

DRAFT
Letter of Interest for the
Homestake Deep Underground Science and Engineering Laboratory
December 9, 2005

Breccia evolution associated with degassing of Tertiary veins and dikes,
Homestake Mine, Lead, South Dakota

Participants: Alvis L. Lisenbee, Nuri Uzunlar, (Dept of Geology and Geological Engineering, SDSM&T); Scott Cooper, Sandia National Laboratories, Albuquerque, New Mexico.

Description of Proposed Program:

Breccia dikes, pipes and diatremes are present in many igneous centers associated with alkalic and calc-alkalic plutons. Rounding of the clasts in such bodies indicates a period of movement in gas-charged conditions. The proposed study will examine breccia development associated with evolution of gases from the Eocene rhyolite dikes and veins present within the Homestake mine at Lead, South Dakota.

An Eocene swarm of rhyolitic dikes (Fig. 1) and associated breccias are well exposed in the Homestake Open Cut, many of the underlying drifts, and are penetrated to depths of several thousand meters in the exploratory drill holes associated with the giant gold deposit there. In excellent exposures in the Open Cut the dikes are seen to feed sills in the basal Cambrian sedimentary strata immediately above the Precambrian basement.

Breccias within, or near to, the margins of the Tertiary dikes consist of mixtures of the light-colored rhyolite and the dark Precambrian metamorphic host rock. The size of the breccia bodies increases upward (possibly due to coalescence of smaller breccia masses) as does the proportion of the Precambrian fragments. Locally, the breccias are mineralized and cemented by pyrite and fluorite, indicating a subsequent fluid flow through the porous, broken material.

The presence of Cretaceous shale xenoliths in the Tomahawk diatreme, located approximately 8 km SSE of the mine, indicates that Phanerozoic strata up to the Cretaceous shale remained over the Black Hills uplift at the time (~55 Ma) of dike emplacement. In such an instance, the Precambrian-Cambrian surface in the Homestake area was at a depth of approximately one and one-half kilometers during dike emplacement and breccia formation.

Based on preliminary studies by Cooper and Lisenbee on the breccias and Uzunlar on the veins, it is known that there is a general relationship between the depths of large-scale breccia genesis in Homestake and the evolution of a gas phase within fluid inclusions in Tertiary veins. Therefore, such evolutions appears constrained to original depths of between two and two and one-half kilometers.

Objectives:

- Refine our understanding of the depth, extent, and style of the initiation of breccia evolution associated with degassing of Tertiary dikes and veins.
- Determine the depth at which lithostatic pressure was insufficient to prevent boiling and the evolution of gasses from the Tertiary veins and dikes.

- Determine the nature of any relationship of breccia formation and boiling/gas evolution.
- Determine the vertical characteristics/changes of breccia dikes to pipes from the point of origin to within ~ one and one-half kilometer of the original surface. .

Suggested Work:

- 1) Inventory breccia/dike/vein samples available at the South Dakota School of Mines (SDSMT), Department of Geology and Geological Engineering. Examine samples taken by Uzunlar, Cooper, and Lisenbee in earlier studies.
- 2) Define areas needed for additional sampling of breccias and veins.
- 3) Collect samples from the drill core archive at Homestake and from underground exposures, initially to depths of the 4850 mine level (~1500 m) (Fig. 1) as access allows.
- 4) Conduct fluid inclusion studies of the selected vein materials to refine the preliminary understanding of the depths and character of gas evolution.
- 5) Synthesize the breccia characterization and fluid inclusion studies, compare depths of gas evolution and the lowest breccias, and outline a model of their joint formation, if appropriate.

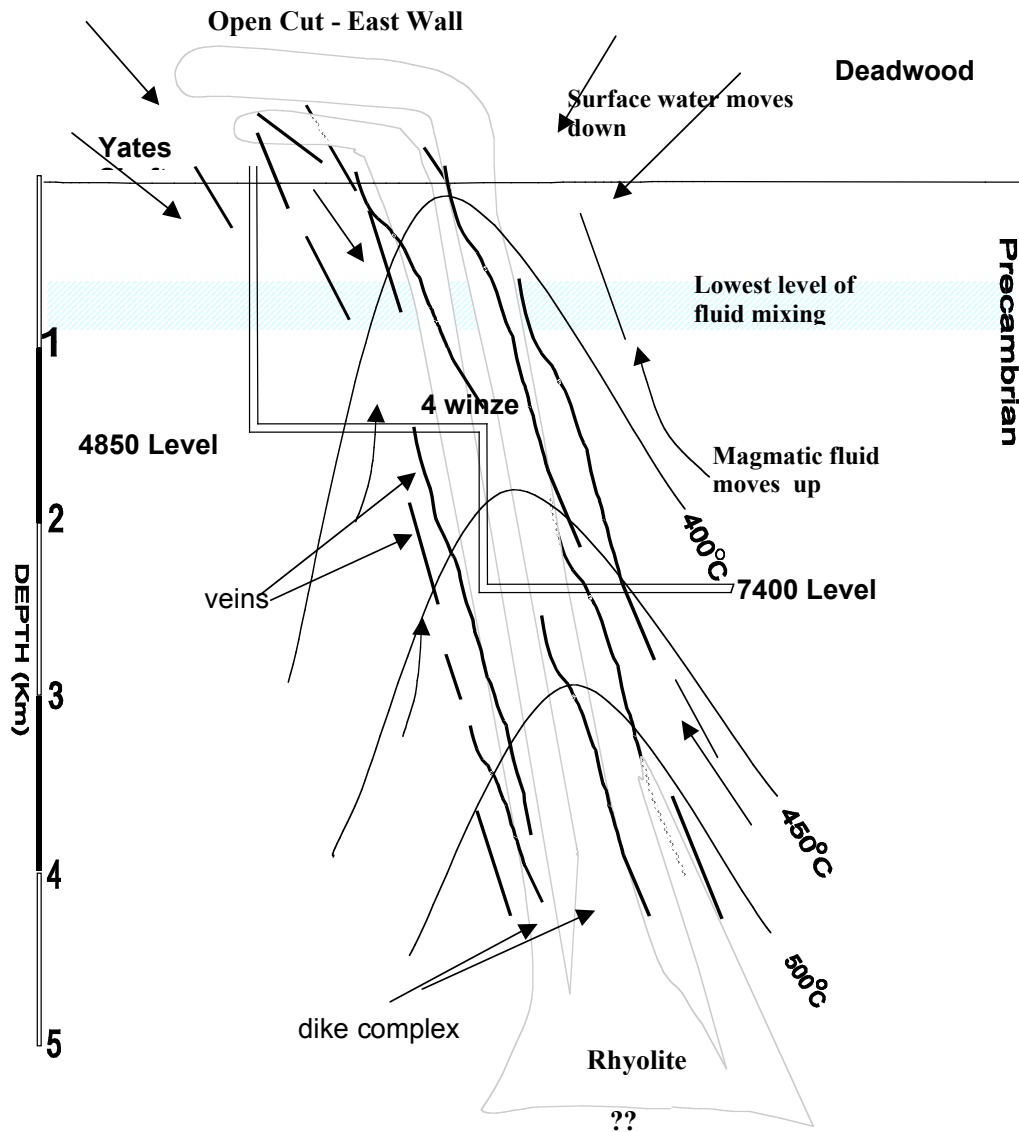


Figure 1. Diagrammatic cross section through Homestake mine, showing some geologic features and generalized isotherms, derived from fluid inclusion studies (Uzunlar, 1993) for Tertiary hydrothermal event. Some locations in the mine are superimposed to the section to simplify orientation.

Space Requirement and Technical Issues:

- Laboratory space for samples examination and preparation for fluid inclusion studies is available at the SDSMT.
- Subsequent selection of key areas for additional samples, based on the preliminary analysis, will utilize the mine database composed of geologic maps and cross-sections, Homestake Core Repository and diamond drill hole logs, and the Vulcan digital data base.
- The fluid inclusion laboratory at SDSMT will be utilized for fluid inclusions studies.

Access to the underground facility:

- No access is required for the initial phase of this study.
- Access to drifts to at least the 4850 mine level is needed to complete the sampling phase.

Other general requirements:

None

Selected Bibliography:

Cooper, S., 1999, Breccia formation in the Homestake Mine, Lead South Dakota: B.S. thesis, South Dakota School of Mines and Technology.

Lisenbee, A. L., and Roggenthen, W.M., 1990, Diatremes and breccia pipes of the northern Black Hills, South Dakota—Wyoming, *in* Paterson, C.J., and Lisenbee, A. L., *editors*, Metallogeny of gold in the Black Hills: Society of Economic Geologists Guidebook Series Vol. 7, p. 175-181.

Uzunlar, N., 1993,