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Methodology for the estimation of mining face stresses using rock core diametrical deformation

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ABSTRACT

In-situ stress measurements usually take place away from the underground mine work areas to capture the pre-mining stress tensor. However, mining face stresses around drifts, ramps, and stopes in underground mines are quite different from pre-mining stresses due to the excavations created by mining activities and the presence of geological structures. Therefore, investigating the development of an effective and practical method to estimate mining-induced stresses near a mining face should prove useful in practice. This study presents a simple and practical methodology based on rock core deformations for determining mining-induced stresses near underground mine openings, such as drifts and crosscuts where the near-field stresses in the sidewalls, the back, and the face could be of concern to the stability of the opening. The analytical solution developed in this paper can be used to determine the major and minor principal stresses near the mine opening in a plane perpendicular to the borehole axis and parallel to the free mining face. The analytical solution has been validated with published test results of laboratory experiments on rock cores extracted while subjected to uniaxial compression. It is shown that the results presented by the proposed method agree well with the applied stresses measured in laboratory experiments.

1. Introduction

Existing stress measurement methods can be divided into two categories: destructive and observational.[1] Destructive methods induce failure, strains, or deformations in the rock around the borehole. Observational methods have less influence on the mining activities, such as borehole breakouts and strain recovery methods. The most widely used stress measurement techniques are hydraulic fracturing and overcoring methods.[2,3] These are considered destructive methods and are usually conducted far from the work area to capture the pre-mining stress tensor. These techniques are costly and cumbersome to perform in the field requiring specialized equipment. Therefore, only a few tests can be conducted during the life of a mine. While it is possible to use far field stress measurements in 3D numerical modelling to estimate mining induced stresses near the mining face, it is nearly impossible to account for the complex geometry of surrounding mine openings such as mined stopes and drifts. Moreover, near field stresses caused by mining activities are influenced by the presence of geological structures such as faults, dykes, and shear zones in the vicinity of the orebody where mining-induced stresses are sought.[4] Thus, the focus of this paper is on estimating the near field mining-induced stresses.

Knowing the magnitude and orientation of mining-induced stresses is crucial for the design and operation of underground excavations.[5] Surface failure such as spalling, slabbing, burst, buckling, and out-of-plane shear failure, is often caused by the biaxial stresses in the plane parallel to the free mining face and where out-of-plane stress equals zero.[6–9] Such mining-induced planar stresses are required when assessing the ground control. For example, it is important to have the knowledge of induced stresses around the opening to determine if a rockburst control measure such as destress blasting is necessary at a drift face.[10]

In this paper, a methodology for mining-induced stresses estimation using rock core diametrical deformation is proposed. It provides a simple and practical technique to determine the biaxial induced stresses in the rock. The analysis of diametrical core deformation is developed based on strain relief, which occurs once the rock core is drilled off; the relief is a function of the surrounding stress field. This methodology requires the extraction of rock cores at the mine using exploration-type diamond drilling. Effort should be made to orient the direction of drilling perpendicular to the rock surface. By doing so, the extracted core

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