A SUBSIDIARY OF AMAX INC. EXPLORATION, INC.

**GEOTHERMAL BRANCH** 

### INTER-OFFICE MEMORANDUM

SUBJECT: Geothermal Potential of the DATE: July 28, 1983 Houston International Minerals Corporation Lands in South Central Oregon (4252A)

TO: H.J. Olson cc: Wim Lodder W.M. Dolan J.E. Deymonaz

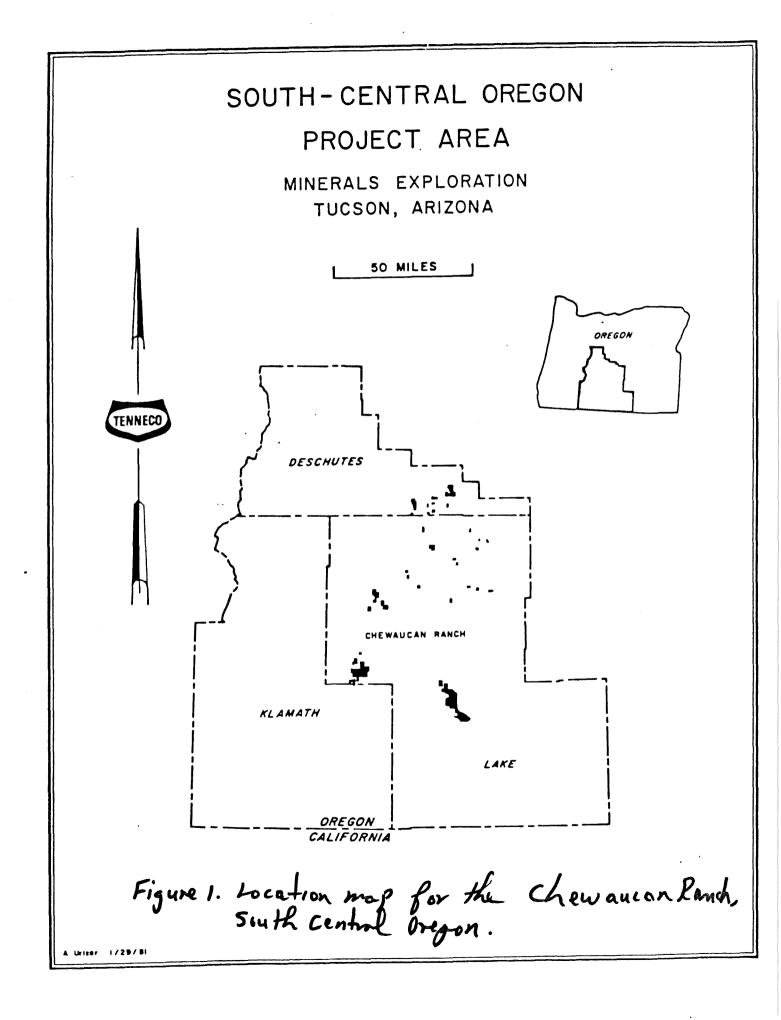
The Tenneco Mineral lands in Oregon are a part of the Chewaucan Ranch located in Lake, Deschutes, and Klamath counties in south central Oregon (Fig. 1). The property consists of 78,988 acres of mineral lands in scattered blocks of varying sizes.

### Geologic Features

The Chewaucan Ranch stretches from the High Lava Plains on the north into the Basin and Range on the south. The area is underlain by Cenozoic volcanic and sedimentary rocks. Figure 2 shows the distribution of rhyolitic domes and faulting in the area after MacLeod, Walker and McKee (1975). The rhyolite domes are concentrated along two northwest trending belts which become progressively younger toward the northwest. Figure 3 is a plot of the radiometric age dates for the rhyolite domes in south central Oregon. A very generalized outline of the main areas of the Chewaucan Ranch have been drawn on Figure 3 for reference. The Chewaucan Marsh area, T33, 34 and 35S, R19 and 20E, has a 7.4 million year old rhyolite dome on the west side. In the Lycan Marsh area, T32S, R13 and 14E, there is a 5.0 million year old rhyolite, the youngest volcanic feature. The area southeast of Brothers, the youngest volcanics are the rhyolites of Frederic Butte dated at 3.9 million years. Quaternary basalts cap most of the area around Brothers.

### Thermal Manifestations

In 1975, the Department of Geology and Mineral Industries drilled four (4) gradient holes in the Frederic Butte area southeast of Brothers (Fig. 3). The gradients average  $50-60^{\circ}$ C/Km in the shallow holes and  $110-117^{\circ}$ C/Km in the deeper portion of the holes. In 1978, AMAX measured gradients in seven (7) existing holes in the area and found gradients of  $32^{\circ}$  to  $98^{\circ}$ C/Km. Again, the deeper holes had the highest gradients. Thus, the Brothers area represents a thermal anomaly within the area of generally elevated heat flow along the Brothers zone.



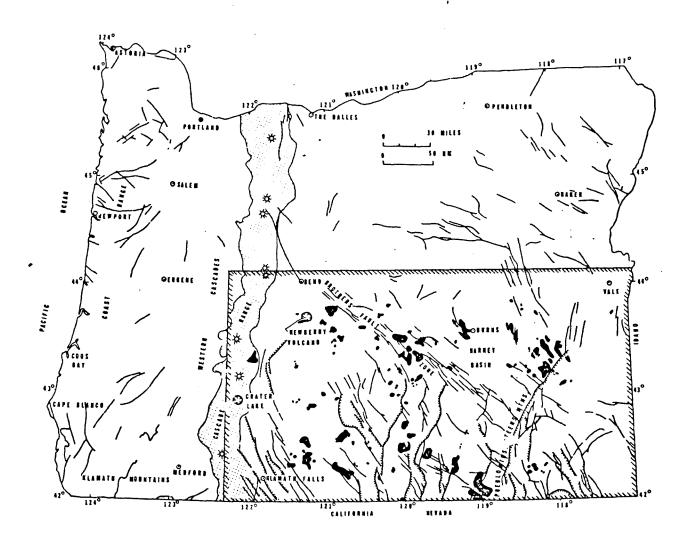
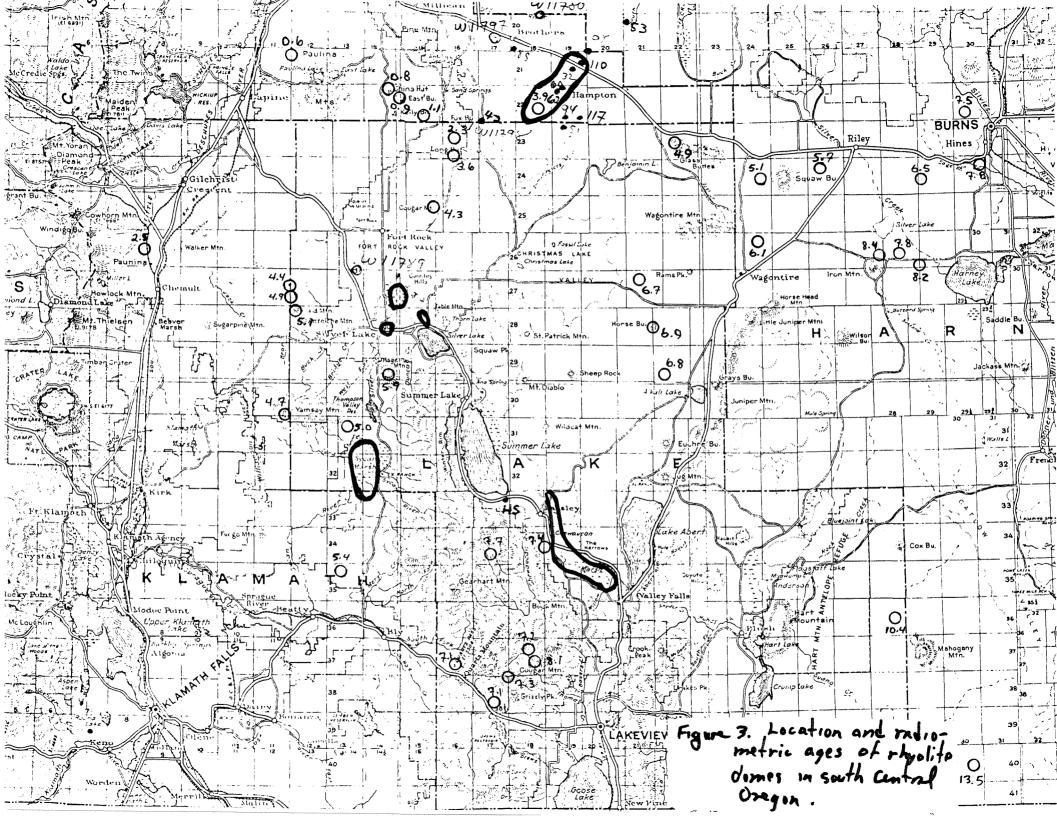


Figure 2. Map of Oregon showing the location of the rhyolitic domes in the southeastern part of the state (black). Major faults shown are from Walker and King (1969); hachures are shown on the downthrown side of the larger faults of the Basin and Range Province. The area shown in figures 2 and 4 is outlined.

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### TABLE I: Chemical Analysis of Water Samples from the Chervancan Ranch area South Central Oregon

	Mariner et al 1974 Summer Lake HS <u>NE1/4S12T33SR17E</u>	X90227 JE Allen WS NWNWS3ST30SR16E	X90230 Emery HS SESWS11T31SR16E	X90233 Brittain WW SESES22T31SR16E
Temp <sup>O</sup> C Flow (gpm)	43 	23 60	51 30	27 150
pH Cl F SO4 HCO3 CO3 SiO2 Na K Ca Mg Li B	8.43 280.0 2.2 120.0 406.0 10.0 94.0 390.0 4.6 2.1 0.1 0.15 6.9	9.21 0.8 5.0 477.0 16.0 47.0 330.0 12.0 2.0 1.0 0.01 3.6	8.84  1.0 2.0 92.0 0.0 75.0 230.0 4.1 5.0 0.3 0.01 10.0	8.64  0.3 4.0 259.0 0.0 64.0 510.0 14.0 7.0 1.0 0.01 6.9
TDS Ec(K)	1790	898.4 	420.3	872.3
TqSiO <sub>2</sub> TcSiO <sub>2</sub> TNa-K TNa-K-Ca TLi/Na TLi	130 107 84 112 32 97	100 69 143 160 	120 94 103 116 	113 85 127 143 

# Table I: (Continued)

	X90248 Murphy WW SWNWS12T33SR17E	X90250 Summer Lake HS NENES12T33SR17E	X90251 Blitz WW NENES12SR17E	X90259 Spider WW NWNES15T33SR18E
Temp <sup>O</sup> C Flow (gpm)	34 3	45 1 <i>5</i> 0	24 25	32 750
pH Cl F SO4 HCO3 CO3 SiO2 Na K Ca Mg Li B	9.10  20.0 168.0 0.0 80.0 100.0 4.5 1.0 0.1 0.01 0.01	8.87  2.1 60.0 440.0 0.0 90.0 450.0 5.9 1.0 0.1 0.01 7.6	8.89  3.0 507.0 12.0 64.0 410.0 8.3 1.0 0.4 0.01 5.9	7.95  93.0 144.0 0.0 100.0 130.0 5.9 6.0 0.8 0.01 1.8
TDS	374.0	1058.4	1013.3	481.6
TqSiO <sub>2</sub> TcSiO <sub>2</sub> TNa-K TNa-K-Ca TLi/Na TLi	123 97 157 156 	128 104 89 123 	113 85 110 141 	133 111 155 147 

# Table I: (Continued)

	X90262 Red House WW SWSES8T33SR19E	X90263 Paisley WW SWSWS24T33SR18E	Wll780 Circle F WW S35Tl9SR18E
Temp <sup>O</sup> C Flow (gpm)	23 100	34 1001	18 1
pH Cl F SO <sub>4</sub> HCO <sub>3</sub> CO <sub>3</sub> SiO <sub>2</sub> Na K Ca Mg Li B	8.74  20.0 321.0 32.0 70.0 190.0 14.0 3.0 2.0 0.01 2.1	9.69  4.0 113.0 0.0 34.0 57.0 0.7 1.0 0.01 0.01 0.01	7.42 0.3 48.0 80.0 253.0 0.0 24.0 60.0 1.0 81.0 29.0 0.0 0.0
TDS	654.2	209.7	576.3
TqSiO <sub>2</sub> TcSiO <sub>2</sub> TNa-K TNa-K-Ca TLi/Na TLi	117 90 192 183  37	88 54 86 71 3 37	75 39 100 6 

	W11789 Horning Gap WW T26SR15E	W11797 King WW NWNES27T2OSR17E	W11798 Sand WS NESWS31T21SR16E
Temp <sup>O</sup> C Flow (gpm)	20 1000	21 40	24 
pH Cl F SO <sub>4</sub> 120.0 HCO <sub>3</sub> CO <sub>3</sub> 0.0 SiO <sub>2</sub> Na K Ca Mg Li B	7.79 76.0 0.5 110.0 196.0 0.0 58.0 130.0 8.6 81.0 18.0 0.0 2.4	7.73 $10.0$ $0.2$ $0.0$ $116.0$ $0.0$ $49.0$ $26.0$ $4.4$ $14.0$ $11.0$ $0.0$ $0.0$	6.61 3.0 0.0 87.0 22.0 6.0 11.0 10.0 7.0 0.0 0.0
TDS	690.5	241.6	146.2
TqSiO <sub>2</sub> TcSiO <sub>2</sub> TNa-K TNa-K-Ca TLi/Na TLi	109 80 184 67 	102 71 267 65 	72 35  86 

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## Table I: (Continued)

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### Geochemical Manifestations

The chemistry of the Summer Lake Hot Springs has been published by Mariner et al (1974) and represents the only water analysis available within Chewaucan Ranch area (Table I). During the summer of 1974, the AMAX reconnaissance program collected a total of 64 water samples in the vicinity of our Paisley prospect. Ten examples of thermal waters in the Paisley area are given in Table I. In the summer of 1978, the AMAX recce program collected four (4) water samples from the northern part of the Chewaucan Ranch (Fig. 3).

The thermal waters in the Chewaucan Marsh area of Lake County appear to be the product of deep circulation and heating, then returning to the surface. The waters are sodium-bicarbonate water or sodium-bicarbonate-chloride-sulfate waters which have seen a maximum equilibrum temperature of 120–160°C. The discrepency between the silica and alkali geothermometers is probably related to  $CO_2$  loss and subsequent precipitation of silica.

The waters in the Brothers area are either normal groundwaters, or meteoric waters that have circulated only to rather shallow depths of, say, one kilometer, then come back to the surface.

#### Recommendations

The thermal anomaly in the Brothers area may be indicative of an area with some geothermal potential. However, unless deeper holes are drilled, it will be difficult to evaluate because of the abundant cold waters in the basalts. Therefore, based upon the 2-4 million year age for the nearby rhyolite domes, I cannot recommend any further action by AMAX on the northern most part of the Chewaucan Ranch. In the Chewaucan Marsh area, the hydrogeochemistry suggests a low temperature hydrothermal system, which is of no interest to AMAX.

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