COMPILATION OF A GEOTHERMAL EXPLORATION GUIDE MAP OF SURPRISE VALLEY, CALIFORNIA BASED ON AEROMAGNETICS, ERTS IMAGERY, AND PUBLISHED DATA

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Introduction

The recent interest shown by the large number of noncompetitive lease applications on federal land in Surprise Valley has brought to our attention the lack of regional geological and geophysical data needed for proper interpretation and evaluation of landholdings in this critical area.

Aeromagnetics combined with a tectonic interpretation from 1:250,000 color composite enlargements of Earth Resources Technology Satellite (ERTS) imagery is a very cost-effective way to evaluate large areas for basement topography and surface faulting. The cost of having individual companies contract for separate aeromagnetic surveys is both expensive and redundant. Often insufficient coverage is obtained to construct a regional geothermal model.

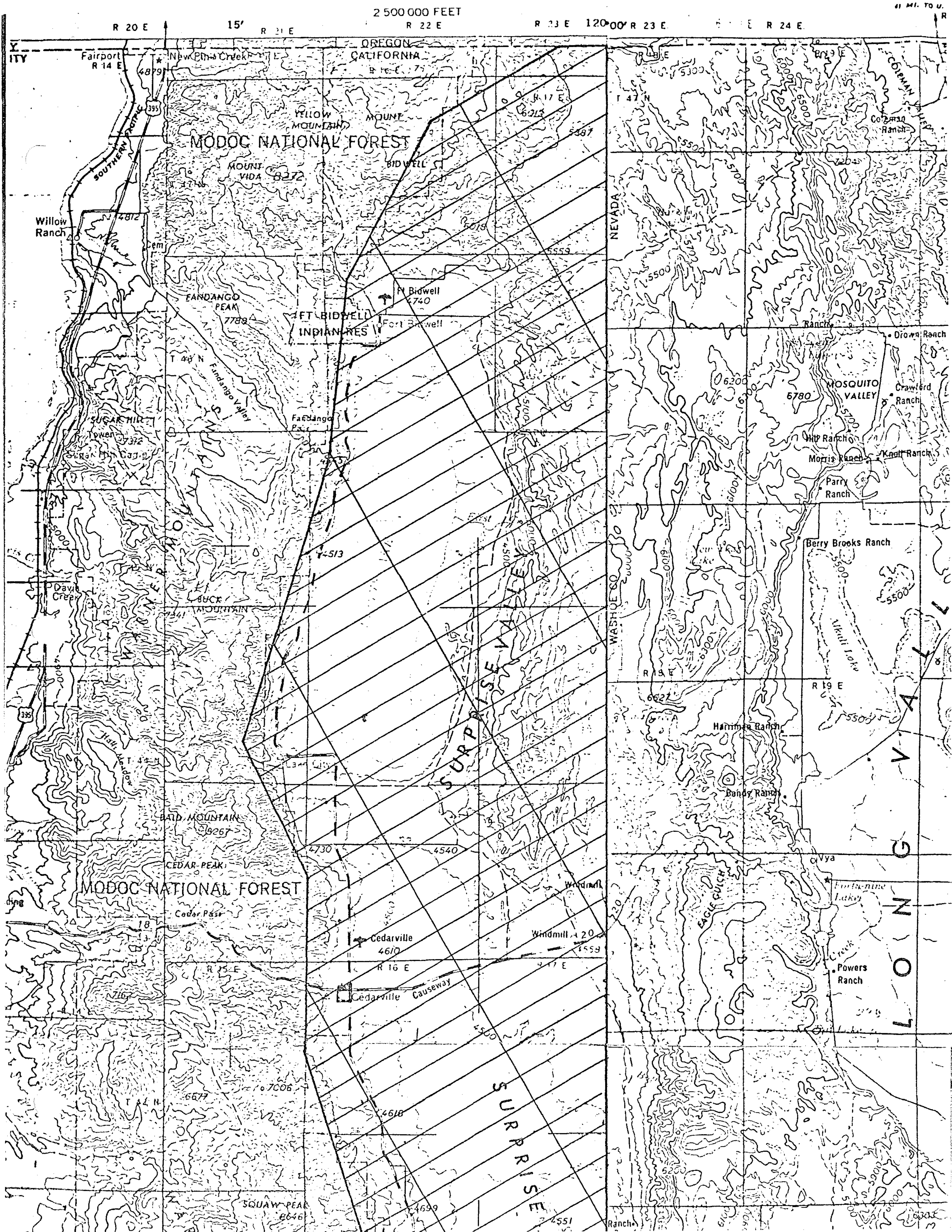
Earth Satellite Corporation (EarthSat) has spoken with a number of geothermal companies (American Thermal Resources, Eason Oil, Gulf Minerals Resources, Mobil Oil, Standard Oil of California, Union Oil) that have expressed interest in receiving a proposal for an aeromagnetic and ERTS interpretation for potential geothermal energy in Surprise Valley.

Approach

EarthSat would contract to have 700 line miles of aeromagnetics flown in Surprise Valley over an area of approximately 500 square miles that lies in the northeast corner of California (Figure 1). The survey is designed to have one mile flight line spacing at an azimuth of N60°E, a direction that makes strong angles with both the N-S and the NW faults that transect the Warner Mountains and Surprise Valley. These strong angles will best define structures and structural location and aid greatly in the interpretation. The tie-line spacing at five mile intervals will help both in profile analysis and in contouring the total intensity data that will be presented at a scale of 1:62,500. The survey will be flown at a 1,000 foot terrain clearance (drape flying) with the magnetic and radar altimeter data being recorded on both analog and digital recorders. The survey will be flown by a reputable survey contractor that has many years of aeromagnetic surveying experience for mining companies and the USGS. Depending upon price and availability of aircraft, we will select one of the following contractors: Aerial Surveys Limited, Airborne Geophysics, or Geometrics. All of these contractors use fast sampling proton magnetometers with 1 or 0.5 gamma resolution.

The total intensity aeromagnetic and filtered contoured maps will be on stable transparencies (mylar) that overlay to the USGS 15° quadrangle topographic maps (scale 1:62,500). The filtered contour map will accentuate lower frequency anomalies. The filtering will remove surface effects (high frequency) from deeper ones and will be helpful in trying to identify intrusives that underlie thin surface volcanics. The aeromagnetics will be photographically reduced at scales of 1:250,000 and 1:125,000 for direct correlation to an ERTS color composite image.

A Geothermal Exploration Guide Map of Surprise Valley will be compiled and will incorporate the following published data: hot spring locations (Waring, 1965; Duffield and Fournier, 1974), Bouguer gravity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OREGON
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4879
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SOUTHERN PACIFIC
YELLOW MOUNTAIN
MOUNT
MODOC NATIONAL FOREST
MOUNT VIDA
8372
BIDWELL
6015
5587
T 47 N
Coleman Ranch
COLEMAN VALLEY
Willow Ranch
4812
5019
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NEVADA
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7204
FANDANGO PEAK
7788
Ft Bidwell
4740
FT BIDWELL INDIAN RES
Fort Bidwell
T 46 N
Fandango Valley
Ranch
Drown Ranch
6200
MOSQUITO VALLEY
6780
Crawford Ranch
SUGAR HILL
Tower
7372
Sugar Hill Cabin
Fandango Pass
WARNER MOUNTAINS
Hill Ranch
Morris Ranch
Knoll Ranch
Parry Ranch
5000
4513
Berry Brooks Ranch
Davis Creek
BUCK MOUNTAIN
WASHOE CO
6000
6300
5500
SURPRISE VALLEY
Mud Lake
R 19 E
6627
Harriman Ranch
Hell Meadow
T 44 N
Lake City
Bandy Ranch
BALD MOUNTAIN
8267
4730
4540
LONG VALLEY
CEDAR PEAK
Vya
MODOC NATIONAL FOREST
Windmill
EAGLE GULCH
Cedar Pass
18
Windmill
Cedarville
4610
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Powers Ranch
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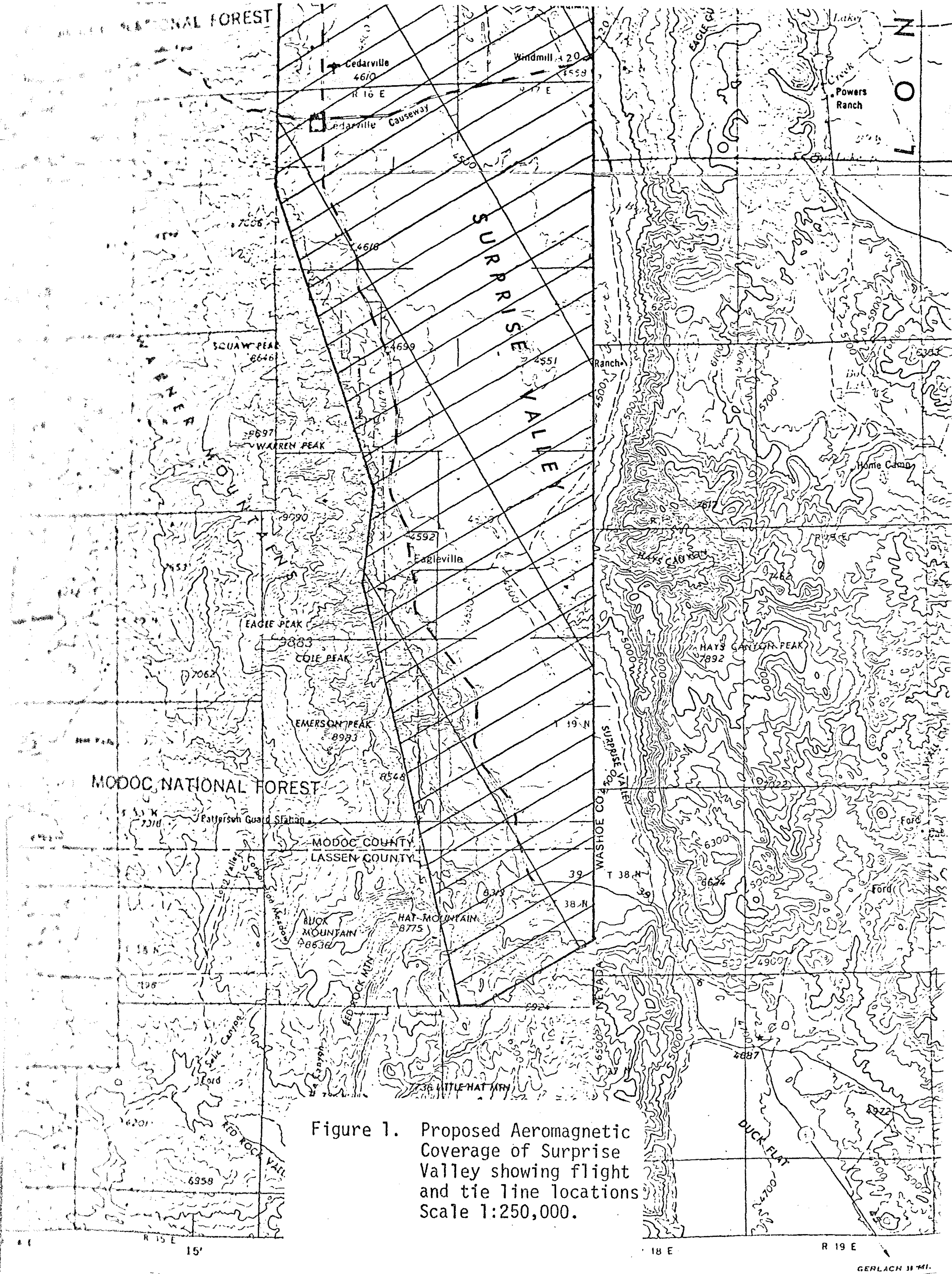


Figure 1. Proposed Aeromagnetic Coverage of Surprise Valley showing flight and tie line locations Scale 1:250,000.

and geology map (Chapman, 1968), groundwater investigational data (California Department of Water Resources, 1963), in addition to the structural interpretation from ERTS imagery and aeromagnetic data.

The "Areal Geology, Surprise Valley Groundwater Basin" Map, scale 1:125,000 (California Department of Water Resources, 1963) will be used as a base map for this composite interpretation map.

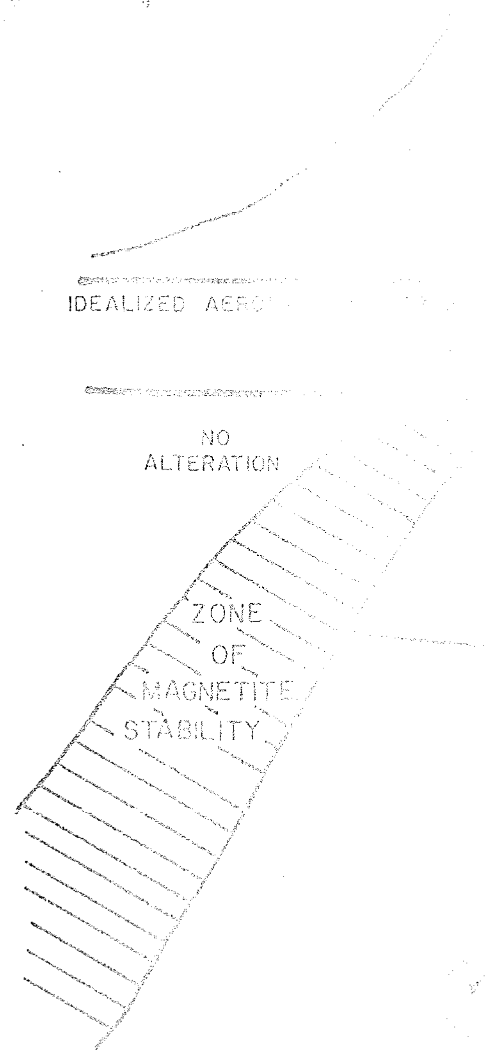
Accompanying the maps will be an interpretational report that will be presented at a one day seminar in Berkeley for all the companies.

Geothermal Model

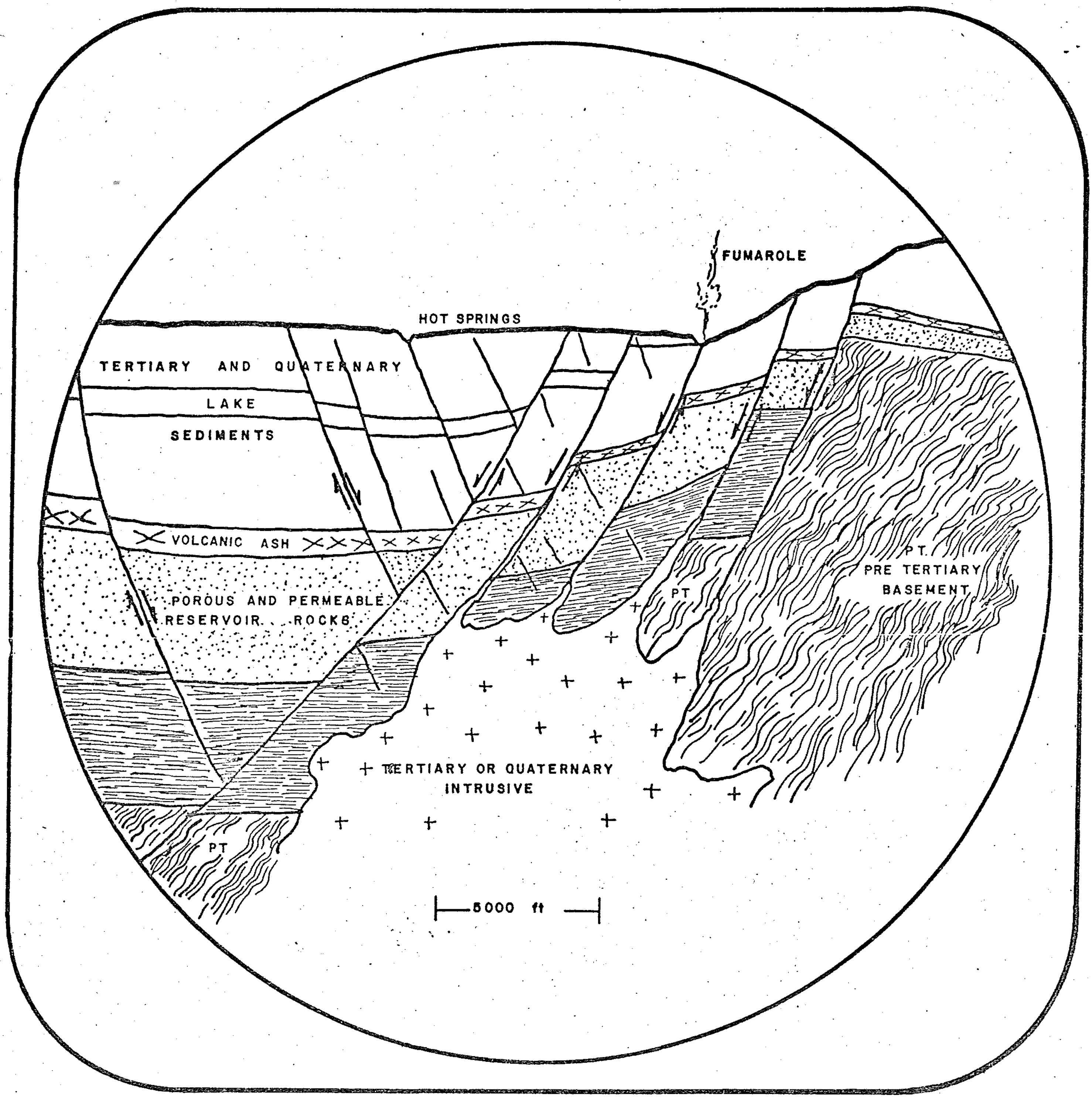
White and McNitt (1969) classify geothermal reservoirs into two types: (1) those with permeable extensions to the surface permitting escape of thermal fluids as hot springs and fumaroles, and (2) deep, insulated reservoirs with capping rocks of low permeability and little or no surface expression. Gradations exist between extremes of the two types. Surprise Valley with its numerous hot springs is evidence of the first of these reservoir types and their permeable extensions (faults). The synoptic view and regional scale of ERTS imagery will enable the mapping and extension of many of these faults that act as conduits for geothermal reservoirs, while aeromagnetics can possibly help in locating the heat source for both types of reservoirs. It has been our experience that ERTS imagery makes it possible to identify many faults that have not been previously mapped by conventional field and photogeology procedures. In many cases when hot springs are mapped on a transparency overlay to the imagery they fall on these faults, or at the intersection of faults and circular features. These circular features, ranging in diameter from 3 to 15 miles, are attributed to doming, collapse, or resurgence of igneous activity. Also structural features observed on ERTS such as ring dikes, radial, and concentric fractures associated with the Modoc Plateau mafic volcanic centers (Duffield and Fournier, 1974) and their flows just west of Surprise Valley can be mapped and classified using Smith and Bailey's (1969) Table of Geologic Events of the Resurgent-Cauldron Cycle.

ERTS winter- or early springtime imagery--with the combination of low sun angle, light snow cover, and lack of vegetation cover on black-and-white prints utilizing channel 7 (0.8 to 1.1 μm)--produces imagery that best displays and enhances the regional structure and will be used along with summertime color composites (channels 4, 5, and 7, or 0.5 to 1.1 μm bandwidth of the electromagnetic spectrum) in tectonic interpretations.

The heat source for geothermal reservoirs can be considered roughly as an incipient volcano or one that never fully developed. Figure 3 shows an idealized model of a geothermal system with an intrusion which is the local heat source at depth (approximately two miles) that has risen until it reaches a pressure equilibrium with the intruded rocks (Brewer, et al., 1972). Geothermal models with different versions and modifications e.g., Facca and Tonani's (1967) self-sealing geothermal field, White's (1965) discussion of mud volcanoes due to sudden release of energy stored in near-surface hydrothermal systems, and Banwell's (1963) critique on high-temperature systems, all attribute the heating of the thermal waters to near-surface igneous (magma chamber) activity. The overlay (Figure 2) to Figure 3 shows an idealized aeromagnetic profile across the intrusion (heat source). This model is similar to that of Jerome's (1966) for a "typical" porphyry copper deposit that undergoes magnetite destruction in the oxide front. The zone of magnetite stability shows as two positive anomalous peaks on either side of the alteration low.


IDEALIZED AERO
NO ALTERATION
ZONE OF MAGNETITE STABILITY

EXPLORATION AND DEVELOPMENT FOR GEOTHERMAL RESOURCES



IDEALIZED GEOLOGIC CROSS SECTION OF A GEOTHERMAL AREA

Figure-3

McNitt (1963) also reports of magnetic lows over thermal areas due to the hydrothermal alteration of magnetite to pyrite; this has also been the experience of EarthSat geophysicists and mining geologists when interpreting aeromagnetic data of geothermal areas. The model shown has symmetrical magnetite anomalies on both sides of the intrusion, whereas aeromagnetic data over varying geologic conditions produces one-sided and nonsymmetrical anomalies that are often hard to interpret due to overlying volcanics or low magnetic susceptibility contrasts between the intrusion and parent rock. The filtering and depth-to-basement techniques to be applied to the magnetic data will help in the geological interpretation.

Pricing

The price will be $5,000 for each subscriber and we will need at least four orders before we will undertake the project. If we get five or more subscribers, we will fill in the missing gravity stations to a density of about one per square mile along the eastern side of Surprise Valley and recontour the data for this area on the State of California Bouguer Gravity Map for the Alturas sheet (Chapman, 1968) and use these new data in our interpretation. One set of the maps, ERTS imagery, and final report will be delivered to each client. Formatted aeromagnetic digital tapes will be supplied at cost if desired.

Clients will not give, sell, reproduce, show, or disclose any information from this EarthSat Surprise Valley project to other non-subscribing parties.

Schedule

In the interest of timely results EarthSat would like to hear of your interest by telephone as soon as possible, hopefully within two weeks of receiving this proposal. We will proceed to contract for the aeromagnetic survey as soon as we have received four letters of commitment. We feel that we can present the final results at a seminar here in Berkeley six weeks from that date.

We would expect to receive from your company $2,500.00 upon notice from EarthSat that the program is proceeding and the second $2,500.00 upon presentation of our final report.

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