

## **SURFACE MINING TRANSPORTATION SYSTEMS**

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### **Summary**

In the first part of this chapter, surface mining operation and methods are overviewed to give general information and what kind of hauling equipment is being used. In the second part, combinations of surface mining equipment, transportation system and management system are explained.

## **1. Surface Mining**

### **1.1. Surface Mining Operation**

Surface mining is a form of mining operation popularly practiced all over the world for extracting minerals that occur near the surface, including such metallic minerals as copper, iron, gold and bauxite and such non-metallic minerals as coal and phosphate. Today, we can see the surface mining operated on a large scale at approximately 715 locations around the world.

In surface mining operation, amount of materials to be daily transported within and/or from the site is massive. It is especially huge at coal and copper mines compared to other kinds of mines and the world's demands for these commodities have been steadily growing as the entire world economy is expanding. A large-scale coal or copper mine may haul one million tons each day. The overall volume of coal, mineral ores and

mining waste being hauled in the world is gigantic and the haulage cost comes to an enormous sum of money. An estimate says it accounts for about half the total mining cost.

In addition to such situation, the transportation issue is increasingly more significant to the mining industry from another aspect. Faced with the fact that mining conditions are becoming more and more difficult as easy mines are being exhausted, it is now anticipated that surface mining of the future will need to dig further deeper, remove much more undesired materials, and mine much lower grade of ore. For this, the mining industry tries to maintain and improve its productivity by employing larger equipment. For mining trucks, for instance, a larger payload capacity and better uphill travel performance are required.

Moreover, the demand for reclamation of mined out areas will become much more strong for the environmental restoration of the land. For these reasons all combined, the transportation issue is increasing its significance to the surface mining management.

### 1.2. Surface Mining Methods

Surface mining process somewhat varies depending on how the target mineral deposit is situated, e.g. horizontal, inclined, or interbedded, but commonly includes the following four steps: 1) top soil removal, 2) overburden removal, 3) extraction of ore, and 4) reclamation of mined-out site. Each step is further detailed in Table 1.

Step	Details
(1) Topsoil Removal	Earth-moving equipment such as motor scraper and bulldozer gather and remove topsoil from the earth. For later use for the restoration of vegetation at the site, the removed topsoil needs transporting by hauling equipment such as dump trucks to another place for temporary stocking.
↓	
(2) Overburden Removal	Hard rocky layers overlying a target mineral deposit are broken up by a method suited to rock hardness and soil conditions, then fragmented materials are loaded and transported to an already mined out area or a specially arranged accumulation site.
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(3) Extraction of Ore/Coal	Target ore/coal is extracted by a suitable method as in the overburden removal. The ore/coal extracted is transported to a crusher by mining trucks, then carried to a plant by belt conveyor, etc.
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(4) Reclamation of Mined Site	Recently in more and more cases the once removed overburden is used as backfill for reclamation of the mined site and the removed topsoil is spread over the site for restoring vegetation there.

Table 1. Four Steps of Surface Mining Process

Surface mining is a very broad term. Mining of metal bearing ores by surface mining methods is specifically termed as “Open Pit Mining” while mining of coal is usually referred to as “Strip Mining”.

In open pit mining, reclamation of mined site is normally undertaken only after the mineral or ore has been extracted altogether to an economically profitable limit. Until reaching the ultimate bottom of the pit, mining continues down creating shelves or benches. A typical example of open-pit mine is Chuquicamata Copper Mine in Chile, the world’s largest copper mine, operated by Codelco Chile Company. A pit there will be 4km at the longest and 2.5km at the shortest in width with a depth of about 750m. At this mine, more than one hundred dump trucks in 320 or 240US ton class are daily carrying ore and waste materials for a distance of nearly 6-8km at an 8-10% gradient. The hauling capacity is about 600,000ton/day.

In strip mining, extraction and backfilling are performed concurrently. Strip mining methods are further subcategorized into two types according to topographic features of a mining site. “Area Mining” is practiced on relatively flat or gently rolling terrain while “Contour Mining” is practiced in areas of hilly topography.

Area Mining is also called as “Open Cast Mining” or “Furrow Mining.” This mining method is applied at many bituminous coal, lignite, and oilsand mines and has the advantages of relatively low mining cost, high productivity, good extraction rate, and safety level higher than underground mining. Large-scale area mines in North America and Australia are featured by large-sized draglines, stripping shovels and/or bucket wheel excavators (BWE) used for overburden removal.

Contour mining is typically practiced in confined areas of rugged topography where the coal deposit is interbedded near the surface. There are several variations of contour mining such as the so called Haulback Mining, Box-cut Mining, and Block-cut Mining. Contour mining is commonly found in the Appalachian Mountains, where hydraulic excavators and dump trucks are primarily used for digging and hauling respectively (see *Surface Mining Methods and Equipment*).

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### **Biographical Sketch**

**T. Nagai** has graduated from Yokohama National University and joined Komatsu Ltd. in 1974. He is engaged in design engineering and product planning of Off Highway Dump Truck. Nowadays, he is a general Manager, IT Group, Development Division, Komatsu Ltd.