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# MODERN TENDENCIES IN OPEN-PIT MINING

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***Surface mining*** (also commonly called strip mining, though this is actually only one possible form of surface mining), is a type of mining in which soil and rock overlying the mineral deposit (the overburden) are removed. It is the opposite of *underground mining*, in which the overlying rock is left in place, and the mineral is removed through shafts or tunnels.

Surface mining is used when deposits of commercially useful minerals or rock are found near the surface; that is, where the overburden is relatively thin or the material of interest is structurally unsuitable for tunneling (as would usually be the case for sand, cinder, and gravel). Where minerals occur deep below the surface – the overburden is thick or the mineral occurs as veins in hard rock – underground mining methods are used to extract the valued material. Surface mines are typically enlarged until either the mineral deposit is exhausted, or the cost of removing larger volumes of overburden makes further mining no longer economically viable.

In most forms of surface mining, heavy equipment, such as earthmovers, first removes the overburden. Next, huge machines, such as dragline excavators or bucket wheel excavators, extract the mineral.

***Open-pit mining*** refers to a method of extracting rock or minerals from the earth by their removal from an open pit or borrow. The term is used to differentiate this form of mining from extractive methods that require tunneling into the earth.

Open-pit mines that produce building materials and dimension stone are commonly referred to as quarries. People are unlikely to make a distinction between an open-pit mine and other types of opencast mines such as quarries, borrows, placers, and strip mines.

Open-pit mines are typically enlarged until either the mineral resource is exhausted, or an increasing ratio of overburden to ore makes further mining uneconomic. When this occurs, the exhausted mines are sometimes converted to landfills for disposal of solid wastes. However, some form of water control is usually required to keep the mine pit from becoming overfilled.

***Advantages*** The main advantage of surface mining is high efficiency and relatively low cost as compared to underground mining. Another significant factor is labor safety.

***Some features of technological process*** Open-pit mines are dug as benches, which describe vertical levels of the hole. These benches are usually on four to sixty meter intervals, depending on the size of the machinery that is used. Many quarries do not use benches as they are rather shallow.

Most walls of the pit are generally dug at an angle less than vertical, to prevent and minimize damage and danger from rock falls. This depends on how weathered the rocks are, and the type of rock, and also how many structural weaknesses occur within the rocks, such as faults, shears, joints or foliations.

The walls are stepped. The inclined section of the wall is known as the batter, and the flat part of the step is known as the bench. The steps in the walls help to prevent rock falls continue down the entire face of the wall. In some instances additional ground support is required and rock bolts, cable bolts and shotcrete are used. De-watering bores may be used to

relieve water pressure by drilling horizontally into the wall, which is often enough to cause failures in the wall by itself.

A haul road is usually situated at the side of the pit, forming a ramp up which trucks can drive, carrying ore and waste rock. Waste rock is piled up on the surface, near the edge of the open pit. This is known as the waste dump. The waste dump is also tiered and stepped to minimize degradation.

Ore which has been processed is known as tailings, and is generally slurry. This is pumped to a tailing dam or settling pond, where water evaporates. Tailings dams can often be toxic due to the presence of unextracted sulfide minerals, some forms of toxic minerals in the gangue, and often cyanide which is used to treat gold ore via the cyanide leach process. This toxicity has the potential to negatively impact on the environment.

***Development and improvement*** Opencast mining technology is developing to reach its maximum: engineers and technicians have steadily improved the extraction process. They are pursuing two main goals: first, with the lowest possible outlays for personnel, maintenance and energy, they wish to achieve the highest productivity in the core processes: transportation of materials and overburden. The capacity of bucket wheel excavators is a very important indicator of general progress. Thus, the daily output of such excavator can reach 250,000 bank cubic meters of overburden and useful material, for example coal. Second, they wish to systematically and continuously monitor and ensure the high quality of materials on the entire route from deposits to consumers. And finally, ultra-modern process and control technologies are being introduced.

***Ecological Problems and Rehabilitation*** After mining process finishes, the mine area must undergo rehabilitation. Waste dumps are contoured to flatten them out and stabilize them. If the ore contains sulfides it is usually covered with a layer of clay to prevent access of rain and oxygen from the air, which can oxidize the sulfides to produce sulfuric acid, a phenomenon known as acid mine drainage. This is then generally covered with soil, and vegetation is planted to help consolidation of material. Eventually this layer will erode, but it is generally hoped that the rate of leaching or acid will be slowed by the cover such way that the environment can handle the load of acid and associated heavy metals. There are no long-term studies on the success of these covers due to the relatively short time in which large scale open-pit mining has existed. It may take from hundreds to thousands of years for some waste dumps to become "acid neutral" and stop being harmful for the environment. The dumps are usually fenced off to prevent livestock denuding them of vegetation. The open pit is then surrounded with a fence, to prevent access of animals, and it is eventually filled up with ground waters. In arid areas it may not fill due to deep groundwater levels.

***Typical open cut grades extracted by open-pit mining*** Gold is generally extracted in open-pit mines at 1 to 2 ppm (grams per ton) but in certain cases, even 0.75ppm gold is economically efficient. This was achieved by bulk heap leaching at Alkane Minerals Ltd. Peak Hill mine in western New South Wales, near Dubbo, Australia. Another example is the Boroo Gold Mine - an open-pit gold mining site in Mongolia located about 110 km of the capital Ulaanbaatar. The Boddington Gold Mine is gold and copper mine located 17 km northwest of Boddington, Western Australia. In Chile, where the size of the resources and favorable metallurgy makes it economically profitable, copper is extracted at grades as low as 0.15% to 0.2%, generally in massive open-pit mines.

Nickel, generally as laterite, is extracted via open-pit down to 0.2%.

Materials typically extracted from open-pit mines also include:

– Precious stones: diamonds (for example Udachnaya pipe is a diamond deposit in the Daldyn-Alakit kimberlitic field in Sakha Republic, Russia. It is more than 600 meters deep, which makes it the 3rd deepest open-pit mine in the world).

– Coal is mostly extracted by surface mining methods at present. A good example is a Kansk-Achinsk basin in the Krasnoyarsk region, which is considered to be one of the richest coal deposits in the world.

– Opencast technologies are employed to extract building materials such as clay, coquina, granite, gypsum, limestone, marble, gravel, etc.