NEVIN | SADLIER-BROWN | GOODBRAND | LTD

Suite 401 - 134 Abbott St., Vancouver, B.C. Canada V6B 2K4 (604) 683-8271

Hg and As Soil Geochemistry of the Meager Creek Geothermal Area

by

R. E. Openshaw
Nevin Sadlier-Brown Goodbrand Ltd.
134 Abbott Street, Vancouver, B.C.

Introduction

The Meager Creek Geothermal Area (Figure 1) is centered around the Meager Creek Volcanic Complex of Pliocene to Recent age. This volcanic complex is the most northerly volcano of the Garibaldi Volcanic Belt, an extension of the High Cascade Volcanos.

A primary target of about 6 km^2, termed herein the South Reservoir, has been identified on the south flank of the complex. Preliminary testing of the first deep test well, completed in November 1981 to a depth of 2500m, indicates equilibrium temperatures over 230°C and permeable structures at 1350m and 1600m. A second deep test well is in progress.

Broad targets in the northern part of the area correspond approximately to the resistivity anomalies in Figure 1. Four shallow gradient wells have been drilled to date and heat flows of the same magnitude as the South Reservoir (up to 670 Mw/m^2) have been measured.

. . .

This report was prepared for the British Columbia Hydro and Power Authority ("BC Hydro"). BC Hydro does not:

(a) represent, guarantee or warrant to any third party, either expressly or by implication: (i) the accuracy, completeness or usefulness of; (ii) the intellectual or other property rights of any person or party in; or (iii) the merchantability, safety or fitness for purpose of; any information, product or process disclosed, described or recommended in this report,

(b) assume any liability of any kind arising in any way out of the use by a third party of any information, product or process disclosed, described or recommended in this report, or any liability arising out of reliance by a third party upon any information, statements or recommendations contained in this report.

Should third parties use or rely on any information, product or process disclosed, described or recommended in this report, they do so entirely at their own risk.

A detailed case history of the exploration is given in Fairbank, et.al., 1981. The most useful exploration techniques have been found to be water geochemistry, electrical resistivity, shallow thermal gradient drilling, and detailed geologic mapping and fracture analysis.

In this report we are concerned with the results of a survey of the Hg and As soil geochemistry carried out in the Meager Creek area during the 1981 field season. Hg in soils has been found to show good correlation with high heat flow areas (Mattick and Shiraki, 1981) and to outline geothermally active structures (Capuano and Bamford, 1978). As soil geochemistry is highly complimentary to Hg soil geochemistry in that Hg is transported mainly in the vapor phase and As in the liquid phase.

696 soil samples have been collected along sample lines (Figure 1) and 77 samples in 6 soil profiles. The survey focuses on the South Reservoir but reconnaissance lines have been run in other parts of the area. New water geochemistry and surface water electrical conductivity results complimentary to the soil geochemistry are discussed.

In a preliminary study of the Hg soil geochemistry in the Meager Creek Area (NSBG, 1979) most of the anomalously high values were associated with organic rich soils and the overall usefulness of Hg as an exploration guide

. . .

was not conclusively demonstrated. The present work shows that Hg-As soil geochemistry can be successfully integrated with the ongoing exploration of the Meager Creek geothermal area at both the reconnaissance level and at more advanced stages of development.

Sampling and Analytic Techniques

Valley glaciers have left behind extensive deposits of glacio-fluvial material in the Meager Creek area and soil horizons are generally poorly developed. Only the organic rich A horizon is clearly distinguishable in most locations. Based on soil profile results 50 to 70cm was established as the optimum sampling depth.

Samples were collected in 150 cc screw-capped plastic jars. Sample drying, preparation, and analyses were done at Chemex Labs Ltd., a commercial laboratory in Vancouver, B.C. Both Hg and As soil contents were determined using atomic absorption techniques.

The sampling interval for the line survey was 100m except in areas of particular interest where the interval was reduced to 50m and in one case 20m.

. . .

Results

Mean values and standard deviations are listed in Table 1 for three sets of samples. Line S is outside the geothermally active area and is underlain by the same rock types as the South Reservoir. It can thus be used to establish background values for the South Reservoir area. General background values for the entire project area can be represented by the mean for all samples outside the South Reservoir.

In Figure 2 are illustrated results typical of the South Reservoir. The background As and Hg values are shown by lines in Figure 2 and it can be seen that most values for the South Reservoir are anomalously high as suggested by the mean in Table 1. There is good correspondence between Hg and As on a sample by sample basis.

The contoured As results are presented in Figure 3. There is one trend corresponding to No Good Creek, a second trend running east-west and a third southeast-northwest trend in the Angel Creek area.

The Hg results are similar but less discrete. One large anomalously high response is centered roughly around Angel Creek and a second zone around No Good Creek.

. . .

The most significant result from the soil profiles is that on the geothermally active parts of the area Hg is enriched at depth and depleted at the surface, including in the A-horizon. Profiles outside the South Reservoir area showed strong Hg enrichment in the organic A horizon and a flat, low response over the rest of the profile.

In Figure 1 areas having anomalous As and Hg soil values are marked by heavy lines. The two areas noted with asterixes in Figure 1 are characterized mainly by strong As responses.

Discussion

The principle result of the study is that the South Reservoir has been clearly delineated by the As-Hg soil geochemistry. The As and Hg responses are remarkably coincident with the dipole-dipole resistivity anomaly in Figure 1.

Three structural features in the South Reservoir area have been proposed as controls on fluid movement, at least in the near surface environment: the No Good Creek zone, east-west faulting parallel to the Meager Creek Fault, and the Ryan River Lineaments. The latter feature has been identified in air photos and is correlated with a predominant fracture set in the South Reservoir area. Geothermal activity along these three features is recorded by three trends of anomalously high As values.

. . .

To the southeast and on strike with the Ryan River Lineaments have been found swamps and streams with highly electrically conductive waters indicative of above normal salinities and water chemistry similar to waters of probable geothermal origin. The waters in the swamps and streams are cool and are considered to represent outflow waters from the South Reservoir that have been channelled along the Ryan River Lineaments.

The South Reservoir is characterized by complimentary Hg and As responses. If such geochemical behaviour is a general rule for geothermal areas then the two reconnaissance targets defined principally by high As values may be due to non-geothermal causes.

Surface depletion of Hg in soil profiles has also been observed by Buseck (1977) and Capuano and Bamford (1978) and thus seems to be characteristic of geothermal systems. It may represent a diffusion gradient of elemental Hg degassing into the atmosphere.

On a reconnaissance scale electrical conductivity results also compliment the anomalous geochemical results in the Job Creek-Affliction Creek area. Job Creek itself has high electrical conductivities as do many small streams coming into Job Creek and Affliction Creek. This area thus is a high priority target for further exploration.

Conclusions

Hg-As soil geochemistry clearly delineates the South Reservoir and combined with other work indicates that the Ryan River Lineaments, a regional feature, are prime targets for permeable structures in the deep reservoir. Production drilling should be oriented to intersect these structures at high angles.

In the northern part of the project area prime interest areas within the broader targets have been outlined by the present work.

Soil profiles are an important integral part of any Hg-As soil geochemistry survey. They are essential to determining optimum sampling depths and are potentially useful as a discriminating tool.

Acknowledgements

The Meager Creek Geothermal Project is operated by B.C. Hydro and Power Authority. The author wishes to thank Mr. J. Stauder, Senior Project Engineer for B.C.H.P.A., for his support of the study and for his permission to present the results.

* * * * * *

References Cited

Buseck, P.R., 1977, Geothermal Exploration: Arizona State University Semi-Annual Technical Report II, Geothermal Research Program, U.S. Geological Survey, Grant No. 14-08-001-G-383, 5 pp.

Capuano, R.M. and Bamford, R.W., 1978, Initial Investigation of Soil Mercury and Geochemistry as an aid in Drill Site Selection in Geothermal Systems. University of Utah Research Institute, Earth Sciences Laboratory Report DOE/ET/283902-20, 32 pp.

Fairbank, B.D., Openshaw, R.E., Souther, J.G., and Stauder, J.J., 1981, "Meager Creek Geothermal Project - An Exploration Case History". Geothermal Resources Council Bulletin 10, 3-7.

Matlick, J.S. and Shiraki, M., 1981, Evaluation of the Mercury Soil Mapping Geothermal Exploration Techniques. Geothermal Resources Council, Transactions 5, 95-98.

Nevin Sadlier-Brown Goodbrand Ltd., 1979; Report on 1978 Field Work, Meager Creek Geothermal Area, Upper Lillooet River, British Columbia (unpublished) to B.C. Hydro and Power Authority, 82 pp.

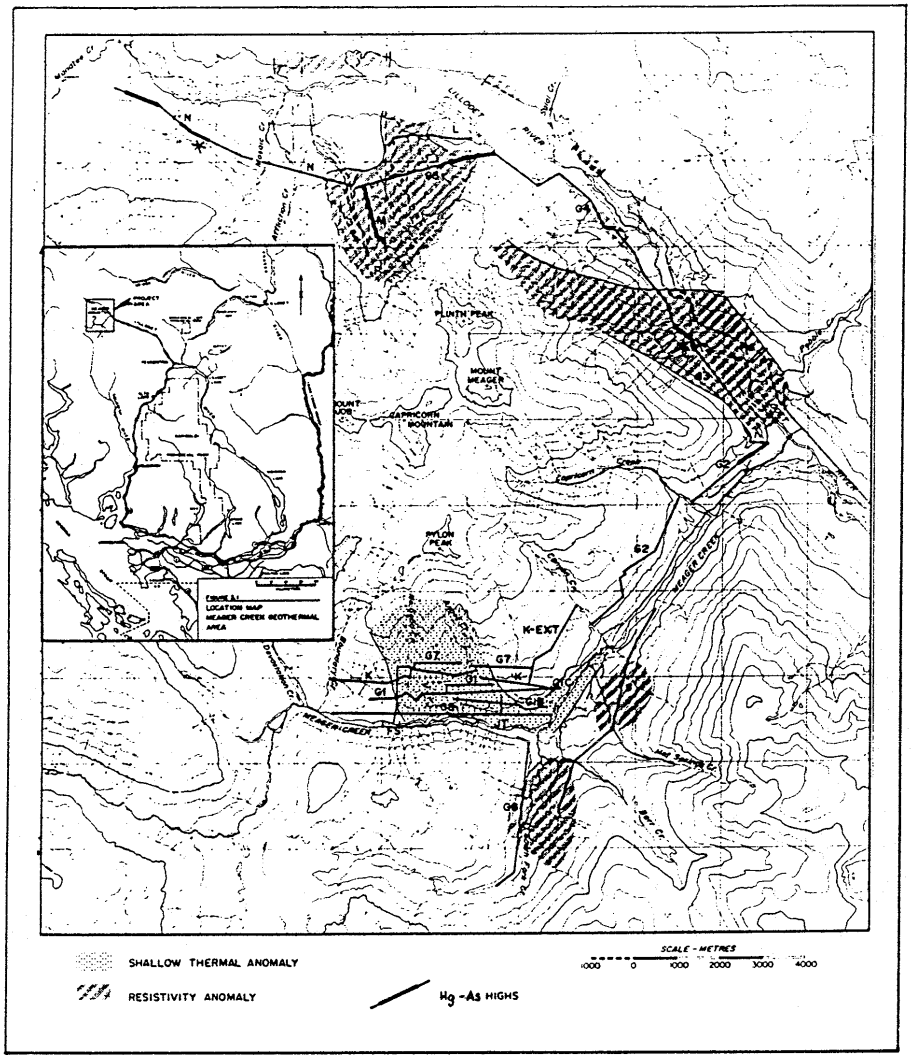

Figure 1

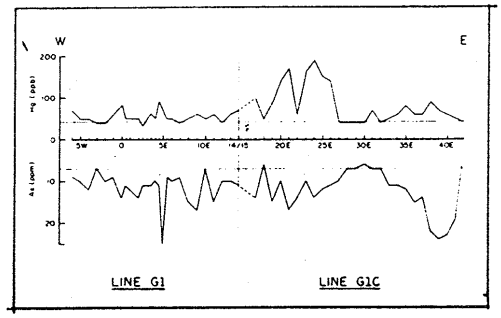

Figure 2

TABLE 1

Means and Standard Deviations for Soil Line Samples

Samples	Hg (ppb)	As (ppm)
outside South Reservoir	44 ± 19	5.6 ± 4.7
over South Reservoir	77 ± 67	9.1 ± 6.0
Line S	31 ± 11	5.0 ± 1.9

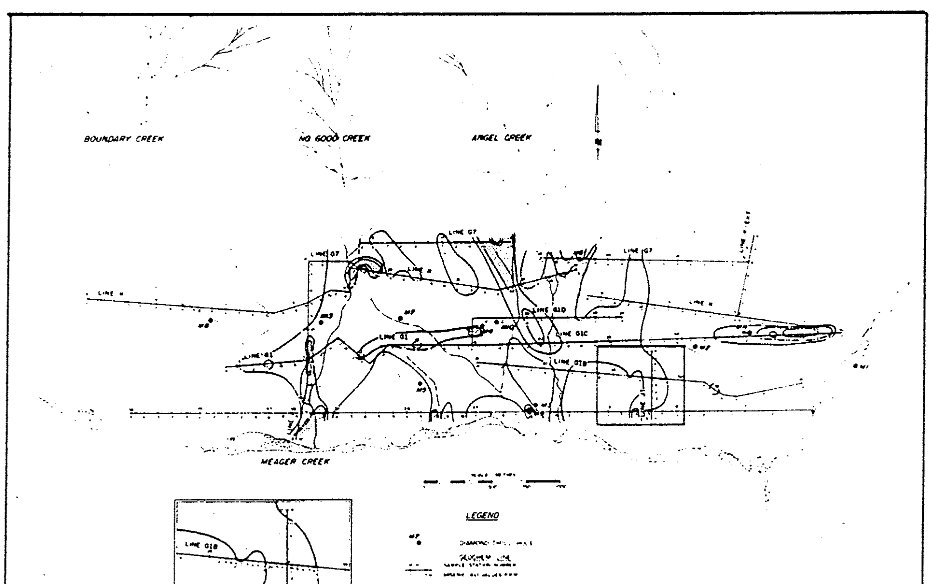

Figure 3

Figure 1: Location Map of Geothermal Area, Geochemistry Lines, and Resistivity Anomalies.

Figure 2: Representative Hg and As Results over the South Reservoir Area (Lines G1 and G1C).

Figure 3: Contoured Results for As over the South Reservoir.