A-5

A CURIE POINT RECONNAISSANCE SURVEY
ACROSS THE GEOTHERMAL AREAS
OF
WESTERN NEVADA

P-8075

July 13, 1978

EUREKA Resource Associates, Inc.

A CURIE POINT RECONNAISSANCE SURVEY
ACROSS THE GEOTHERMAL AREAS
OF
WESTERN NEVADA

P-8075

July 13, 1978

EUREKA

A CURIE POINT RECONNAISSANCE SURVEY
ACROSS THE GEOTHERMAL AREAS OF WESTERN NEVADA

ABSTRACT

Eureka Resource Associates, Inc. proposes to map the Curie point isotherm from fifty aeromagnetic profiles 208 km long and five tie lines 320 km long, across northwestern Nevada and covering 21 KGRA's. Four competitive KGRA land sales scheduled for September are among those covered by this 66,650 sq km study.

The objective of the project is to furnish clients with reconnaissance data showing where the Curie point isotherm (500°C) comes closest to the surface, and to evaluate that data together with Landsat, gravity and other published geological, geochemical and geophysical data to produce a composite geothermal prospect map.

Deliverables include:

- Composite prospect maps

- Curie point data as isotherm and gradient contour maps

- Residual aeromagnetic contour maps

- Bouguer gravity maps

- Enhanced Landsat images

- Location maps
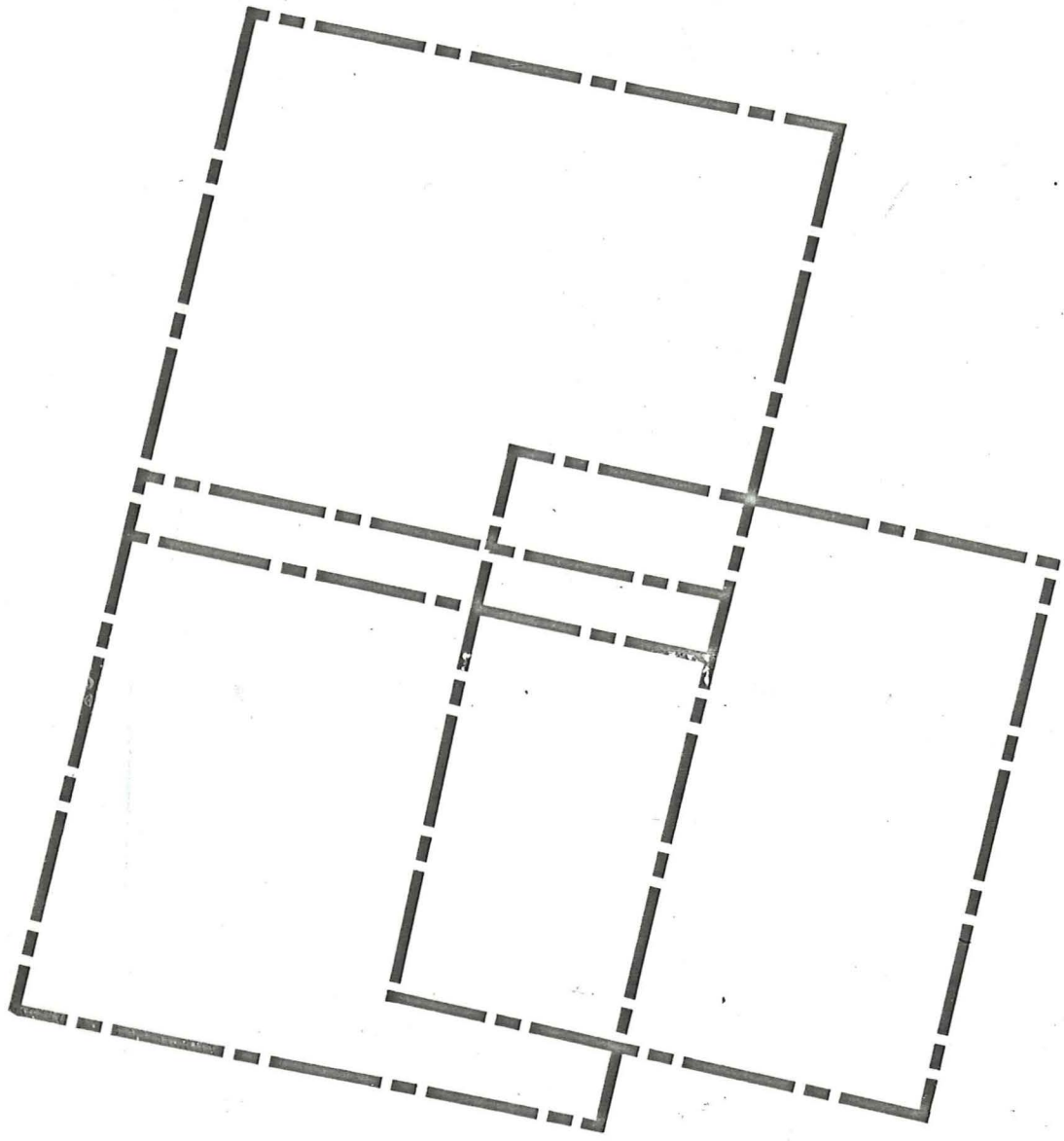
- Interpretive final report

The price to early subscribers is $22,000 for the complete study, and $13,500 for either the northern or southern half.

INTRODUCTION

Eureka Resource Associates, Inc. proposes to map the depth to the Curie point isotherm of a region in northwestern Nevada (Figure 1) that is of interest to geothermal companies. The location of shallow Curie point depths, regions of high estimated temperature gradient, will be identified and analyzed along with enhanced Landsat imagery, regional gravity and available published geologic and geophysical data for prospective geothermal targets. The work will be presented in two parts: (1) Reno Area; and (2) Winnemucca Area, with plates and maps presented at a scale of 1:192,000.

The project areas encompass more than 21 KGRA's and are currently the focus of extensive exploration, with discoveries by Phillips Petroleum at Desert Peak and Imlay (Figure 2). Four of the KGRA's (Stillwater-Soda Lake; Gerlach NE; Fly Ranch, Trego; and Fly Ranch NE) are presently scheduled for competitive lease sales on September 26, 1978.

The objective of the project is to furnish clients with data showing where the Curie point isotherm comes closest to the surface, and to evaluate the isotherm, together with other data that are indicative of a geothermal prospect. An estimated temperature gradient profile, based on the Curie point temperature of rocks in place (approximately 500°C), will provide information to a greater depth, on a much greater volume of rock, than conventional temperature gradient measurements. While not an absolute determination, the Curie point isotherm provides relative depths and useful qualitative data as to the lateral variation in temperature gradients. In past surveys, shallow Curie point depths have led some clients to acquire new land positions and conduct follow-on exploration of promising geothermal targets not previously considered.

PROJECT AREA

CURIE SURFACE

TIE LINES

KGRA

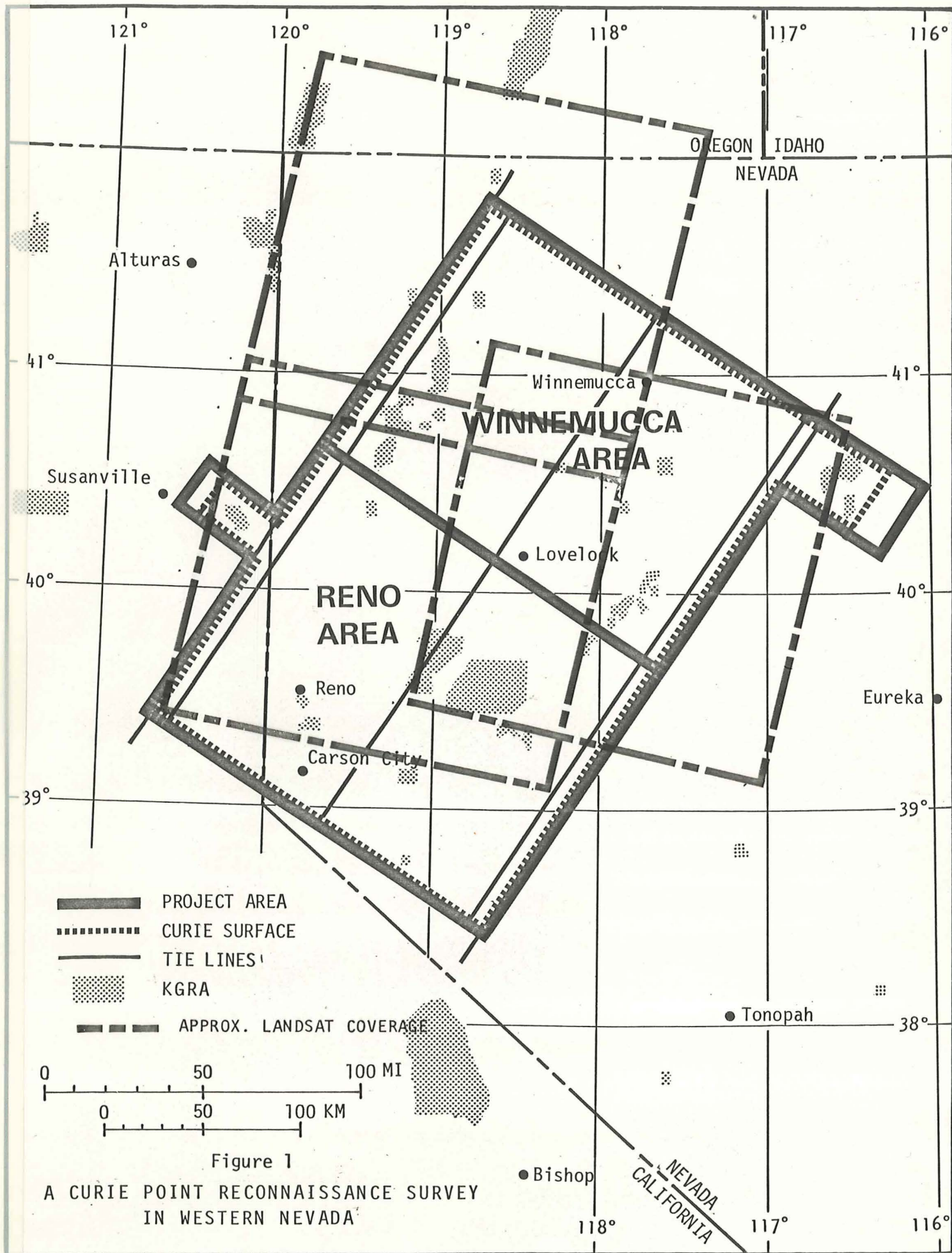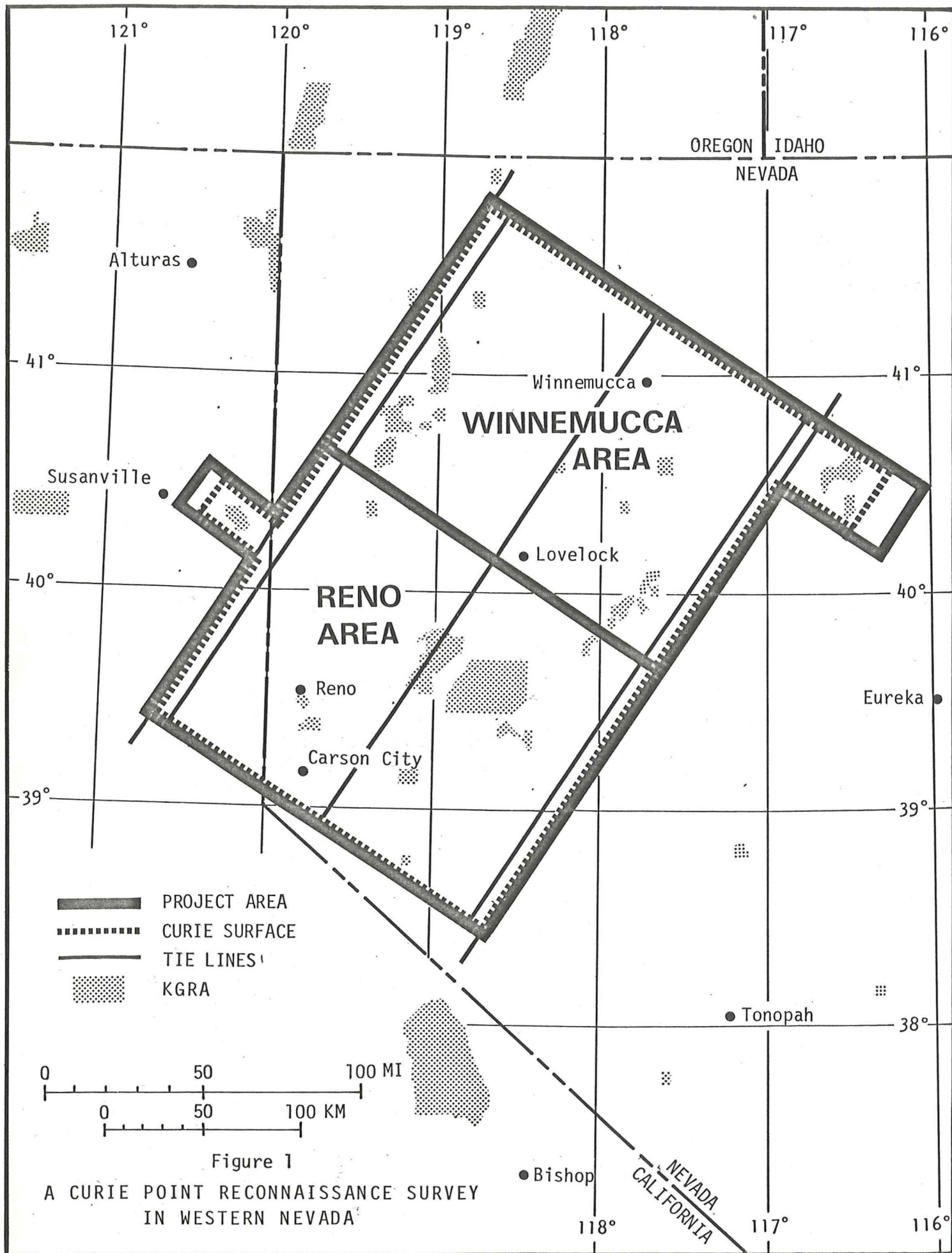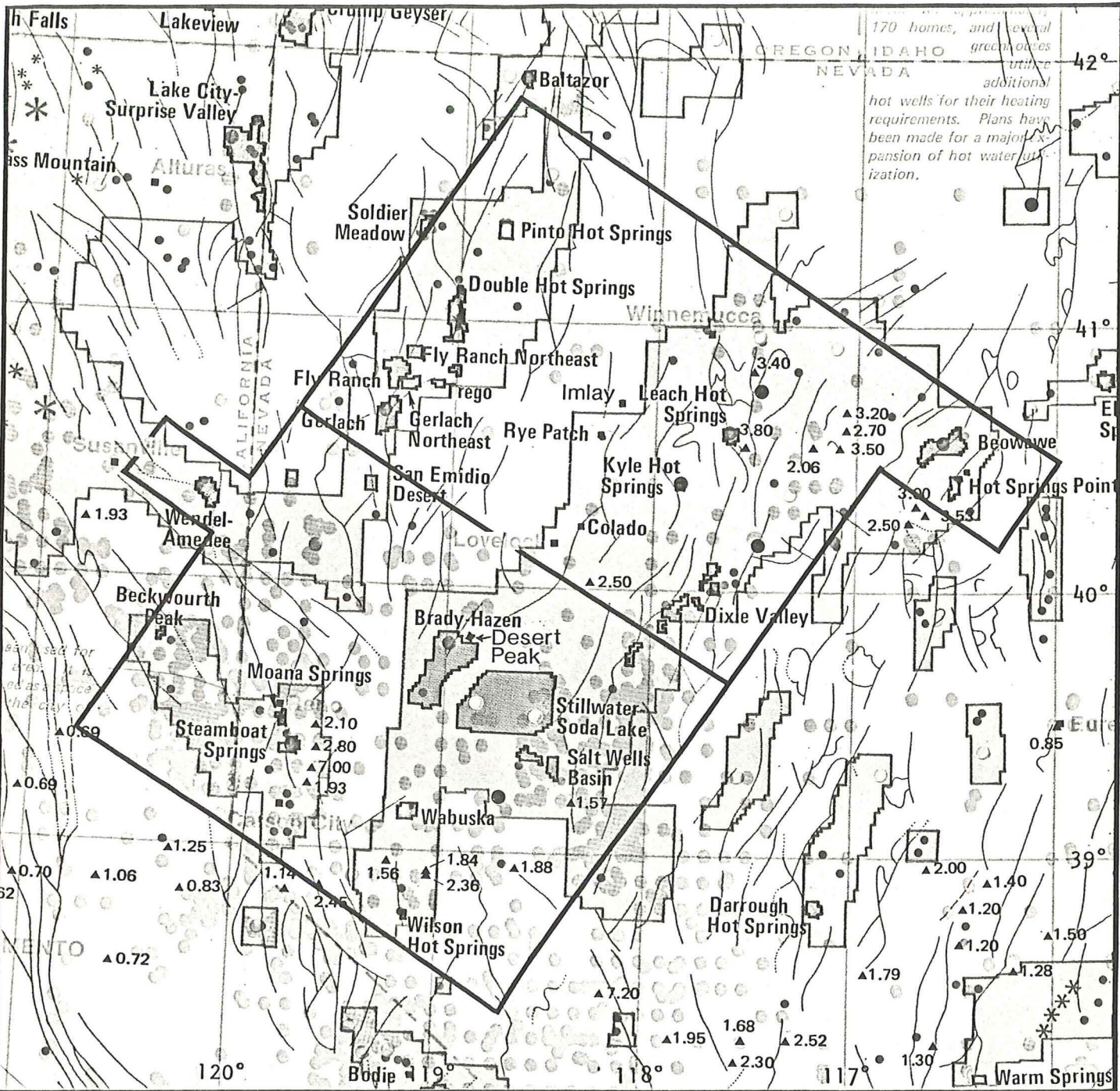**APPROX. LANDSAT COVERAGE**
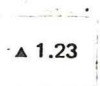
0   50   100 MI

0   50   100 KM

Figure 1

A CURIE POINT RECONNAISSANCE SURVEY
IN WESTERN NEVADA

WINNEMUCCA AREA

RENO AREA

OREGON IDAHO
NEVADA

Alturas

Winnemucca

Susanville

Lovelock

Reno

Carson City

Eureka

Tonopah

Bishop

NEVADA
CALIFORNIA

Figure 1

A CURIE POINT RECONNAISSANCE SURVEY
IN WESTERN NEVADA

Figure 2

GEOTHERMAL RESOURCES
IN PROJECT AREA

0   50   100 Mi
0   50   100 Km

This map reproduced from "Geothermal Energy Resources of the Western U.S.", N.O.A.A., Boulder, Colorado, 1977, Scale 1:2,500,000.
See original for data sources, greater legend detail and thermal hot springs locations.

Legend:
- Castle Creek — Known Geothermal Resources Areas (KGRA)
- Prospective Geothermal Resources Areas
- Major Faults
- Earthquake epicenters
- ▲1.23 Heat flow locations and values (given in microcalories/cm²-sec).

Eureka will endeavor to have the aeromagnetic, Curie point and estimated temperature gradient data compiled before the September 26, 1978 competitive KGRA lease sales.

APPROACH

Eureka has designed a program that will cover the western portion of the Battle Mountain heat flow areas (Sass et al., 1971). This region is characterized by higher than normal heat flow measurements (2.50 to 3.50 HFU). Furthermore it is the location of two recent geothermal discoveries by Phillips Petroleum Company. Figure 2, taken from "The Geothermal Energy Resources of the Western United States" (Clark et al., 1977), was used as a guide to design the survey. Within the boundaries of the study area are at least 21 KGRA's, including Beowawe and Hot Springs Point in the northeast; Wendel-Amedee; Fly Ranch in the northwest and Wilson Hot Springs in the southwest.

Aeromagnetics

The project area is approximately 208 km by 320 km (130 mi by 200 mi) and covers 66,650 sq km. Fifty northwest-southeast flight lines, each 208 km long, plus five tie lines 320 km long, will be semi-drape flown at approximately 320 m (1000') above terrain to minimize topographic effects. The flight lines are nearly perpendicular to the major fault systems. The tie lines are located to maximize the Curie point surface coverage on the ends of the flight lines where approximately 18 km (11 mi) are normally lost due to mathematical operator size.

The airborne survey data will be closely monitored and corrected for diurnal changes to ensure that the geomagnetic variations are due solely to

spatial variations within the crust. A one-gamma resolution magnetometer in the aircraft will sample twice a second. Another one-gamma base station magnetometer, with analog recorder, will be set up in the center of the flight area to monitor diurnal variations. Magnetic and altimeter (radar and barometric) data will be recorded on both analog and digital recorders.

Curie Point Depths

The depth to the Curie temperature in the crust will be calculated along each profile. In calculating the Curie point depth, we assume that the crust becomes non-magnetic at the depth where the temperature reaches about 500°C; at shallower depths the crust retains its magnetism. Hence, the Curie depth is calculated by estimating the thickness of the magnetic crust in the following manner:

(1) Calculating the centroid depth location of the bodies causing anomalies along the profile.

(2) Calculating the average depth to the top of the same bodies

(3) Assuming that the magnetic crust is symmetrical about its centroid. The method, essentially that of Bhattacharyya and Leu (1975), has been described in detail by Erskine (1976); a copy of Dr. Erskine's report is available. A modification of that method for profile analysis will be used in this project.

A contour map of the estimated depth (in km) to the Curie point isotherm will be furnished on a transparent overlay (scale 1:142,000).

Temperature Gradients

An estimated temperature gradient contour map will be constructed from the Curie point depth data, based upon the assumption of a Curie temperature

of 500°C and a mean surface temperature. These data, expressed in terms of C°/km, will give a gradient averaged over a much greater temperature and depth range than temperature gradients collected from shallow drill holes where near surface geothermal aquifers can bias the results.

Eureka will make its best effort to deliver preliminary Curie point and estimated temperature results prior to the scheduled September 26, 1978 competitive KGRA lease sales.

Landsat Imagery

Three digitally enhanced Landsat images covering approximately 75 per cent of the project area (Figure 1), each at a scale of 1:192,000 or 1" = 16,000', will be furnished. They will be used to make the final interpretation for those locations of high temperature gradients. These images will be provided to clients for their own use as soon as they are available.

Bouguer Gravity Contour Map

A Bouguer gravity contour map based on published values will be generated by computer/machine gridding and contouring techniques. This transparency will be used in the interpretation of the high temperature gradient areas and can be overlain directly on the Landsat imagery.

Interpretation

The final interpretation of all the data, emphasizing the shallow Curie depth (high temperature gradient) locations, will be presented in a seminar to be held in Berkeley. At that time each client will receive an interpretive project report, a composite prospect map delineating the best prospect areas, and all other supporting data.

DELIVERABLES, PRICES AND TERMS

It is anticipated that the project will be completed within approximately four months from start-up. Preliminary results of Curie point isotherms and estimated temperatures for one of the two areas, Reno or Winnemucca, will be made available, if possible, prior to the competitive lease sales. Should one area receive more support than the other, we will begin with that area of greater interest. The final results will be presented in a seminar in Berkeley.

The following data will be presented and delivered to each participant. Maps will be presented at a scale of 1:192,000 (1" = 16,000').

- Composite prospect map (highlighting shallow Curie depths, but containing other supporting geologic and geophysical data)

- Curie point isotherm contour map

- Estimated temperature gradient contour map

- Filtered residual aeromagnetic contour map

- Bouguer gravity map

- Two digitally enhanced Landsat images (three for clients subscribing to both areas

- Base map showing Ranges, Townships and Sections

- Two copies of the final report

The price of the complete project is $22,000 for clients who subscribe prior to project completion. The cost of either the Reno or the Winnemucca Areas is $13,500.

After completion of the study and presentation of results, the price will be $26,000 for the complete project and $15,500 for either the Reno or the Winnemucca Areas separately. Enhanced Landsat images covering the remaining 25% of the project area and beyond can be purchased for $1100.00 each.

Terms are 50% of price payable at time the order is placed, and 50% payable within 30 days after delivery of the final report.

Subscribers will warrant that they will not give, sell, reproduce or disclose any information from the Reconnaissance Survey of Western Nevada project to non-subscribing parties without express written permission of Eureka Resource Associates, Inc.

REFERENCES CITED

Bhattacharyya, B. K. and Leu, L., 1975, Spectral analysis of gravity and magnetic anomalies due to two dimensional structures. *Geophysics*, vol. 40, no. 6, pp. 993-1013.

Erskine, M. C., Jr., 1977, Determination of Curie point depths from aeromagnetic data. *Research Report, Eureka Resource Associates, Inc.*, 2161 Shattuck Ave., Berkeley, California 94704, pp. 1-23. Unpublished.

Grim, P. J., Clark, J. M., Morris, L. D., 1977, *Geothermal Energy Resources of the Western United States, Scale 1:2,500,000*. Nat. Geophys. and Solar-Terrestrial Data Center, Environmental Data Service, NOAA, Boulder, Colo. 80302.

Sass, J. H., Lachenbruch, A. H., Munroe, R. J., Greene, G. W., and Moses, T. H., 1971, Heat flow in the western United States. *Journal of Geophysical Research*, vol. 76, no. 26, p. 6376-6413.