

"WALL CONTROL AT MICHIGAN IRON ORE MINES"

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INTRODUCTION

The Cleveland-Cliffs Iron Company operates three open pit iron mines on the Marquette Iron Range of Michigan's Upper Peninsula. Open pit iron ore mining began in the area in the 1840's. Underground mining was predominant from 1860 through 1960. Large scale low grade-open pit iron ore mining began in the early 1950's with the establishment of the Humboldt Mine, concentrator and pelletizing plant. This pit operated until 1970, when the reserves were exhausted.

Due to economic conditions, the Republic Mine (opened in 1954) is currently mothballed.

The present mining activity is located on the east end of the Marquette Syncline, a highly folded, faulted and metamorphosed pre-cambrian sequence. (The dark brown in the slide is the iron formation). The Negaunee iron formation varies from 100 to 5,000 feet in thickness.

The Tilden and Empire Mines are adjacent to each other and located on the southeast end of the syncline where a large thickness of iron formation occurs.

Pit wall control assumes a great importance beginning with the planning stage. A large mining venture with concentration and pelletizing is a plus 300 million dollar investment and the ratio of stripping to final product is an important factor in the feasibility of a property.

Figure 1 is a cross section showing the importance of slope control. The Tilden pit is designed for an inter-ramp angle of 45° . A 3° increase in this angle to 48° , by reducing backbreak from 30' to 25', would result in an increase of ± 100 million tons of ore over the life of the mine.

The large exposed final pit slope at Tilden will have approximately 85 miles of 45' high benches, exposed to continuous blast vibrations, ground water, and weather conditions for up to 25 years.

The entire mining sequence, the pit planning, the drilling and blasting, and eventually the loading must be done with the final wall in mind. The early final wall work becomes very

critical near the end of the life of a property. At that time the haul roads are established on the final walls and any stability problem could have serious effects because many pits have only one road out.

Large failures could shut down a mine temporarily with loss of reserves and equipment or cause it to shut down prematurely. (This one shut down a pit for many months).

Small failures may cause equipment damage and road closures. They always interfere with production.

Even a few rocks rolling down onto a haul road or drill pattern from a high wall is a cause for concern and some times a hint of more to come.

In today's mining economy, final wall location can change at any time. Stripping always tends to be spread out as long as possible. Therefore, final walls are reached late in the life of a property.

A mine, of course, is very production orientated. Equipment is designed to drill large holes and move rock efficiently. Most large mines are drill 10025 la" blast holes. Shovelers are rTj-0.00259Tc T(oes

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production. 30% of the time drill 19 7/8" holes along final walls

Lowert power factor and extra drill 10025 final walls amount to a decrease in production.

Equipment is so designed that extra blast holes are necessary to avoid wall damage

the first bodies are highly reworked and extra many twisted and deformed and a number of small find ear