UNDERGROUND MINING
KEY

Terminology
Define the following terms as they relate to mining.

Vein - A fissure, fault or crack in a rock filled by minerals that have travelled upwards from some deep source.

Vug – A small cavity in a rock, frequently lined with well-formed crystals. Amethyst commonly forms in these cavities.

Adit – a horizontal or nearly horizontal passage driven from the surface for the working or dewatering of a mine. If an adit is driven through the hill or mountain to the surface on the opposite side, it is called a tunnel.

Portal – The structure surrounding the immediate entrance to a mine; the mouth of an adit or tunnel.

Shaft – A vertical or inclined excavation in rock for the purpose of providing access to an orebody. Usually equipped with a hoist at the top, which lowers and raises a conveyance for handling workers and materials.

Stope – An excavation in a mine from which ore is, or has been, extracted.

Drift – A horizontal underground opening that follows along the length of a vein or rock formation as opposed to a crosscut, which crosses the rock formation.

Breast – A working face in a mine, usually restricted to a stope.

Incline – Any entry to a mine that is not vertical (shaft) or horizontal (adit). Often incline is reserved for those entries that are too steep for a belt conveyor (+17 degrees -18 degrees), in which case a hoist and guide rails are employed. A belt conveyor incline is termed a slope. Alt: Secondary inclined opening, driven upward to connect levels, sometimes on the dip of a deposit; also called "inclined shaft".

Decline – A sloping underground opening for machine access from level to level or from surface; also called a ramp.

Winze – An internal shaft.

Hangingwall – The rock on the upper side of a vein or ore deposit.

Footwall – The rock on the underside of a vein or ore structure.

Headframe – The structure surmounting the shaft, which supports the hoist rope pulley, and often the hoist itself.

Cage – The conveyance used to transport men and equipment between the surface and the mine levels.

Roof bolt – A long steel bolt driven into the roof of underground excavations to support the roof, preventing and limiting the extent of roof falls. The unit consists of the bolt (up to 4 feet long), steel plate, expansion shell, and pal nut. The use of roof bolts eliminates the need for timbering by fastening together, or "laminating," several weaker layers of roof strata to build a "beam."

Room and Pillar – a form of underground mining in which typically more than half of the ore is left in the mine as pillars to support the roof. Room and pillar mines are generally not expected to subside, except where retreat mining is practiced. The mining method is used for thick and/or flat-lying industrial, metal, and nonmetal mineral deposits, such as coal, limestone, trona, and salt.

Bit – The cutting end of a drill frequently made of an extremely hard material such as industrial diamonds or tungsten carbide.

Blast hole – A drill hole in a mine that is filled with explosives in order to blast loose a quantity of rock.

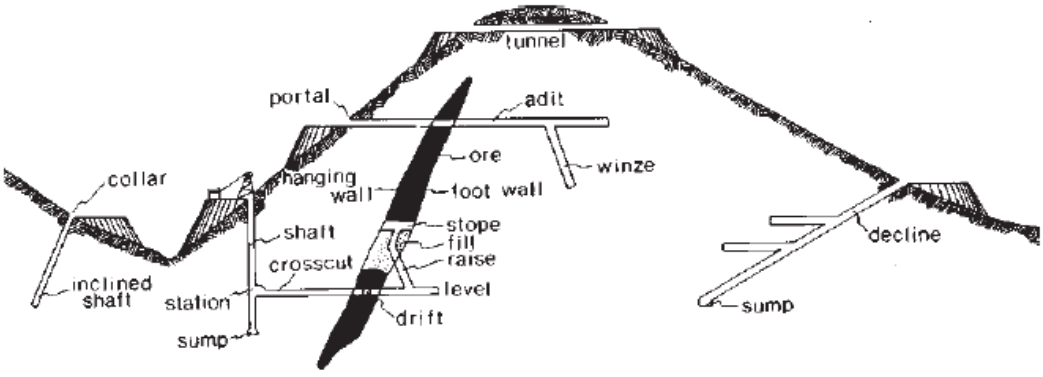
Muck – Ore or rock that has been broken by blasting.

Chute – An opening, usually constructed of timber and equipped with a gate, through which ore is drawn from a stope into mine cars.

Run-of-mine – A term used loosely to describe ore of average grade.

Questions
Answer the following questions related to underground mining.

1) Describe the workings of a surface mine. (Hint: Use vocabulary)



For this question, the students should show a picture like the one above and describe all the different tunnels and “workings”. They should use the definitions they find for the terminology above.

2) Where are underground mines located in Park County?
Generally, the underground mines are located in topographically high areas, and placer deposits are located in stream/river valleys. Most lode and placer production has come from northwest Park County, accounting for 95% of the precious metal and 85% of the base metal production from the county. The students have the option of using the Colorado Geological Survey map. This map shows the name of claims but does not necessarily indicate if they are underground or surface mines. The students will then have to look up the individual mines in the Geology and Mineral Resources of Park County publication to determine if they were underground or placer mines. Some main examples include: Sweet Home Mine, Buckskin drainage; The London Mine, Mosquito drainage; Orphan Boy Mine, Mosquito drainage; Hilltop-Last Chance Mine, Horseshoe drainage. Load output was primarily from the Mosquito, Buckskin, Horseshoe, and Consolidated Montgomery subdistricts, especially from the London Mine Group, Sherman-Hilltop Mine complex, the cluster of mines centered on and around Mount Lincoln and Mount Bross (Russia and Moose Mines), and Phillips Mine Group.

3) What type of geological deposit(s) is/are mined underground? (Hint: where do hydrothermal fluids carrying the dissolved metals travel?)
Pegmatites and hydrothermal deposits are the most common type of mineral deposits that would be mined underground. Hydrothermal deposits originate from hot, metal rich fluids that are remnants of late stage magmatic processes. During solidification, liquids plus various metallic ions accumulate near the top of the magma chamber. Because of their mobility, these ion-rich solutions can migrate great distances though the surrounding rock before they are eventually deposited, usually as sulfides of various metals. Some of this fluid moves along openings such as fractures or bedding planes, where it cools and precipitates the metallic ions to produce **vein deposits**. Another important type of accumulation generated by hydrothermal activity is called a **disseminated deposit**. Rather than being concentrated in narrow veins and dikes, these ores are distributed as minute masses throughout the entire rock mass. See Page644-653 in Tarbuck and Lutgens Earth Science (textbook).

Lode claims are staked on veins or lodes of quartz or other rock in place bearing gold, silver, cinnabar, lead, tin, copper, or other valuable deposits. A lode is frequently considered as a zone or belt of mineralized rock clearly separated from neighboring nonmineralized rock.

This is a little over the top info about the actual deposits that were mined in South Park:
Load Deposits- deposit types include vein-, fissure-, fault-, and fracture-controlled mineralization, mantos, and strata-bound and nonstrata-bound disseminated mineralization. Metallic mineral deposits of northwest Park County (the Greater Alma district) contain primarily gold, silver, lead, zinc, and copper in sedimentary-hosted deposits of Paleozoic age. Ores of the Greater Alma district were probably formed 35 Ma years ago from magmatic and hydrothermal solutions heated by intrusion of various porphyry phases.
Gold Veins of the London Mine Type – this is a vein type deposit carrying equal amounts of gold and silver and composed of quartz, pyrite, sphalerite, galena, and chalcopyrite. Mineralized veins strike parallel to the north--northwest trending, northeast dipping London Fault. Host rocks are composed of a 175-275 ft thick shattered zone near the base of Pennsylvanian Minturn or Belden Formation where siltstone, sandstone, and shale beds are intruded by a series of thick quartz monzonite and rhyolite sills (London ore porphyry zone).
Gold veins and mantos in the Sawatch quartzite- polymetallic precious and base metal sulfide veins, with attendant mantos are hosted by the Cambrian Sawatch Quartzite, mines of this type include the Paris, Phillips, and Orphan Boy. Silver-Lead Mantos and Veins in Carbonate Host Rock – stratabound

base and precious metal bodies (mantos) that follow the course of solution channels and attendant feeder veins are hosted by various carbonate units of Paleozoic age.
The largest deposits occur in dolomite of the upper Mississippian Leadville Limestone, smaller deposits are found in the Lower Ordovician Manitou Limestone, and Devonian-Mississippian Dyer Dolomite. Mines of this type include the Russia, Moose, and Dolly Varden.

4) How do underground mines use water in the mining process?
Hydraulic percussion drills use water to lubricate the drill bit. This also keeps the dust down and saved many minors from succumbing to black lung. Drilling actually consumes a great deal of water.

5) What environmental impacts are caused by underground mining?
All aspects of mining can have some measurable effect on air quality. Emissions from various stages of mining can result in particulate matter, including gases, dust, and other substances. Significant vegetation and habitat destruction can result from mining. Waste rock and gauge must be taken out of the mine and stored somewhere. Waste rock piles often disposed of improperly in streams and down the sides of mountains, covering and disturbing all nearby vegetation. Construction of roads to get to the site can affect the environment, with impacts including soil compaction, vegetation removal, and added dust due to transport to and from the mine.

6) What water quality impacts are caused by underground mining?
Underground mining can alter groundwater flow through the creation of subsurface preferential pathways as well as associated mine dewatering pumping. Acid mine drainage is a very common water quality impact. Mining typically increases the amount of oxygen in disturbed soils and rock as well as increasing water mobility. By increasing the surface area of rocks as well as the pore volume around rocks, mining activity allows acid-producing reactions to occur more quickly.

At may older underground mines located in steep terrains, such as in Colorado, underground mining was locally made possible through construction of a local adit that drained ground water to a nearby stream. Such draining adits, which were constructed miles underground, could water many square miles of workings and potentially provide water for other uses. However, if left untreated, these draining adits pose additional environmental problems by allowing mining influenced waters to dominate local streams and rivers.

Mining methods that do not minimize water and rock contact, pyrite oxidation, or biological activity can promote the formation of sulfuric acid. Environmental impacts on water and drainage quality are typically related to the specific type of mineral deposit and site-specific conditions. Deposits containing high concentrations of pyrite and other sulfide minerals specifically are susceptible to acid rock drainage.

There are four major types of potential impacts from mining and metallurgical processing on water quality including 1) acid drainage, 2) metal leaching and resultant contamination, 3) release of processing chemicals and 4) increased erosion and sedimentation.

7) Describe the basics of solution mining or in-situ mining. What kinds of materials are mined by this process, and what are some of the environmental considerations? (BONUS)
(see pg 20 in *Basics of Metal Mining Influenced Water*)
This form of mining involves the circulation of leaching solutions directly into ore zones and recovery of the leachates for processing through a series of injection and recovery wells. Thus, the ore is processed in its original geological location. Several commodities, including uranium, copper, manganese, salt, potash, and sulfur have been mined economically using solution mining techniques. The main environmental consideration is subsurface geologic conditions and groundwater. It is possible that the subsurface geology is not well characterized, having additional fractures or unknown impermeable layers that could interfere with the recovery of the dissolved commodity and associated solution. The dissolved commodity and solution may enter the groundwater and cause contamination.