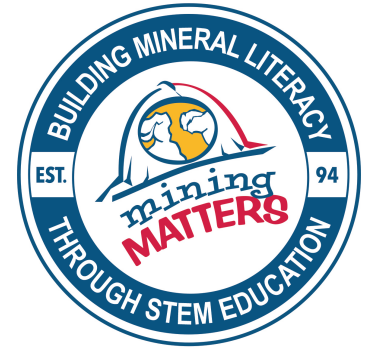


# Underground Mining Methods



## What to Do

In this activity, you will watch a series of animations outlining the various methods used to get ore from deep within the Earth to the surface where it can be processed and used for products.

The underground mining animations have been produced by Sandvik. They can be found at [MiningMatters.ca/miningweek](http://MiningMatters.ca/miningweek).

- 1** As you watch the animations take note of the following:
- heavy equipment and machinery,
  - location of where the operation begins,
  - presence of tunnels,
  - the direction of the tunnels, as well as
  - drilling and blasting.

- 2** a) Stop the animation. Read the appropriate section of the **Underground Mining Methods Backgrounder** describing the mining method. Watch for key ideas that relate to the criteria set out in step 1 above.

b) Pick one animation to watch a second time and reflect back on the mining method description you just read. In the video, look out for examples of the following:

<i>Backfill material</i>	<i>Bolting</i>	<i>Cave</i>	<i>Crusher</i>
<i>Drift</i>	<i>Drilling and blasting</i>	<i>Jumbo</i>	<i>Load Haul Dump</i>
<i>Mineral</i>	<i>Muck</i>	<i>Open pit</i>	<i>Ore body</i>
<i>Ore pass</i>	<i>Pillar</i>	<i>Raise</i>	<i>Ramp</i>
<i>Room</i>	<i>Skip</i>	<i>Stope</i>	<i>Tailings</i>

On the worksheet, circle the words that apply to the mining method you chose.

- 3** There are many new terms and concepts related to underground mining methods. To demonstrate your understanding of the basic concepts, create a **Sequence Chain** outlining the steps that occur in the method you chose to watch for a second time.

The deepest mine in the world is in South Africa; it goes down to almost four kilometres.

Sudbury is a town in Ontario, Canada.

# Underground Mining Methods Backgrounder

Animations courtesy of Sandvik Tamrock Canada

Accompanying text by Terry Gong, UBC Mining Engineering student

Animations can be found on our website: [MiningMatters.ca/MiningWeek](http://MiningMatters.ca/MiningWeek)

## Room and Pillar

**Ramps** (inclined tunnels) are excavated to connect the surface to the underground **ore body**. **Drifts** (horizontal tunnels) are excavated at different elevations to surround the ore body. Next, **stopes** (tunnels that have direct access to mining the ore) are mined to gain access to the ore. All tunnels are excavated by **drilling and blasting**. **Jumbos** are in charge of drilling the holes in the rocks and filling them with explosives. The loose rock, also called **muck**, is transported by either dump trucks or **Load Haul Dump (LHD)** vehicles back up to the surface for either waste disposal or processing. As mucking progresses, rooms (tunnels) are cut into the ore body. In order to provide safe roof support for mining, pillars of material around the rooms are left standing to hold up the rock ceiling above. Some parts of the mine roof can be particularly weak and fragile. In addition to pillar support, a jumbo is then brought back in for rock **bolting** of the roof to ensure safety. When all the ore in the stopes has been transported up to surface, some pillars can be removed, since they still have valuable **mineral** content, while some must be left standing to provide active support for the ceiling. In some **room and pillar** mines, pillars are all excavated as mining nears completion, to allow the natural collapse of the roof.

## Sublevel Stoping

Sublevel stoping is a mining method in which ore is blasted from different levels of elevation but is removed from one level at the bottom of the mine. Before mining begins, an ore pass is usually drilled from a lower to a higher elevation. **Jumbos** selectively drill holes into the roof of the **drift** and fill them with explosives. When the roof is blasted, loose rocks, or **muck**, fall through the drilled **ore pass**. A **Load Haul Dump (LHD)** vehicle transports the muck to another ore pass where it falls to a hopper that feeds a **crusher**. The crushed ore is then elevated (raised) to the surface in a **skip**. As the muck is taken out, more drilling of the now higher roof continues. The roof is blasted till it is so high that it cannot be reached by a jumbo. Then a jumbo working in a higher elevation drift is used to intersect the **stope**. After blasting, the ore falls down to the lower drift where LHDs can drive in to load the muck and dump it at an ore pass. **Drilling and blasting** continues until the **stope** is completely excavated. Once the stope is completely hollowed out, it is backfilled from the bottom, up. The **backfill material** used can be a mixture of sand and rocks, waste rock with cement, or dewatered mill **tailings** (rejected low grade ore from processing, usually fine and sandy). The backfill material must have a lot of strength to support the roof of the empty stope.

## Cut and Fill Stopping

In cut and fill stopping, the **ore body** is retrieved in horizontal slices beginning at the very bottom and advancing upwards towards the surface. **Ramps** (inclined tunnels) are excavated to connect the surface to the underground ore body. **Drifts** are excavated to come in contact with the ore slices. The slices are **drilled** using a **jumbo**, **blasted** by charging the drill holes with explosives, and ore is removed by using dump trucks or **Load Haul Dump (LHD)** vehicles. The ore is dumped into an **ore pass**, an inclined tunnel where ore is transported to a lower elevation in the mine. The ore is picked up at the other end of the ore pass by a LHD to be transported out of the mine through a **ramp** (inclined tunnel). Once a slice is completely mined out, the empty space is partially backfilled hydraulically. The **backfill material** used can be a mixture of sand and rocks, waste rock with cement, or dewatered mill **tailings** (rejected low grade ore from processing, usually fine and sandy). The backfill underground serves to keep the mine walls stable and also as the floor for mining the next slice. Mining continues upwards towards the surface until the **ore body** is depleted.

## Sublevel Caving

Sublevel caving is usually carried out when mining of the **ore body** through an **open pit** method is no longer economically feasible. Mining now proceeds underground, underneath the open pit. At first, both a **raise** and a network of tunnels are made. At different sublevels, **jumbos** are used for long hole drilling, drilling directly upwards into the roof. These holes are then charged with explosives and blasted. As the roofs **cave** in, the rock from the ground surface will cave in to the underground as well. **Load Haul Dump (LHD)** vehicles transport the **muck**, loosened rocks, to an **ore pass** where the rocks are lifted to the surface. **Drilling and blasting** takes place at different underground levels of the mine at the same time. As the blasted rock, muck, is continuously transported to the **ore pass**, more blasting will encourage the roof to cave in to the void and further into the **drift**. This is repeated until blasting, caving and transporting depletes the entire ore body.

**Worksheet**

# Underground Mining Methods

1. As you watch the animations take note of the following:

Mining Method: Room and Pillar	
(a) heavy equipment and machinery:	
(b) location of where the operation begins:	
(c) presence of tunnels:	
(d) the direction of the tunnels:	
(e) explosives and blasting:	

Mining Method: Sublevel Stoping	
(a) heavy equipment and machinery:	
(b) location of where the operation begins:	
(c) presence of tunnels:	
(d) the direction of the tunnels:	
(e) explosives and blasting:	

Mining Method: Cut and Fill Stoping	
(a) heavy equipment and machinery:	
(b) location of where the operation begins:	
(c) presence of tunnels:	
(d) the direction of the tunnels:	
(e) explosives and blasting:	

Mining Method: Sublevel Caving	
(a) heavy equipment and machinery:	
(b) location of where the operation begins:	
(c) presence of tunnels:	
(d) the direction of the tunnels:	
(e) explosives and blasting:	

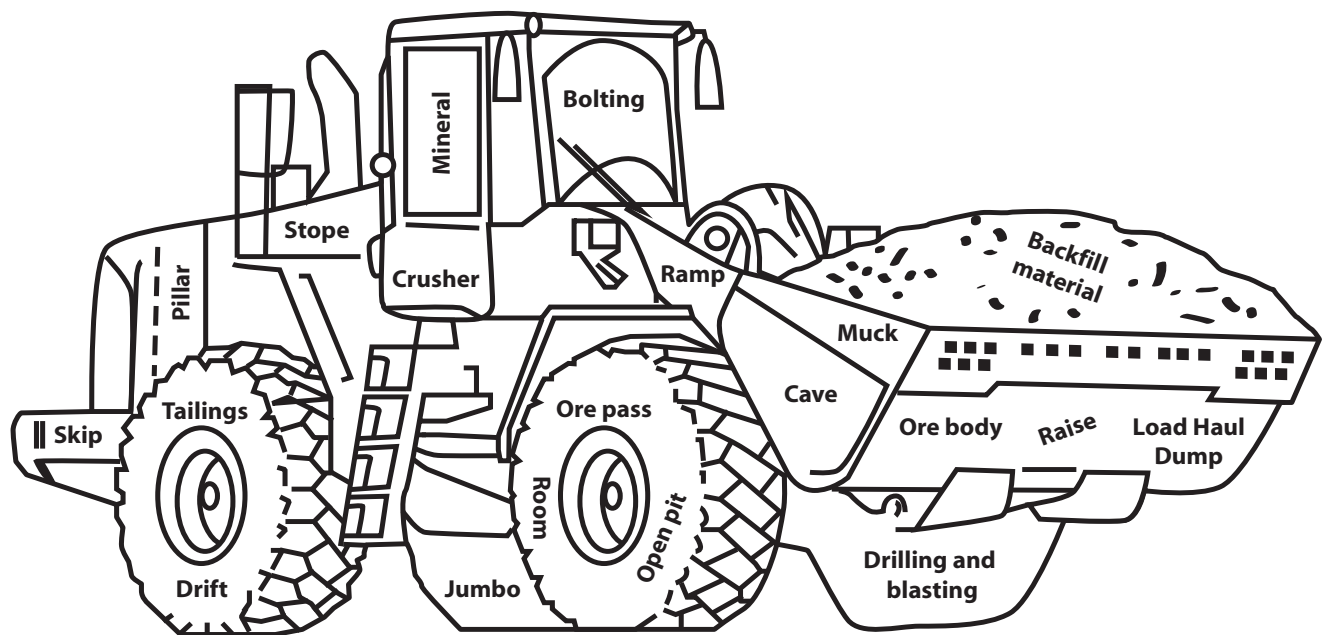
**Underground Mining Methods**

2. Place a check mark in the box to identify the method you would like to focus on for this activity.

Watch the animation a second time and reflect back on the mining method description you just read.

- Room and Pillar
- Sublevel Stopping Cut
- and Fill Stopping
- Sublevel Caving

In the illustration below, circle the words that apply to the mining method.



**Underground Mining Methods Sequence Chart**

3. There are many new terms and concepts related with underground mining methods. To demonstrate your understanding of the basic concepts, create a **Sequence Chain** outlining the steps that occur in the method you selected. There are six steps presented on the next page. Not all of the steps need to be filled in in order to successfully complete the task. Most of the **Sequence Chains** can be completed in five steps.

**Worksheet**

**Underground Mining Method:** \_\_\_\_\_


## Underground Mining Methods Key Terms

Key Terms	Explanations
Bolting	Drilling a hole, and inserting a bolt to strengthen the ceiling and walls of an underground mine.
Crusher	A machine used to crush ore before it is transported.
Drift	A horizontal underground tunnel that follows a vein or ore body.
Drilling and blasting	The process of using a drill to create long, narrow cylindrical holes in the rock, and filling these holes with explosives which are then detonated to fragment the rock.
Jumbo	A drill which is capable of drilling more than one hole at a time and is especially useful in preparation for blasting.
Load Haul Dump	A vehicle with a large bucket on the front used for transporting ore to crushing stations and mucking.
Mineral	Naturally occurring chemical compound with a unique three dimensional crystalline structures and chemical composition; component of rocks.
Muck	Waste rock that has been broken by blasting.
Ore body	A naturally occurring concentration of minerals that can be mined at a profit.
Ore pass	A vertical or inclined passage that is used for transporting ore down to a lower level or hoist.
Pillar	The columns of rock that are left to support the ceiling in room and pillar mining.
Raise	A vertical or inclined opening from one level of a mine that is driven toward the level above.
Ramp	Inclined tunnels used to transport ore or machinery.
Room	The open areas left open by blasting in room and pillar mining.
Skip	A self-dumping bucket used in a shaft for hoisting ore or rock.
Stope	An underground mine from which ore has been removed extracted.
Tailings	Materials rejected from a mill after the recoverable valuable minerals have been.

Glossary References: MineralsEd, *Social Studies 10/11: Mining in BC A Resource Unit*; The Northern Miner, *Mining Explained: A Layman's Guide* (1996)