The Decision of a Lifetime

Choosing a suitable mining method, whether it is for a new mining venture or when switching from one method to another, is a complex process, and with good reason. Whatever the final decision, it will be crucial for success throughout the entire life of the mine.

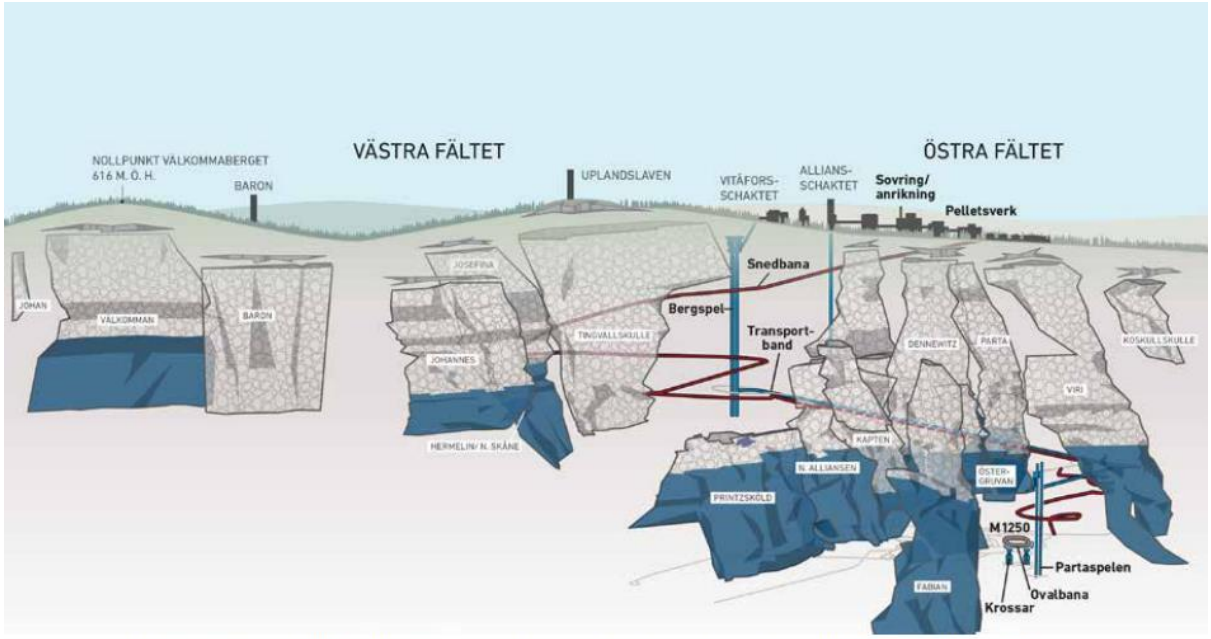

Figure 1: Sweden's iron ore mine LKAB Malmberget consists of more than 20 orebodies, of which 12 are mined using the sublevel caving (SLC) method. It has four main production levels, with the newest crusher station located at the 1 250 m haulage level. The ore to be mined (marked in blue), is transported to surface facilities via roads and ramps (see red line), conveyor belts and hoists.

There are about ten basic mining methods in use around the world and just as many variations. Choosing the right one involves a complex decision-making process in which many different parameters must be considered. The cardinal rule is to always start with the geometry of the orebody and then look at the rock conditions, which is the second critical factor.

In most cases, it is the size, shape and dip of the deposit that determines the mining method, the layout, and the method in which the material is to be handled and transported.

Some orebodies are massive, flat formations stretching over several kilometres. Others are almost vertical and steep (see example above, Figure 1). As a result, the methods at the planner's disposal are generally grouped into two categories according to the orebody dip: steep orebodies and flat orebodies, each presenting its own set of preconditions for mining.

Steep Orebodies

When it comes to upright standing orebodies, or steep orebodies as shown in Figure 3, page 104, the natural force of gravity is invaluable in the mining process as it will greatly assist the rock flow, from which the miners can reap large benefits.

The physical differences can also be used to an advantage in transportation. For the stoping method and where the dip exceeds 50 degrees, it means that mucking and haulage can be carried out at a lower level. Where the dip is less than 50 degrees, these operations can be carried out at the mining level.

However, this initial observation is only the first step in the process. A wide range of other factors also must be taken into consideration, such as the nature and behaviour of the rock, the existence of any environmental restrictions in the area, safety, and the availability of skilled labour and, not least, the potential cost of extracting the ore.

In building this equation, the planner will naturally also be correlating all these factors with the methods that are likely to meet short-term and long-term production targets in the most efficient and sustainable way.

For steep orebodies, the main mining methods normally employed are:

- Sub-level Open Stoping
- Long Hole Open Stoping
- Rill Mining
- Cut and Fill Mining
- Shrinkage Stoping
- Sublevel Caving
- Block Caving

Flat Orebodies

For flat orebodies, the main mining methods are:

- Room and Pillar: classic, post and step
- Longwall Mining

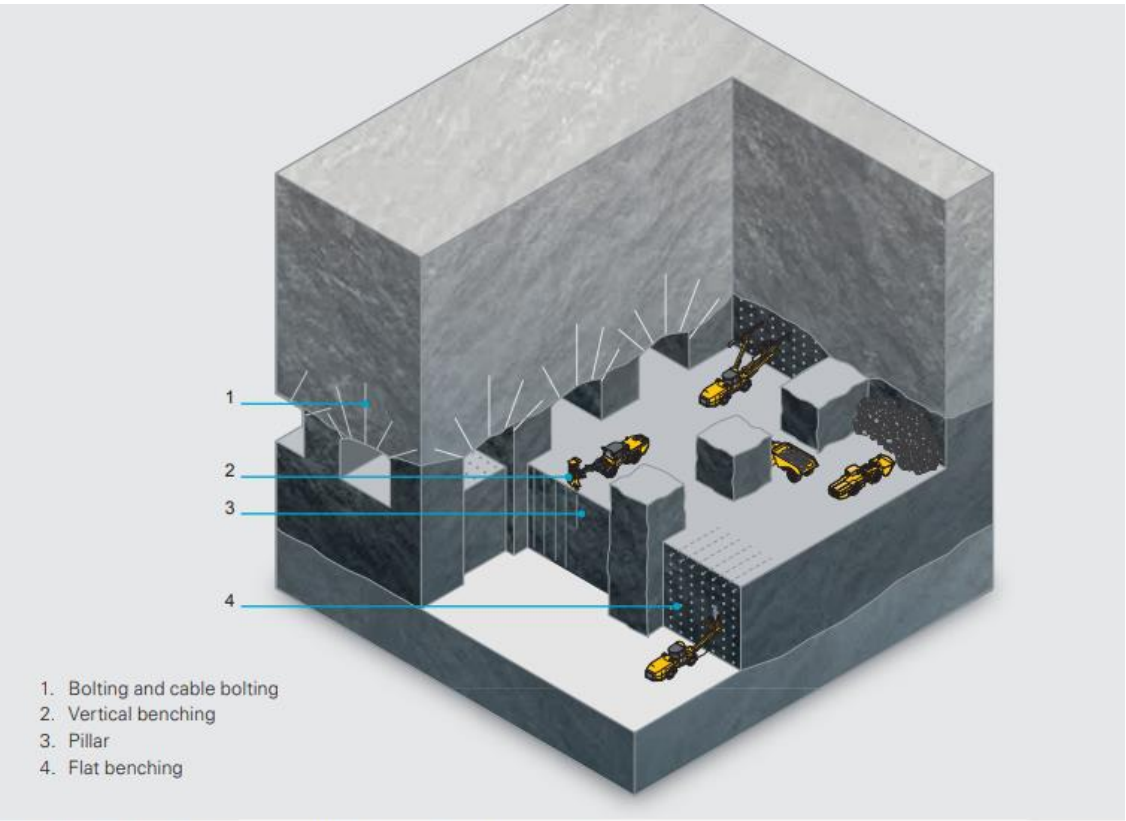

Figure 2: The illustration shows a flat horizontal orebody and typical mining activity.

Ore and waste properties are crucial to the evaluation of mining methods and how they are weighed against each other. Computerized equipment is used to gather geotechnical information and to calculate production rates and costs using data analysis, which greatly contributes to the research studies and final reports that determine the optimal choice.

In the past few years, no new mining methods have been introduced, but many have been substantially improved with the development of new and better technology. Preferences change, however, and some methods have clearly become more popular than others.

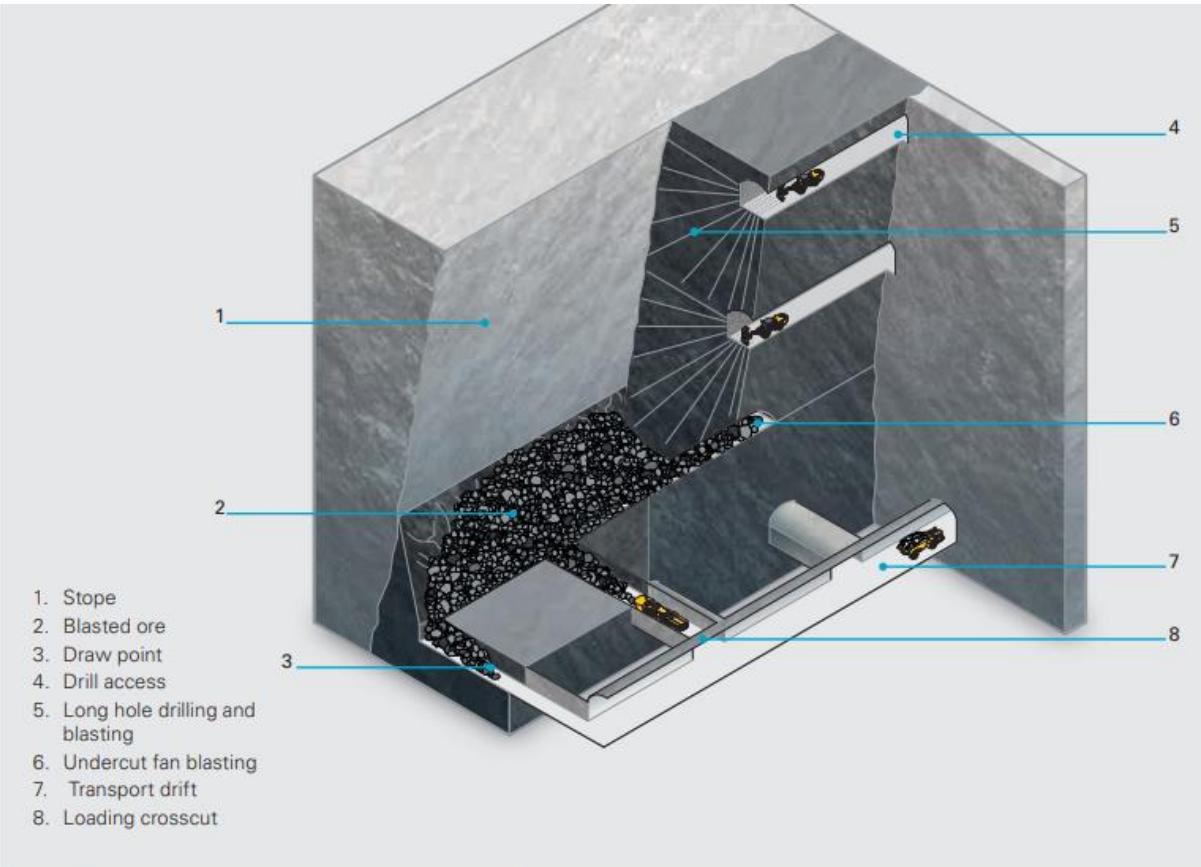

Figure 3: The typical mining process in a standing, vertical orebody.

Relative cost and productivity

Method	T/Manshift	Avg. T/Day	Relative Operating Cost per tonne
Resuing (small scale cut and fill)	0.2 - 0.5	50 - 100+	70+
Cut and Fill	12 - 48	500 - 1 500	20 to 70
Shrinkage	20 - 28	200 - 800	20 to 50
Room and Pillar	15 - 150	1 500 - 10 000	7 to 20
Sublevel Open Stoping	20 - 115	1 500 - 20 000	7 to 25
Sublevel Caving	65 - 180	1 500 - 70 000	5 to 15
Block Caving	300 - 2 000	10 000 - 100 000	1 to 2.5

Figure 4: The relative cost of typical mining methods and the excavation tonnages yielded.

The Right Choice

The most common mining methods today all have unique pros and cons for each mining situation and involve relative costs and productivity levels that vary considerably, as shown in Figure 4 on the next page. Block caving is a typical example of a large-scale, highly productive method that has the lowest costs, making it ideally suited for mining low grade orebodies. In addition, such large-scale methods, which also includes sublevel caving and sublevel open stoping, are more suited to automated operations, and the growing trend toward automated mining is expected to continue. Experts predict that the dominant methods over the next 10 years will be block caving, sublevel caving, cut and fill, sublevel open stoping with backfill, and room and pillar mining. This is due to the increase in demand for larger volumes, better recovery ratios and increased safety.

Although these methods have a longer planning horizon, experience shows that they lead to better, smoother production systems and, thereby, lower running costs, but with higher demand for quality and good performance.