TELEX. 45-556

AMAX EXPLORATION, INC.
A SUBSIDIARY OF AMAX INC.
4704 HARLAN STREET • DENVER, COLORADO 80212 • (303) 433-6151

October 8, 1976

Mr. Miles Reynolds, Jr.
Vice President
Austral Oil Company, Inc.
2700 Exxon Building
Houston, Texas 77002

Re: Waunita Hot Springs
Gunnison County,
Colorado

Dear Mr. Reynolds:

I am returning seismic data on Waunita Hot Springs which you loaned us on October 8, 1976.

Thank you for letting us see them.

Sincerely,

Arthur L. Lange, IV

Arthur L. Lange

ALL:d

AUSTRAL OIL COMPANY
INCORPORATED

2700 Exxon Building Houston, Texas 77002

(713) 228-9461
cable-AUSTROIL

October 28, 1975

AMAX Exploration, Inc.
4704 Harlan Street
Denver, Colorado 80212

Attention: Mr. Arthur L. Lange

Re: Waunita Hot Springs
Gunnison County,
Colorado

Dear Mr. Lange:

We enclose copies of the Senturion Science micro-earthquake and ground noise survey reports for Waunita Hot Springs. In addition, we have requested John Bailey at Senturion to forward the original tapes from the 1974 detailed survey for your examination. The original tapes of the 1971-72 reconnaissance survey are being shipped from this office. Please return both sets of records to this office.

Yours very truly,

Miles Reynolds, Jr.

Miles Reynolds, Jr.
Vice President

MR,Jr/js
Enclosures

AMAX EXPLORATION, INC.
4704 HARLAN STREET • DENVER, COLORADO 80212

INTER-OFFICE MEMORANDUM

SUBJECT: Microearthquake Reconnaissance
Waunita

DATE November 7, 1975

TO: W. M. Dolan, H. J. Olson,
F. Dellechaie, M. H. Alldredge

FROM: A. L. Lange

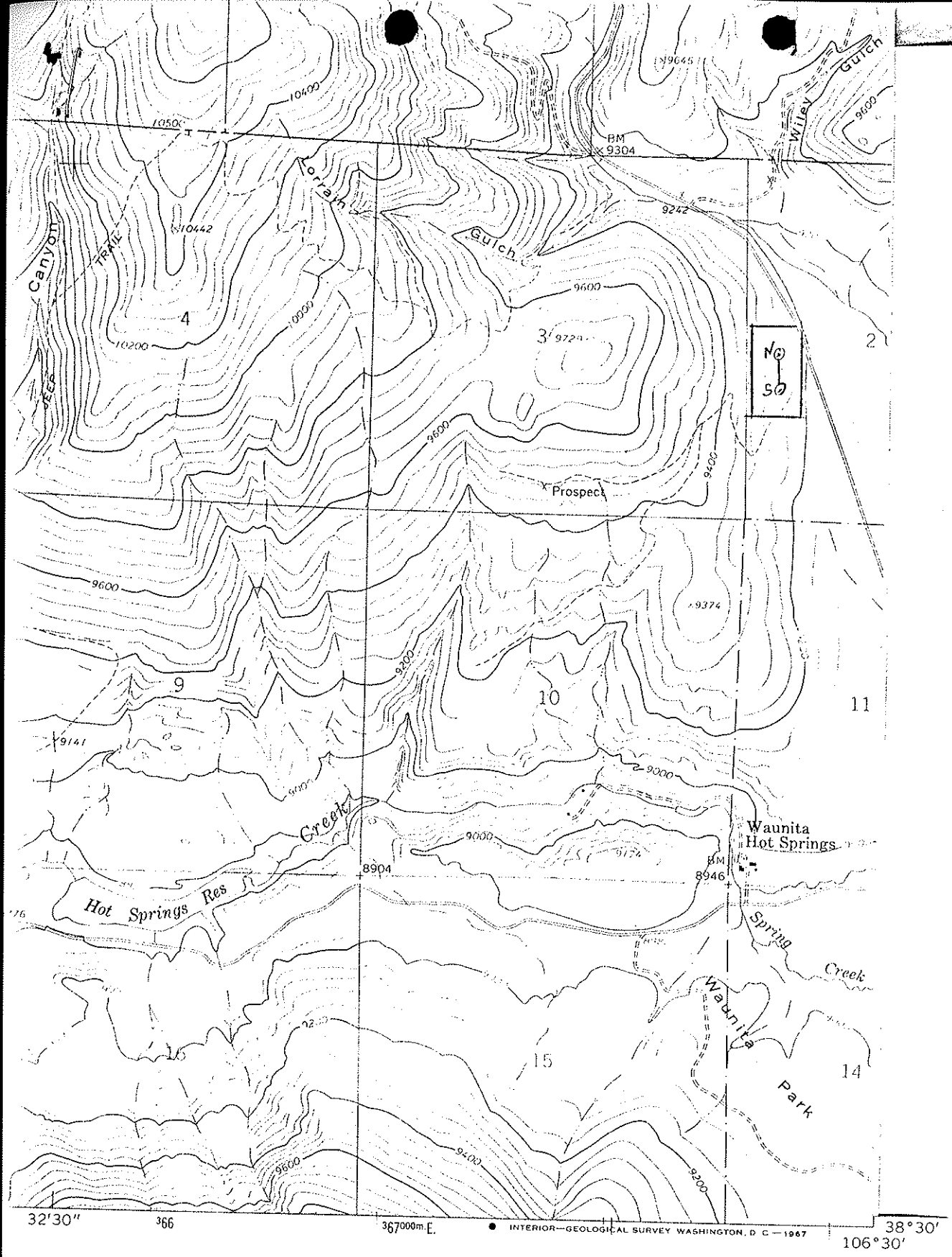
A reconnaissance study using 2 MEG-800's was conducted during the three days, 20-22, October, 1975. The stations shown on the accompanying map were selected on the basis of a microearthquake swarm center mapped by Senturion in 1973 (?).

Our study disclosed no local events. The fact that Senturion's second survey in 1974 resulted in no events from this center suggests either a) swarming; or b) misidentification or mallocation.

Despite the apparent evanescence, I feel that seismicity will be established at Waunita. To do so, I propose a longer period of monitoring using stations on volcanic rock of Tomichi Dome or associated dikes. Special care needs to be taken to maximize signals.

Arthur L. Lange
A. L. Lange

ALL/c

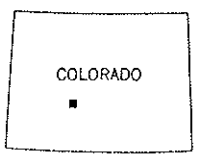


MILE

ROAD CLASSIFICATION

Light-duty

Unimproved dirt



QUADRANGLE LOCATION

PITKIN, COLO.

SE/4 PITKIN 15' QUADRANGLE

N3830 -W10630/7 5

TELEX. 45-556

AMAX EXPLORATION, INC.
A SUBSIDIARY OF AMAX INC.
4704 HARLAN STREET • DENVER, COLORADO 80212 • (303) 433-6151

May 5, 1975

Mr. Miles Reynolds
Jr. Vice President
Austral Oil Company Inc.
2700 Exxon Building
Houston, Texas 77002

Re: Waunita Hot Springs Data
Gunnison Co., Colorado

Dear Miles:

Enclosed are the data on Waunita Hot Springs that you loaned Amax. I'm very sorry and apologize for the delay in returning them to you but I've been in and out of town almost continually for the past several weeks.

I've had the data copied and Amax now has the complete file.

We currently have our field crews fully scheduled, but plan to run several telluric lines with MT readings and EM soundings as soon as scheduling permits.

Best regards.

Sincerely,

AMAX EXPLORATION, INC.

Harry J. Olson

Harry J. Olson
Managing Geologist
Geothermal Exploration

HJO:d
Encl.

AMAX EXPLORATION, INC.
4704 HARLAN STREET • DENVER, COLORADO 80212

INTER-OFFICE MEMORANDUM

SUBJECT: The Geophysical Environment around Waunita Hot Springs

DATE April 3, 1975

TO: W. M. Dolan, H. J. Olson, F. Dellechaie

FROM: A. L. Lange

This report summarizes available geophysical information on the Waunita Hot Springs geothermal prospect. Considerations of hydrogeochemical signs and geological interpretation are not included here.

Arthur L. Lange

ALL:d

Geological Engineer - Mining & Oil
Licensed Marine Engineer

Registered Professional Engineer - Colorado No. 4646
Registered Geologist - California No. 862

K. W. NICKERSON
EXPLORATION CONSULTANT
P.O. Box 1048
Golden, CO 80401

December 30, 1974

Mr. Donald P. Degen
Austral Oil Company
Houston, Texas 77002

Re: Waunita Hot Springs Project

Dear Don:

A preliminary map of the latest resistivity work by Heinrichs GEOEX arrived today and after a quick review I have arrived at some conclusions regarding the Waunita Hot Springs Geothermal Project. These conclusions are subject to change when the final report and maps by Heinrichs have been received and evaluated. Our meeting on Friday January 3, 1975, with Senturion Sciences, Inc., should also contribute materially to our total review of the current status of the project.

The additional resistivity survey in the northeast portion of the map does not give any strong definitive correlation with the Senturion Hot Springs Creek anomaly. Heinrichs is of the opinion the resistivity-groundnoise correlation in this area is very weak and insignificant, yet the possibility exists that the data is pointing to a very deeply buried heat cell.

The resistivity work did firm up and close off the broad main resistivity low correlating with the sedimentary section that lies northeast of Tomichi dome and southeast from Waunita Hot Springs. This is still the most attractive resistivity feature. Although the low values of 30 ohms or so are higher than at any of the commercial geothermal units, they do offer a good low ratio to the high resistivity values in the area.

Subsidiary resistivity features are:

1. At Tomichi Dome where one low trends northeasterly from Section 29 and another trends northwesterly from Section 34 toward the mean frequency of integrated power feature in Section 27.

2. Immediately west of Waunita Hot Springs is a narrow northwest trending low that may be of interest.

MILES REYNOLDS, JR.

3. In Section 2 northeast of Waunita Hot Springs is a northwest trending resistivity low that may have more significance since it overlaps the area of seismic activity.

There is a wide diversity of opinion as to what is necessary for outlining a drillable geothermal target. Some believe that groundnoise is suitable although the tendency at present is away from this, others feel that micro-earthquakes are the determining factor, and yet others think that a resistivity anomaly is sufficient. In all cases, however, heat gradient drill holes are considered essential to finalize the target drill site.

It will be advisable to review the micro-earthquake data as these locations are subject to large errors.

At this time a top grade geothermal prospect has not been outlined at Waunita Hot Springs because of a failure to obtain a correlation between the target areas found by the various exploratory methods. The most likely prospective area for geothermal heat gradient drilling is in the vicinity of the center of the east line of Section 24-49N-4E.

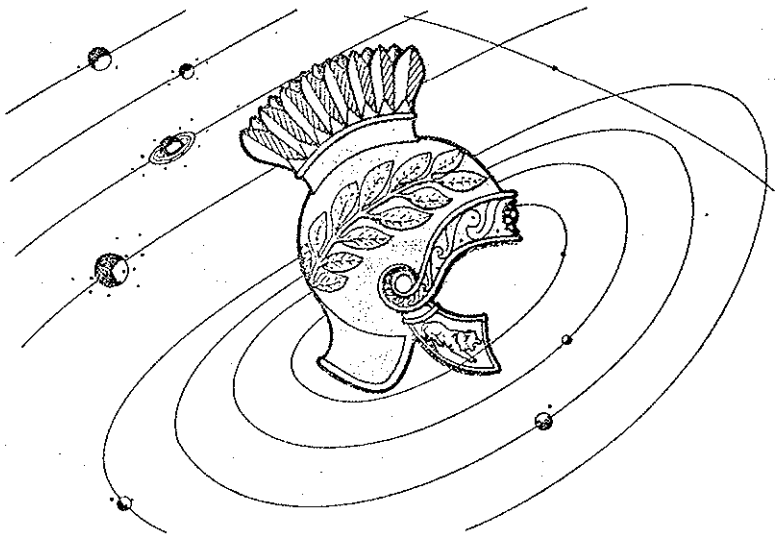
Recommendations for proceeding with this prospect will be made after the conference with Senturion and when the final report by Heinrichs GEOEX has been received. In any event, all the geothermal leases should be kept active.

Very truly yours,

K.W. Nickerson

K.W. Nickerson

KWN:leg



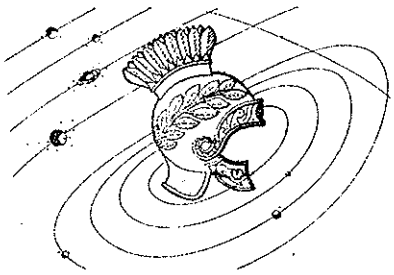
WAUNITA HOT SPRINGS

for

AUSTRAL OIL CORPORATION

SENTURION SCIENCES, INC.
TULSA, U.S.A.

FEB. 20, 1974



SENTURION SCIENCES, INC.

6945 EAST 11TH STREET, TULSA, OKLAHOMA
P.O. BOX 15447, TULSA, OKLAHOMA 74115
PHONE (918) 836-6746

WAUNITA HOT SPRINGS PROSPECT

Introduction

Senturion Sciences, Inc. conducted simultaneously a groundnoise and microearthquake survey of the Waunita Hot Springs area in exploration for a geothermal cell capable of producing steam sufficient for electric power generation. A crew was deployed in the area in December, 1971 and again in February, 1972.

The initial survey indicated substantial area seismicity suggesting a close-in thermal cell anomaly. Although the data did not indicate a strong groundnoise, the subsequent survey data did indicate two anomalies. The stronger of these anomalies was also defined very well by microearthquake data. The other weaker groundnoise anomaly was only tentatively located on the western boundary of the prospect area.

The microearthquake analysis defined three faults within a shear zone showing evidence of alteration (indicative of extreme hydrothermal alteration).

Geological Summary

The Waunita Hot Springs prospect is defined as the area contiguous to Tomichi Dome, a Teritary shield volcano penetrating Cretaceous and Jurassic sediments. The sediments indicate synclinal features with the apparent outcropping thicknesses thinner at the extremities than in the mid-section. The axis of the trough could be defined as the zone of weakness acted upon by the Teritary vulcanism.

The subsequent vulcanism followed paths of least resistance. The stress field with respect to the prospect area during diapirism shows a maximum stress from the southwest. This is evidenced by the Crookton Thrust Fault and the fact that the sill flowed outward to the northwest of Tomichi Dome.

Microearthquake Analyses

A review of Table I illustrates the extent of microseismicity in and about Waunita Hot Springs. Effectively, most (7 out of 9) on stream and economically successful geothermal projects in the world relate to swarms of microearthquakes and it is the presence of plentiful microseismicity plus the very recent vulcanism, abundant water and good aquifer that makes Waunita a good geothermal prospect.

TABLE I

SEISMICITY SUMMARY

STA. #	HRS. REC.	TOTAL EVENTS	COMMON EVENTS	COMMON EVENTS/DAY	TOTAL EVENTS/DAY	SEISMIC SENSITIVITY
1-A	140	144	56	9.6	24.6	2.56
3-A	16	18	7	10.5	27	2.57
3-B	21	21	9	10.3	24	2.33
3-C	22	13	8	8.7	14	1.60
3-D	19	11	5	6.3	13.9	2.20
3-E	19	22	11	13.9	27.8	2.00
3-F	19	10	7	8.9	12.6	1.42
3-G	20	8	7	8.4	9.6	1.14
				Avg., aside from 1-A = 9.57	Avg., aside from 1-A = 18.4	Avg., aside from 1-A = 1.92

WAUNITA II

STA. #	HRS. REC.	TOTAL EVENTS	COM. EVENTS	COM. EVENTS/DAY	TOTAL EVENTS/DAY	SEISMIC SENSITIVITY
1	238	269	201	20.28	27.2	1.34
2	235	231	201	20.53	23.5	1.15
3	232	243	201	20.80	25.1	1.21
4	235.5	317	201	20.48	32.3	1.58
				Avg. = 20.52	Avg. = 27.0	Avg. = 1.32

The frequency of the groundnoise exhibited in the shear zone area (section 9, 10, 14, 15, 16; Township 49 North, Range 4 East) suggests the presence of a hydrothermally altered zone at a reasonably shallow depth which is further confirmed by anomalous seismic velocities of microearthquake signals which traversed the area.

Approximately 20-30%* of the observed common microearthquake events were accurately positioned. From these, three faults were mapped, two altered zones suggested and a total of 62 microearthquake events located in the three fault clusters.

Cluster 1 (events W, X, Y, S, D, E, F, C , R , H, W) is a northwest/southeast trending shear zone with approximate dips of 41 and 10 to the southwest. This shear zone was defined by 11 microearthquake events having a total vertical range of 10,000 feet. This zone could be part of a fissure system that channeled the Tomichi vulcanism and provides plumbing to the Waunita Hot Spring.

Cluster 2 (events A5, N, DA, V, R, O, P, U, K, Q) is a second order due north trending zone of seismicity that intersects Cluster 1 beneath the northeast of the northeast of section 22, T49N, R4E, with an indicated shallow cross fault or highly brecciated zone between 6000' and 9000' elevations. These two clusters are most likely structurally dependent and closely interrelated.

Conclusions

The strongest evidence of the existence of a geothermal anomaly at Waunita Hot Springs is exhibited by the clustering of microearthquakes indicative of hotter rocks than contiguous areas. The Waunita Hot Springs prospect has good groundnoise gradients which are indicative of a local noise generator. Unfortunately, the groundnoise stations are extremely sparse since the data was acquired before RF telemetry. The station spacing was dictated by trying to perform microearthquake mapping and groundnoise surveying simultaneously which is a sad effort for neither one is performed properly. Nonetheless and in spite of ignorance at the time data was acquired, there is definite evidence for further pursuit of economic geothermal reservoirs.

In summary, Waunita has good evidence for geothermal potential because there is:

- Good microseismicity clustering
- Evidence of altered zones

*This is about as well as can be expected when recording on 4 separate tape recorders and striving to time align events. Senturion is the only firm who now can transmit data via R.F. telemetry, and this new ability improves the number of events which can be accurately positioned.

- Extremely recent vulcanism
- Plentiful hot flowing waters from Waunita Hot Springs
- Two anomalous groundnoise areas in line fabric wise with the Waunita Springs and the microearthquake clustering

There is a good aquifer in the Dakota Sandstone and snow runoff should provide good hydrogeology support.

Recommendations

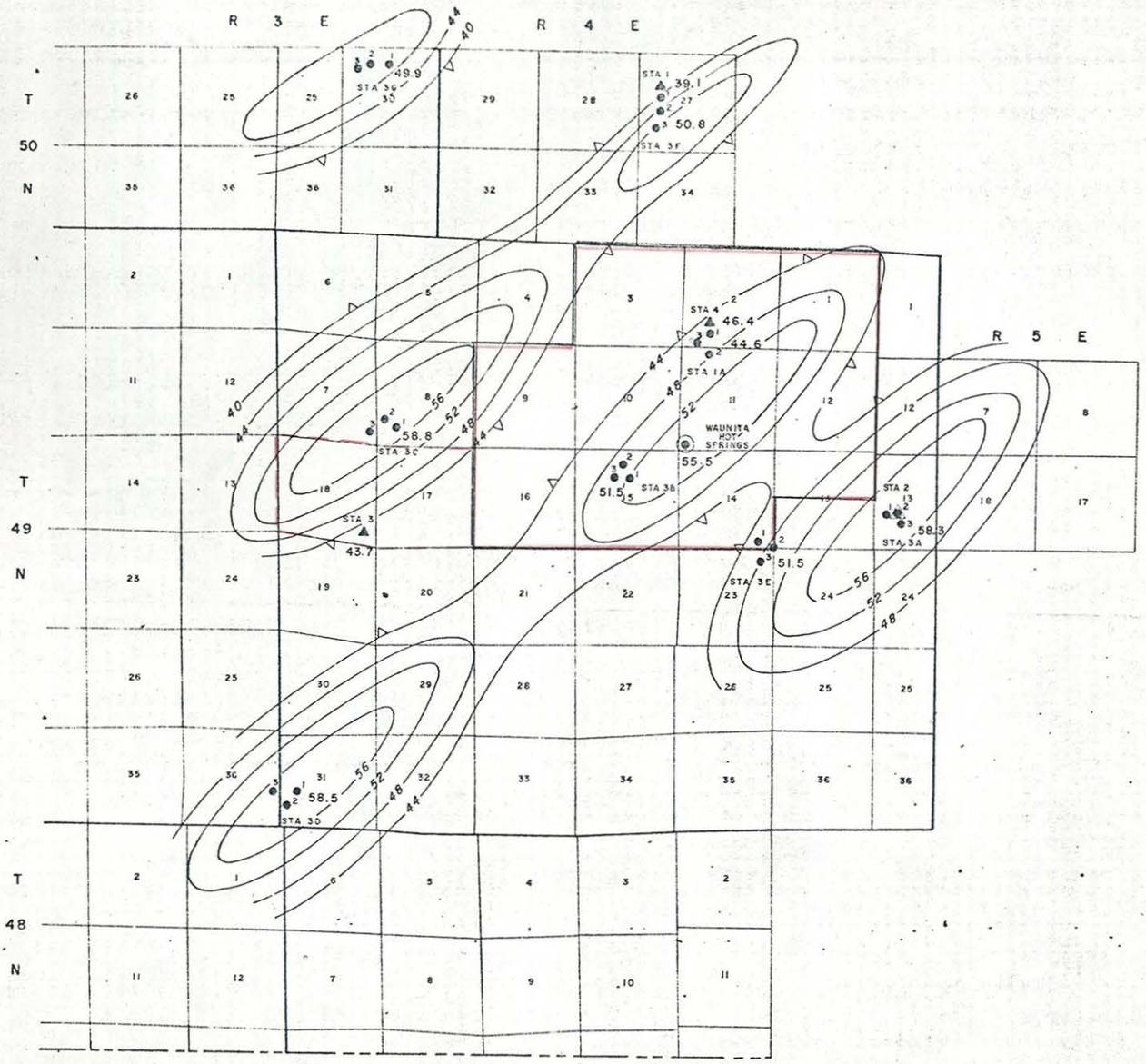
It is recommended that the anomaly be classified according to the geology, hydrogeology, microseismicity and direct heat evidence of the hot spring. The anomalous microseismicity is an indicator of weaker rocks which are a result of hotter rocks. (The hotter the rock the weaker the rock, and stress relieving is going to focus on the weakest zone which is where the hot rocks exist.)

Senturion feels the following efforts in some combination are justified:

- Perform a groundnoise survey filling in the widely spaced groundnoise data already existing. Twenty five additional data points (<$6000.00) would suffice to resolve structure in detail and better define the anomaly.

- And/or perform heat flow studies utilizing shot holes of approximately 150 feet. We suggest a pattern of 6 to 10 holes relating to the area between the microearthquake clustering and Waunita Hot Springs and 4 to 8 shallow heat flow holes in and about the groundnoise anomaly in section 31, T49N, R4E. These studies should cost approximately $5000.00.

- Sink an exploratory well in NW¼, NW¼, section 11, T49N, R43E to a depth of 7100 feet (per the supplemental report, April 1972).



PROJECT:

AREA: WAUNITA HOT SPRINGS

COUNTY: GUNNISON

STATE: COLORADO

INTEGRATED POWER

CONTOUR INTERVAL: 4 UNITS

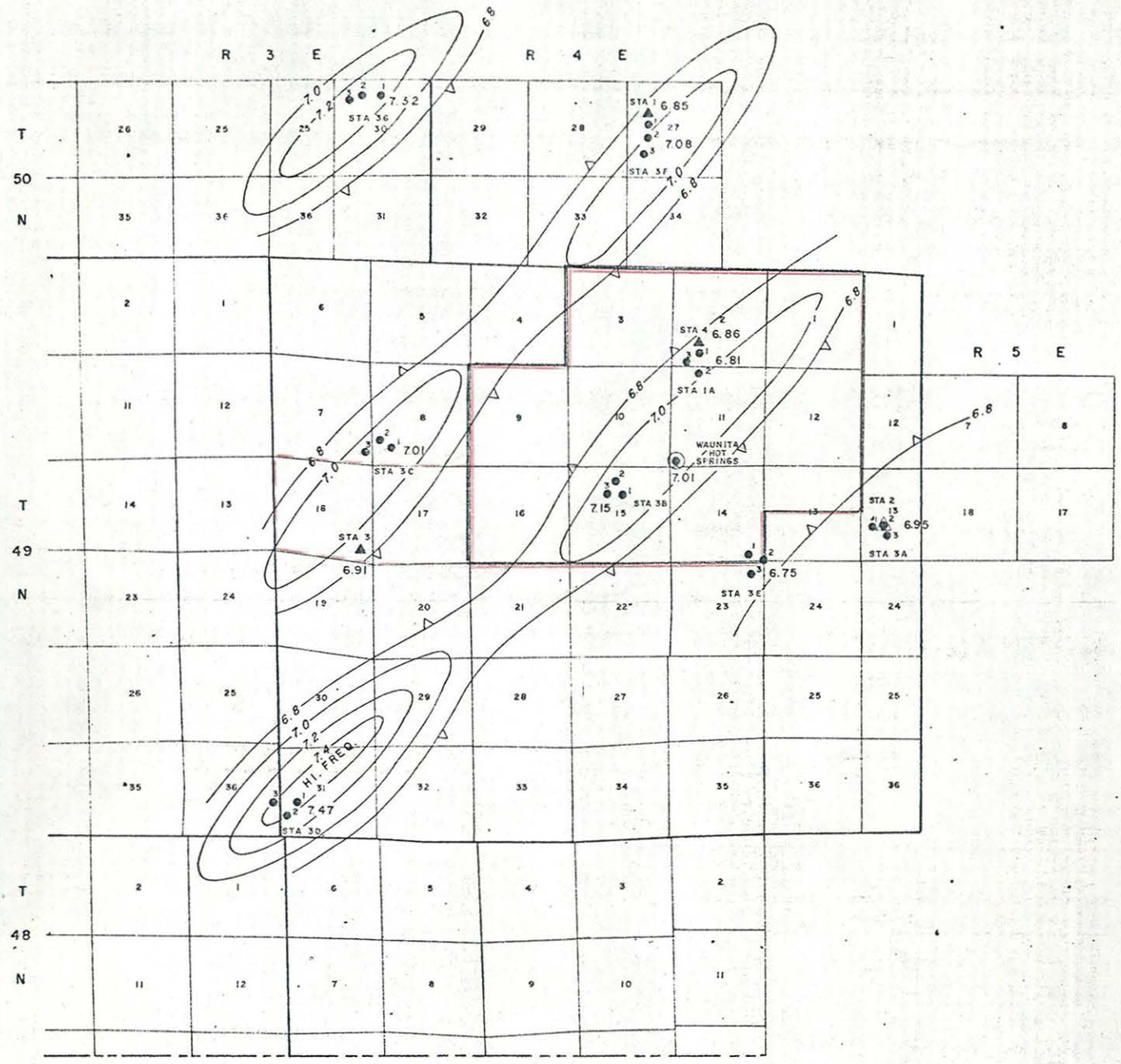
0 1 2 3 4

MILES

SENTURION SCIENCES, INC.

TULSA, U. S. A.

FIGURE 1



PROJECT:

AREA: WAUNITA HOT SPRINGS

COUNTY: GUNNISON

STATE: COLORADO

MEAN FREQUENCY OF THE INTEGRATED POWER

CONTOUR INTERVAL: 0.2 Hz

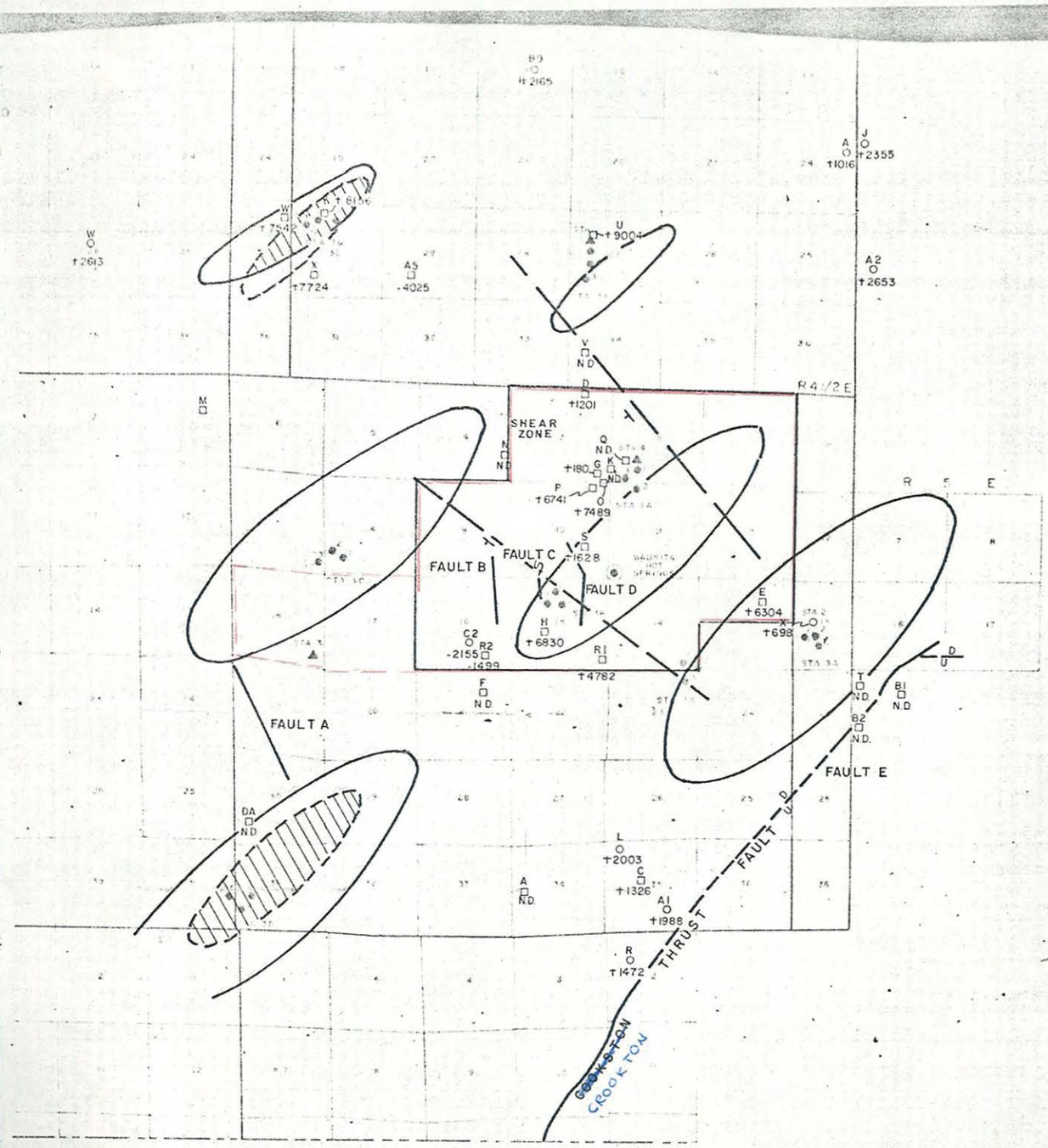
0 1 2 3 4

MILES

SENTURION SCIENCES, INC.

TULSA, U. S. A.

FIGURE 2



AUSTRAL OIL COMPANY, INC.

AREA: WAUNITA HOT SPRINGS

COUNTY: GUNNISON

STATE: COLORADO

HYPOCENTER LOCATION MAP

□ WAUNITA 1 DATA

○ WAUNITA 2 DATA

DEPTHS REFERRED TO SEA LEVEL

ANOMALOUS AREAS

——— INTEGRATED POWER

– – – – MEAN FREQUENCY OF THE INTEGRATED POWER

DATE: DECEMBER 9-16, 1971 & FEBRUARY 12-21, 1972

0 1 2 3 MILES

SENTURION SCIENCES, INC.

TULSA, U. S. A.

AVERAGE ± 1 STD. DEV.	
INTEG. POWER	46.64
MEAN FREQ.	7.21

FIGURE 3