HOW A BALL MILL WORKS

The remains of an abandoned ball mill in Arizona. The rest of the mill has fallen into ruins.

The *ore* that miners removed from a mine was very heavy and only contained a small percentage of precious metal. Since transportation was expensive, miners wanted to remove as much of the valuable material from the ore as possible before transporting it to a *smelter*. The smelter would then process the ore further into pure metal. This process of separating the waste rock from the metal prior to smelting is called milling. Although not all mills were the same, the following is an outline of a basic mill process.

1. **Receiving Room** - Ore was received at the top of the mill building.
2. **Crushing** - The raw ore went through several crushers. The jaw crusher broke the rock into smaller pieces, and then the gyratory crusher turned the pieces into sand-sized particles.
3. **Grinding** - A hopper introduced the crushed material to a rod or ball mill along with water to form slurry. The mills were slowly turning cylinders with steel rods or balls inside. As the cylinders turned, the steel rods or balls collided and ground the ore even finer.
4. **Sorting** - The slurry was carried to a classifier to separate out the large pieces which were sent back to the grinder. The small pieces continued to the concentration process.
5. **Concentration** - Unlike the rest of the process, concentration was not linear, which is why it was on the lowest and largest floor.

a. Slurry from the classifier was sent to flotation cells where agitators mixed in more water and various *reagents*. Agitation caused aeration, causing a froth to form at the top. The reagents caused certain metal ore particles to cling to the froth bubbles. By using different reagents, specific metal ores could be targeted.

b. The froth was swept off the top of the cell by paddles into a *flume* while the heavier material settled to the bottom.

c. The metal-containing froth was sent to a thickener and drier where it was rinsed, dried and packaged for shipment to the smelter.

d. The heavier material might be sent to a second or even third set of flotation cells where the reagents were changed to remove a different metal ore. The material might also be sent to vibrating tables that separated the heavier metal ore particles from the lighter waste materials. The concentrated heavier metal ore was then sent to the thickener and drier prior to being sent to the smelter.

6. Depending on the metal ore being recovered, other steps such as *amalgamation* might be needed.
7. Once the ores were processed, they were shipped to the smelter for final processing into metal.

A CUT-AWAY VIEW OF A BALL MILL. THE ORE-CRUSHING IRON BALLS ARE SEEN INSIDE.