

History of the Industry and Overview of Minerals & Energy

Wyoming has the smallest population of any state, but it is a top supplier of energy and other mineral resources to the rest of the nation. Wyoming produces more energy than the lowest-ranking 28 states combined. Our clean coal produces electricity in more than 30 states. Wyoming is also the top supplier of uranium for energy across the country. Additionally, Wyoming has large amounts of minerals such as trona, bentonite, and rare earth minerals, which are used in many products that we use today, like toothpaste, glass, and magnets. Wyoming mines more bentonite than any other state in the United States and has 70 percent of the world's known supply. 5 million tons of bentonite were produced in Wyoming in 2014. Wyoming also has the world's largest deposit of trona, supplying about 90% of the nation's soda ash. 17 million tons were mined in 2014. Northeast Wyoming is home to one of the highest grade rare earths deposits in the world.

Ancient seas that once covered what is now Wyoming helped create our natural resources. Seas expanded and retreated many times over millions of years, leaving behind plant and animal matter, as well as mineral deposits. Marine sediments worked together to form and preserve hydrocarbon deposits. Under ideal geologic conditions of pressure and temperature, coal, oil, and natural gas deposits were formed and preserved. Historically, these natural resources have been used by humans since ancient times.

The mineral and energy industry in Wyoming provides many jobs statewide. Almost all Wyoming citizens are connected to the industry in some way, even if it's indirectly. Think of adults you know. Do you know a miner? Teacher? Biologist? Engineer? Someone who works for the railroad? People who replant trees? These people are all supported by the vast mineral and energy industry.

Now, think about your morning. When you were getting ready for school, did you turn on a light? When you had breakfast, did you drink milk from a glass? Did you remember to brush your teeth? Did you happen to look out the window on the bus/car? Did you play a game on your phone? Did you have to clean your cat's litter box? If you did any of these things, you used products from Wyoming produced by Wyoming workers.

Write something new you learned about Wyoming minerals: _____

List a few products you have used today that were possibly produced with Wyoming minerals: _____



Wyoming Minerals

Bentonite

Wyoming mines more bentonite than any other state in the United States and has 70 percent of the world's known supply of bentonite. Almost 5 million tons of bentonite is produced in Wyoming each year. Wyoming Bentonite is mined in the northeast corner of the state, and along the east and west parts of the Big Horn Range.

The bentonite mined in Wyoming has unique characteristics that are rarely found anywhere else. Bentonite is a brownish-gray clay that can swell up to 16 times its original size and absorbs up to 10 times its own weight in water. These characteristics are mostly due to the presence of sodium instead of calcium, which is normally found in bentonite. Geologists believe that the sodium in Wyoming's bentonite is from the sodium in the sea that covered Wyoming 120 million years ago. Wind blew ash from erupting volcanoes into the sea, and chemical changes in the volcanic ash created bentonite.

The deposits of bentonite in Wyoming average a depth of 25 feet, and it is surfaced mined. Once mined, the bentonite is cleaned and then tested to confirm its quality. It is then dried in the field before it is taken to be processed.

Bentonite has been called the mineral of 1,000 uses. It is used for absorbents, animal feed, drilling fluids, and sealants. Wyoming bentonite is particularly in demand for pet litter because of its ability to absorb many times its volume in water and control odors. Among other uses, bentonite is found in crayons, medication, and cosmetics, such as shampoos, lotions, face creams, and lipstick. Originally, Wyoming bentonite was used by local Indians as a bleaching clay and a washing agent. Pioneers used it as a substitute for axle grease to cure inflamed horses' hooves and to waterproof roofs.



BY THE NUMBERS

- Wyoming is the nation's leader in bentonite production.
- 3.3 million tons of bentonite were produced in Wyoming in 2016.
- 631: The number of people bentonite mining employed in 2016
- 16x: Wyoming Bentonite can swell up to 16 times its original size



Information adapted from <https://www.wyomingmining.org/minerals/bentonite/>

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Wyoming Minerals

Coal

Coal is an organic sedimentary rock. Coal isn't technically a mineral; it's a black, burnable rock and is considered a fossil fuel. When burned, the coal produces a high, white flame. Bituminous coal, is so-called, because it contains a tar-like substance called bitumen.

Wyoming, the nation's leading coal producer since 1986, provides about 40% of America's coal through the top 10 producing mines located in the Powder River Basin. Most Wyoming coal is sub-bituminous, which makes it an attractive choice for power plants because it has less sulfur and burns at around 8,400 to 8,800 BTUs per pound. Wyoming coal is considered clean burning, which means it is better for the environment. Wyoming coal has steadily gained a growing share of the nation's total electricity over the past few decades for a variety of reasons.

- It's more affordable than eastern coal and other fuels.
- There are huge reserves in the state.
- Wyoming's supply of coal is reliable.
- Wyoming's low-sulfur coal can be produced and used in compatibility with the nation's environmental objectives.

The majority of Wyoming's coal formed between 50 and 58 million years ago from peat that collected in vast swamps that often covered a thousand square miles and lasted for thousands of years. Peat is woody plant material that falls into the swamp, which soon decays into a blackish, carbon-rich gel layer at the bottom of the swamp. The thicker the gel layer, the thicker the coal seam will be. To become coal, the gel layer must be heated.



BY THE NUMBERS

- 40%: Amount of America's coal that comes from Wyoming
- 297,501,894: tons of coal that Wyoming mines produced in 2016
- 5,682: Number of people Wyoming coal mines employed in 2016
- 162 billion: Amount of recoverable coal in tons contained in the Powder River Basin
- 20 lbs: The amount of coal each person in the U.S. uses every day



Information adapted from <https://www.wyomingmining.org/minerals/coal/>

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Wyoming Minerals

Coal (continued...)

Wyoming's peat collected in freshwater swamps, so it has very little sulfur, resulting in our valuable low-sulfur coal. Currently, most Wyoming coal is mined from coal seams 100 feet thick. These are some of the world's largest and thickest coal seams. Coal in Wyoming is uncovered and removed by large machines in a process called surface mining.

Coal supplies more than half of the electricity in the nation. Consider the following statistics: Each person in the U.S. uses 20 pounds of coal every day, and 8 out of 10 tons of coal are used to produce electricity. How does coal make electricity? Trains and trucks take coal to power plants. At the plant, coal is burned to boil water which creates steam. Steam turns turbines, which generate the electricity. A pound of coal supplies enough electricity to light ten 100-watt light bulbs for one hour. Coal is also widely used in U.S. industries and manufacturing plants to make chemicals, paper, ceramics, and a variety of metal products. It is an important source of coke for the steel industry, and coal by-products are used to make linoleum, medication, detergents, perfumes, food flavorings, fungicides, insecticides, solvents, and wood preservatives.

FUN FACTS ABOUT COAL

- Composition: Carbon, hydrogen, sulfur, oxygen, nitrogen
- Wyoming's coal is low-sulfur and more environmentally friendly than other forms of coal.
- Coal isn't technically a mineral. It's a black, burnable rock and is considered a fossil fuel.
- The coal deposits in the Powder River Basin are among the largest in the world.
- A pound of coal supplies enough electricity to light ten 100-watt light bulbs for one hour.



Information adapted from <https://www.wyomingmining.org/minerals/coal/>

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Wyoming Minerals

Rare Earths

Northeast Wyoming is home to one of the highest grade rare earths deposits in North America, currently under development. Despite their name, rare earth elements are actually commonly found on the earth, but most do not occur in large enough quantities and high enough concentrations to mine easily. They need to be separated from one another using a variety of mining and processing techniques.

These 17 minerals include: Scandium, Yttrium, Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Holmium, Dysprosium, Erbium, Thulium, Ytterbium, and Lutetium. These minerals have unique chemical and physical properties that allow them to interact with other elements.

Rare earth elements were discovered in 1787 by Swedish Army Lieutenant Carl Axel. They were first mined in the 1880s in Sweden and Norway, Brazil in 1887, and India in 1911. Until the 1980s, the U.S. was one of the world's largest producers. China has increased production by more than 500% since 1990 because of its large deposits and cheap labor.

Rare earth elements make up key components of cellphones, televisions, weapons systems, wind turbines, MRI machines, and the regenerative brakes in hybrid cars.



FUN FACTS ABOUT RARE EARTHS

- There are 17 rare earth elements.
- Rare earth elements aren't actually that rare.
- China is the world's dominant producer of rare earth elements, with more than 95% of production.
- Only one rare earth mine, at Mountain Pass, CA has ever been developed in the United States. The one in WY is under development.
- The cost of putting together a rare earth element mine can cost up to a half a billion dollars or more.



Information adapted from <https://www.wyomingmining.org/minerals/>

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Wyoming Minerals

Trona

Trona is a sodium carbonate compound that is processed into soda ash or bicarbonate of soda, or baking soda, as it is commonly known. It is a fairly soft material, with a hardness of 2.5 - 3 on a scale of 10. It can be gray, colorless, white, pale brown or yellowish. The crystals are transparent to translucent. Trona is soluble in water, and it effervesces (bubbles) in acids.

Wyoming has the world's largest deposit of trona, supplying about 90% of the nation's soda ash. This mineral is Wyoming's top export, and is shipped to markets around the globe. Wyoming mines produced over 17 million tons of trona and employed 2,284 people in 2016.

A large freshwater lake, Lake Gosiute, covered an estimated 15,000 square miles in a basin in southwestern Wyoming. All the minerals and mud settled in the bottom of the lake, and sodium, alkaline and bicarbonate were transported to the lake by runoff water. The mixture of all these elements formed the trona deposits we mine today. Large trona deposits are found in the Green River formation, with 42 beds that cover about 1,300 square miles.

All trona is mined underground, and then processed into soda ash or baking soda. An underground trona mine is like an underground city. There are maintenance shops, bathrooms, electricity lines, and streets.

In the 1st century, the Romans used soda ash for making bread, glass, and medicine, uses which continue today. Baking soda and baking powder both come from soda ash, so most Americans have a product of Wyoming trona right in their own kitchens. Soda ash is also used to manufacture many chemicals used in industry including sodium bicarbonate, sodium chromates, sodium phosphates, sodium silicates, and sodium cyanide. It can also be added to adjust the pH of water and reduce acidity. Cattle feed, swimming pool products, medicines, paper, textiles, and toothpaste all use soda ash.



FUN FACTS ABOUT TRONA

- 17.5 million tons: Amount of trona mined in 2016
- 2,284: Employees in 2016
- The Federal Reserve Board uses soda ash as a national economic indicator.
- 5,000 years ago, the Egyptians used soda ash for making glass ornaments and vessels.
- Trona is Wyoming's top international export.
- At the current rate of operation, Wyoming's trona reserves will last over 2,000 years.



Information adapted from <https://www.wyomingmining.org/minerals/trona>

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Wyoming Minerals

Uranium

Uranium is a silvery-white metallic element that is a solid at room temperature. It is a naturally radioactive element. Uranium is the second heaviest metal on the Periodic Table.

Uranium is one of the most common elements on earth and occurs in most rocks. In ancient times, it was used in pigments and glazes, but since 1950, the primary use for this mineral is fuel for nuclear power plants.

Wyoming is America's leader in uranium production with an estimated 2 million pounds produced in 2016. This is about 78% of American production. Wyoming has an estimated 456 million pounds available for mining. About 1 pound of uranium can produce the same amount of power as 20,000 pounds of coal. Presently, the uranium produced in Wyoming is mined in-situ (meaning "in place").

Uranium is used in the military to build high-density projectiles (missiles), including ones used to pierce armored targets; in armor plating for vehicles, such as tanks; in containers that store radioactive materials; and as a power source for submarines and ships. The main use for uranium is in nuclear power plants. However, it is also used in smoke detectors and x-ray machines.



Yellow cake processed from Uranium.

FUN FACTS ABOUT URANIUM

- The element was discovered in 1789 by Martin Klaproth, a German chemist.
- Uranium was formed in supernova about 6.6 billion years ago, and provides the main source of heat inside the Earth.
- Uranium is so dense it is used in the keels of yachts and as counterweights for aircraft control surfaces, as well as radiation shields.
- More than 13% of the world's electricity is generated from uranium in nuclear reactors.



Information adapted from <https://www.wyomingmining.org/minerals/uranium>

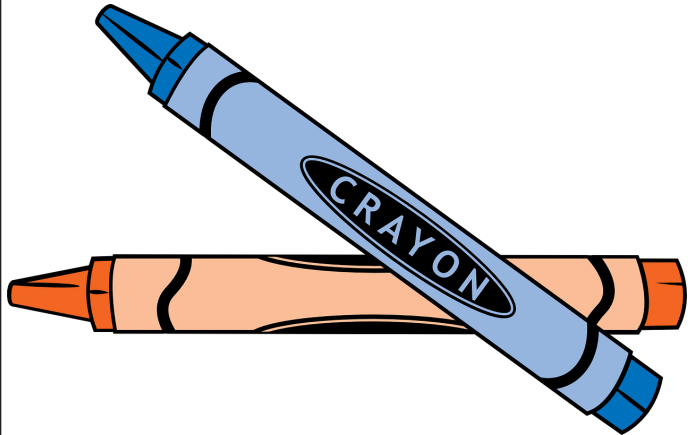
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Mineral Mystery Bag Items

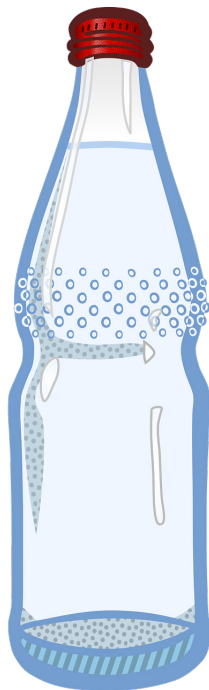
Kitty Litter



Crayons



Mineral Water

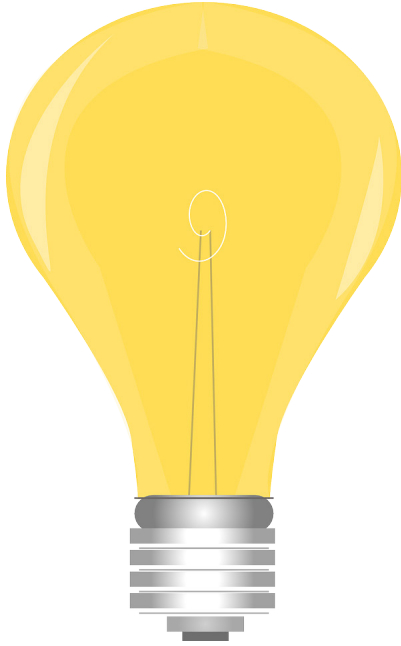


Lipstick



Mineral Mystery Bag Items

Light Bulb



Cement Mixer



Electric Generator



Refineries



Mineral Mystery Bag Items

Smoke Detector



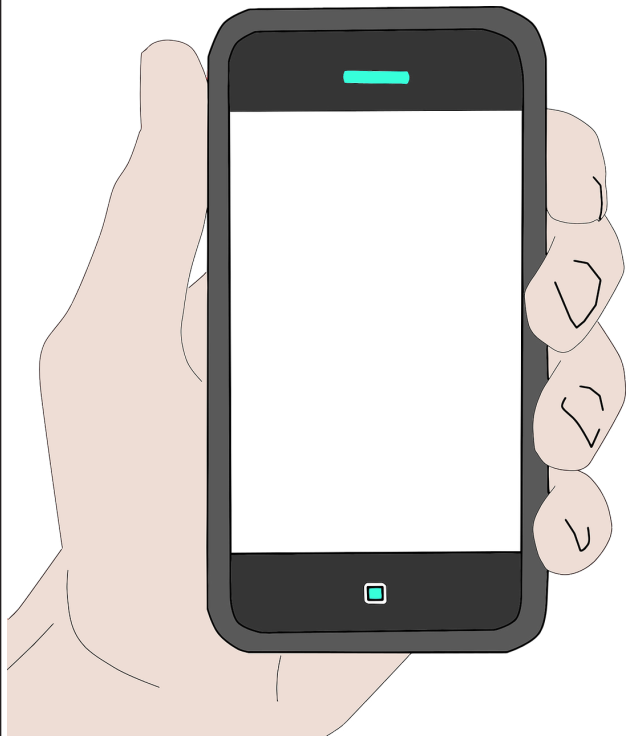
Camera



Welding Visor



Cell Phone



Mineral Mystery Bag Items

Cattle Feed



Tank



Nuclear Power Plant



X-Ray Machine



Mineral Mystery Bag Items

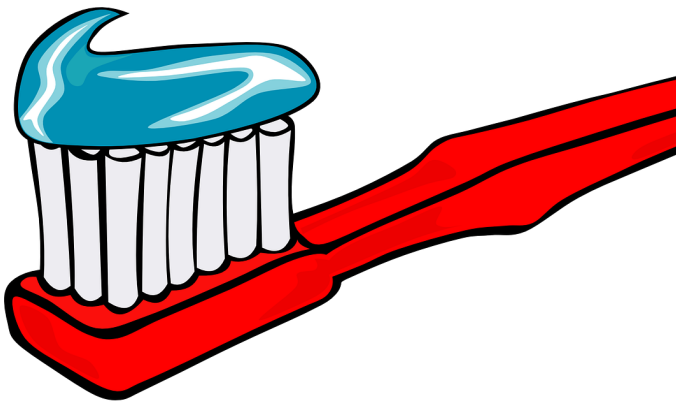
Baking Soda



Glass



Toothpaste



Cookie



Mineral Mystery Bag Items

Calamine Lotion



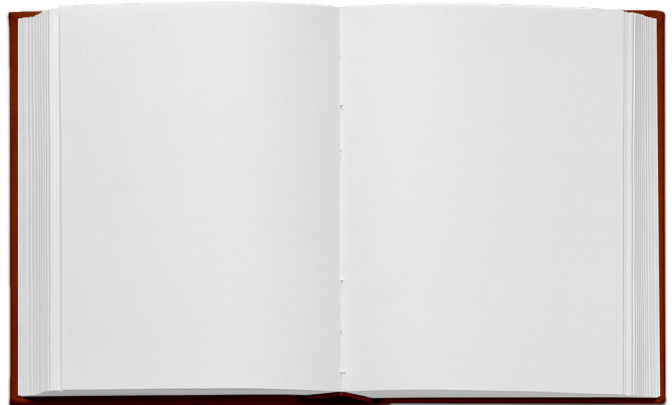
Mud Mask



Laundry Detergent



Paper



Wyoming's Minerals - Graphic Organizer

Coal	Bentonite	Trona	Uranium	Rare Earth Elements



Name: _____

Date: _____

Wyoming's Minerals Property Sort Sheet

Directions:

Read the following statements, and decide what mineral they correspond to then highlight the statement to match the mineral color.

Coal

Bentonite

Uranium

Trona

Rare Earth Elements

- Includes 17 minerals
- Organic sedimentary rock
- Silvery white
- Formed 50-58 million years ago from peat
- Gray, colorless, white, pale brown, yellowish
- Used in nuclear reactors
- Minerals need to be separated
- Brownish-gray clay
- Very absorbent
- Minerals that don't occur in large quantities
- Second heaviest metal on the Periodic Table
- Produces a white flame when burned
- Soluble in water
- Radioactive
- Mineral that has a hardness of 2.5-3
- Contains sodium or calcium
- Made of crystals



Answer Key

Wyoming's Minerals

Property Sort Sheet

Directions:

Read the following statements, and decide what mineral they correspond to then highlight the statement to match the mineral color.

Coal

Bentonite

Uranium

Trona

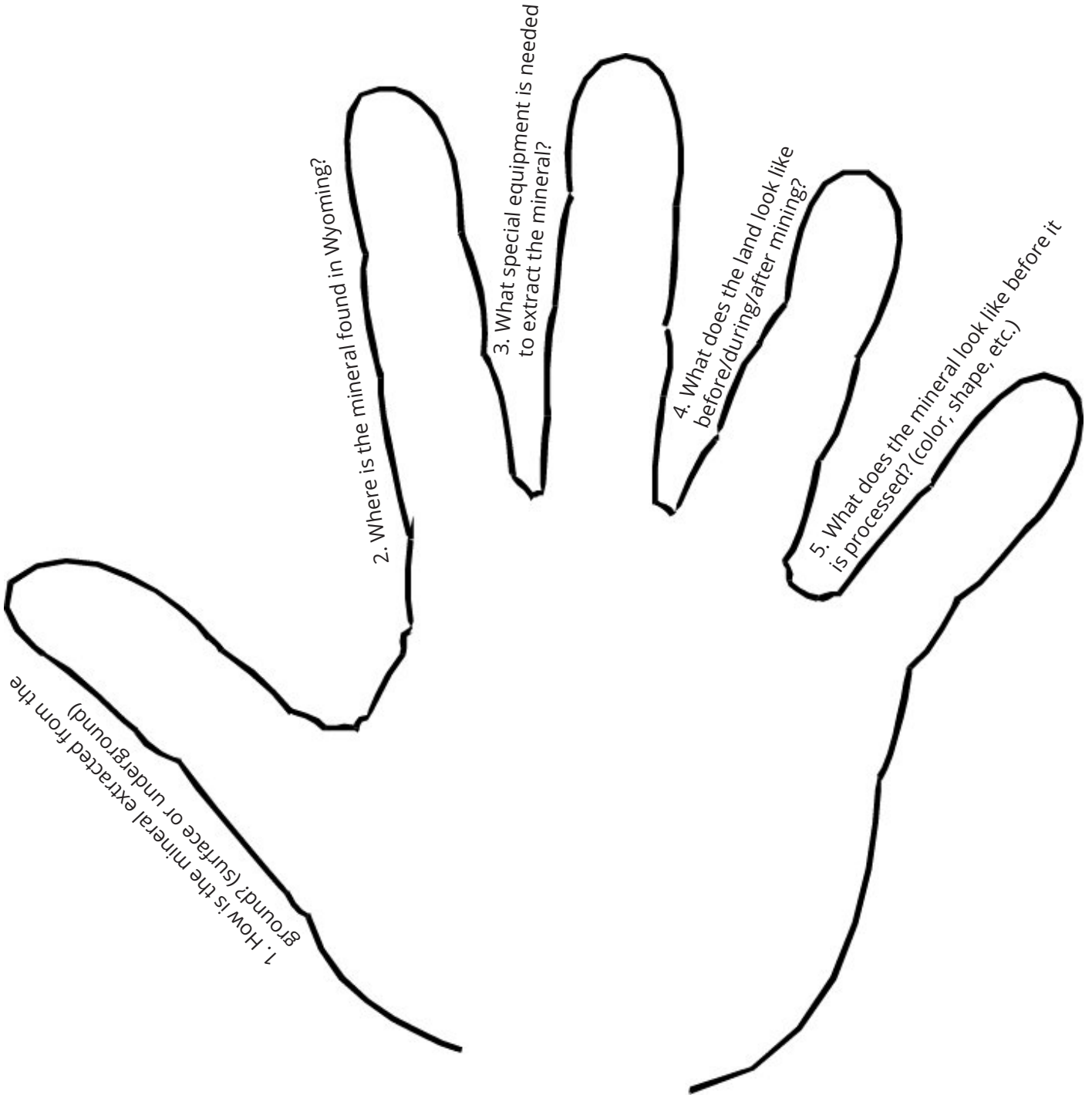
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Hand Organizer

Mineral: _____

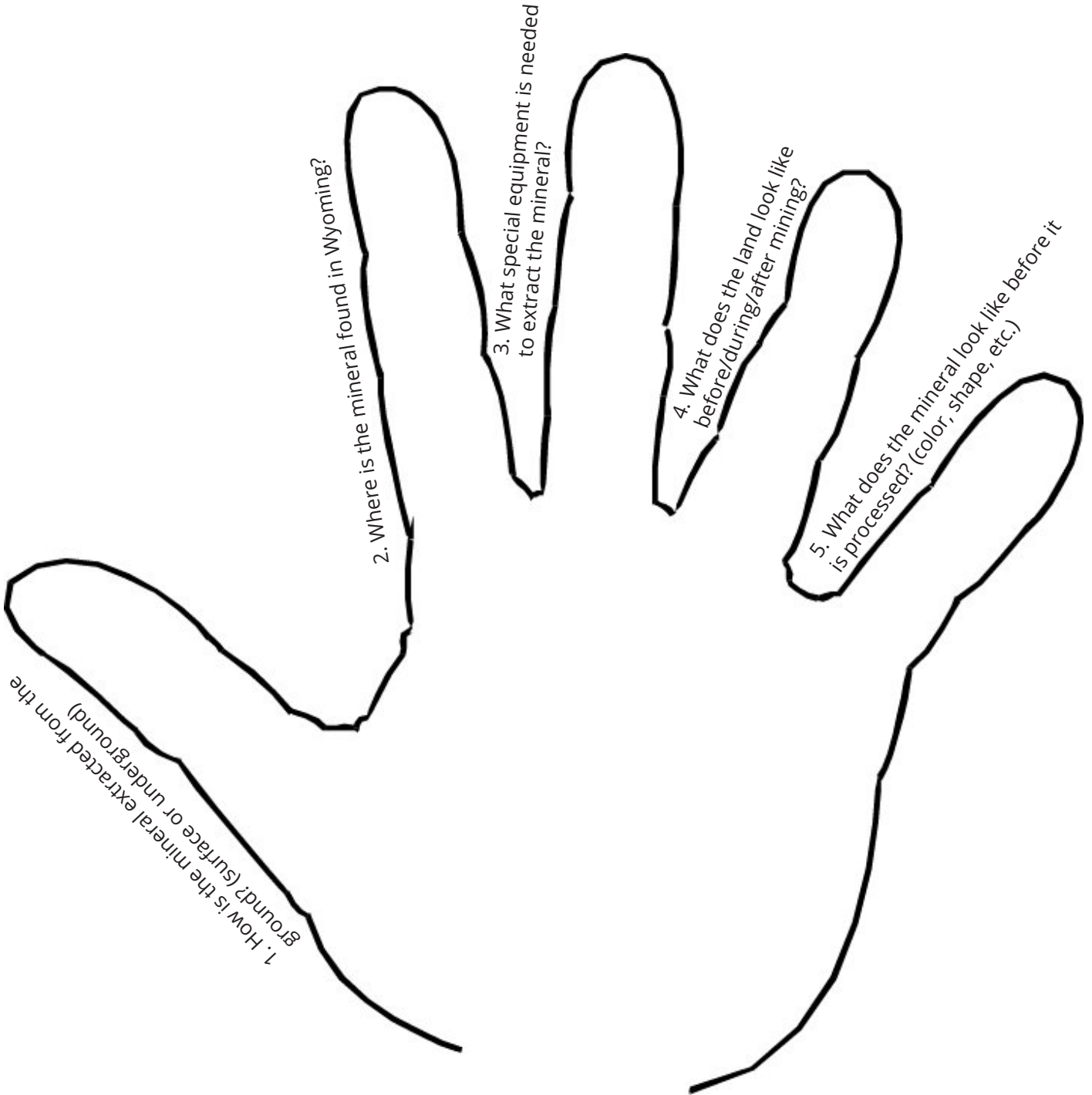


6. In the palm of the hand, write a short summary about the video you watched.



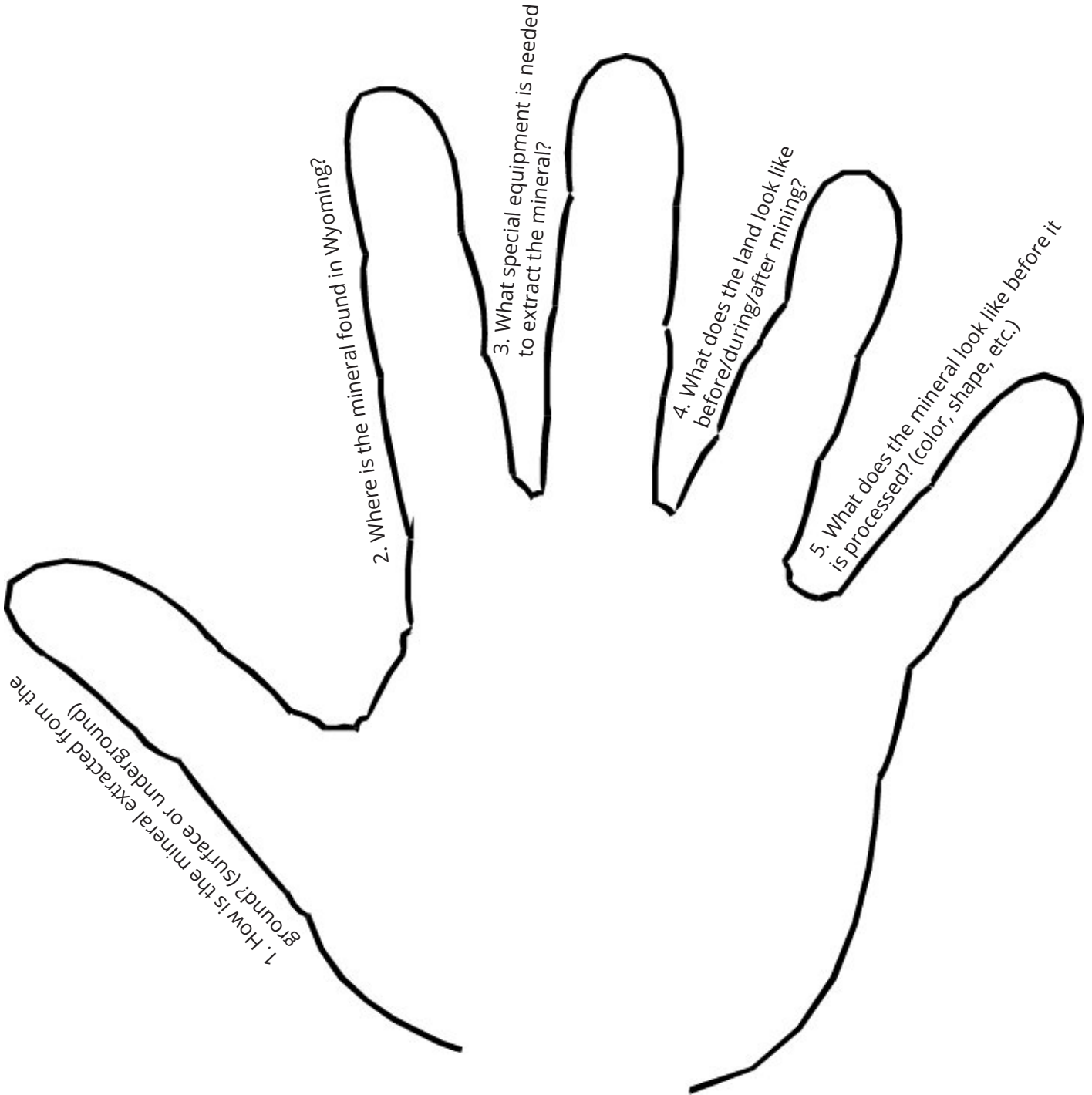
Hand Organizer

Mineral: _____



Hand Organizer

Mineral: _____

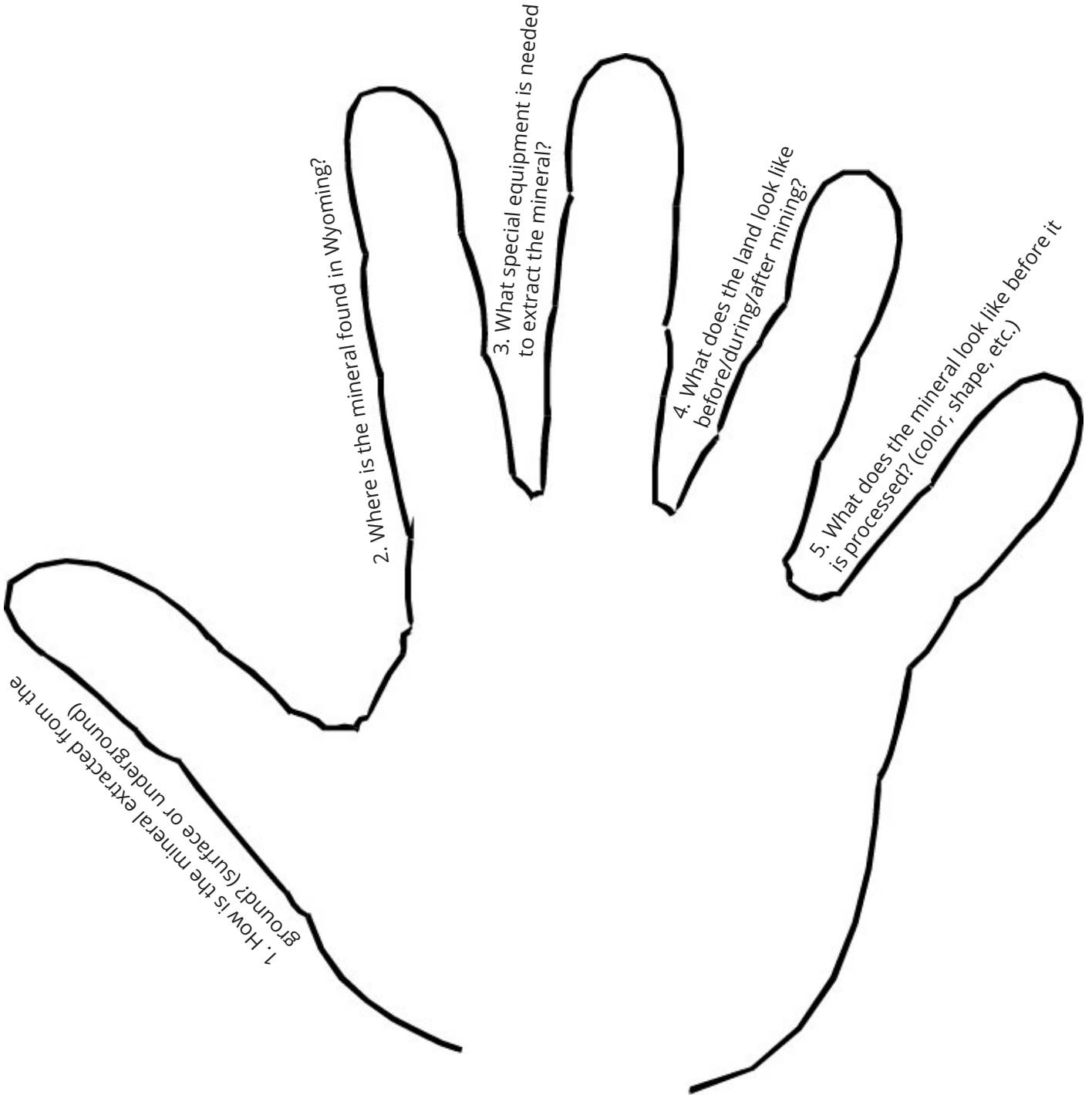


6. In the palm of the hand, write a short summary about the video you watched.



Hand Organizer

Mineral: _____

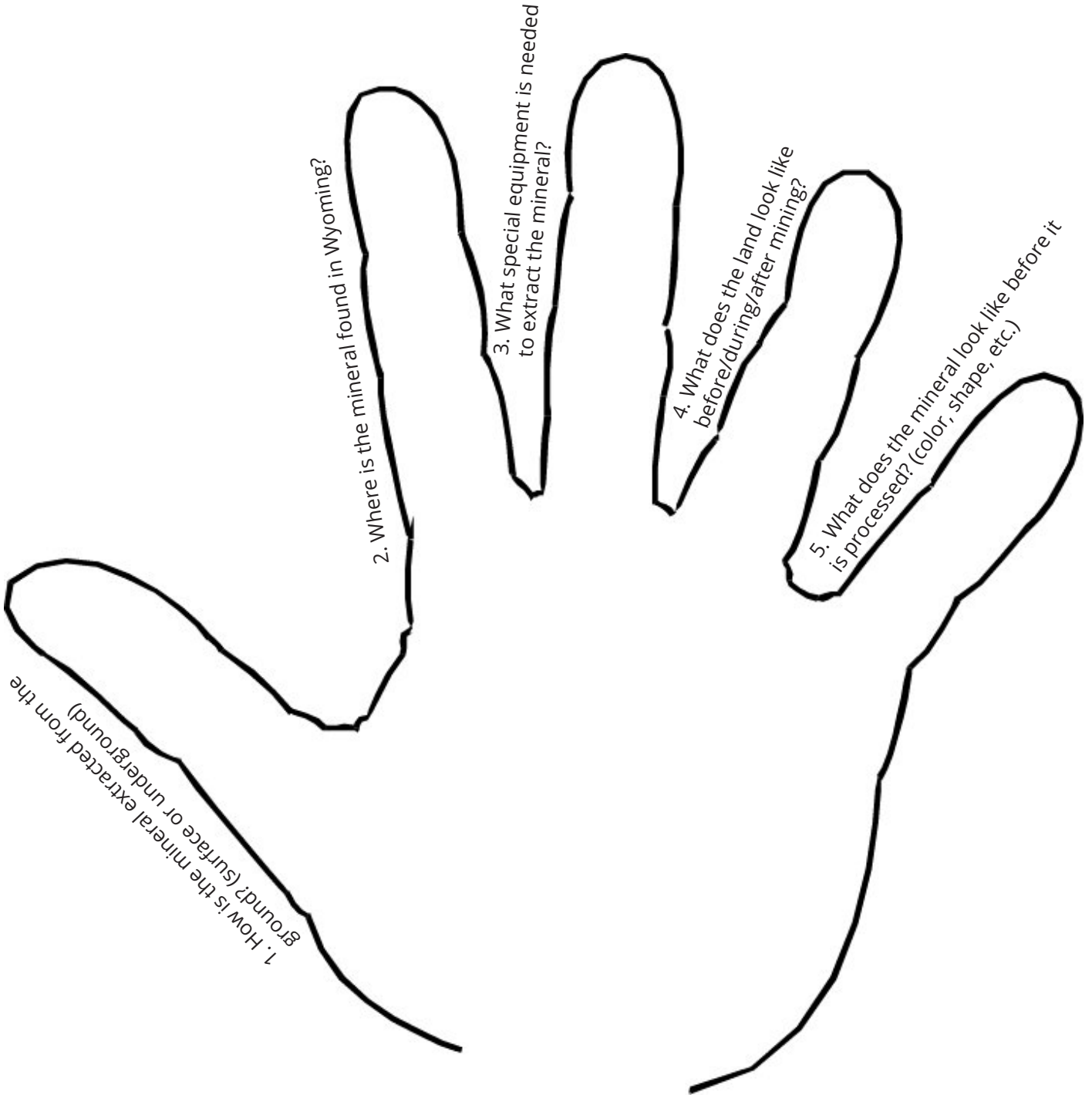


6. In the palm of the hand, write a short summary about the video you watched.



Hand Organizer

Mineral: _____



6. In the palm of the hand, write a short summary about the video you watched.



Wyoming Minerals

Scavenger Hunt

	Production	% of U.S. production	Estimated reserves/ Years expected to last	Jobs	Tax Revenue
Coal					
Bentonite					
Trona					
Uranium					
Rare Earth					
Total					

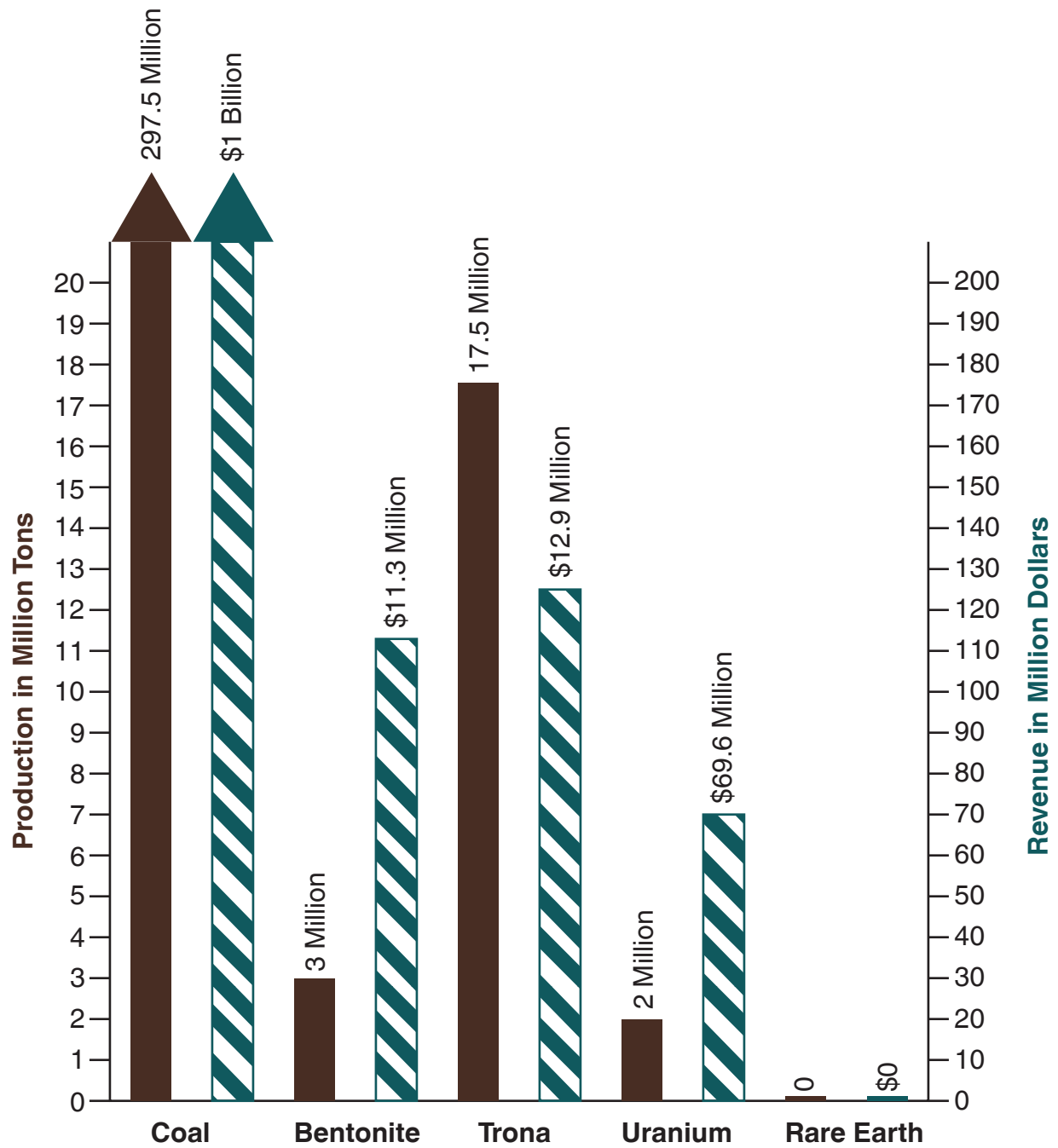


Wyoming Minerals Scavenger Hunt Answer Key

	Production	% of US production	Estimated reserves/ Years expected to last	Jobs	Tax Revenue
Coal	297.5 mil tons	40	162 bil. tons 110 yrs	5,682	\$1 billion
Bentonite	3.3 - 4 mil tons	70	250 mil. tons 55 yrs	631 - 688	\$11.3 mil
Trona	17.3 - 17.5 mil tons	90	40 bil. tons 2,000 - 2,350 yrs	2,284 in 2016 2,583 in 2015	\$112.9 mil
Uranium	1.97 - 2 mil pounds	78	456 mil. tons	280 - 300	\$33 - \$69.6 mil
Rare Earth	0	0	unknown at this time	0	0
Total				8,954 (Numbers may vary from year to year. Bold numbers are included in total)	\$1.94 bil (Numbers may vary from year to year. Bold numbers are included in total)

Wyoming Minerals

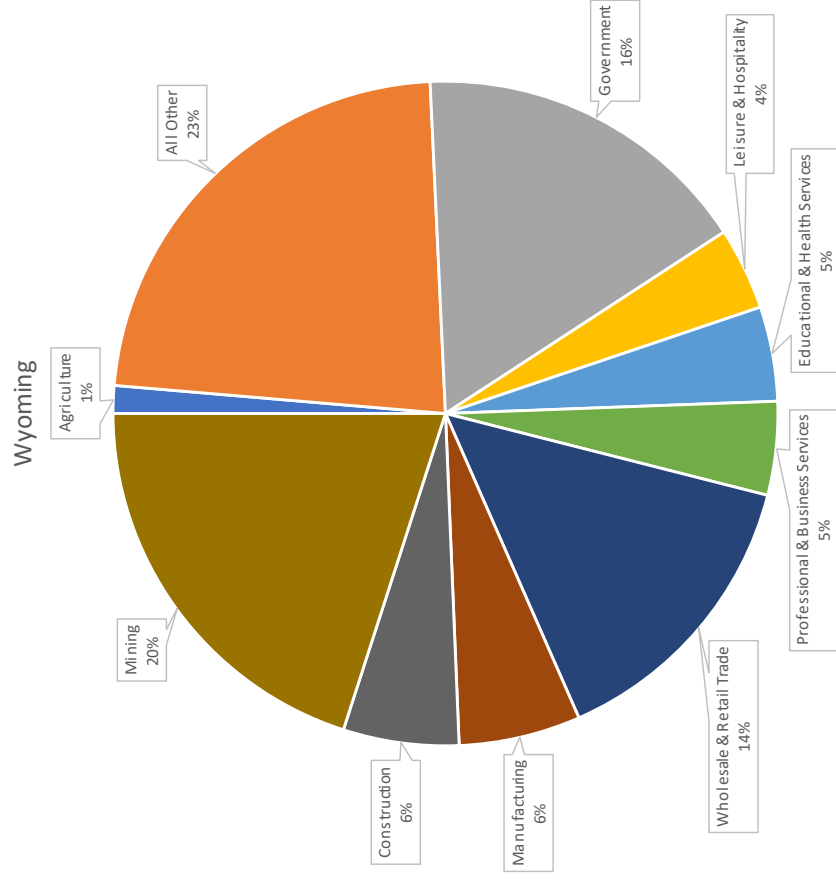
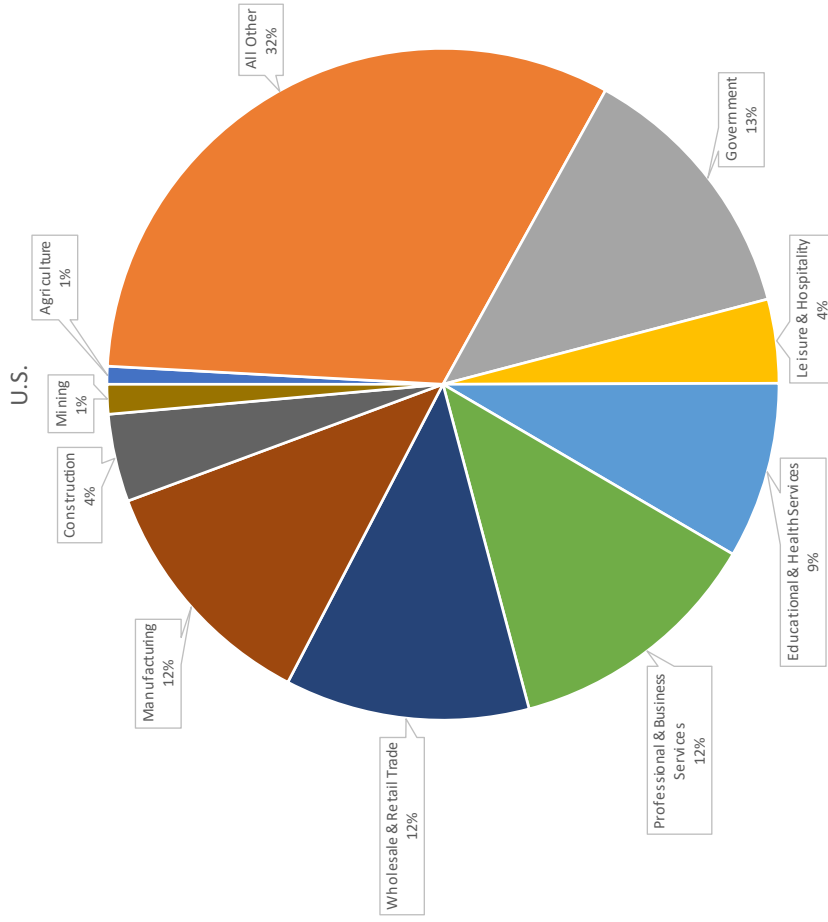
Mining Production and Revenue Comparison



When looking at the graph, what comparisons can you make between the production and the revenue of Wyoming's minerals?



— Gross Domestic Product for U.S. and Wyoming: 2016 by Industry —



Source: U.S. Bureau of Economic Analysis, and Wyoming Department of Administration & Information, Economic Analysis Division



Wyoming Minerals

Quick Write

Why is reclamation important for the good stewardship of our minerals and other resources?



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Wyoming Minerals

Quick Write

Why is reclamation important for the good stewardship of our minerals and other resources?



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Cleaner Coal Coming to Wyoming

By Bobby Poitevint | Posted: Thu 4:57 PM, Jun 15, 2017 | Updated: Thu 4:57 PM, Jun 15, 2017
<https://www.kcwy13.com/content/news/Cleaner-Coal-Coming-to-Wyoming-428750053.html>

Clean Coal Technologies is a New York-based company with big plans for the Wyoming coal industry.

Clean Coal Technologies officers say they plan to build several plants here.

That could mean more jobs and a boost to Wyoming's coal industry.

After establishing a test plant in Sheridan, company managers plan building two more plants in undisclosed locations around Wyoming.



But what is their plan?

Robin Eves says, "The answer is a more efficient use of coal. By producing more efficient coal, which our technology does, you burn less coal and automatically reduce the carbon footprint. We believe it will also re-establish the PBR coal as a major competitor in the coal market, which we believe is the future of the coal market here in the United States."

Eves says, "Clean Coal Technologies patented technology reduces chemical pollutants from coal such as sulfur by ninety percent."

But how does this technology work?

"Dehydration technology extracts water from the coal, increases the BTU value, but more importantly, it stabilizes the coal. The coal then will not reabsorb water, will not self-combust, and it is ash free. It's a totally clean product to transport," says Eves.

Drew Perkins with the Wyoming legislature says this is a big deal for Wyoming's coal industry. He says new jobs are on the way.

"It will be exciting for both high tech, low tech, and jobs for young people who either want to work with their hands or want to work with their minds and computers. It's going to be an opportunity for everyone."

But it means more to the state than just jobs.

“Majority of revenue for the state of Wyoming comes from various sources of mineral severance taxes not to mention all the employment and the other things that happen in the mineral industries.”

After a downhill slide in Wyoming’s coal industry, there is hope for the state’s biggest source of revenue.

Construction for the Sheridan test plant will start in October.

All three plants will be built and operated in Wyoming.

Reprinted from KCWY 13 News: <http://www.kcwy13.com/content/news/Cleaner-Coal-Coming-to-Wyoming-428750053.html>



Stewardship Public Service Announcement Assignment

Assignment:

Create a persuasive public service announcement (PSA) that convinces both citizens and mineral companies to develop and use mineral resources responsibly since they are nonrenewable

Your PSA must address the following prompt:

“As a state, we make decisions about our minerals all the time. What things do we need to think about to ensure that as a state we are being good stewards of our mineral resources so that our minerals last for future generations?”

Public Service Announcement scoring guide:

0	Student did not create a PSA.
1	Student’s PSA shows no evidence of answering the question; student does not discuss why mineral stewardship is important. “Wyoming stewards do lots of stuff.”
2	Student’s PSA gives 1-2 reasons why stewardship of Wyoming’s minerals is important. “We should be good stewards because minerals will run out.”
3	Student’s PSA gives 3-4 valid reasons for why stewardship of Wyoming’s minerals is important. “We should be good stewards because minerals are nonrenewable. They will run out. Our economy is dependent on them. We need to look for new technology to make them sustainable. We need to reclaim the sites when finished in order to give the land multiple uses.”
4	Student’s PSA addresses all aspects of why stewardship of Wyoming’s minerals is important. Student work goes above and beyond a 3 criteria by giving specific examples of new mineral technologies that have not been mentioned and cite expert opinions, etc.



Public Service Announcements

Voting Tickets

1. Number of the public service announcement that was the most persuasive: _____
2. Explain why this public service announcement was most persuasive to you.



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Public Service Announcements

Voting Tickets

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