TEC-3

U.S. Gen - O'Brien Rec'd

AMAX EXPLORATION, INC.
A SUBSIDIARY OF AMAX INC.

GEOTHERMAL BRANCH

INTER-OFFICE MEMORANDUM

SUBJECT: Review of the 1981 AMAX/O'Brien Reconnaissance Prospects and Recommendations for 1982

DATE: February 16, 1982

cc: W. Lodder
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TO: H. J. Olson

FROM: H. D. Pilkington

Conclusions and Recommendations

In October of 1981, O'Brien selected five prospects for additional work. One or more thermal gradient holes have now been completed. Only one of the prospects is considered to have sufficient geothermal potential to warrant action by AMAX. My recommendations for that prospect and for the 1982 O'Brien program are:

1. Noquez, NV-52 - I recommend additional work in the area including (1) drilling additional thermal gradient holes to the east and northeast of the mine. Selected intervals of drill cuttings should be analyzed for Ag, Au, As, Sb, and Hg for the company precious metals program; (2) exploration should be extended to include an area of bleached Tertiary rocks on the west side of Huntoon Valley and the range of hills between Huntoon Valley and Teels Marsh.

2. O'Brien 1982 Program - After completion of work on Noquez the remainder of the 1982 budget for project 1121 should be spent on prospect evaluation and not on an airborne recon program which duplicates what AMAX has already done with Jetrex. The Rast property discovered in 1980 needs more work including mapping and gradient drilling. Finally, if funds remain we should consider work on either the Shoshone, Nevada or Excelsior, Nevada O'Brien properties.

Introduction

The 1981 reconnaissance exploration program (Project 1121) conducted by O'Brien Resources Corporation for AMAX examined a total of 225 mercury/sulfur/alunite areas in California, Nevada, Oregon, Idaho, Washington, Wyoming, Utah, Arizona and Texas. Five prospects from this group (Figure 1) were selected by O'Brien for additional investigations including geologic mapping and shallow thermal gradient drilling.

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Ken Lovstrom had Skyline Laboratories run a total of 69 mine dump samples collected by O'Brien during the 1980 phase of the exploration program. The samples were analyzed for Au, Ag, Cu, Pb, Zn, Mo and Hg. Ten samples contained anomalous Au. Therefore, during the 1981 phase of the reconnaissance program O'Brien collected over 200 mine dump samples after being briefed by Ken Lovstrom on sampling techniques. Figure 2 shows the locations of some of the more anomalous precious metal areas identified to date. A review of the precious metals geochemistry will be made at a later date.

Prospect Reviews

Needles, AZ-21 - The prospect is located in Mohave County in northwestern Arizona in Sec 35 T17NR19W (Figure 1). The kaolinte alteration within the prospect trends NE parallel to a known linear. A second linear trends NW and Oatman Warm Spring occurs 10km to the northwest. Bedrock in the area reportedly consists of Cretaceous andesites and Tertiary rhyolites with Quaternary basalts capping some hills.

Geothermal manifestations include kaolinitic alteration of the rhyolites, proximity to Oatman Warm Spring, measured gradient of 45°C/km in a 300 meter well located in the SWNW Sec 12 T17NR18W, and the gradient reported by O'Brien of 46°C/km in a 98 meter thermal gradient hole in the SWNE Sec 20 T16 1/2NR19W.

The thermal gradients of 45°C/km and 46°C/km are somewhat elevated for the Basin and Range province. The average thermal conductivity of ash flow tuffs in 4.5 to 5.0 TCU; therefore, the heatflow in the area is 2.0 to 2.25 HFU. The literature contains conflicting reports on the subsurface temperatures forecast by Oatman Warm Spring. Swanberg, et al (1977) reported possible reservoir temperatures greater than 150°C; however, Witcher (1979) lists the reservoir temperatures as 50°C.

No further work by AMAX is recommended for this prospect.

Crater, CA-38 - The Crater prospect is located in Inyo County, California and centers about a sulfur mine in Sec 33 and 34, T8SR39E (Figure 1). The prospect is located near the crest of the Last Chance Range, a Basin and Range structure bounded on the east by the Furnace Creek Fault zone. Bedrock in the immediate area of the sulfur mine consists of Lower Paleozoic carbonates and the quartzites.

Hydrothermal manifestations include argillization, silicification and sulfur mineralization. The alteration and mineralization appears to have been confined to the more argillaceous carbonates or calcareous shales, however, very massive open space filling by sulfur occurs in quartzite breccias.

The thermal gradients as measured in three mineral exploration holes (50-100 meters deep) gave values which average out about 30°C/km. O'Brien drilled one thermal gradient hole to a depth of 126 meters which yields an average gradient of 42°C/km. Therefore, the thermal data is typical background values for the Basin and Range which suggests the system is too old to have any geothermal potential. No additional work by AMAX is recommended.

Selected samples of the drill cuttings will be sent to the lab to determine whether they contain the geochemical signature of precious metals systems.

Noquez, NV-52 - The Noquez mercury prospect is located in Mineral County, Nevada, Sec 36 T3NR32E (Figure 1). The mercury workings are on the north slope of a small range of hills located between the White Mountains on the south and the Excelsior Range to the north. Bedrock in the area consists of sleeply dipping, strongly folder Lower Paleozoic quartzites and siliceous siltstones exposed in the footwall block of a high angle normal fault. The Paleozoic rocks are overlain by Pliocene andesites to felsic ashflow tuff.

Hydrothermal alteration and mineralization consists of strong argillic alteration of the volcanics adjacent to the high angle fault. The alteration is confined to a zone a few meters wide. The rocks are strongly iron-stained with both limonite and hematite. The mercury mineralization occurs in vein breccias within the Ordovician quartzites. Strong limonitic and perhaps manganese staining occurs in many quartzite outcrops.

The thermal anomaly as reported by O'Brien consists of gradients from one 110 meter mineral hole at 100°C/km, one cleaned out 85 meter mineral hole with an average gradient of 134°C/km and two thermal gradient holes with depths of 74 meters (average gradient 94°C/km) and 75 meters (average gradient 111 C/km). If the lower 80 meters of the 110 meter mineral hole was in quartzite as the cuttings suggest then average thermal conductivity should be about 10 TCU and the heatflow is 10.4 HFU.

O'Brien gradient hole #1 was reported to have a gradient of 95°C/km and a heatflow of 7.3 HFU at 7.7 TCU. However, most ashflow tuffs, even when

strongly welded, have thermal conductivities in the 4.5 to 5.0 TCU range. I would give the hole a heatflow of 4.3 to 4.8 HFU. For O'Brien hole #3 they reported gradients of 171.5°C/km and 103°C/km with heatflow of 12.7 and 7.6 HFU respectively. The locations of the hole suggests it was drilled in the Tertiary volcanics hence should have a thermal conductivity in the 4.5 to 5.0 TCU range. Using my gradient calculations of 208°C/km from the surface to 50 meters and 117°C/km between 50 and 85 meters and assuming unaltered rocks in the lower part of the hole, the heatflow would be 5.3 to 5.9 HFU. In O'Brien #[illegible] they reported gradient of 122°C/km, q= 9.4 HFU @ 7.7 TCU, 114°C/km, q=10.3 HFU @ 90 TCU and 90°C/km, q=9.0 HFU @ 10.0 TCU. My gradient calculations yield 138°C/km from the surface to 20 meters in volcanics; therefore, heatflow would be 6.2 to 6.9 HFU with thermal conductivities of 4.5 to 5.0 HFU. In the weathered fractured quartzites from 20 to 40 meters depth the gradient equals 112°C/km and thermal conductivities calculate out as 6.2 TCU. The bottom segment from 40 to 75 meters has a gradient of 70°C/km which means the thermal conductivity must be in the 9.9 TCU range.

The AMAX Exploration, Inc. "recce" files contain four thermal data points and five hydrogeochemical sites (Figure 3) which are close to the Noquez prospect. The thermal gradients measured include: ΔT 384-30°C/km, BHT 16.7°C @ 50m; ΔT 385-97°C/km, BHT 18.6°C @ 60m; ΔT 386-43°C/km, BHT 166°C @ 70m and ΔT 387-70°C/km, BHT 12.3°C @ 21m. The gradient for ΔT 385 is significant because it comes from the same geologic block, and the gradient of 97°C/km in Tertiary volcanics gives a heatflow of 4.3 to 4.9 HFU for thermal conductivities of 4.5 to 5.0 TCU.

The hydrogeochemical data (Table I) suggests the springs have a thermal component as evidenced by the B, Li, F and Cl contents. The geothermometers give subsurface temperatures of 85-126°C for silica and 70-200°C for Na-K-Ca.

The geothermal potential of the Noquez prospect is encouraging and I would recommend that AMAX continue our geothermal exploration in the area. The exploration should also be extended to cover an area of bleached (?) Tertiary rocks on the west side of Huntoon Valley as seen on the Jetrex survey and also the mountain block between Huntoon Valley and Teels Marsh. Additional thermal gradient drilling should be done to the east and northeast of the Noquez Mine. Selected intervals of the drill cuttings should be analyzed for Ag, Au, As, Sb and Hg for the company precious metals program.

Poinsettia, NV-25 - The prospect was named for the Poinsettia Mercury Mine located in Mineral County, Nevada in Sec 34 T11NR33E. Bedrock in the area is a thick sequence of rhyo-dacitic ashflow tuffs of Pliocene age.

The mercury prospect is covered by claims held by Gene Mattson, Sandra Wolfe and Sandra Palmer, P. O. Box 265, Hawthorne, Nevada 89415. Assessment work was filed on September 1, 1981. A series of shafts explore a N65W vein which dips 80-85°S. The main shaft is reported to be 150 feet deep. Pervasive argillic alteration is exposed along the drainage for over 0.8 km. Limonitic iron-staining occurs everywhere in the altered rocks. Opalite and some vein quartz occur with the cinnabar mineralization.

One-half mile north of the Poinsettia Mine is a large area of altered volcanics. The zone extends for about one mile in a N70W direction and average about 0.4 km wide. The alteration consists of clay minerals, limonite staining and gypsum.

The two holes drilled by O'Brien were reported to have the following gradients: Poinsettia #1 ΔT 67°C/km, q=4.3HFU @ 6.5 TCU and ΔT 57°C/km, q=4.0 HFU @ 7.0 TCU and for Poinsettia #5 ΔT 41°C/km, q=3.1 HFU @ 7.6 TCU and ΔT 47°C/km, q=3.5 HFU @ 7.4 TCU. My gradient calculations are as follows: from 0-35 meters have a downward migration of groundwater so gradients are meaningless. From 35-50 meters gradient averages 50°C/km and if we assume the mineralized rock has a concutivity similar to that in Poinsettia #1 then have a heatflow of 3.8 HFU @ 7.5 TCU. Hole number 5 was located near the western side of the altered area north of the mine. The altered area has been covered by claims of the Bingo group.

The geothermal anomaly here is quite low and probably does not merit additional work. Selected intervals of the mineralized drill cuttings will be sent to the lab to determine whether or not they have a geochemical signature for precious metals.

Cina Mine, UT-8 - The Cina Mine is located in Iron County, Utah in Sec 5 T31S, R15W. The property is along the southern end of the alunite zone which extends from the Maryvale area of the Tushar Mountains in a west southwest direction for over 100 miles.

The alteration and mineralization consists of pervasive argillization, alunite, opalite, sulfur and mercury. The general age of mineralization within the alunite zone is thought to be 13-15 m.y. in the Tushar Mountains.

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O'Brien drilled one thermal gradient hole to a depth of 100 meters. The average gradient of the hole is 38°C/km. Although O'Brien reported a heatflow of 3 HFU, I would give the hole a heatflow of about 1.1 HFU @ 3.0 TCU. The gradient is background for the area which suggests a fossil system. with no geothermal potential. No further work by AMAX is recommended.

H. D. Pilkington

HDP/c

Table I. Hydrogeochemical analyses for water in the area of the Noquez prospect.

	W11103	W11104	W11106
Temp (C)	23	17	21
Flow (GPM)	10	10	1
PH	8.3	7.6	7.8
CL	130	310	320
F	1.5	5.4	6.3
SO_4	95	210	220
HCO_3	318.6	708.6	720.
CO_3	0	0	0
SIO_2	81	43	34
NA	190	500	530
K	29	57	66
CA	28	40	90
MG	11	37	19
LI	.5	1.7	1.8
OH	0	0	0
B	3.4	8.0	9.0
MO	0	0	0
NH_3	0	0	0
TDS	888.0	1920.7	2016.1
$TSIO_2$	126	95	85
TNA/K	239	200	211
TNA-K-CA	204	202	200

Table I. Hydrogeochemical analyses for water in the area of the Noquez prospect.

	W11107	W11634
Temp (C)	21	17
Flow (GPM)	1	0
PH	8.62	8.16
CL	230	13
F	3.6	3.1
SO_4	140	38
HCO_3	354.	112
CO_3	20	0
SIO_2	24	34
NA	280	27
K	28	7.6
CA	28	26
MG	15	11
LI	.8	0
OH	0	0
CU	0	0
B	4.6	.7
MO	6	0
NH_3	.11	0
TDS	1128.1	272.4
$TSIO_2$	70	85
TNA/K	184	348
TNA-K-CA	187	70

Figure 1. Prospect Location Map - 1981 Program

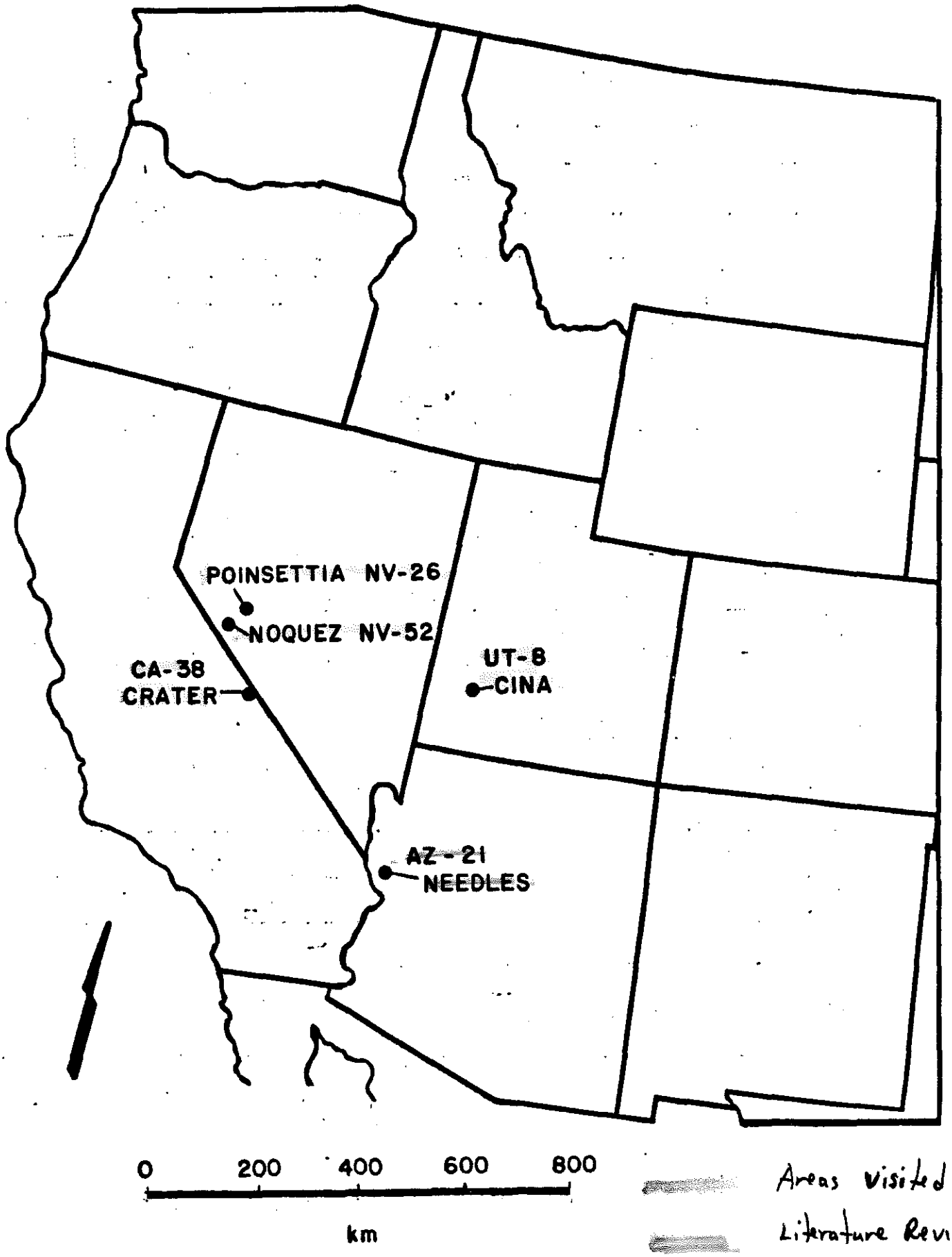
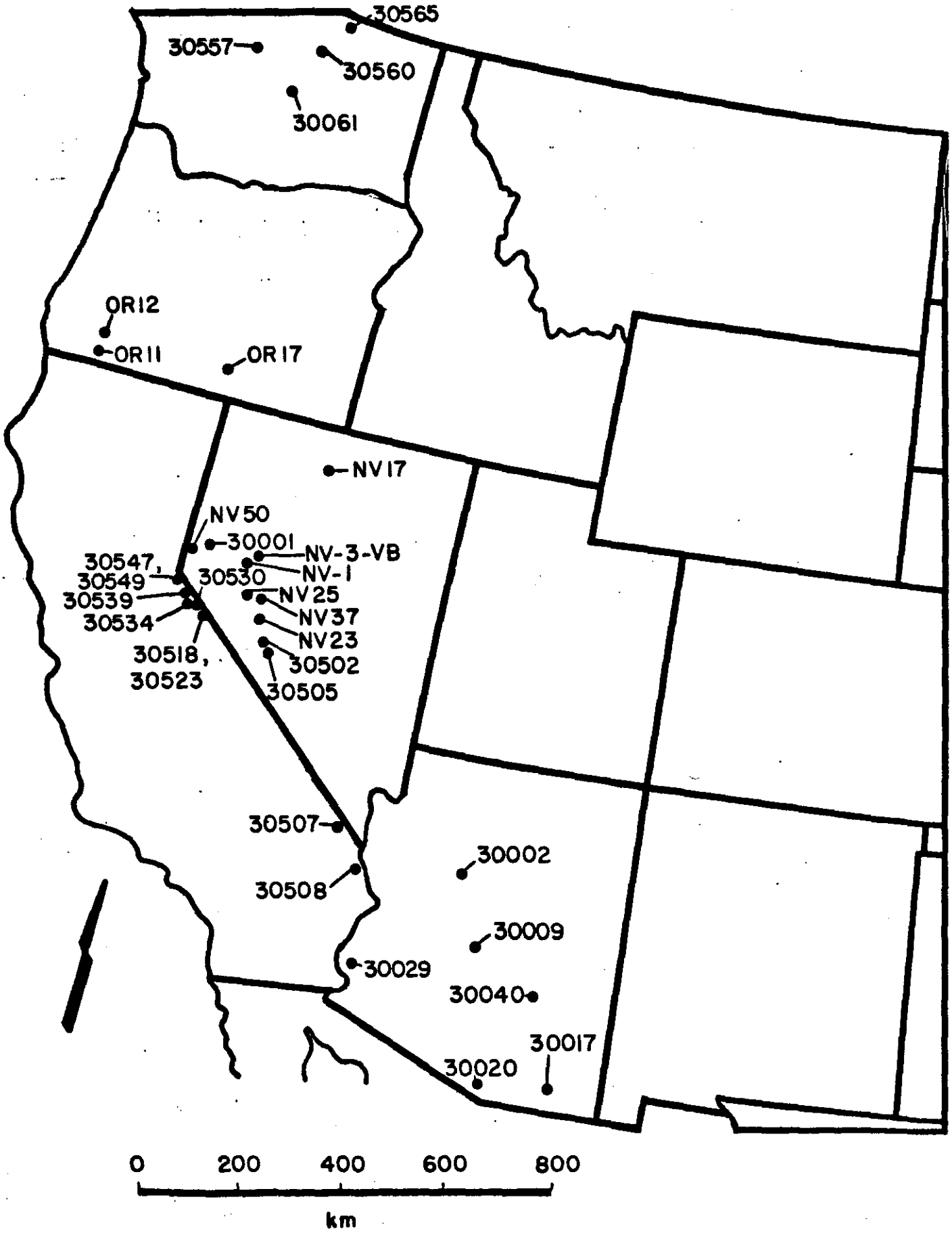


Figure 2. Precious Metal Anomaly Location Map



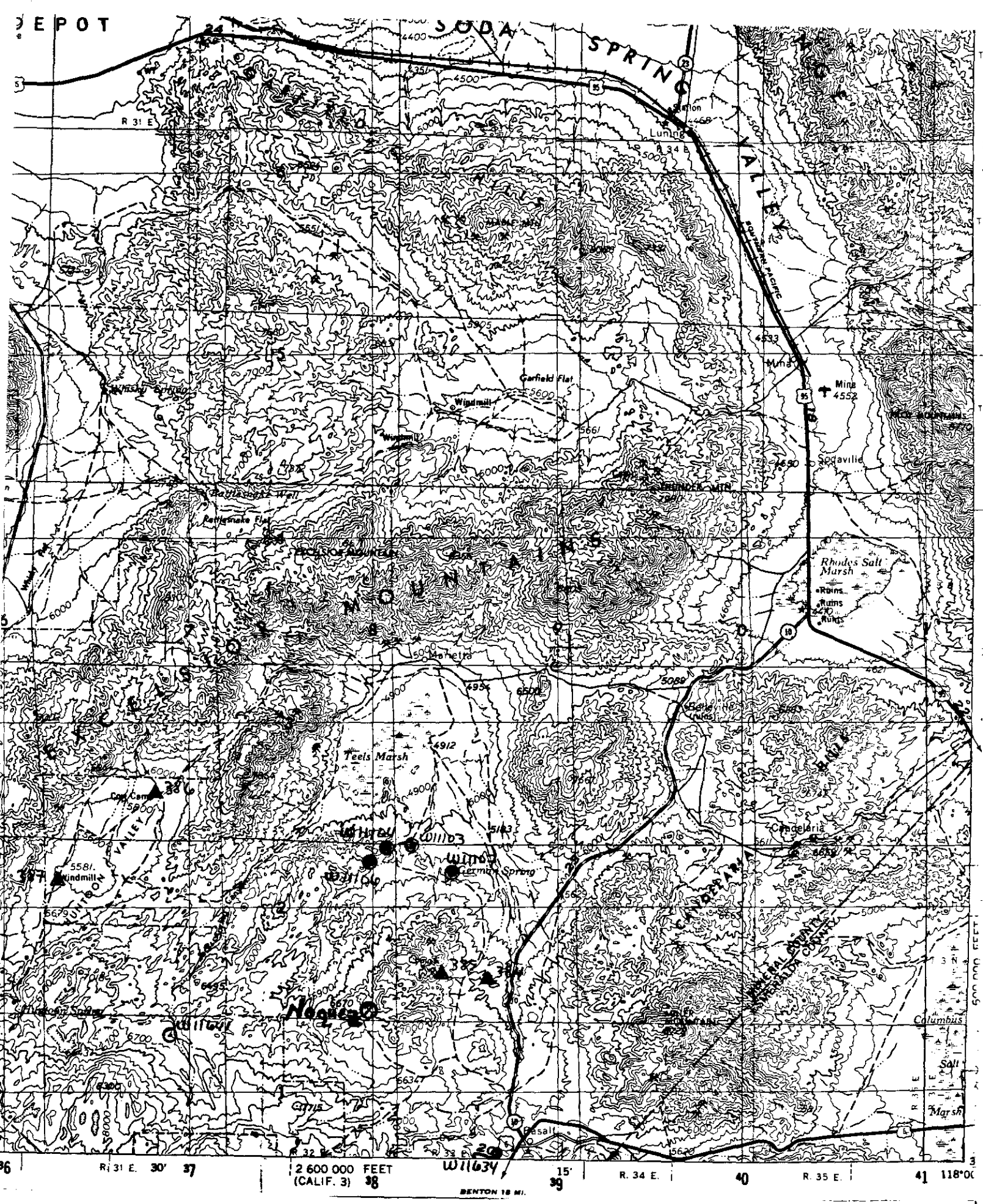


Figure 3. AMAX Recee Data

▲ 384 ΔT Holes

● Water Samples