Exploration for Concealed Structures at Desert Peak Using Mercury Soil Gas Detectors

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Abstract

The Desert Peak geothermal field has little or no surface expression and thus represents a blind exploration target. Resource expansion in this area requires using methods that can identify favorable structural zones which, at Desert Peak, are covered by extensive blankets of sand and/or sandy soil that may conceal bedrock indicators of an underlying geothermal system. Thermal infrared imagery has not been useful in the exploration for favorable targets at this site. A detailed mercury (Hg) soil gas survey has the potential to identify favorable targets at a very low cost.

Mercury is commonly associated with fossil and active geothermal systems. In the vapor phase Hg is readily transported along permeable bedrock structures and through overlying soil cover, a feature that has made Hg useful for both mineral and geothermal exploration. Through the process of amalgamation, gold or silver wires can be used to collect Hg vapor from soil gas to locate areas of high Hg flux, and mapping such anomalies can help identify structures that may be favorable geothermal conduits.

A preliminary orientation survey at the southwest end of the Brady's geothermal system indicated a good correlation between Hg soil gas emissions and steam-heated ground, confirming the usefulness of this technique in the Brady's/Desert Peak area. This proposal outlines a detailed Hg soil gas survey to be conducted over the Desert Peak geothermal area. Results of this study will be combined with other data and evaluated in a GIS context to identify possible extensions of the geothermal system, providing guidance for a subsequent expansion of the resource. This project has the potential to have a very rapid impact on the geothermal resource production in the Great Basin.

Purpose

The purpose of this project is to conduct a detailed Hg soil gas survey to delineate concealed structures at the Desert Peak geothermal field. Both Hg soil gas and soil Hg concentrations have shown good correlations to fossil and active geothermal systems, and are commonly used for mineral exploration (Rose, 1979) and geothermal exploration (Klusman, 1993). Mercury vapor analysis correlated well with temperature gradients at Dixie Valley in previous geochemical surveys, for instance (Klusman, 1993). Mercury vapor is capable of penetrating sand and soil cover, which makes it useful for identification of buried structures favorable for fluid transport in geothermal systems. Combined with structural, geophysical, and thermal data, Hg soil gas surveys can yield valuable information to help identify geothermal targets. The cost of such a survey is very low, on the order of $10.00/sample.

Results of a preliminary Hg vapor survey conducted by the authors at the southwest end of the Brady's geothermal system indicate a positive correlation with areas of steaming and warm ground

(Figure 1). Mercury emissions from steam-heated ground over inferred structural trends ranged from approximately 116 to 485 $ng/m^2/day$ versus values of 40 to 100 $ng/m^2/day$ for areas away from or between structures. A higher Hg emission relative to background was also

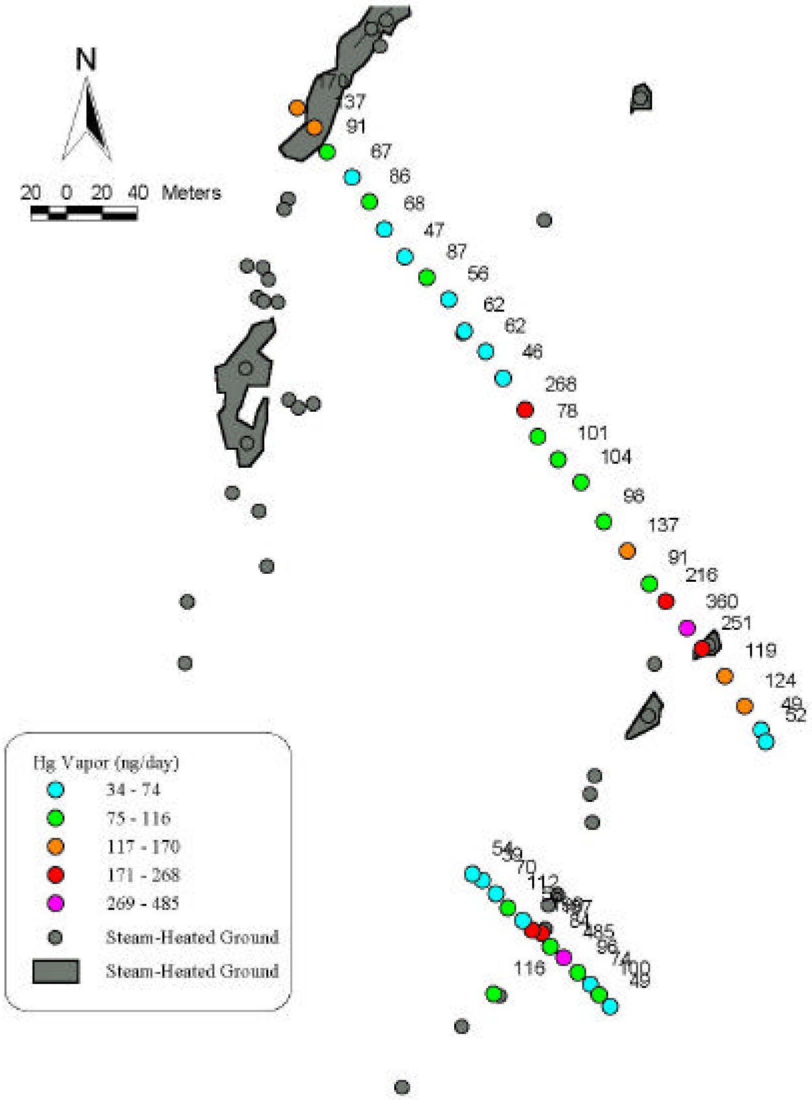

Figure 1. Results of Hg vapor orientation survey over a small, well-characterized portion of the Brady's Hot Springs area. Known structures and areas of steam-heated ground are closely correlated to high Hg vapor fluxes.

found associated with warm ground (40°C at 50cm) along a tufa ridge underlain by silicified sand units or sinter. Peak to background resolution for this methodology is very good.

Previous studies (e.g. Lechler, 1993) have deomonstrated the essentially linear relationship between soil Hg concentrations and Hg soil gas emission rates. In order to discriminate between anomalous Hg vapor sourced in Hg-enriched surficial soils and Hg vapor having a deeper source related to active bedrock structures, soil Hg concentrations will also be determined at some sampling sites. A relationship between soil Hg concentrations and Hg vapor emission will be established for the project area, and those locations exhibiting excess Hg vapor emission unsupported by soil Hg concentrations will be assigned a deep-seated, active source. These sites will have very high priority for follow-up evaluations and drilling. Sample sites exhibiting background Hg soil gas fluxes will not be checked for soil Hg concentrations.

The Desert Peak geothermal system does not display any active surficial manifestation of a geothermal system as does the nearby Brady's system. Subtle indicators of past geothermal activity are locally present but a large portion of the area is covered by sand. Thus, the Desert Peak geothermal site is an excellent candidate for delineation of blind geothermal targets. A detailed Hg vapor survey can indicate areas with anomalously-high Hg vapor flux, which are likely to be associated with bedrock structures hosting a geothermal system in this area.

Methods

Hg vapor collectors (polypropylene soil vapor collectors containing silver wire Hg samplers) will be placed on 50 to 100m grids. After an integration period of one to two weeks, the detectors will be analyzed at the Nevada Bureau of Mines and Geology following the methods described by Lechler (1993). This method uses a heated graphite atomizer attached to an atomic absorption spectrometer to heat the silver wire collectors. The released Hg is quantified by the spectrometer and the wires are then clean and ready for re-use in the field.

Results will be entered into a GIS database and evaluated on a continuing basis to adjust and focus the survey for better definition of anomalous zones, while still providing overall coverage of the area. The quick turnaround of analysis and data entry (1-2 days) after samples are collected allows for near real-time adjustments in the survey. Shallow (1m) soil temperature measurements will be conducted in areas which have elevated Hg fluxes. Soil temperatures have aided in the delineation of a complex surficial expression of the nearby Brady's system. Initial transects at Desert Peak will be conducted near producing zones and across high temperature-gradient zones. This will provide initial data to guide the main survey phase which will investigate and characterize extensions and peripheral zones of the system.

Deliverables

The data together with interpretive anomaly maps will be added to existing GIS databases being developed as a part of sister research projects at Desert Peak. This will facilitate efforts to identify extensions to the geothermal field. Both digital and hard-copy (poster) formats of the information will be delivered to Ormat, and results will also be presented at a selected geothermal forum.

References Cited

Klusman, R.W., 1993, Soil gas and related methods for natural resource exploration: John Wiley and Sons, New York, 483p.

Lechler, P.J., 1993, Mercury vapor sampling at the Carson River Superfund Site: Proceedings Heavy Metals in the Environment, Toronto, p. 377–380.

Rose, A.W., Hawkes, H.E. and Webb, J.S., 1979, Geochemistry in Mineral Exploration (2nd Edition): Academic Press, New York, 657p.

Milestones

Field sampling and analysis completed	October, 2003.
GIS data base finalized	November, 2003
Final Report	December, 2003