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A GEOTHERMAL EXPLORATION PROGRAM

IN THE

CASCADE RANGE, OREGON

P-8100

February 1979

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INTRODUCTION

Eureka proposes a comprehensive study of a portion of the Cascade Range (Figure 1) for mapping geothermal prospects.

Using reconnaissance geological and geophysical data and skills developed in the search for targets in poorly mapped areas, experienced geothermal interpreters will produce tectonic and composite prospect maps of a 40,000 sq km (15,650 sq mi) area (Figure 1). There are five KGRA's within the area, three of which have been scheduled for competitive lease sales in July 1979 and 1980. The objective of this study by Eureka is to help in the evaluation of the KGRA's and to locate other possibly attractive geothermal targets.

Thick vegetation cover, steep topography, and the absence of rock outcrops in the Cascade Range have limited geologic mapping and made ground geophysical exploration difficult. Therefore the use of digitally enhanced Landsat images, aeromagnetics, Curie point isotherm determinations, in combination with available geophysical and geological data, is very cost effective and helps develop a uniform data base with which to evaluate and rate prospect areas.

The project is designed and priced for group participation at a cost of $21,000 for the entire area. However, to assist those with limited land positions or budget restrictions, the project has been divided into three separate areas, any one of which may be purchased separately.

GEOLOGIC SETTING

The geology of the Cascade Range has not been studied in any great detail, mostly due to the rugged relief, poor rock exposure and heavy vegetation. The Cascade Range has been estimated to have a total volume of over

25,000 cubic miles of calc-alkalic volcanic rocks. Volcanic activity began 40 million years ago and has continued up to the present, with radiometric age dates as young as 1,300 years within the caldera of Mt. Newberry and even more recent volcanic eruptions (1800 A.D.) at Mt. Hood (Peck et al., 1964).

The Range is comprised of two physiographic divisions: the Western Cascades, which include a wide, deeply dissected belt of volcanic formations, makes up the western slope of the range; and the High Cascade Range, which includes chiefly younger cones and lava flows, forms the less eroded crest of the Range.

Hot springs are concentrated in the volcanic rocks of the Western Cascades along a line close to the surficial junction of the ranges (Peterson and Youngquist, 1975). Five KGRA's in the project area (shown in Figure 1) have been defined based on surface manifestations ranging from recent ash eruptions (1800 A.D.), to active hot springs with subsurface temperatures of 150°C (Rosenfeld and Schlicker, 1976; Peterson and Youngquist, 1975).

APPROACH

Aeromagnetics

Eureka will obtain aeromagnetic data along 3540 km (2200 line miles) of flight line in three separate east-west elongate areas covering five of the major KGRA's in the Cascade Range (Figure 1). Within each area, data will be collected at 0.25 gamma resolution along flight lines 100 to 120 miles long and spaced three miles apart. These lines will be semi-drape flown at an elevation of 2000 feet above terrain to minimize topographic effects. Aeromagnetic and altimeter data will be recorded in both digital and analog form.

Magnetic field data collected at a fixed base station will be used to monitor diurnal variations during flying, and will later be used to correct the aeromagnetic data for these changes. A north-south tie line will be flown to aid in tieing the individual flight lines.

The aeromagnetic data coverage to be flown will be combined with published aeromagnetic data from various sources, to provide the data for a structural interpretation used in compiling the tectonic map. Eureka's proprietary data will be used for Curie point determinations as well.

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

(2) Calculating the average depth to the tops 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 1:250,000).

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.

Bouguer Gravity Contour Map

A Bouguer gravity contour map based on approximately 2,400 published gravity values will be generated by computer-machine gridding and contouring techniques. This transparency, which can be overlain directly on the Landsat imagery, will be used in the preparation of the tectonic and composite prospect maps.

Tectonic Map

Eureka will make a tectonic map (scale 1:250,000) encompassing the entire survey area, with special attention delegated to the three areas outlined in Figure 1 (only that portion of the tectonic map in and adjacent to each area will be included as a deliverable). Two color composite, enhanced Landsat images and high altitude color IR photographs will be used to map major geologic structures, as well as structures that are suggestive of possible near surface magma chambers.

Pattern recognition features, such as radial and circular faults, vents, and recent volcanic flows, will also be used in mapping prospective targets onto the composite prospect map.

In addition to the imagery and photographic interpretation, geologic mapping done by other investigators, such as Wise (1968), Peck (1964) and Williams (1957), will be used in the construction of the composite tectonic map. By using Landsat imagery as a base, we can arrive at a uniform geologic interpretation and eliminate boundary mismatches often created by consolidating the work of many investigators. The gravity and aeromagnetic maps described above will provide additional structural information. Lastly, the most recent NGSDC earthquake data file will be used to map epicenter locations within the survey area, thus giving evidence of ongoing tectonic activity.

Composite Prospect Map

Final interpretation of the data discussed above, with particular emphasis on the composite tectonic and the Curie depth maps, will take the form of a composite geothermal prospect map for each of three survey areas. We feel that the data sources discussed above, in conjunction with radiometric age data and utilization of the USGS GEOTHERM computer data bank to provide location, temperature, flow rate, geochemical and drill hole data on hot springs and geothermal wells in the area, should make possible a nearly complete reconnaissance geothermal prospect map to use as a guide in evaluating prospects in the area.

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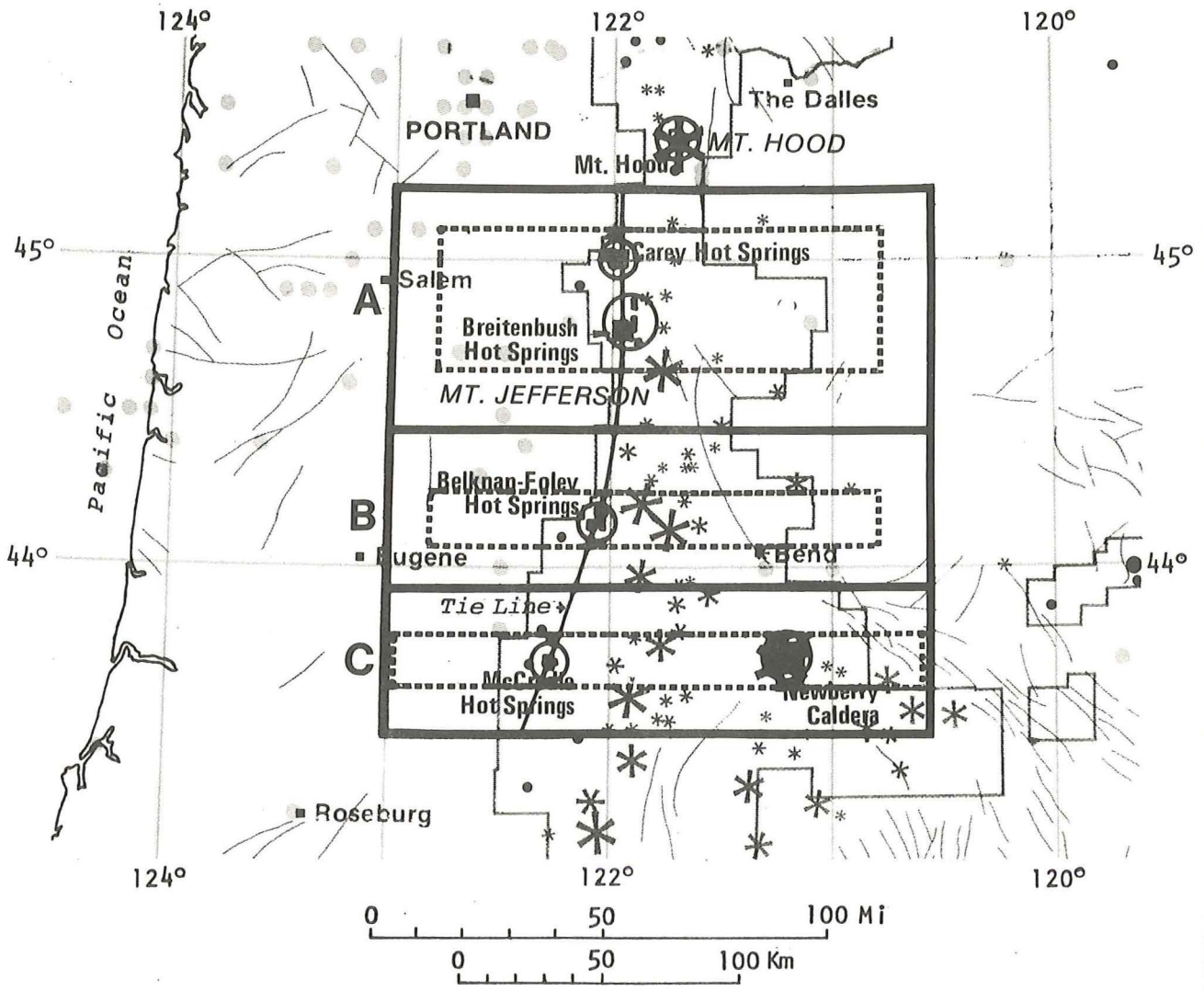

Figure 1

PROJECT AREA

Regional Study Areas

Detailed Aeromagnetic and Tectonic Study Areas

Castle Creek — Known Geothermal Resources Areas (KGRA)

Prospective Geothermal Resources Areas

Thermal Springs

Volcanoes and Volcanic Cones of Quaternary and Tertiary Age

Earthquake Epicenters

Major Faults

Map reproduced from 'Geothermal Energy Resources of the Western U.S.', N.O.A.A., Boulder, Colorado, 1977. Scale 1:2,500,000.

Eureka No. 8100

DELIVERABLES, PRICES, AND TERMS

The following data will be presented and delivered to each participant. All maps and images will be at a scale of 1:250,000. Subscribers not participating in all three areas will receive maps and images covering only the survey area(s) requested, as indicated on Figure 1.

- Contour map of depth (km) to the Curie point (500°C) isotherm (transparency)
- Contour map of thermal gradient (°C/km) between the surface and the Curie point isotherm (transparency)
- Contour map of filtered residual, diurnally corrected total magnetic field (gammas)
- Composite geothermal prospect map
- Tectonic map
- Contour map of simple Bouguer gravity anomaly (transparency)
- Base map showing ranges, townships, and sections
- Two digitally enhanced Landsat images
- Two copies of the final report

The price of the complete project will be $21,000 for clients who subscribe prior to April 1, 1979.

The prices to participate in one of the following three sub areas is:

Area	Flight Line Length (mi)	Price
A. Breitenbush-Carey	1100	$17,000
B. Belknap-Foley	500	10,000
C. McCredie-Newberry	600	12,000

Those purchasing portions of the total project will receive their copies of the deliverables and report at the same time as those participating in the entire study, but they will not be invited to attend the initial presentation at which the whole project area will be discussed. They are, however, invited to arrange a presentation at a later time.

It is anticipated that the project can start in March 1979 if two subscribers commit in that month. The project completion date would be dependent upon weather conditions and could be as early as June 1979; however, to assist clients in evaluating their land positions, Eureka can deliver a preliminary tectonic map and the Landsat imagery before the other deliverables.