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LIMESTONE SAMPLING AND TESTING
CEMENT AND LIME MINES

Homogeneous Geological Formations

Some limestone mines contain reserves that are massive, thick deposits with small variances in the chemistry of the limestone. Provided there are no complicated geologic structures within the deposit, the mine can rely heavily on the original core testing data to predict the quality of the limestone feeding the plant. Core holes can be widely spaced as long as the geology shows consistency in the reserve. Mine sampling and testing are performed to make sure the mine stays within the boundaries of the quality horizon or seam.

To maintain quality of the limestone in these types of deposits, the following methods are used:

- Typical Method in Open Pit Quarries:

  - A quarry rotary air drill is used to find either the top (hanging wall) or bottom (foot wall) of the deposit between core holes.
  - Samples are taken at intervals necessary to locate the quality by simply blowing out the chips at specific intervals and placing them in sample bags for testing.
  - This can be done in advance of final drilling and blasting to make sure enough overburden is removed or that the mine does not go too deep and below the foot wall.

- Typical Method in Underground Mining:

  In underground mining, the thickness of the quality seam will determine the number of lifts or layers that can be removed at one time:

  - For thicknesses of up to 10 meters, a single heading will remove all the limestone from the seam.
  - Thicker seams will require multiple lifts to remove all of the quality stone.
  - There may be a heading to remove the first layer followed by removal of the bench.
  - Sampling of the initial heading is usually done by taking samples of the top, middle and bottom of the mine face.

This is performed after the heading is cleaned out and scaling has removed any loose stone from the top and face.

- Bench sampling can be done using the same method as the open pit quarry using the rotary air drill chip samples.

There could be a certain consistent tracer seam that is visible on the core holes and assists the mine personnel in finding the head and foot wall. A geologist should be able to point this out when he logs the core. Mine personnel will use this as a method to stay within the seam.

Plant sampling and testing of incoming limestone feed from a very consistent mine deposit can be limited to taking a sample during each shift, more for the record than to control the quality.

Complex Geologic Formations

Sedimentary deposits that are jumbled and faulted present difficult conditions for maintaining the quality of the limestone feed to the plant. Often these deposits contain anticlinal or synclinal folding; faulting; blocking; and, other geologic structures that make mining difficult.

The more complicated the limestone structure, the more sampling and testing required to ensure the delivery of quality limestone to the process. In these conditions, the number of core holes will have to increase to define the areas of quality limestone and the geologic structures, and to determine the “mineability” of the deposit.

These types of limestone deposits are normally only mined by open pit quarrying. Underground mining is usually too difficult to mine safely.

Sampling in the pit becomes a significant part of the mining operation:

- Not only are you looking for head and foot wall but also geologic structures that can cause contamination in the stone. For instance, in an anticlinal fold, the upper portion of the reserve is in tension and the bottom is in compression. The upper portion is prone to cracks and crevices that fill with contamination from the layers above. In faulting, the area displaced can contain similar contamination. If the deposit is broken up in blocks, additional testing will need to be done to determine the boundaries of the good limestone.

- Sampling and testing in the mine will need to increase. Chip samples along with face samples will be used to locate the areas of good quality stone. Sometimes a geologist will need to visit the mine on a regular basis to assist the mine personnel in interpreting the location of quality stone.

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- Quality of the Limestone Feeding a Cement Plant:

    - These types of limestone reserves require further testing at the cement plant prior to the raw material blending process.
    - Sampling and testing must be continuous to meet certain chemical requirements. Based upon the quality of the limestone delivered to the plant, high grade limestone, silica, alumina and iron are added to the mix to meet certain chemical properties for the formation of clinker in the kiln.
    - To ensure proper mixing, the mixture is conveyed to a specially designed homogenizing silo to further blend the raw meal prior to clinkerization.
    - Most cement plants blend raw materials using an on-line analyzer. The on-line analysis is imperative for the production of good quality clinker.

- Quality of the Limestone Feeding a Lime Plant:

    - In the process of converting high calcium limestone into calcium oxide in a lime kiln, the rule of thumb to follow is "*the more complicated the deposit, the more sampling and testing is needed prior to the kiln*".
    - There is not a whole lot that can be done with the limestone once it is fed to the kiln.
    - Unlike cement, there is usually no blending system to improve the mix. An on-line analyzer may be employed to divert low quality limestone to waste in the crushing and screening area.

This article was contributed by Ken R. Schweigert, Senior Process Consultant at PEC Consulting, St. Louis, Missouri.