

**Letter of Interest for the  
Homestake Deep Underground Science and Engineering Laboratory  
December 3, 2005**

**Thermal History of Homestake Mine  
Lead, South Dakota**

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**Description of Proposed Program:**

**Objective:** To find an area within the Homestake mine, which has not been subject to temperatures exceeding 100°C (120) to search for potential preserved Precambrian life forms.

The Homestake mine displays excellent exposures of both Precambrian metamorphic rocks and Tertiary dikes and associated mineralization. Three Precambrian formations are exposed in the Homestake mine: from oldest to youngest these are the Poorman Formation, Homestake Formation and Ellison Formation.

Key elements to thermal evolution of the mine area are:

- Lithostatic burial history.
- Magmatic activity in the mine.
- Hydrothermal activity.
- Magmatic and/or thermal activities in the surrounding area and at depth.

**Thermal History**

Precambrian metamorphic events probably occurred between 1.8 and 1.7 Ga (Billion years) at which time temperatures may have locally reached 600°C. The cooling period may have ended before 1 to 1.3 Ga when temperatures decreased to the 100 to 150°C range. There are no other known thermal events in the area to 60 Ma.

During the period ~550 Ma (million years) to 65 Ma temperatures in the Homestake mine at 8000 level (approximately 2.5 km below current surface) ranged from 45 to 95°C, depending on the thickness of the lithostatic cover (Fig. 2). During a period of time during the magmatic event between 60 to 38 Ma in the northern Black Hills, temperatures in the mine area locally reached at least 500°C (Fig. 2). Such higher temperatures were localized around igneous dikes and fractures, which were conduits to hydrothermal fluids. Fluid inclusion studies (Uzunlar, 1993 - PhD dissertation) show that the fluid that formed the mineralized veins around the 7400 level reached to 450°C. Lower temperatures (as low as 280°C) were obtained from small veins in drill distal from the dike complex.

We believe the Tertiary heating event was localized around the dikes and veins and was not pervasive to the entire mine. Within this context, the greatest probability of preservation of life forms in other non-mineralized fractures during the thermal peak in Tertiary time would be in the east cooler, side of the mine.

**Suggested Work** : To test the potential for preservation of Precambrian life forms, we propose to identify those areas within the mine, which has not been subjected to temperatures greater than 100°C.

Apatite fission-track thermochronology will be conducted on samples collected from drill core (Homestake Core Repository).

**Space Requirement and Technical Issues:**

Initially, emphasis will be on the mine database composed of geologic maps and cross-sections, Homestake Core Repository and diamond drill hole logs, and the Vulcan digital data base. Particular interest will be in the core from the deep drill holes closer to the east ledges

Selection of key areas will be based on preliminary analysis, and on currently accessible locations underground. Likely, parts of the east ledges would be the key areas.

**Access to the underground facility:**

No access required for the initial phase of this study. Initial phase samples will be selected from currently available Homestake Core Repository.

**Other general requirements:**

None

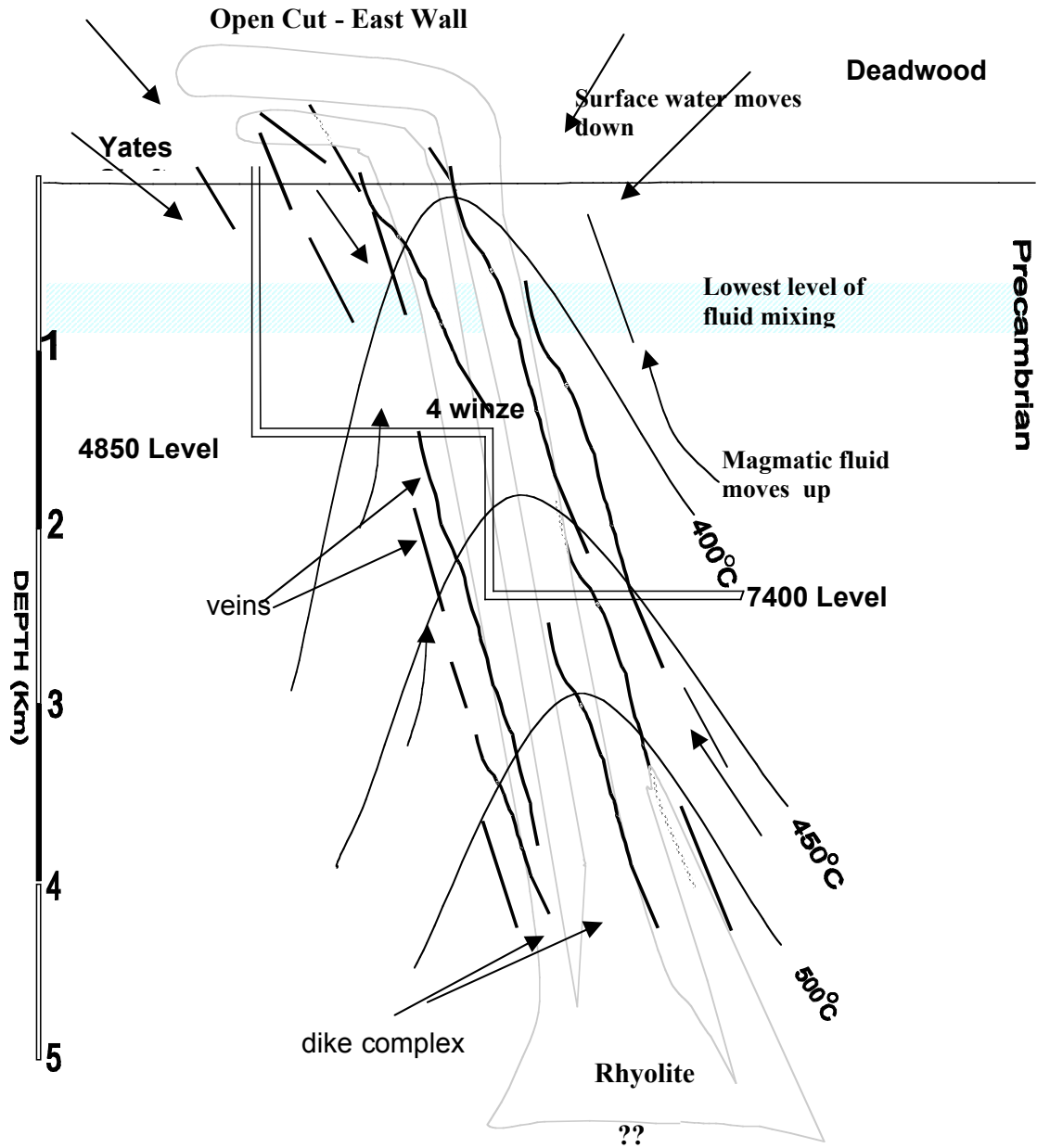
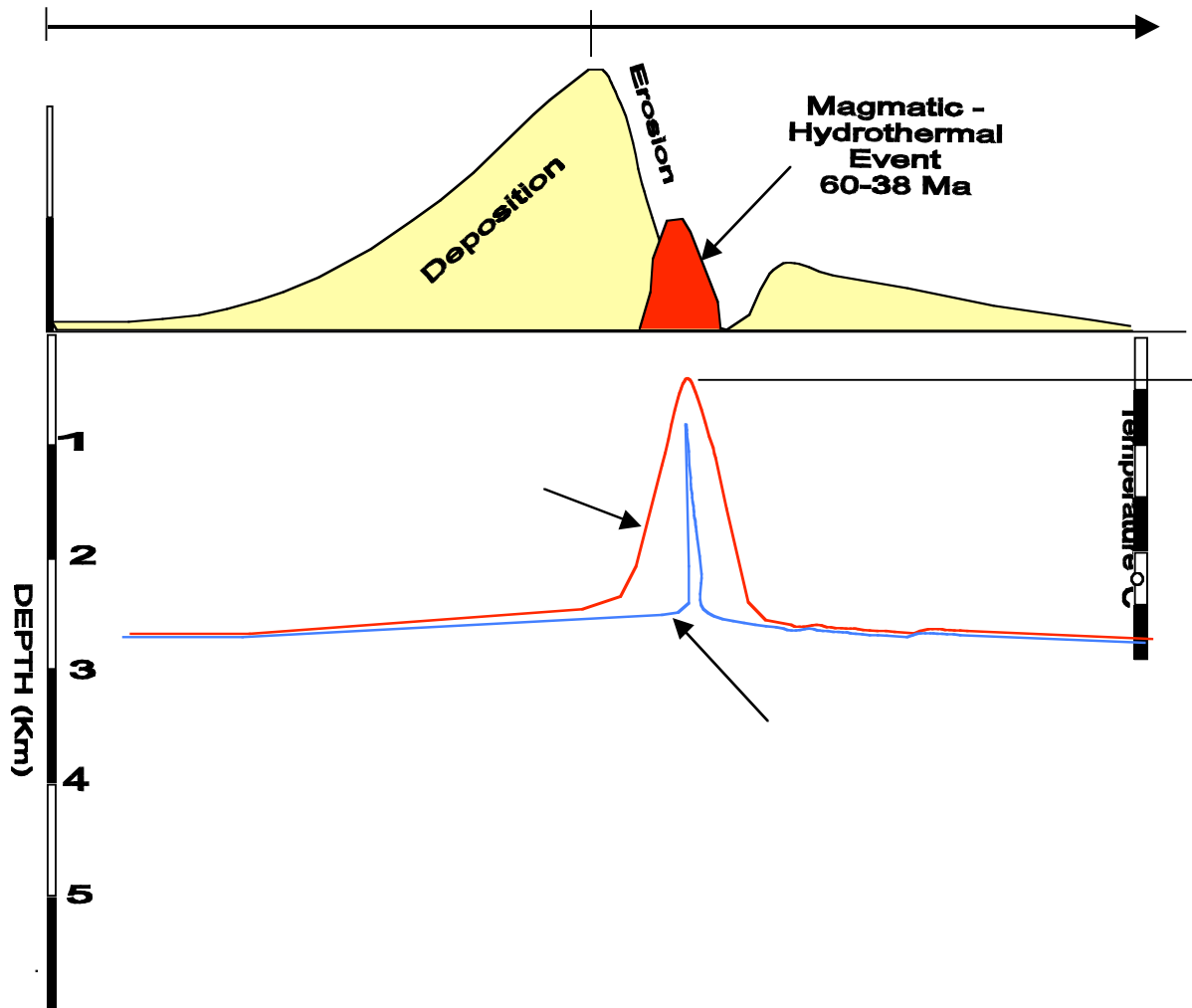


Figure 1. Diagrammatic cross section through Homestake mine, showing some geologic features and generalized isotherms, derived from fluid inclusion studies (Uzunlar, 1993) for Tertiary hydrothermal event. Some locations in the mine are superimposed to the section to simplify orientation.

550 Ma 64 Ma Today 100 200 300 400 500 Northern Black Hills - Cutting Stock Homestake mine, 800



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