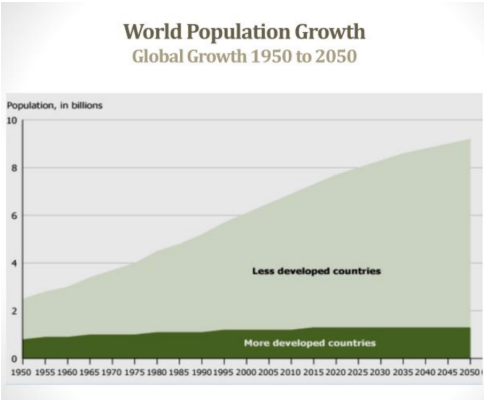
2.

3.

Background information:
Copper is a valuable and important metal, supporting many modern devices, energy grids, and even our money supply (pennies). The Bingham Canyon Copper Pit was created to meet consumer demand for copper. Pit mining disrupts the surrounding environment and leaves visible scars on the land. In this activity, you will **engage in an argument** supported by <u>evidence</u> about the environmental impacts of the per capita consumption of copper. (Enlarged images are available at the end of the document.)
Information about Consumption of Copper:







https://www.slideserve.com/may/santa-cruz-project-pinal-county-arizona

Copper Mining and the Environment: Internet research and suggested sites:

Copper Mining and Production Wastes (EPA)
How Metal Mining Impacts the Environment
World Atlas
The Environmental Impact of the Mining Industry
Copper Alliance Copper Recycling
Sustainable Copper
RioTinto Kennecott

Your claim: Choose an environmental impact of copper mining. Develop a statement relating per capita consumption to that environmental impact.

Your evidence: Use statements from the internet research you performed to support your statement. Cite your sources.

Your reasoning: How can the need for copper balance with the mining processes?

Copper Industry Demand Issues

Global Growth

Downward pressure on demand

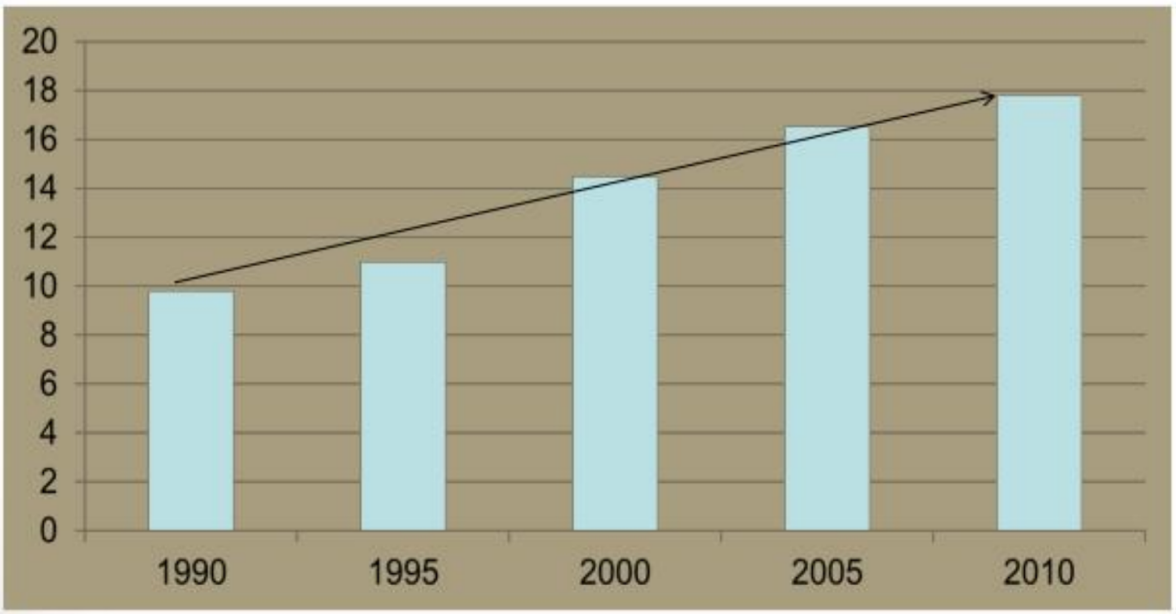
- Wireless technology
- Substitution
- More efficient construction
- Overbuilt infrastructure in Western world

Upward pressure on demand

- Infrastructure in developing world
- Growing world population - 9.2 billion by 2050
- Rising living standards in Asia
- Infrastructure rebuilding in US/Europe
- Alternative energy (solar, wind, electric cars)

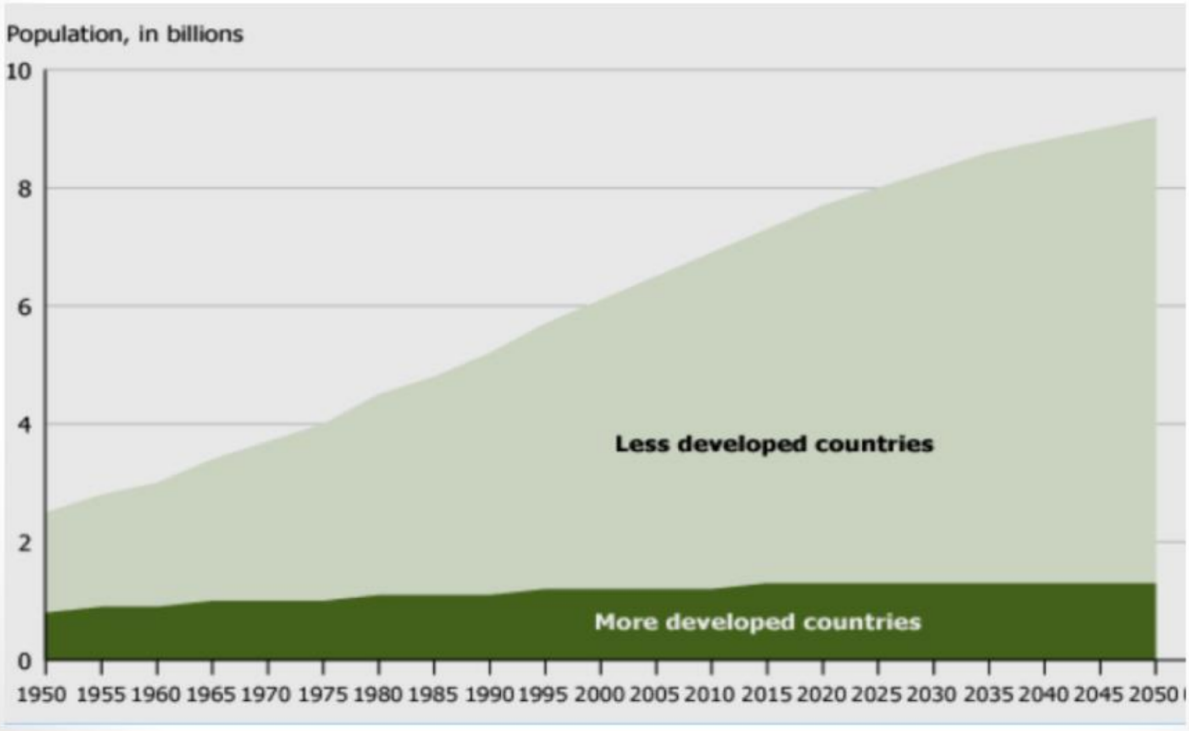
Worldwide Copper Consumption

Million Metric Tons



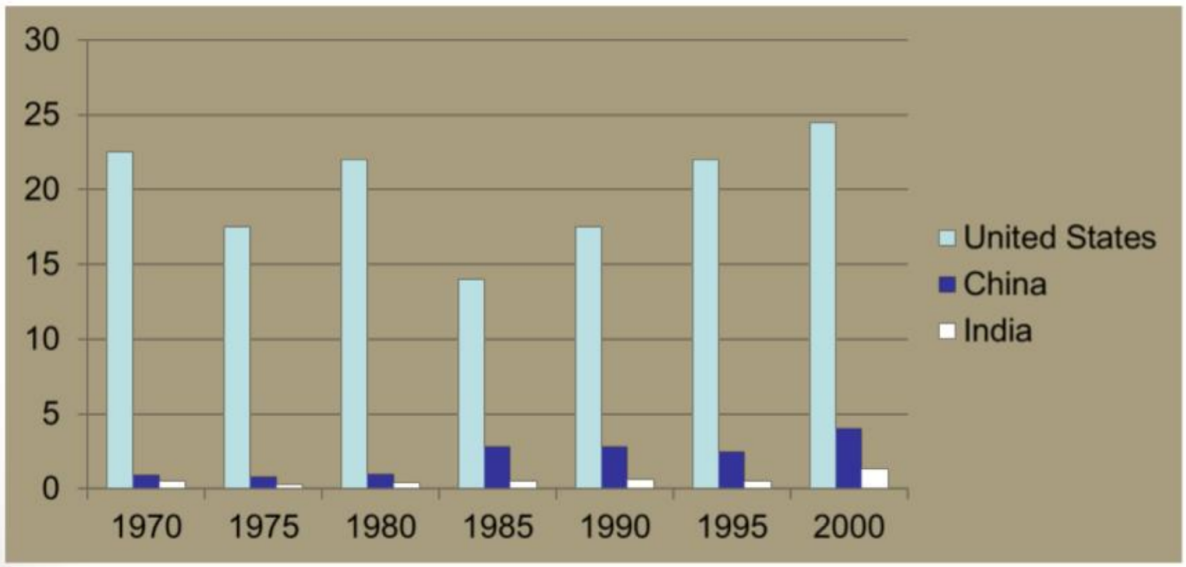
World Population Growth

Global Growth 1950 to 2050



Per Capita Copper Consumption

(Annual pounds copper consumed per person)



8 Challenges in Development of Mineral Resources

- Growing Populations
- Growing per Capita Mineral Use
- Physical Availability of Minerals
- Competition for Land
- Competition for Water
- Competition for Energy
- Biosphere's Capacity to Absorb Mineral Waste
- Technology Development