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### Progressive failure of hanging wall and footwall Kiirunavaara Mine, Sweden

Ph.D., P.E. John F. Lupo

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#### Abstract

This paper presents an evaluation of the progressive failure of the hanging wall and the footwall at the Kiirunavaara Mine in northern Sweden. The failure of the hanging wall and footwall is a direct result of sublevel caving operations and has caused significant surface and subsurface disturbances. On the hanging wall, these disturbances include: large scale subsidence, surface cracking, and shear displacements. The footwall has experienced shear displacements and failure of underground openings.

Using mine data, failure mechanisms describing the progressive failure of the hanging wall and footwall were developed. These data indicate that the primary failure mechanism is shear failure, with toppling and wedge failures being present as secondary mechanisms. Shear failure occurs along pre-existing geologic structures as well as through intact rock. The data also showed that the hanging wall and footwall rock mass

failure is closely linked to mining activity, movements of caved waste rock, and the presence of geologic structures.

An analytical model is presented to provide a simple tool for evaluating the extent of rock mass failure in the hanging wall and footwall, while also accounting for interactions of caved waste rock. The analytical model is unique in that it combines a limit equilibrium approach for the hanging wall and footwall with a Coulomb-type surface traction force to represent the caved rock. The developments presented in this paper can be used to further the understanding of large scale rock mass behavior related to underground mining. The failure mechanisms presented may also be applicable to open pit slope stability.



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## Keywords

Progressive Failure; Slope Stability; Subsidence; Underground Mining; Sublevel Caving; Limit Equilibrium; Granular Flow

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