Underground Mining Methods

(Animations courtesy of Sandvik Tamrock Canada. Accompanying text by Terry Gong, UBC Mining Engineering student)

Room and Pillar Mining

Ramps (inclined tunnels) are excavated to connect the surface to the underground orebody. **Drifts** (horizontal tunnels) are excavated at different elevations to surround the orebody. 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.

Cut and Fill Stoping

In cut and fill stoping, the orebody 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 orebody is depleted.

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.

Sublevel Caving

Sublevel caving is usually carried out when mining of the orebody 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 orebody.

Glossary

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 structure and chemical composition; component or rocks

Muck - waste rock that has been broken by blasting

Orebody - 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 excavation from which ore has been removed

Tailings - materials rejected from a mill after the recoverable valuable minerals have been extracted.

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