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Memorandum (11/20/05)

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Subject: Letter of Intent - Homestake Mine, DUSEL

This "letter of intent" is in response to a notice posted on the internet and a brief exchange with Dr. J. Wang and LBL. We propose a fundamental study of **scale effects in rock mechanics** at the Homestake Mine site. The Homestake Mine offers a unique opportunity for basic research into this long-standing, key-question in rock mechanics by virtue of access to a large, three-dimensional rock mass. There are more than 300 miles of shafts, raises, drifts and crosscuts at the site that have been developed in the course of many years of mining that now extends to a depth of 8,000 ft. No other candidate site offers as much access to such depth. Access in the near future to the 4850 Level opens the door to this important investigation of scale effects. The work would be done mainly by personnel in the Department of Mining Engineering at the University of Utah, but possibly in cooperation with other interested groups.

1) Title: "Experimental Study of Scale Effects in Rock Mechanics at the Homestake Mine"

2)Participants: Participants are mainly at the University of Utah (Bill Pariseau, James Donovan). Because of the widespread interest in scale effects in rock mechanics, we anticipate participation by other interested parties. However, at this early stage, only an outline of the proposed investigation is suggested here. We would need mine personnel to assist in transport of equipment in and out of the mine. Importantly, we would need to gain access to ever larger volumes of rock and would therefore need to define selected passageways in the mine for possible rehabilitation, ventilation and so forth.

3) Proposal: We propose to do an experimental study of scale effects in rock mechanics by determining rock properties at one scale and examining corresponding properties at a larger scale. In this regard, the micro-structural model approach that leads to estimates of properties at the usual laboratory scale of test specimen is well-accepted in mechanics of solids. In this approach, detailed micro-structural information, including geometry of grains, voids, microcracks, and properties such as elastic moduli are integrated - homogenized - to obtain properties of a test specimen that includes many grains. We propose to apply the same approach but at ever increasing

scales. In our approach, the integrated scale at one step becomes the "micro-scale" for the next "sample" size. Scales of interest were identified during the NeSS02 conference and were labeled as:

Rock mass scale (whole mine experiments)	-10^{3} m
Stope, cavity scale	-10^{2} m
Tunnel, shaft scale	-10^{1} m
Drill hole scale	-10^{-1} m
Laboratory (cm) scale	-10^{-2} m
Grain (mm) scale	-10^{-3} m
Sub- (:m) scale	-10^{-6} m

with addition at the smaller scale. During NeSS2 a question was asked about the possible importance of an even smaller scale (micron scale). We have the capability of x-ray micro-tomography at the micron scale. For example, we have recently looked at a three-dimensional image of a 60 micron cubical sample of a highly porous, light-weight gypsum material and have readily examined this material using the image as a three-dimensional finite element model where each voxel becomes an element. We proposes analogous sequences of "micro-structural" imaging and homogenization at ever larger scales. We recognize the need for different imaging techniques at each scale. Even at the step from grain to laboratory scales, the x-ray tomography requires change. At the tunnel scale, conventional geologic mapping of discontinuities may be adequate to define the three-dimensional structure on the scale of a few meters. However, we anticipate using photographic techniques that have been specifically developed for the purpose. At the stope scale, laser imaging tools are available, and at the mine scale, seismic tomography seems appropriate. A major question concerns the appearance of discontinuities, flaws in the rock mass, at one scale that were absent at a smaller scale.

4) Space Requirements: We would need some staging area at the mine, probably at the hoist collar of the Ross Shaft and also some storage space for equipment, core boxes and so on. We do not anticipate unusual conditions.

5) Access Underground: We would need access from the surface to the 4850 Level and places in between. Once a definitive scaling and imaging strategy is developed, we would be able to pin point desirable locations in the rock mass that could be accessed via old workings. Access in 2006 is desirable for gathering small samples for laboratory and smaller scale study and for starting larger scale study. We would need ventilation air, of course, and possibly electrical power at selected sites. Some drilling requiring water and compressed air may be desirable.

6) Other: We have two other projects under consideration. In this regard, we are very much interested in student and young investigator involvement. In particular, we see a need to pass the skills associated with doing underground rock mechanics work to the next generation of engineers and scientists.