RESOURCES

The resource section provides valuable information and supplemental materials for teachers and students. It also suggests several resources that can provide support, direction, additional materials, and the “know-how” to enrich the educational experience that involves mineral resources and mining businesses and organizations in the school and community.

This section contains the following materials in this order:
• Media and Materials
• Guest Speakers and Field Trips
• Organizations and Agencies
• Focus on Careers
• Tools of the Trade
• Large Group Activities
• Mini-Posters
• Skills/Processes
• Conceptual Framework
I. Media and Materials

A. Films/Videos

The SME Foundation for Public Information and Education provides VHS videos which can be checked out at no charge for a maximum of two weeks. The only cost involved is the return postage on videos to SME Foundation. For a complete listing of SME’s videos you may write or call:

- SME Foundation
  P.O. Box 625002
  8307 Shaffer Parkway
  Littleton, CO 80127
  (303) 973-9550
  FAX: (303) 973-3845
  http://www.smenet.org/education/gem/

B. Maps

To obtain free map indexes and catalogs, and to order topographic maps or any of the wide variety of thematic maps available from the United States Geological Survey, contact:

- USGS Map Distribution
  Box 25286, Building 810
  Denver Federal Center
  Denver, CO 80225
  (303) 236-7477
  http://education.usgs.gov/

Contact your state’s Geological Survey from where you may also obtain a variety of maps. Find your state at http://geology.com/groups.htm

C. Rock and Mineral Specimens

Small collections of rock and mineral samples are available from some state geological surveys, at little or no cost.

Numerous private companies sell educational or exhibition minerals. Here are a few of many such companies. Please refer to catalogs or directories for others in your area.

- National Energy Foundation
  3676 California Ave., Suite A117
  Salt Lake City, UT 84104
  http://www.nefl.org

- Carolina Biological Supply Company
  http://www.carolina.com

- D.J. Minerals
  http://www.djminerals.com

- Fisher Scientific
  http://www.fishersci.com

- Forestry Suppliers
  http://www.forestry-suppliers.com

- Miners Inc.
  http://www.minerox.com

- American Educational Products/Scott Resources
  http://www.amep.com

- Ward’s Natural Science Establishment, Inc.
  http://www.wardsci.com

D. Resource Books for Teachers

- Minerals—Foundations of Society by Ann Dorr and Alma Hale Paty

  by Herbert S. Zim and Paul R. Shaffer

- Rocks and Minerals
  by Paul E. Desautels

  by W. R. Hamilton, A. R. Woodley, and A. C. Bishop

- Our Modern Stone Age
  by Robert Bates and Julia Jackson

E. Children’s Literature

- Crystals by Philip Carona

- Everybody Needs A Rock by Byrd Baylor

- How to Dig a Hole to the Other Side of the World by Faith McNulty

- I Can Be A Geologist by Paul Sipiera

- If You Find a Rock by Peggy Christian

- Industrial Minerals: How They Are Found & Used by Robert Bates

- Let’s Go Rock Collecting by Roma Gans

- Metals by Robin Kerrod

- Metals and Alloys by Kathryn Whyman

- Metals and Minerals by Jacqueline Dineen

- Rock Collecting by Roma Gans

- Rocks and Minerals by George Fichter

- Rocks and Their Stories by Carroll Lane Fenton and Mildred Adams

- Rocks and What They Tell Us by Lester del Rey

- Secrets in Stones by Rose Wyler and Gerald Ames

- The Earth’s Story by Gerald Ames

- The Magic School Bus Inside the Earth by Joanna Cole

- The Rock Quarry Book by Michael Kehoe

- What Does A Geologist Do? by R. V. Fodor

- What is a Rock? by John Syrocki
II. Guest Speakers and Field Trips

A. Guest Speakers

The world is full of people to learn from. Invite individuals to your classroom to share their knowledge and experience with your students. Encourage students to come up with their suggestions as to who these people or "experts" need to be. Here is a start:

- Any student's mother or father working in the mining, oil and gas, sand and gravel, or related industry.
- Geologist
- Geology Teacher from local High School, Community College, or University.
- Spokesperson from local Gem and Mineral Club.
- Mining Historian
- Mining Engineer
- Environmental Engineer
- Safety Engineer
- Spokesperson from local mining, oil and gas, or sand and gravel company
- Spokesperson from local environmental group like Friends of the Earth and Sierra Club.
- Representative from company which provides supplies and equipment to the mineral resource industry.
- Economist
- Spokesperson from Bureau of Land Management, or U.S. Forest Service to discuss multiple land use.

B. Field Trips

Classroom instruction is always enhanced when you can leave the four walls of your classroom and experience learning in another part of the school, the neighborhood, at a local business or industry, or at a nearby museum. Here are a few ideas for field trips:

- Rock Quarry
- Geology Museum
- Mineral Museum
- History Museum
- Mining Operation
- Sand and Gravel Operation
- Recycling Plant
- Refinery
- Reclamation Site
- Supermarket

III. Organizations and Agencies

A. Local Community Contacts

- Mining Companies
- Oil and/or Gas Companies
- Sand and Gravel Operations
- Consulting Geologists
- Equipment Suppliers to Industry
- Recycling Companies
- Environmental Organizations
- Gem and Mineral Societies
- Rock Clubs

B. State Agencies and Professional Organizations

- Department of Mines/Mineral Resources
- Mine Inspector's Office
- Department of Environmental Quality
- State Geological Survey
- State Geologist
- State Bureau of Land Management Office
- State Mining Association
- Trade/Supplier's Organization
- Gem and Mineral Society

C. Federal Agencies and National Organizations

- AIMS (Activities to Integrate Mathematics and Science) Education Program
  http://www.aimsedu.org
  (209) 291-1766
- American Association for the Advancement of Science
  http://www.aaas.org
  (202) 326-6400
- American Coal Foundation
  http://www.teachcoal.org
  (202) 466-8630
- American Geophysical Union
  http://www.agu.org
  (202) 462-6903
- American Geological Institute
  http://www.agiweb.org
  (703) 379-2480
• American Institute of Mining, Metallurgical, and Petroleum Engineers
  www.aimeny.org
  (303) 948-4255

• American Institute of Professional Geologists
  www.aipg.org, click “About AIPG”
  (303) 412-6205

• Copper Development Association, Inc.
  www.copper.org
  (212) 251-7200

• Association for Iron and Steel Technology
  www.aiist.org
  (724) 776-6040

• Federal Resources for Education Excellence
  http://www.free.ed.gov/

• Mineral Information Institute
  www.mii.org
  (303) 277-9190

• Mineralogical Society of America
  www.minsocam.org
  (703) 652-9950

• National Association of Geoscience Teachers
  www.nagt.org

• National Earth Science Teachers Association
  www.nestanet.org

• National Energy Foundation
  www.nef1.org
  (801) 908-5800

• National Mining Association
  www.nma.org
  (202) 463-2600

• National Science Teachers Association
  www.nsta.org
  (703) 243-7100

• National Stone, Sand and Gravel Association
  www.nssga.org
  (703) 525-8788

• Northwest Mining Association
  www.nwma.org
  (509) 624-1158

• Salt Institute
  www.saltinstitute.org

• Smithsoninian Institute
  www.si.edu
  (202) 633-1000

• Society for Mining, Metallurgy, and Exploration, Inc.
  www.smenet.org
  (303) 973-9550

• U.S. Bureau of Land Management
  www.blm.gov
  (202) 452-5125

• U.S. Environmental Protection Agency
  www.epa.gov
  (202) 272-0167

• U.S. Forest Service
  www.fs.fed.us
  (202) 205-8333

• U.S. Geological Survey
  Minerals Information Office
  http://minerals.usgs.gov
  Education site
  www.education.usgs.gov
  (888) 275-8747

• Women in Mining
  www.womeninmining.org
  (303) 298-1535
FOCUS ON CAREERS
FOCUS ON CAREERS

This section focuses on a number of careers which are commonly found in the mining industry. The collection is designed to illustrate the diverse nature of work performed by individuals who make up the industry’s work force. Each profile includes what individuals in that career do, where they work, what education or experience they might have, and other interesting aspects of the occupation or profession.

Careers dealt with in this section are:
- Accountants
- Administrative Assistants
- Attorneys
- Belt Maintainers
- Blasters
- Chemists
- Computer Programmers
- Drill Operators
- Environmental Engineers
- Federal Mine Examiners
- Geologists
- Haulage Truck Drivers
- Hydrologists
- Mechanical Engineers
- Mechanics
- Metallurgists
- Mine Inspectors
- Mining Company Presidents
- Pilots
- Purchasing Agents
- Security Officers
- Shovel Operators

Listed below are a few suggestions for classroom application of the careers. We encourage you to identify other careers and learn more about them.
- Provide the information, and have students prepare a more in-depth study of a specific career.
- Identify parents or other members of the community who have careers in the mining industry, and invite them to come to class and present an overview of their job.
- Provide the information as part of a broader "Career Fair."
- Arrange for a Human Resource expert in the mining industry to provide an overview of the careers in the mining industry in your area.
- Use the materials as character or "voice" approaches to creative writing assignments, or have the students create and carry out a "job interview," using two different careers as the role models.
FOCUS ON CAREERS

ACCOUNTANTS

WHAT THEY DO: The accountants handle the financial data and keep track of income, expenditures, and taxes. They provide statements and information showing profit and loss, financial position, as well as assets and liabilities. They help the mining company run as economically as possible.

WHERE THEY WORK: Accountants work in an office.

TOOLS THEY USE: Accountants’ main tools are calculators and computers.

EDUCATION NECESSARY: Accountants need a degree in accounting—an associate, a bachelor’s, or a master’s degree, depending on the level of responsibilities.

INTERESTING ASPECTS OF THIS CAREER: The accountant is able to provide the company with important financial information.

FOCUS ON CAREERS

ADMINISTRATIVE ASSISTANTS

WHAT THEY DO: Administrative assistants in a mining operation do record keeping, typing of statistics and technical reports, sometimes travel planning, and a lot of organizing.

WHERE THEY WORK: They work in an office, generally at the mine facilities or administration offices.

TOOLS THEY USE: Administrative assistants use several basic office machines: a computer, calculator, telephone, fax, copy machine, and dictaphone among others.

EDUCATION NECESSARY: Administrative assistants need basic training in secretarial skills. They need computer training and good public relation skills. A good background in science is helpful for the technical aspect.

INTERESTING ASPECTS OF THIS CAREER: Administrative assistants work with many different people: administrators, miners, contractors, sometimes government officials, depending on their level of responsibility.
WHAT THEY DO: They maintain the large conveyor belts that carry coal or ore out of the mine. They grease and service the drive motors that run the belts. They change worn rollers and bearings. They also must maintain the pipes and water in the fire line.

WHERE THEY WORK: They generally work underground in the mine; however, some conveyors are above ground.

TOOLS THEY USE: They use basic repair tools. In a coal mine, a grease gun and shovel are used most. The shovel is used to remove the fine coal dust under the belts. An accumulation of coal dust is a safety violation.

EDUCATION NECESSARY: Experience and knowledge of mining is required. Also, classes are held at the mines, giving training in fire safety and updated procedures.

INTERESTING ASPECTS OF THIS CAREER: Belt maintainers deal with different problems each day. They help things run smoothly and safely.

WHAT THEY DO: There are many legal services attorneys provide a mining company. They write title searches, obtain legal titles, file mining claims, write leases, negotiate employment contracts, and work with governmental agencies. They defend or prosecute any lawsuits concerning the mine or company.

WHERE THEY WORK: Attorneys work in an office, and occasionally in the courts.

TOOLS THEY USE: County and federal land records along with law reference books are important tools to lawyers.

EDUCATION NECESSARY: Attorneys need a college degree plus a law degree.

INTERESTING ASPECTS OF THIS CAREER: Attorneys are able to protect a mining company and its interests by making sure all legal aspects are in order.
FOCUS ON CAREERS

WHAT THEY DO: Blasters are responsible for breaking up the coal, ore, or rock. After the drill operators do their job, the blasters insert an explosive charge into the pattern of holes. Special blasting agents are used, sometimes as much as 50,000 lbs. in a single blast pattern. The blasters fire the charge, and then the broken rock can be hauled away.

WHERE THEY WORK: Blasters work outdoors, and occasionally underground.

TOOLS THEY USE: Blasters use powerful explosives or blasting caps and blasting fuses.

EDUCATION NECESSARY: Blasters need to have a high school education and several years of mining experience. They must also be certified to handle dangerous materials.

INTERESTING ASPECTS OF THIS CAREER: Blasters get to work outdoors and to work with dangerous explosives every day. They must be very safety conscious.

BLASTERS

FOCUS ON CAREERS

WHAT THEY DO: Chemists are skilled in making chemical examinations and investigations. They analyze chemical reactions to improve mineral resource extraction methods and mineral purification. Their research and testing also provide data for reclamation.

WHERE THEY WORK: Chemists do field work, sampling and testing. Most of their work time is spent in a laboratory.

TOOLS THEY USE: Chemists use technical lab equipment, such as microscopes, and computers.

EDUCATION NECESSARY: At least a four year degree in chemistry.

INTERESTING ASPECTS OF THIS CAREER: Chemists get to do a lot of experimental research or puzzle solving. Their results continually modify and improve mining procedures.

CHEMISTS
FOCUS ON CAREERS

WHAT THEY DO: Computer programmers write the programs for the people in the mine who use them. They also design the program to fit the needs of the mine. Some programs are designed to communicate and keep records. Some programs are designed to monitor conveyor systems and gas levels in the mine or other operation systems. The programs have internal alarms to signal problems.

WHERE THEY WORK: Programmers work in an office. Periodically, for feedback and to recommend necessary changes, they inspect the systems.

TOOLS THEY USE: Programmers need a computer, printer, and a lot of textbooks.

EDUCATION NECESSARY: Computer programmers need a high school education with a strong math background, plus one to two years of technical school for programming. Many have four year degrees in computer science.

INTERESTING ASPECTS OF THIS CAREER: To keep up with the rapid changes in computers, computer programmers must continually be learning. Programmers do a lot of problem solving to help make the mine safe and efficient.

FOCUS ON CAREERS

WHAT THEY DO: Drill operators drill a carefully designed pattern of holes in the rock. These holes are then loaded with explosives to blast and break apart the rock.

WHERE THEY WORK: Drill operators work outdoors in surface or open pit mines or occasionally underground.

TOOLS THEY USE: Drillers use large rotary drills. Some drills can be up to ninety-nine feet tall. They also use smaller drills and measuring equipment, usually underground.

EDUCATION NECESSARY: Drill operators must have at least a high school diploma and ten to twelve years of mining experience.

INTERESTING ASPECTS OF THIS CAREER: Miners must work their way up to drill operator, and demonstrate great concern for safety because of the opportunity to work with powerful equipment and explosives.
**ENVIRONMENTAL ENGINEERS**

**WHAT THEY DO:** Environmental engineers develop the mining plans to provide the least impact on air, water, and social quality of the affected environment. During operation of the mine, they assure compliance with all mining regulations. After the mineral resources are extracted, the environmental engineers develop plans for reclamation, restoring the land to its previous condition or alternate uses.

**WHERE THEY WORK:** Environmental engineers spend part of their work time in an office and part outdoors.

**TOOLS THEY USE:** Computers, field samples, and testing equipment are the main tools of environmental engineers.

**EDUCATION NECESSARY:** Environmental engineers must have a four year degree in environmental or biological engineering. They may also have degrees in such fields as chemistry, hydrology or hydrogeology.

**INTERESTING ASPECTS OF THIS CAREER:** Environmental engineers have the opportunity to work outdoors in nature with plants and wildlife, improving the environment.

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**FEDERAL MINE EXAMINERS**

**WHAT THEY DO:** Federal mine examiners check working mines for any safety violations. They insure air quality and safe working conditions. They investigate all accidents that occur in their area. And they review accidents nationwide to prevent similar accidents. Federal mine examiners also check abandoned mines, completed workings, and sealed mines for safety.

**WHERE THEY WORK:** Federal mine examiners spend much of their time on the road, traveling to all the mines in their area. They spend some of their time in the mines and part of it in an office.

**TOOLS THEY USE:** Federal mine examiners use a government vehicle, lots of reports, and testing equipment.

**EDUCATION NECESSARY:** Many have a four year degree in a mining related field such as engineering, and a lot of mining experience.

**INTERESTING ASPECTS OF THIS CAREER:** Federal mine examiners are kind of their own boss, working independently. They get to travel and are able to prevent accidents and injuries in the mines.
WHAT THEY DO: Geologists analyze the rocks, looking for the characteristics that may lead to the discovery of mineral resource deposits. They find the mineral resource concentrations by taking core samples and testing. Then they determine whether the concentrations are worth mining. They are also involved in the mining process and the reclamation. There are many areas in which geologists can specialize. There are economic geologists, exploration geologists, petroleum geologists, engineering geologists, hydrogeologists, and research geologists.

WHERE THEY WORK: Geologists can spend part of their time outdoors collecting data and part of their work time in an office studying and interpreting the data.

TOOLS THEY USE: Typical tools of geologists are a rock hammer, hand lens, coring tools, a Brunten compass, and lots of sketches, maps, cross-sections, and computers.

EDUCATION NECESSARY: Geologists need a four year degree in geology and sometimes a master’s degree in a specialized field of geology.

INTERESTING ASPECTS OF THIS CAREER: Geologists are often able to travel and study the geology of different countries.

WHAT THEY DO: They operate the million dollar trucks which transport the raw ore to the crushers or conveyors or transport the waste to the tailings dump. They often drive hundreds of miles a day.

WHERE THEY WORK: The drivers work inside the trucks, riding 18 feet--nearly 2 stories--above the ground.

TOOLS THEY USE: The truck drivers operate the king-sized haulage trucks that can carry up to 240 tons of material and have 1,000 gallon fuel tanks.

EDUCATION NECESSARY: Most truck drivers have a high school diploma and a minimum of 12–15 years of mining experience. Drivers must train for about thirty days before they are fully qualified on a haulage truck.

INTERESTING ASPECTS OF THIS CAREER: Truck drivers get to work outdoors, operating massive, expensive machinery. It is a prestigious job, second only to a shovel operator.
WHAT THEY DO: Hydrologists study the surface and underground characteristics of water resources. Their responsibilities are to provide the water resource and protect the supply from overuse and contamination. Water is essential to mining and mineral processing.

WHERE THEY WORK: Field work occupies a small percentage of a hydrologist’s time. Hydrologists also sample soil and ground water and measure water levels. The greater portion of time is office work: researching information, evaluating field data, and preparing reports.

TOOLS THEY USE: Hydrologists use a lot of maps, aerial photos, and cross-sections, field samples, testing equipment, and a computer.

EDUCATION NECESSARY: A bachelor of science degree in hydrology, or a master’s degree.

INTERESTING ASPECTS OF THIS CAREER: Hydrologists study water flow, are able to see water interaction in the different layers of earth, and are able to prevent and control water contamination.

WHAT THEY DO: Mechanical engineers design and maintain the systems within the mine. They design the pump systems according to volume and size needed; also dust collectors, conveyor systems, and fire lines are some of their tasks.

WHERE THEY WORK: They work in both an office and at the mine site.

TOOLS THEY USE: Mechanical engineers use computers, calculators, and reference books in designing mine systems. A drafter and a secretary can be important to a mechanical engineer.

EDUCATION NECESSARY: A bachelor of science degree in mechanical engineering is necessary for this career.

INTERESTING ASPECTS OF THIS CAREER: There is a lot of variety in consulting, working with different people and different projects.
WHAT THEY DO: Mechanics service and repair equipment. They do a great deal of preventive maintenance to get maximum performance out of the expensive mining equipment.

WHERE THEY WORK: When equipment can be brought to them, mechanics work in a shop near the mine. For some big equipment, they must work in the mine, or wherever the equipment is located.

TOOLS THEY USE: Mechanics use basic repair tools from hammers and wrenches to very specialized tools to repair mining equipment.

EDUCATION NECESSARY: Mechanics need a high school diploma plus vocational training which includes an apprenticeship. In mining they need specialized training in hydraulics and electrical equipment.

INTERESTING ASPECTS OF THIS CAREER: Mechanics have a great knowledge of the workings of the mining equipment, and they have many opportunities for advancement.

WHAT THEY DO: Metallurgists devise techniques to separate the valuable material from the ore. They use processes to recover the desired component in a pure form. They test material to evaluate its properties, and they develop ways to recycle material.

WHERE THEY WORK: They work in the plant, likely a smelter or mill.

TOOLS THEY USE: Reference books and testing equipment are very important to a metallurgist.

EDUCATION NECESSARY: A four year degree in metallurgy is required.

INTERESTING ASPECTS OF THIS CAREER: Metallurgists have a lot of creative opportunity in developing new processes and products. Metallurgy is a specialized and challenging career.
WHAT THEY DO: Mine inspectors work to maintain safe working conditions. They check ventilation, insuring adequate oxygen supply. They test for strength of the roof and ribs of the mine, and safety of the equipment. A mine inspector is a trouble shooter for any potential hazards.

WHERE THEY WORK: Mine inspectors work throughout the mine doing safety checks. Also they spend time in an office doing research on accidents and prevention, and writing reports.

TOOLS THEY USE: A mine inspector uses testing equipment such as an MX270 which tests the gases in the air.

EDUCATION NECESSARY: Mine inspectors need a lot of practical education obtained through years of mining experience.

INTERESTING ASPECTS OF THIS CAREER: They are responsible for maintaining safety and prevention of accidents and injuries.

WHAT THEY DO: Presidents of mining companies or divisions are responsible for overall management. They hire key personnel. They obtain and allocate funds. They are responsible for safety and the actual implementation and efficiency of the mining operation plans.

WHERE THEY WORK: Presidents spend the majority of their time working in an office. The remainder is spent in the mine, doing follow-up work and promoting public relations.

TOOLS THEY USE: A computer is helpful to a president. But the most important resources are the department heads or division managers who provide important information to them.

EDUCATION NECESSARY: Presidents generally have a technical degree, a B.S. or M.B.A., and several years of mining experience, also good communication and negotiation skills.

INTERESTING ASPECTS OF THIS CAREER: Presidents have a good overview of the entire company. They deal with the business, the employees, and the community. It is an influential and powerful position, but it also carries heavy responsibilities.
WHAT THEY DO: Airplanes and helicopters are used as an aid in the exploration of mineral resources. They allow a large area to be photographed, mapped, and measured in a relatively short time. Pilots fly the airplanes and, in many cases, are required to operate exploration equipment.

WHERE THEY WORK: Pilots work in the plane and also spend time in an office, mapping and planning.

TOOLS THEY USE: Their most important tool is, of course, the airplane. They also have equipment for aerial photography, mapping, and measuring.

EDUCATION NECESSARY: A pilot’s license would be required.

INTERESTING ASPECTS OF THIS CAREER: Pilots get to see a lot of different terrain and explore new areas. They get to enjoy the thrill of flying.

WHAT THEY DO: Purchasing agents or buyers purchase everything for the mining operation from the heavy equipment to office supplies. In a large operation there might be several buyers, each with a different specialty.

WHERE THEY WORK: Purchasing agents work in an office.

TOOLS THEY USE: They use a computer, fax machine, and price catalogs.

EDUCATION NECESSARY: Purchasing agents need at least a high school diploma and experience in buying. They must be knowledgeable about mining and mining equipment.

INTERESTING ASPECTS OF THIS CAREER: Purchasing agents get to meet and work with a variety of people. They get exposure to the mine operation and all the commodities available.
FOCUS ON CAREERS

SECURITY OFFICERS

WHAT THEY DO: Security officers patrol the grounds and facilities, monitor people coming in and going out, and inspect vehicles. They deal with any security problems such as trespassing or vandalism.

WHERE THEY WORK: Security officers work in an office at a facility or gate. Some officers are on foot patrol; others patrol in a vehicle.

TOOLS THEY USE: Security officers use computers, surveillance cameras, and communication devices: telephone, pager, or walkie-talkie.

EDUCATION NECESSARY: Security officers need a high school education and basic security training. Many are Emergency Medical Technicians. They continually receive training in security and safety procedures.

INTERESTING ASPECTS OF THIS CAREER: Security officers meet a variety of people and sometimes get to work outdoors. They are prepared to think and act quickly to handle any problems.

FOCUS ON CAREERS

SHOVEL OPERATORS

WHAT THEY DO: Shovel operators run one of the primary pieces of mining equipment, the large shovel. They load the broken ore into the big haulage trucks. Some shovels hold as much as 60 tons per shovel scoop.

WHERE THEY WORK: The shovel operators work inside the cab of the huge shovel. Some cabs are three stories above the ground.

TOOLS THEY USE: The main tool shovel operators use is the giant shovel. Some shovels weigh up to 2 million pounds and can cost up to $6 million.

EDUCATION NECESSARY: Shovel operators must have a high school diploma, and some have at least 15–20 years of mining experience, moving up from other jobs, demonstrating great skill and aptitude. They must also demonstrate a concern for safety in order to become a shovel operator.

INTERESTING ASPECTS OF THIS CAREER: The shovel operators are the chief miners. This career is one of the more prestigious jobs in the mine, and is frequently the highest paid of large equipment operators.
TOOLS OF THE TRADE
TOOLS OF THE TRADE

This section describes specific tools and equipment used in the mining industry. The information presented about each tool tells what the tool is used for, and how it is used. The description includes who uses it, and where the tool is used. A very important aspect of any job is the tool or equipment necessary to get the job done safely and effectively. Each tool is accompanied by an illustration of at least one model or type of the particular tool.

Tools or pieces of equipment highlighted in this section include:
- Autoclave
- Computers
- Belt Conveyors
- Drills
- Explosives
- Steel-Toed Footwear
- Geiger Counter
- Hand Lens
- Hard Hat
- Haulage Trucks
- Helicopters
- Hoist
- Magnetometers
- Microscope
- Mills
- Dewatering Pumps
- Rock Pick
- Shovel (Electric/Hydraulic)
- Smelter
- Spectroscope

Listed below are a few suggestions for classroom application of these tools. We encourage you to identify other tools of the trade and learn more about them.
- Invite a local mining company representative to discuss the types of equipment used in their particular mining operation.
- Use photocopied, clipped and pasted reproductions of the tool illustrations to form the bases of an identification game or flash card sets: “What is it?” “What does it do?” “Where is it found?”
- Contact a mining equipment manufacturer or distributor for information regarding the tools or equipment they create or sell.
- Invite parents or mining industry workers who use special “tools” to talk about their equipment.
- Acquire a tool or piece of equipment (or a photograph), and let the student examine it and describe the ways it is used.
- Identify tools used in early mines. Compare them with modern mining equipment.
WHAT THE TOOL DOES: Acting somewhat like a great pressure cooker, the autoclave pressure oxidizes certain ores (gold, for example) so that they can be successfully treated by cyanide leaching. This pressure oxidation accomplishes in minutes what nature takes millions of years to do. The ore comes from the grinding mills as a slurry which is then thickened and pumped to tanks for the acidulation process which converts carbonates into sulfates.

The autoclave is a steel vessel. It is sectioned into compartments, each separated by a brick wall and lined with brick. Each compartment is separately agitated. Both high pressure steam and high pressure water are piped into each compartment for temperature control. Oxygen, which is supplied to each compartment, combines with elevated pressures and temperatures to oxidize the ore rapidly.

Pumps are used to increase gradually the pressure of the slurry from atmospheric pressure to the elevated pressure in the autoclave. Additionally, heat is captured from the slurry leaving the autoclave to raise the temperature of slurry entering the autoclave. The hot, high pressure slurry exits the last autoclave compartment through a pipeline in a series of tanks designed to reduce the high pressure and decrease the temperature. The oxidized slurry then enters the neutralization tanks where it mixes with slaked quick lime to raise the alkalinity of the slurry significantly. The acid slurry is raised to a pH of 10.5 in preparation for introduction into the conventional carbon-in-leach (CIL) circuit.

WHO USES THE TOOL: The technicians who operate the autoclave generally have on-the-job-training. Before the ore is processed in the autoclave, samples of the ore are tested by a laboratory. The study of these samples gives them information on the temperature, pressure, and length of time required to process the ore in the autoclave.

WHERE THE TOOL IS FOUND: Used in the refining process, the autoclave is an extra ore pretreatment step between grinding and leaching. From the autoclave, the gold can be recovered by conventional cyanide/vat leaching.
WHAT THE TOOL DOES: Computers have two parts, the hardware and the software. The hardware is the actual, physical computer. Computers range in size from the personal computer which may have 640K of memory to very large computers that have gigabytes of memory and take up a whole room. The software of a computer is the programs which have been written to manage information. Computers have been a help to the mining industry. They facilitate collection and organization of large amounts of information. About the only thing limiting their use is whether a computer program has been written to handle the data. Drill hole information, for example, can be put into a computer to show the location of the ore. The logs or records of 50,000 drill holes were recorded in a computer for one mine. Computer programs used for keeping track of the mining company’s expenses have also been written. Small computers cost about $2,000, and a large computer may cost as much as $1 million.

WHO USES THE TOOL: Computers are used by many mine workers. The accountants use large computers to handle the financial records. The geologists use them to plot the locations of drill holes.

WHERE THE TOOL IS FOUND: Personal computers are found in offices of many of the mine workers. Some may be linked to other computers for communication. A larger computer is usually found in a central room, and is used by several people. Computers are also found in the controls of trucks and trains used in the mine. Many desks that didn’t have a personal computer a few years ago now have them.
Belt conveyors move the mined ore, coal, or stone from the mine to the mill. They are also used in heap leach mining. Made of rubber, canvas, or steel, the belt is moved along rollers by a motor. The ore is fed onto the belt at the start and conveyed along to its end. There, the ore may be fed onto a vibrating conveyor that is used to shake out the already fine ore before it goes to be ground in the rod and ball mills. The price of the conveyor depends upon the length of the conveyor and the size of the hills that it goes up or down. One conveyor, for example, is three miles long and five feet wide. The cost may be $1 million for each half mile.

The conveyor is used by mine workers to transport the ore. It costs less to move the ore by a conveyor than it does to move the ore using a shovel and trucks.

Conveyors can be found in the mine (coal mines), or between the mine where the ore is recovered and the mill where the ore is processed. They can also be found at heap leach pads.

The old saying “There’s gold in them thar hills!” may be true, but the only way to find out for sure is to get inside the rock, and drills are the way to do this. Three types of drills are used: Jackleg drills, rotary drills, and “jumbo” drills. Each has four main parts: the support, the motor, the drill steel or pipe, and the drill bit. The driller controls the motor which turns the drill steel which causes the drill bit to cut a core sample. The drills used for this are Jackleg and “jumbo” drills. If the rock is very hard, a metal drill bit will wear out quickly. Therefore, a more expensive bit with diamonds on the cutting surface may be used. A rotary drill, which costs approximately $1.8 million is used to drill blast holes.

When geologists want to know what the rock is like in a certain place, they send in a person called a driller to obtain core samples which are then assayed to determine ore grade. Miners also use the drill to loosen the waste rock and the ore. Holes are drilled and then loaded with explosives. The explosion breaks up the rock.

Drills are used both in the search for new ore deposits as well as in the mining of the ore deposits. The drills are used in surface, as well as underground, mining.
**Tool of the Trade**

**Explosives**

WHAT THE TOOL DOES: Explosives are used to break up ore and waste rock. Two kinds of explosives are used. One is ammonium nitrate, a brand of explosive that has a bead form as well as a powdered form, and the other is Dynamite. The powdered ammonium nitrate works well in dry areas, and the bead ammonium nitrate can be used in areas where water is a problem. The ammonium nitrate is mixed with a diesel fuel, and is then primed and exploded. Dynamite too has forms that allow it to be used in dry or wet conditions. The use of explosives accounts for a large part of a mine’s operating costs.

WHO USES THE TOOL: Workers who use explosives must have at least twenty-four hours of training in working with explosives. Companies that supply the explosives have mining engineers to provide technical support to the mine. Blast holes and the explosives must be set so that the correct rock is moved. Sometimes only the waste rock on top of the ore is to be moved. Sometimes the ore has to be broken up. The ability to do this has to be learned and comes with experience.

WHERE THE TOOL IS FOUND: Explosives are used in surface, as well as underground mining. They are used to break up waste rock as well as to loosen the ore.

**Steel-Toed Footwear**

WHAT THE TOOL DOES: Steel-toed footwear protects the workers’ feet. The toe is strengthened by steel, but the footwear is generally made of leather, canvas, or rubber. Rated according to their ability to protect the wearers’ feet, the footwear is rated as class 25, 50, or 75. To test for class 75, a clay cylinder one inch in diameter is placed in the toe. A fifty-pound weight is dropped on the footwear from a height of eighteen inches. If the clay is not broken, the footwear is rated class 75. An approximate cost of steel-toed boots is between $59 and $77.

WHO USES THE TOOL: All mine industry workers, working in an area where their feet may be injured by falling or dropped objects, are required to wear steel-toed footwear. Geologists working in the office don’t have to wear it, but when they go into the mine, they must put it on. If the mine workers are working where water is a problem, they wear footwear made of rubber.

WHERE THE TOOL IS FOUND: Steel-toed footwear is worn in any mining industry environment where possible foot injury from falling or dropped objects is a hazard.
WHAT THE TOOL DOES: The Geiger counter is a tool that was developed by H. Geiger and E. W. Muller in 1928. It has a glass tube about three-fourths of an inch in diameter which has been filled with a gas, usually argon. Inside the glass tube is a copper cylinder which is about four inches long. Both the copper cylinder and the end of the glass tube are connected to a source of electricity. The geiger counter is used to help locate minerals such as carnotite or uraninite, which are ores of uranium. When the tube of the geiger counter comes near radioactive materials, fast moving, high energy particles which are always being given off by the radioactive minerals, pass through the glass tube. As they do, they cause the electricity to flow in the tube. The geiger counter has a loud speaker which produces a sound as each particle moves through the tube. The more uranium in an area, the more radioactive particles are given off by the mineral, and the more clicks from a geiger counter.

WHO USES THE TOOL: Prospectors or geologists use the tool in their search for radioactive minerals.

WHERE THE TOOL IS FOUND: The geiger counter would be carried along as part of an exploration geologist’s equipment.

WHAT THE TOOL DOES: A small version of a magnifying glass, a hand lens is approximately one and a half inches long and three-fourths to one and a half inches wide. It has two parts, the lens and protector. The hand lens is constructed so that when the lens is not in use it folds away inside a metal or plastic protector. When in use, the lens rotates out from the protector which then serves as a handle. Hand lenses magnify from ten to twenty times, and vary in price, depending upon their quality, from $3 to $60.

WHO USES THE TOOL: The exploration and production geologists use this tool to be able to see the very fine features of a rock or a small quantity of mineral in a core sample.

WHERE THE TOOL IS FOUND: The hand lens is often carried on a string hanging around the neck. There it is always available and out of the way.
WHAT THE TOOL DOES: Haulage trucks carry large loads of ore and waste rock from the surface or open pit mine. They are powered in two different ways. An electric haulage truck has a diesel engine which generates electricity that powers electrical motors that are in each of the wheels. A mechanical haulage truck is powered by one motor which moves the wheels. Haulage trucks are able to carry an amount of ore that is equal to the weight of the truck. Different sizes of haulage trucks can carry from 170 to 240 tons. The wheels of the truck can be 8 to 12 feet high. Two pickup trucks could hide in the bed of a large haulage truck. A driver sitting in the truck would be thirty feet off the ground. A large mine may have fifty to seventy trucks. A small haulage truck can cost as much as $1.5 million.

WHO USES THE TOOL: Haulage truck drivers must learn to use the controls to drive this truck. They must also be able to move the truck into the correct position for the shovel operator. Because it is so large that the driver cannot see nearby small vehicles or people, safety is very important for those who operate haulage trucks.

WHERE THE TOOL IS FOUND: Haulage trucks move the ore from the shovels or loaders at the mine to a crusher, conveyor belt or to a stock pile. The waste rock is moved out of the mine and dumped.

WHAT THE TOOL DOES: A hard hat or “comfo-cap” is worn by mine workers as part of their personal safety equipment. There are two parts to a hard hat, a hard outer shell and a liner. The outer shell is made of poly-carbonate plastic. The liner, made with strips of plastic, holds the hard shell away from the person’s head. This space between the liner and the hard outer shell acts as a cushion against falling objects and bumping your head against rock walls and ceilings. Hard hats used in underground mines also have a clamp on the front to hold the light and one on the back to hold the cord going from the light to a battery pack. The cost of a hard hat is approximately $4 to $20.

WHO USES THE TOOL: Anyone working or even visiting mine areas labeled “Hard Hat Area” must wear a hard hat for safety.

WHERE IS THE TOOL FOUND: The hard hat is worn in mine or mill areas that have been posted because the possibility exists that falling objects could produce head injuries.
WHAT THE TOOL DOES: Because helicopters have the ability to land and take off vertically, they have access to areas that are too small or possibly too remote for other kinds of transportation. They are used in the search for new ore deposits. They can be used to move drillers and drilling equipment into remote areas, and they are also used to transport large pieces of equipment short distances over rough ground where it would be difficult for a truck to go.

WHO USES THE TOOL: Helicopter pilots are often called “chopper” pilots. The skills required for flying a helicopter are different from those required to fly an airplane, but most helicopter pilots are also certified to pilot other aircraft.

WHERE THE TOOL IS FOUND: If the “chopper” is owned by the company, and that is rare, it might be kept on the mining site. Most of the time the helicopter is contracted from a flight service for a specific job or a specific length of time. Many mines, and areas that are being searched for minerals, are in the mountains or other limited access terrain, and these would be places where helicopters would be of great assistance.
WHAT THE TOOL DOES: A hoist is used to move cages which carry workers and materials in and out of the mine. It also moves the skips, which carry the ore or coal out of the mine. The hoist is a large tapered drum, around which the steel cables are wound. It is powered by an electric motor. As the hoist turns, the cable is either wound on or off the drum. The cables are made of several threads of steel that are twisted together. Each of the threads of the cable is also made of several steel wires. The cable may be as much as four inches in diameter. The other end of the cable, away from the hoist, is attached either to a cage or to a skip. Riding in or out of the mine in a cage requires the workers to swallow every so often to get the air pressure on their eardrums to balance. The speed at which the workers are moved up or down may be as much as seventy to seventy-five feet per second. Two skips run together so that as one goes down, the other comes up. If there are many levels in a mine, a system of bells is used. The number of bells tells the hoist operator to which level to move the skip or cage.

WHO USES THE TOOL: Hoist operators control the movement of the cages and the skips. In order to know to which level to move them, the hoist operators have to learn the bell system. Because of the importance of their job, hoist operators must stay on duty at the hoist. While at their station, they cannot leave or be bothered by other people.

WHERE THE TOOL IS FOUND: The hoist may be located on the surface or underground. Near the hoist will be a shaft in which the cages or skips move up and down. The cables go from the hoist to a tall frame over the shaft.
**WHAT THE TOOL DOES:** The magnetometer is a tool used in the search for valuable minerals. The name derived from Magnetic Island off the coast of Australia. The island has a large deposit of magnetite. This magnetite deposit was first discovered because of its effect on the compasses of passing ships. Magnetometers measure the magnetic field produced by iron-containing rocks. The first magnetometers used magnets and springs. The strength of the magnetic field was measured by the amount the spring was stretched. Modern magnetometers use electronic systems.

**WHO USES THE TOOL:** Magnetometers are used by geologists in the search for iron, nickel, and cobalt ores, and other ores which contain these elements. For example, the magnetometer could be used to search for copper ore because there is iron in some copper minerals.

**WHERE THE TOOL IS FOUND:** The magnetometer is attached to a cable and pulled behind an airplane or helicopter over land, or behind a ship to search the ocean floor. However, a magnetometer can also be carried and operated on the ground by a geologist. Places indicated by the magnetometer to have an increase in their magnetic fields are then searched more closely for ore deposits.

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**WHAT THE TOOL DOES:** A microscope is used to examine very small samples. A polarizing microscope has two polarizing filters, one above the microscope stage and one below, and is used to see the crystals of different minerals in rocks. Polarizing filters only allow light traveling in certain directions to pass through. The light coming through the first filter then passes through the thin-section that is placed on the stage of the microscope. A thin-section is made by gluing a small piece of rock to a glass slide. The rock is cut thinner using a diamond saw. Then the rock is ground down to a thickness of one thousandth of an inch so that light can pass through it. Because of the way the light is bent as it goes through the thin-section, the light can then pass through the second filter and the crystals of the thin-section are seen in brilliant colors.

**WHO USES THE TOOL:** The geologist or petrologist uses the polarizing microscope to identify the minerals that are in the rocks. With this information they can find ore and learn about the processes that produced the ore. In addition, they can learn how to get the ore away from the other minerals in the rock.

**WHERE THE TOOL IS FOUND:** A polarizing microscope would be used in the geologist’s office or in the assay office where samples are analyzed by a petrologist.
WHAT THE TOOL DOES: Mills crush the ore to smaller fragments, even to a fine powder. Sag, rod, and ball are the three types of mills. They are used to grind the ore so that it can be processed. These mills employ rotating drums that are used to grind the ore. The length of time that the ore remains in either of these mills depends upon the hardness of the ore, the size of the pieces going into the mill, and the desired size of material coming out. The following is an example of the size of the mills. Rod mills are twelve feet long and six feet in diameter, and they are half filled with rods that are three inches in diameter and about as long as the drum. Ball mills are eleven feet long and nine feet in diameter, and each contains about 80,000 pounds of steel balls, one and a half inches in diameter. A mixture of crushed ore and water is moved into the mills, where it is first ground to the size of wheat grains and then, ground to the texture of flour. A rod mill costs millions of dollars. Depending on the hardness of the ore, about 750,000 pounds of steel rods and 2,000,000 pounds of steel balls would be used in the mills in a year. The largest sag mill in the world is 36 ft. in diameter and 17 ft. in length.

WHO USES THE TOOL: Mill operators are laborers who receive on-the-job training for their position.

WHERE THE TOOL IS FOUND: The mills are located between the mining area and the refinery. The ore goes into the mill as larger pieces of ore and comes out as very fine material, the consistency of face powder, ready to be refined for metal or other elements.
WHAT THE TOOL DOES: A rock pick can be used to break the rock. It has a hardwood handle that is about two feet long. The head of the pick is about eighteen inches long. The pointed end of the pick is called the pick point. The other end, called a mattock, is two inches wide and looks like a very dull knife. Since rock samples usually need to be hand sized, the rock pick is helpful to break rock down to this more useable size. The head is made of hardened steel. Hardened steel is necessary to avoid pieces of the head chipping off. Such chipped-off pieces become flying particles of metal that could injure the person using the pick.

WHO USES THE TOOL: Mine workers use the tool for breaking rock and for making trenches. Loose rock on the ceiling of a mined-out area can be dangerous. Miners use the rock pick to find loose rock. When tapped with the hammer, loose rock has a hollow sound compared to the sound from solid rock. The pointed end of the rock pick is also used to test for rotting places in the timbers that line the drifts.

WHERE THE TOOL IS FOUND: The rock pick may be carried by the geologist as part of the tools used in exploration. The rock pick would also be one of the tools that are used in the mine.
WHAT THE TOOL DOES: Getting the ore from the ground to the haulage truck requires the use of a shovel. In the early days of mining, the ore was moved by a person doing the shoveling. Now, electric or hydraulic shovels are used to move the ore to a haulage truck. The large shovels used today employ tracks to move and have a very large scoop to shovel the ore and waste rock. Shovels may be powered by electricity, which gets to the shovel using electric cables from nine to ten inches in diameter. The cables may be strung across the ground or from poles to allow the haul trucks access to the shovel. A hydraulic shovel is powered by a diesel engine which supplies power to hydraulic pumps to move the scoop. A small shovel has a bucket or scoop that can hold 13 1/2 cubic yards of ore. The larger shovel has a scoop that can hold up to 42 cubic yards. A pickup truck could fit inside a 27 cubic yard bucket. The larger shovels can cost up to $10 million. The smaller shovels weigh 75 million pounds and cost approximately $3 million.

WHO USES THE TOOL: The shovel operator has to learn how to operate all the controls of the shovel. Operators must be able to judge where to place the scoop to dig up the ore and how to move the shovel to get the ore to go into the haul truck.

WHERE THE TOOL IS FOUND: Shovels of these sizes are used in open pit or surface mining to move the ore or waste rock from the ground to haulage trucks.

WHAT THE TOOL DOES: Smelters have two parts, a furnace and a container in which the ore and the flux are mixed. Flux is coke or charcoal or some other material that will combine with the waste part of the ore and not the metal. When the mixture of the ore and flux is heated to a high temperature, the mixture melts. The flux combines chemically with the materials in the ore and not with the metal. The gangue floats to the top of the metal and is skimmed off. Ores of the metals of bismuth, cadmium, cobalt, iron, lead, zinc, tungsten, and nickel can be processed in a smelter.

WHO USES THE TOOL: The smelter is used to process the finely crushed milled ore, and separate out the metal. Before the ore goes into the smelter, samples are collected and studied to determine exactly how the ore should be processed.

WHERE THE TOOL IS FOUND: The smelter is located between the mill and the refinery, or it is offsite, and the ore is shipped to it.
WHAT THE TOOL DOES: A spectroscope is used to determine if minerals are present in the rock samples. When minerals are heated, certain colors of light are given off. The colors of light given off by a mineral are like a person's signature. Just as each person's signature is different, each mineral gives off light of different colors in combinations that are different from other minerals. The spectroscope uses this effect. The spectroscope has a collimator, prism and a telescope. The ore is heated, and it gives off light. The light is formed into a beam by the collimator. The light from the collimator then is bent by the prism. The prism separates the light into the individual colors. (Think of the light coming from the sun. The rain droplets act as a prism and separate the sunlight into the individual colors. The colors of light in the rainbow were in the light coming from the sun, but we could not see them until the light was bent as it passed through the rain droplets.) The operator views the light through the telescope. From these colors the operator can tell what minerals are in the sample, and in what quantities they exist.

WHO USES THE TOOL: A metallurgist uses the spectroscope to see if minerals are in the rock. From this they can decide if the rock in the area is worth mining. Studying samples of the ore also gives information on how to process the ore.

WHERE THE TOOL IS FOUND: The spectroscope is part of the equipment that would be located in the laboratory. Samples collected in the search for ores as well as in the mining, milling, and refining processes would be studied.
LARGE GROUP ACTIVITIES
LARGE GROUP ACTIVITIES

This collection of learning activities is designed to expand the study of mineral resources and mining to groups larger than a single classroom. Their purpose is to involve students, teachers, parents, community members, and members of the mining industry in activities and events to learn more about environmental science, mineral resources, mining history, and the mining industry. Each activity includes a key concept, an objective, materials preparation, and suggested steps to implement the activity.

The activities in this section are as follow:
- Advertising Campaign
- Cut-Out Collage
- Gold Dust Days
- History of Mining Mural
- Invention Convention
- Junk Art Creation
- Mine Boggling Experience
- Mine to Market Masterpiece
- Mining Inventions
- Mining Town Model
- Patchwork Quilt
- Rock and Mineral Collection Showcase

Listed below are a few suggestions for grade level or school applications of large group activities. We encourage you to identify other large group activities and implement more or them.
- Conduct a culminating activity for a unit of study that involves all students within a grade level.
- Conduct a community cleanup or recycling project, and use one of the activities as a media event.
- Sponsor a “Mineral Resources Awareness Week.”
- Sponsor an “Arts” or essay competition with a theme that focuses upon “Our earth, our only source of mineral resources.”
- Develop a local mining history research project, and have school, district, and community displays, competitions and awards.
ADVERTISING CAMPAIGN

CONCEPT: All living things require minerals.

ACTIVITY OBJECTIVE: The students will participate in an advertising contest focusing on minerals.

MATERIALS/PREPARATION:
- Paper
- Crayons or markers

ACTIVITY:

1. Invite a representative from a local advertising agency to come to your school and talk to the students about advertising. This could be done at an assembly or by grade level. Have the advertising representative show examples of good advertisements and discuss what makes them good.

2. Challenge the students to participate in an advertising campaign. They need to produce a newspaper ad focusing on minerals or mining. You can limit this to a certain topic on minerals or be general and let them choose an area from what they have learned in your discussions regarding minerals and mining.

3. Ask the advertising representative to judge the advertisements and award the winners.

4. Display the advertisements.
CUT-OUT COLLAGE

CONCEPT: Students will have an opportunity to illustrate what they know about mineral resources and mining by creating a collage of cut-outs from magazines and newspapers.

ACTIVITY OBJECTIVE: The students will select pictures and words from magazines and newspapers to illustrate important ideas about mining and mineral resources.

MATERIALS/PREPARATION:
• Wide assortment of newspapers and magazines
• Paper cut to the size the finished collage should be
• Scissors
• Paste or glue

ACTIVITY:
1. Discuss the adage, “One picture is worth a thousand words.” Select a key idea and show students how to search for representative illustrations. Also discuss how one can start with pictures and assign meaning or ideas to them.

2. Challenge the students to create collages which represent some of the most important concepts they have learned in class.

3. Upon completion of the collages, have the students write about them.

4. Provide opportunities for student to share orally the ideas their collages are conveying.
LARGE GROUP ACTIVITIES

GOLD DUST DAYS

CONCEPT: The earth is the only source of our minerals.

ACTIVITY OBJECTIVE: The students will participate in a “mining day” celebration and learn how miners lived and also about the processes of mining.

MATERIALS/PREPARATION:
• Gold panning materials--pie tin  • Paper
• Games  • Pencil

ACTIVITY:

1. Research how mining was started in your state. Contact your local Bureau of Mines or ask a librarian for assistance. If possible, have a local historian or representative from the Bureau of Mines come and talk at an assembly and tell the story of your state.

2. Choose a “mining day” for your school. Tell the students to dress like miners for that day.

3. During the “mining day” have the students participate in mining activities such as gold panning, games, etc.

4. Have the students write a short story about a famous miner from your area. Have the students share their stories with the rest of the class or group.

5. Display rock and mineral collections of students; give awards for largest, most unique, best display, etc.
HISTORY OF MINING MURAL

CONCEPT: The learner will know about geologic history.

ACTIVITY OBJECTIVE: The students will research the history of mining in the United States and illustrate the time periods on a large mural.

MATERIALS/PREPARATION:
• Several large pieces of butcher paper for mural
• Crayons or markers

ACTIVITY:
1. Divide the class into several groups to research various time periods of mining in the U.S. (Ask school media coordinator for assistance.) This could be done by grade.
2. Tell the students to write a report on their findings.
3. Using their findings, tell the students to illustrate the important highlights of each period in the history of mining. Give the students time to plan and prepare their mural.
4. Display the mural!
CONCEPT: Students will have an opportunity to create objects relating to mineral resource exploration or processing from classroom and home trash.

ACTIVITY OBJECTIVE: From trash materials, the students will create objects which relate to the mining industry.

MATERIALS/PREPARATION:
• Glue, paste
• Paints, crayons
• Construction paper
• Scissors
• Clay
• Poster paper
• Trash items that students collect from home and classroom

ACTIVITY:
1. Review information on equipment and tools used in the mining industry.
2. Challenge the students to be clever in creating mining tools and equipment from trash items. Their creations can represent “real” or “imaginary” mining tools or equipment.
3. Upon completion of their inventions, have students discuss them with the class.

LARGE GROUP ACTIVITIES

INVENTION CONVENTION
CONCEPT: Students will have an opportunity to illustrate the need for conservation, recycling, and environmental appreciation by creating "art" from classroom and home trash.

ACTIVITY OBJECTIVE: The students will create objects of art which relate to the environmental issues of recycling and conservation by using trash as their medium.

MATERIALS/PREPARATION:
- Glue, paste
- Paints, crayons
- Construction paper
- Scissors
- Poster paper
- Trash items that students collect from home and classroom

ACTIVITY:
1. Review the connections between mineral resources, mining, recycling, and conservation.
2. Challenge the students to create unique art forms which illustrate the concepts of appreciation for the environment, recycling and conservation.
3. Encourage them to combine trash or junk items with regular art supplies and materials.
4. Each piece of art should have a short written description on the back.
5. Creations should be shared with other classes and parents.
CONCEPT: The earth is the only source of our minerals, and every mineral use decision affects standards of living and our quality of life.

ACTIVITY OBJECTIVE: Students will identify ways we obtain and use our mineral resources, and each student will produce a finished piece of writing or art work that reflects this awareness and some aspect related to mining and mineral resources.

MATERIALS/PREPARATION:
• Poster paper
• Crayons, paints
• Writing paper, pencils
• Copies of areas of participation for all levels or classes taking part
• Approval if activity is to be carried out as contest by level or school

ACTIVITY:
1. Review with students the ways in which we obtain mineral resources, the need we have for them, and how our decisions on their use affect our standard of life.

2. Challenge the students to design a poster, create a poem, or write a short story that conveys their awareness of some aspect of mining and mineral resources.

3. Select judges from the school faculty to choose the best three from each grade level.

4. Display the entries by categories and grade levels in the school entry, office, cafeteria, or in a highly visible place.

5. Have a “Parents’ Night” and invite winning students to read or tell about their entry.

Extension of Activity
Before the contest is announced, have the art teachers carry out an activity to have interested students create black and white, line drawings that are illustrations for “mine safety.” The top three of all submitted could be duplicated and a “coloring contest” could be held as part of the Mine Boggling Experience.
LARGE GROUP ACTIVITIES

MINE TO MARKET MASTERPIECE

CONCEPT: Students will have an opportunity to create a “mine to market” illustration for a mineral resource of their choice.

ACTIVITY OBJECTIVE: The students will select a mineral resource and illustrate how it is extracted from the earth and made ready for use by manufacturers or consumers.

MATERIALS/PREPARATION:
- Construction paper
- Paints, crayons
- Poster paper
- Scissors

ACTIVITY:
1. Review the “mine to market” concept by discussing the sequence of steps involved in processing a mineral resource.
2. In groups of five or six, have students select a mineral resource and research how it is mined, processed, and made ready for market.
3. Challenge the students to create an illustration which clearly depicts what happens through the stages of processing to the ore or mineral deposit once it has been discovered.
4. To accompany the illustration, have students prepare a write-up on their mineral resource.
LARGE GROUP ACTIVITIES

MINING INVENTIONS

CONCEPT: Each mineral can be used in many ways.

ACTIVITY OBJECTIVE: The students will invent a new device or product that uses minerals or items made from minerals.

MATERIALS/PREPARATION:
• Graph paper
• Writing paper, pencils
• Drawing paper, crayons, or markers

ACTIVITY

1. Tell the students to pretend they are a scientist or inventor who is trying to invent a product that will help the user save time and/or energy. The product must use a mineral or something made from a mineral.

2. Remind the students that good scientists must be willing to plan, investigate and experiment while producing a new product.

3. Have the students make a model of their product and a written description of how the device works.

4. Have the students display their products for other students to see, as well as to be judged.
MINING TOWN MODEL

CONCEPT: Students will plan and build a model of a mining town.

ACTIVITY OBJECTIVE: The students will demonstrate their knowledge of a mining community by creating a townsite and mine.

MATERIALS/PREPARATION:
- Glue, paste
- Paints, crayons
- Construction paper
- Scissors
- Poster paper, light weight chipboard
- Clay
- Encourage students to bring in other items that they need from trash or discard sources

ACTIVITY:
1. Review with students the idea of a mining town, both past and present. Have them identify the important features which would be found in the town.
2. Challenge the students to create a mining town of the past, present, or future which would illustrate a well functioning community. Encourage them to demonstrate new ideas they have learned about mining and the environment.
3. Provide students an opportunity to display their completed models to other classes or grade levels.
4. Hold a “Parent Night” and have students display and make presentations on their models.
LARGE GROUP ACTIVITIES

PATCHWORK QUILT

CONCEPT: Students will create patchwork aerial impressions using maps to recognize prominent topographical features.

ACTIVITY OBJECTIVE: The students will demonstrate recognition of topographical features as represented on maps.

MATERIALS/PREPARATION:
• Topographical, or road maps cut into 9 x 12 inch pieces
• Tracing paper or other thin paper • Colored markers
• 12 x 15 inch black paper for frame
• Contact your state Geological Survey as a source of maps

ACTIVITY:
1. Put tracing paper over map and trace lines of rivers, roads, and other topographical features. Do not select tiny features.

2. Make different patterns in each section to depict things like plowed fields, forests, mountains, an open-pit mine, etc., as they would appear if seen from the air.

3. Fill in each section using the colored markers.

4. Make a shadow-box frame by centering the design on a piece of black paper 12 x 15 inches. Glue your design down, and then crease the black paper on each side of the design, folding down over the design slightly. Then fold corners diagonally toward the design, creating a shadow-box effect.

5. The class may then assemble all of its squares to make a Patchwork Quilt. Arrangement may be done purely by design or it may be an arrangement by terrain, or it may be random.
LARGE GROUP ACTIVITIES

ROCK AND MINERAL COLLECTION SHOWCASE

CONCEPT: Students will have an opportunity to display their rock and mineral collections.

ACTIVITY OBJECTIVE: The students will prepare their collections for display and write a short description about their collection, when they got started, and what they have learned about collecting rocks and minerals.

MATERIALS/PREPARATION:
• Display tables
• Classroom or school area for the display

ACTIVITY:
1. Discuss rock and mineral collecting and what makes an outstanding collection.
2. Advertise the showcase concept, providing date, time, and location.
3. Have students assist with setting up the display tables.
4. Following the showcase event, present each student with a certificate of participation or appreciation for taking part in the showcase.
Listed below are a few suggestions for classroom applications of these mini-posters. We encourage you to utilize these and other posters and learn more about the topics they portray.

- Have students color their copy of a poster with crayons, colored pencils, or paint.
- Have students identify key concepts such as exploration, development, uses, distribution, etc., by circling or coloring images or sections that depict the concepts.
- Have students use a poster as a springboard for their own illustrations.
- Use for group discussion or brainstorming on a topic or issue that is part of their own community. Have them share their conclusions.
- Have them identify as many different mineral resources and their uses as they can discover on the poster. Reward the individual or group having the greatest number of verified examples.

MINI-POSTERS

The mini-posters are 8 1/2” x 11” black and white miniatures of 23” x 35” full color posters. These, along with numerous other instructional posters, are available from the National Energy Foundation. These miniatures are provided for use by teachers and students as needed to extend teaching and learning. The size lends itself to photocopy applications.
SKILLS AND PROCESSES
SKILLS/PROCESSES

As part of the “Instructional Information” at the beginning of each activity, there is a short list of “Skills/Processes.” Careful attention has been given to the learning processes of the activities and to the skills that the students will be expected to use or apply to successfully complete them. Familiarize yourself with this listing and, by all means, add to it as you discover additional skills and processes that the activities may develop.

ANALYZE: to examine in detail; to separate a thing or idea into its parts to find out their functions, their interrelationships.

APPLY: put to some practical or specific use; to make appropriate or relevant.

BRAINSTORM: unrestrained offering of ideas or suggestions by all members of a group.

CALCULATE: to determine by using mathematics; by reasoning, evaluating; compute.

CATEGORIZE: to place in distinct or separate groupings; to classify.

CHART: to make a chart, an outline, a map, a table, a diagram; to plot.

CLASSIFY: to arrange or group according to some class or system; to categorize.

COLLECT: to accumulate; to gather together, assemble.

COMMUNICATE: give information, signs, signals, or messages by talk, gesture, or writing; to make known.

COMPARE: examine in order to discover similarities or differences; weighing of parallel features for relative values.

CONCLUDE: to decide by reasoning; infer; deduce.

CONSTRUCT: to make; to build or form; to arrive at an idea from a synthesis of sense impressions.

COOPERATE: to act or work together with another or others for a common purpose.

CREATE: to bring into being; to make or design something, requiring art, skill, or invention.

DECIDE: to arrive at a decision, choice, judgment; to determine.

DEDUCE: to conclude from known facts or general principles; to infer from logical reasoning.

DESCRIBE: to tell or write about; to give a detailed account.

DIAGRAM: a chart, graph, drawing, or plan that explains a thing by outlining its parts and showing their relationships.

DISCUSS: talking about something, with varying opinions offered constructively to settle an issue or decide upon a course of action.

DISPLAY: to spread out, disclose, exhibit, reveal.

DRAW: create a visual image (to draw a picture); to reach a conclusion, deduce from facts or principles; to
arrive at conclusions or results by hypothesizing from
known facts or observations.

ESTIMATE: to judge or determine generally, but care-
fully, size, value, cost, requirements, etc.

EVALUATE: to find value or amount; to appraise worth
or quality; to find numerical value, express in numbers.

EXPERIMENT: a test or trial of something; any action or
process undertaken to discover something not yet
known, or to demonstrate something known.

EXTRAPOLATE: to arrive at conclusions or results by
generalizing from known facts or observations.

GRAPH: to put in the form of, or represent by, a graph.

HYPOTHESIZE: to assume or suppose; to assert an un-
proved theory to supply a basis for further investigation
or argument.

IDENTIFY: recognize or show to be the very thing
known, described, or claimed.

ILLUSTRATE: to make clear or easily understood by ex-
amples or comparisons.

IMAGINE: to suppose, guess, think; to form a mental
image of.

INTERPRET: explain, make clear or understandable;
give one's own conception of a work.

INVESTIGATE: search or inquire into systematically so
as to reveal the facts.

LISTEN: make a conscious effort to hear; pay close atten-
tion.

LOCATE: search to find the position of; mark off or des-
ignate.

MATCH: select, show, or produce that which is equal,
suitable, or corresponding.

MEASURE: to find out, determine the extent or dimen-
sion by applying a standard.

MEMORIZE: to commit to memory; learn by heart.

OBSERVE: pay special attention to; examine and study
scientifically.

ORGANIZE: arrange in an orderly way; to make into a
whole, with unified, coherent relationships.

PLAN: to have in mind a scheme for doing, making, or
arranging; any detailed method, formulated beforehand,
for doing or making something.

PREDICT: to say in advance what one believes will
happen.

PROBLEM SOLVE: to find or provide the correct or a sat-
isfactory solution (answer) to a problem.

PROCESS: to prepare by, or subject to, a special method
or procedure.

READ: to gain the meaning of something written or
printed.

REASON: to think coherently and logically; to draw in-
ferences or conclusions from facts known or assumed.

RECORD: to put in writing, sound, or image for future
use; to make a permanent or official notation.

RESEARCH: to study or investigate a topic in order to es-
tablish its facts or principles.

SEARCH: to go over or look through for the purpose of
finding something; explore; examine.

SKETCH: a rough drawing or design; a brief plan or de-
scription of major parts or points; outline.

SPEAK: to express or communicate opinions, feelings,
ideas; formal address to an audience.

SYNTHESIZE: to put together separate parts or elements
so as to form a whole.

TRANSFER: to convey or move something from one po-
sition to another; to use methods or results of one experi-
ence upon another.

WRITE: to communicate in writing; to author or com-
pose written work.
CONCEPTUAL FRAMEWORK

With materials development and instruction, a conceptual framework is a starting point. It serves the educator in much the same way as a blueprint serves an architect or builder. The framework provides an organized view of the components necessary to successfully initiate a desired project. This conceptual framework for mineral resources and mining states instructional domains and concepts in eight topic areas.

It is hoped that educators will be assisted in their materials development efforts by the use of this framework. The framework has other purposes as well; it can be used by writers and other individuals who work in mineral resources and mining-related businesses and industries. Its primary purpose, as created in this document, is for use by educators, and materials developers.

Purpose

This conceptual framework has several important uses. Its most important purpose is to provide educators and materials developers with a thoughtful and organized presentation of fundamental mineral resources and mining goals and concepts. It focuses on the main elements of learning that should be taught. This document is intended to assist educational colleagues in identifying concepts for instruction associated with these important natural resources. We hope that by doing so we will have helped teachers to more completely and appropriately teach about mineral resources and mining in the classroom.

Development Process

The Mineral Resources and Mining Conceptual Framework was created by technical experts and development specialists. Following the initial preparation and editing, the framework was sent to selected evaluators. They represented educators and technical experts in several geographic regions as well as all grade levels and many disciplines. Evaluator recommendations have been carefully considered and incorporated into this framework.

This document contains instructional goals and concepts for K-12 that are fundamental to a functional understanding of mineral resources and mining and their contribution to our society. It describes what numerous contributing education and mineral resources and
mining industry specialists believe a teacher should teach and a student will learn about mineral resources and mining at the completion of their secondary school education.

Curriculum Development

There are many ways to begin the materials development process. Some of these result in the creation of useful teaching and learning resources; some do not. Experience shows the probability of success is greatest when materials are prepared within the context of a carefully conceived and systematically utilized framework.

A conceptual framework is the first component of such a materials development process. It is designed to help the educator-writer quickly and efficiently identify fundamental goals, concepts, and general objectives for a particular subject, discipline, or area of interest. In other words, specialists have provided counsel concerning content in their area of expertise; and by so doing have helped the educator answer the essential question: What should teachers teach and students learn?

With much of the guesswork removed, the writer can focus time and effort on specific learning goals and apply activities which meet the specific needs of students.

This document is the basis for the preparation of other resources within the context of mineral resources and mining education. Other components could include activity guides and lesson plans. For more information about mineral resources and mining education, contact either the United States Bureau of Mines or the National Energy Foundation.
CONTENT DOMAINS FOR MINERAL RESOURCES AND MINING EDUCATION

The Conceptual Framework for Mineral Resource and Mining Education has been organized into several component parts. They include:

• CONTENT DOMAINS FOR LEARNING
  Major instructional statements identifying what learners will understand about a specific topic.
  An example is:
  Content Domain 1:
  ORIGIN AND DISTRIBUTION OF MINERAL RESOURCES.
  The student will understand how mineral resources are formed by geologic processes and that resources are limited and unevenly distributed.

• CONCEPTS FOR LEARNING
  Important ideas that relate to learning the CONTENT DOMAIN.
  An example is:
  Concept 1.1:
  Knowledge of early geologic processes is important in understanding how mineral resources are formed.

Content Domains are the biggest ideas. They are the unifiers under which the concepts can be identified and organized.

The following eight content domains describe, in general terms, what a student will understand about mineral resources and mining at the completion of the student’s formal, elementary and secondary education.
CONTENT DOMAIN 1

ORIGIN AND DISTRIBUTION OF MINERAL RESOURCES
The student will understand how mineral resources are formed by geologic processes and that resources are limited and unevenly distributed.

CONTENT DOMAIN 2

USES OF MINERAL RESOURCES
The student will understand that there are many uses of mineral resources.

CONTENT DOMAIN 3

MINING: THE INDUSTRY
The student will understand the purposes, people, and processes that are the mining industry.

CONTENT DOMAIN 4

ECONOMIC IMPACT OF MINERAL RESOURCE EXTRACTION AND USE
The student will understand that mining and the use of mineral resources have economic impacts.
CONTENT DOMAIN 5

ENVIRONMENTAL IMPACTS OF MINERAL RESOURCE EXTRACTION AND USE

The student will understand that mining and the use of mineral resources have both positive and negative impacts on the environment.

CONTENT DOMAIN 6

LIMITS OF MINERAL RESOURCES

The student will understand that the amount of mineral resources and their availability for use varies and has limits.

CONTENT DOMAIN 7

MINERAL RESOURCES CONSERVATION AND RECYCLING

The student will understand the importance of conserving and recycling mineral resources to extend their useful lives.

CONTENT DOMAIN 8

FUTURE OF MINING AND MINERAL RESOURCE USE

The student will understand that mineral resources, mining technology, and mineral use in the future may be different from those of the present or past.
CONTENT DOMAIN 1

ORIGIN AND DISTRIBUTION OF MINERAL RESOURCES
The student will understand how mineral resources are formed by geologic processes and that resources are limited and unevenly distributed.

Concept 1.1 Knowledge of early geologic processes is important in understanding how mineral resources are formed.

Concept 1.2 Rocks are classified as igneous, sedimentary, or metamorphic.

Concept 1.3 A rock is an aggregate of mineral resources.

Concept 1.4 Knowledge of MOHS’ Hardness Scale is essential in the identification and classification of mineral resources.

Concept 1.5 Crystal systems and other physical properties and characteristics are crucial in the identification and classification of mineral resources.

Concept 1.6 The earth is the only source of our mineral resources.

Concept 1.7 Natural processes form mineral resources very slowly.

Concept 1.8 There are many different kinds of mineral resources.

Concept 1.9 Mineral resources can be classified in many different ways.

Concept 1.10 Varied exploration technologies are used to locate mineral resources.

Concept 1.11 Mineral resource deposits are limited and distributed unevenly around the earth.
## CONTENT DOMAIN 2

### USES OF MINERAL RESOURCES

The student will understand that there are many uses of mineral resources.

| Concept 2.1 | Throughout the history of mankind, civilizations have been judged on their knowledge and expert use of mineral resources. |
| Concept 2.2 | All living things require mineral resources. |
| Concept 2.3 | Most mineral resources can be used in many ways. |
| Concept 2.4 | There are health and safety factors associated with the development and use of mineral resources. |
| Concept 2.5 | Many occupations have been created because of our use of mineral resources. |
| Concept 2.6 | Many mineral resources are used in industry. |
| Concept 2.7 | Some human activities and technologies use more mineral resources than others. |
| Concept 2.8 | Every decision involving mineral resource use affects standards of living and quality of life. |
| Concept 2.9 | Laws and regulations are mandated to control and protect mineral resource development and use. |
| Concept 2.10 | There is a growing need for less familiar mineral resources as new uses for them develop. |
| Concept 2.11 | A number of mineral resources are greatly valued for their aesthetic qualities. |
## CONTENT DOMAIN 3

### MINING: THE INDUSTRY

The student will understand the purposes, people, and processes that are the mining industry.

<table>
<thead>
<tr>
<th>Concept 3.1</th>
<th>Many occupations have been created because of our use of mineral resources.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept 3.2</td>
<td>Mining is one of the basic industries; the other is agriculture.</td>
</tr>
<tr>
<td>Concept 3.3</td>
<td>Mining produces new primary materials that are used by all other industries.</td>
</tr>
<tr>
<td>Concept 3.4</td>
<td>The mining industry is very complex and very important to our society.</td>
</tr>
<tr>
<td>Concept 3.5</td>
<td>The development of mineral resources involves exploration, extraction, processing, and manufacturing.</td>
</tr>
<tr>
<td>Concept 3.6</td>
<td>Mineral resources can be extracted, processed, and manufactured through different types of mining and processing.</td>
</tr>
<tr>
<td>Concept 3.7</td>
<td>Mining into the earth’s surface, via a pit, is referred to as open pit or surface mining.</td>
</tr>
<tr>
<td>Concept 3.8</td>
<td>Mining mineral resources beneath the earth’s surface is referred to as underground mining.</td>
</tr>
<tr>
<td>Concept 3.9</td>
<td>Placer mining is a type of mining that utilizes the specific gravity of a mineral to separate it from sand and gravel.</td>
</tr>
<tr>
<td>Concept 3.10</td>
<td>There are health and safety factors associated with the development and extraction of mineral resources.</td>
</tr>
<tr>
<td>Concept 3.11</td>
<td>Abandoned mines can be deadly due to: falling, drowning in water, poisonous gases, snakes and insects, a cave-in due to decaying, rotting timbers, and discarded explosives.</td>
</tr>
<tr>
<td>Concept 3.12</td>
<td>Mines can have, in and around them, dangerous machinery, high-voltage power lines, explosives, and dangerous chemicals and fumes.</td>
</tr>
<tr>
<td>Concept 3.13</td>
<td>People must obey posted signs in and around old and working mines to insure safety.</td>
</tr>
<tr>
<td>Concept 3.14</td>
<td>Many advances in mine safety have been developed over the history of mining and many more are currently being studied, implemented, and tested.</td>
</tr>
<tr>
<td>Concept 3.15</td>
<td>Modern exploration for mineral resources requires geological testing of core samples.</td>
</tr>
</tbody>
</table>
CONTENT DOMAIN 4

ECONOMIC IMPACTS OF MINERAL RESOURCE EXTRACTION AND USE

The student will understand that mining and the use of mineral resources have economic impacts.

Concept 4.1  There are economic impacts related to mineral resource and mining exploration.

Concept 4.2  Mineral resources development costs include the cost of mineral resource exploration, development, processing, marketing, and reclamation.

Concept 4.3  Mining development can bring social, cultural, and physical changes that are both positive and negative.

Concept 4.4  Mineral resources are commodities that are subject to supply and demand factors in the world marketplace.

Concept 4.5  The use or nonuse of a mineral resource requires environmental and economic trade-offs.

Concept 4.6  Economic factors influence mineral resource exploration, development, marketing and distribution.

Concept 4.7  Mining helps keep the economy healthy in many ways.

Concept 4.8  The mining industry creates jobs which allow employees to spend their money to buy products and pay for services they need.

Concept 4.9  Primary products created by mining are used by other industries.
CONTENT DOMAIN 5

ENVIRONMENTAL IMPACTS
OF MINERAL RESOURCE
EXTRACTION AND USE

The student will understand that mining and the use of mineral resources have both positive and negative impacts on the environment.

Concept 5.1 Mining alters the environment.
Concept 5.2 Mineral resource exploration and mining have both positive and negative consequences on the environment.
Concept 5.3 Industrial societies have a tremendous impact on the environment, as do agrarian societies.
Concept 5.4 Environmental evaluations of a mineral resource development are always required by law.
Concept 5.5 Compromise may be necessary to resolve conflicts concerning the environmental impacts of mineral resource extraction and development.
Concept 5.6 Laws and regulations govern the nature and extent of impacts resulting from mineral resource development.
CONTENT DOMAIN 6

LIMITS OF MINERAL RESOURCES

The student will understand that the amount of mineral resources and their availability for use varies and has limits.

Concept 6.1 Future technologies may be limited by existing mineral resources.
Concept 6.2 High grade (concentrated) mineral resources occur in relatively small quantities compared to average and lower grade mineral resources.
Concept 6.3 It takes mineral resources to obtain mineral resources.
Concept 6.4 All mineral resources have limits to their usefulness, though new uses continue to be discovered.
Concept 6.5 Mineral resources are formed so slowly they are practically nonrenewable.
Concept 6.6 The development of mineral resources influences social, political, and cultural growth, as well as quality of life.
Concept 6.7 The availability of mineral resources is influenced by availability of the technology.
Concept 6.8 Social and political decisions influence the availability of mineral resources.
Concept 6.9 Economic and environmental factors limit mineral resource development and use.
Concept 6.10 The earth's mineral resources are being consumed at a rapid rate.
Concept 6.11 The development of mineral resources affects social and political decisions.
Concept 7.1  Various methods are used to conserve and reuse mineral resource products.

Concept 7.2  Attitudes, beliefs, values, and economic conditions influence the practice of mineral resource reuse and conservation.

Concept 7.3  Social and political decisions affect the implementation of mineral resource conservation and recycling practices.

Concept 7.4  Mineral resource conservation and recycling practices affect lifestyles, quality of life, and the standard of living.

Concept 7.5  Technological development affects mineral resource conservation options.

Concept 7.6  Some mineral resources are more appropriate for certain uses and recycling than others.

Concept 7.7  Recycling can save and use energy.
CONTENT DOMAIN 8

FUTURE OF MINING AND MINERAL RESOURCE USE

The student will understand that mineral resources, mining technology, and mineral use in the future may be different from those of the present or past.

Concept 8.1 New mineral resource technologies will be developed in the future.

Concept 8.2 New mineral resource deposits will be discovered in the future.

Concept 8.3 Different consumption practices would alter future demands on mineral resources.

Concept 8.4 Competition regarding mineral resources will continue to influence relationships between nations.

Concept 8.5 Mineral resource availability will affect future lifestyles and cultural conditions.

Concept 8.6 Future mineral resource development will result in the loss of some employment opportunities and the addition of others.

Concept 8.7 Our national security and economic strength depend on mineral resources availability.

Concept 8.8 New uses for mineral resources will be created in the future.