**ABSTRACT**

**Title:** 3-D discontinuum numerical modeling of rock mass stability investigations due to ore extraction and backfilling, and subsidence estimation for an underground mine

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**Major Theme:** Mining engineering

**Topical Area:**Numerical modeling in mining

**Introduction and Motivation for the Research:**

Xxx iron mine is located in the south of Yyy city, Zzz province in China. The mineral deposits in this location were discovered in the 1960s and the total iron ore reserve was estimated to be about 300 million tons. The mineral in the ore is predominantly pyrite. The major orebody lies at a depth of 400 m, with an average thickness of 250 m. The mining method adopted in this mine is open stoping with subsequent backfilling. The excavation process began in 2007 and the orebody was divided into two sections- the east and west parts, for the purpose of ore extraction.

By early 2014, six stopes were designed with a production rate of 2 million tons and gradually being increased to the design capacity of 3 million tons per annum, at the end of the first phase. The landscape above the underground mine contains multiple villages, farmlands and other miscellaneous infrastructure facilities which must be protected from any adverse effects arising from the mining activities at Xxx. Specifically, ore extraction and blasting are known to cause surface subsidence. While the mine has taken precautions in the form of backfilling, to prevent long-term subsidence, the process of ore extraction itself may cause some level of irreversible subsidence. Hence, there is a need to study the stability of the stopes designed at Xxx, with special emphasis on estimations of future subsidence.

**Objective of the Research and Procedures:**

The distinct element method (DEM) and specifically 3DEC has been selected to carry out analyses on the stability of the underground excavations and surface subsidence at Xxx mine, because it adequately describes behavior of discontinuities and allows for stoping and backfilling simulations. The lithological and structural geology information, rock mass and joint/fault mechanical properties, backfill properties and in-situ stress measurements have been obtained from unpublished reports from the mine to create accurate numerical models. The results of the numerical simulations of 16 sequential stoping and backfilling operations have been used to study and discuss the stability of the underground excavations and to estimate the possible subsidence due to future mining activities at Xxx iron mine.

**Results:**

The numerical model indicated large failure zones around the stopes, compressive stresses in pillars greater than their strengths, and deformations up to 50 cm on the roof of the stopes. Backfilling was seen to prevent subsequent deformations in the stopes. The excavation of the upper stopes was found to destabilize the area around the lower stopes thereby causing large deformations after the excavation of the lower stopes. Due to the irregular shape of the orebody, the surface subsidence weighs more towards the left side of the model with a maximum subsidence of about 22.5 cm observed 150 m to the left of the central axis.

**Conclusions:**

It was possible to include the essential features of complex lithology and fault system, rock mass and joint/fault mechanical properties, backfill properties, in-situ stresses and sequential stoping and backfilling operations in developing the numerical model to investigate stability around stopes and to estimate the surface subsidence. The paper is an excellent addition to the literature in the fields of rock mass stability around underground excavations and surface subsidence estimation in a complex geologic region, with irregular orebodies and incorporating realistic excavation sequences and backfilling operations.