TOMOGRAPHIC IMAGING OF STRESS-REDISTRIBUTION FOR PREDICTION OF CATASTROPHIC ROCK MASS FAILURE

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Prediction of rock failure has been an elusive goal for the geo-engineering community. Catastrophic failure extends to all aspects of rock mechanics including tunnels, mines, rock slopes, earthquakes, waste repositories, and bridge and dam abutments. Accomplishing the ultimate goal of predicting these catastrophic failures will result in significantly reduced fatalities, lowered construction costs, and increased environmental protection.

Rock failures (e.g. earthquakes) are associated with the redistribution and concentration of stresses due to excavation, gravitational forces, inhomogeneities, or crustal movement of the earth. To predict rock failure, it is quite helpful to monitor the redistribution of stresses within the rock. Recent computational power has allowed this to be done using elastic waves and tomographic imaging. The basic principal is that ubiquitous microfractures within the rock are closed under increased loading, allowing the elastic wave to travel at a greater velocity and with less attenuation. Using tomography to image this property, the redistribution of stress can be imaged, allowing identification of areas closer to failure. This has been shown clearly in the laboratory but has had only very limited testing at the field scale.

The proposed experiment includes the construction of multiple pillars at different depths and the incorporation of tomographic monitoring results to predict failure. By constructing pillars at increasing depth, the effect of increasing stress can be clearly determined. At least three pillars will be constructed at approximate depths of 1000, 3000, 5000, and 7000 ft. The facilities required include access to the levels specified, as well as a dedicated site at each level for instrumentation; however the pillars themselves do not need to be constructed concurrently with the DUSEL.

This experiment will put the method of imaging stress-induced changes within rock masses on a sound theoretical and practical basis. It requires a DUSEL, as deep, long-term, dedicated access is not available at current underground tests sites. Beyond the obvious direct applications, the project results will significantly assist educational efforts from the elementary level geology lessons to rock mechanics courses at the university level.