Title: Characterization and Mechanics of Faulting and Rock Fracture at Homestake Mine

List of Participants: Dr. Stephen Martel (this research would dovetail with that of other investigators in rock mechanics, hydrology, geophysics, and biology)

Description of Proposed Program

Fracture and fault systems at Homestake mine control to a large extent the strength of the rock and the flow of fluids at the mine. Accordingly, careful characterization of the faults and fractures is essential for the safe design, construction, and operation of the underground facilities being considered for Homestake. In addition, the existing tunnels and anticipated excavations would provide opportunities to understand how faults and fractures form at depth and how they respond mechanically to changes in stress induced by excavations and by changes in water pressure. Faults and fractures are also potential habitats for microbial life that might exist at depth. Although characterization of the fracture and fault systems at Homestake would be valuable on their own, the results also would be highly valuable to geophysicists, hydrologists, biologists, and engineers.

Dr. Martel has been characterizing fractures and faults in rock, and examining the mechanics of faults and fractures, for more than 20years. He also was part of in a multi-disciplinary team at Lawrence Berkeley Laboratory that participated in rock fracture projects at Stripa, Sweden and Grimsel, Switzerland from 1988-1992.

I see several lines of research that could be pursued at the Homestake mine:

1. Mechanics of natural fault and fracture growth;
2. Induced seismicity and the effect of slip on nonplanar faults, including the formation of deformation products on the fault surface and the "damage" (i.e., secondary fracturing) in the rock adjacent to the fault.
3. The distribution of slip on nonplanar faults.
4. The effect of topography on stresses in the shallow subsurface. This would build on a recently funded NSF project run by Dr. Martel.

These topics are of substantial interest in the rock mechanics, structural geology, and seismology communities. At present, no site exists in the United States where three-dimensional observations and experiments can be conducted at the scale and stress conditions that exist in the Homestake mine. These experiments would illuminate how faulting and fracturing occur under natural conditions in the Earth's crust. The experiments would contribute to our understanding of earthquakes and how heat and mass are transmitted through rock.

Estimate of Space Requirements

Much of the research could require no special space requirements, but rather access to the existing tunnels and pending excavations.

Estimate of Date of Required Access to Facility

Access would ideally be provided prior to the design phase so that the results could be used as part of the design of underground facilities. Access should continue through the construction phase so that characterizations of the fracture and fault systems can be updated during construction.

Other General Requirements

Access to rock cores from boreholes and the associated borehole logs would be extremely helpful. Also, if small earthquakes were induced at Homestake, then the ability to excavate and expose the associated fault(s) would be invaluable. Activities such as this are being done now at deep gold mines in South Africa.