AMAX EXPLORATION, INC.
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INTER-OFFICE MEMORANDUM

SUBJECT: Thermal gradient drilling and four age dates at the Waunita Hot Springs geothermal prospect, Gunnison County, Colorado

DATE November 3, 1976

TO: W. M. Dolan, H. J. Olson, GT Staff

FROM: F. Dellechaie

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Drilling

Eight thermal gradient holes, ranging in depth from 81 to 100 meters, were drilled near Waunita Hot Springs, Gunnison County, Colorado. The drilling proceeded from August 25 to September 19, 1976.

Arrow Drilling Company of Golden, Colorado, was the contractor. The drill was a Sanderson Cyclon TH-100. Near surface clays and the Pierre and Benton shales caused five holes to cave-in. On these holes, the PVC casing was installed through the drill pipe after reaming with a modified tri-cone drill bit. A drill having both air and mud capabilities would have much facilitated the drilling.

Large quantities (greater than 20 gpm) of 10°C water were produced in all but three holes. Wa-4 and Wa-8 were dry. Wa-3 produced 43°C water at 52 meters. The water temperature increased to 53°C at 87 meters when drilling was teminated due to caving of the drill pad.

Age dates

Four samples of rhyolite from the Tomichi Dome were age dated by the K-Ar method on whole rock material. The ages range from 31.0 to 37.8 m.y. (± 1.9 m.y.). The Tomichi Dome may have had two eruptive stages separated by a quiescent period of about 5 million years. The entire eruptive period occurred at about the same time as the crystalization of the Mt. Princeton Batholith at 36 m.y. (± 2 m.y.) before present.

Frank Dellechaie
F. Dellechaie

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SUPPLEMENTAL REPORT

TO

WAUNITA HOT SPRINGS

The purpose of this supplementary report is to display a geological profile from the crest of Tomichi Mountain northeast through the Waunita Springs area to the exposed sedimentary contact with the granite on the northeast rim of the small basin-like structure surrounding the mountain. The profile would be an aid in exploitation of the hot springs geothermal project, particularly with regard to the drilling conditions that will be encountered. Columnar sections of the profile from the surface downward show from 600 to 2,500 feet of Tertiary and Jurassic sedimentary strata overlying some 20,000 feet of Precambrian crystalline rocks.

In constructing the cross section of sedimentary strata, it is assumed that the Morrison formation of Upper Jurassic Age rests unconformably on the Precambrian rocks. This was due to the area being occupied by the Uncompahgre highland during Triassic time, and the rocks of the Paleozoic and Triassic eras were eroded away prior to deposition of later Mesozoic and Cenozoic formations.

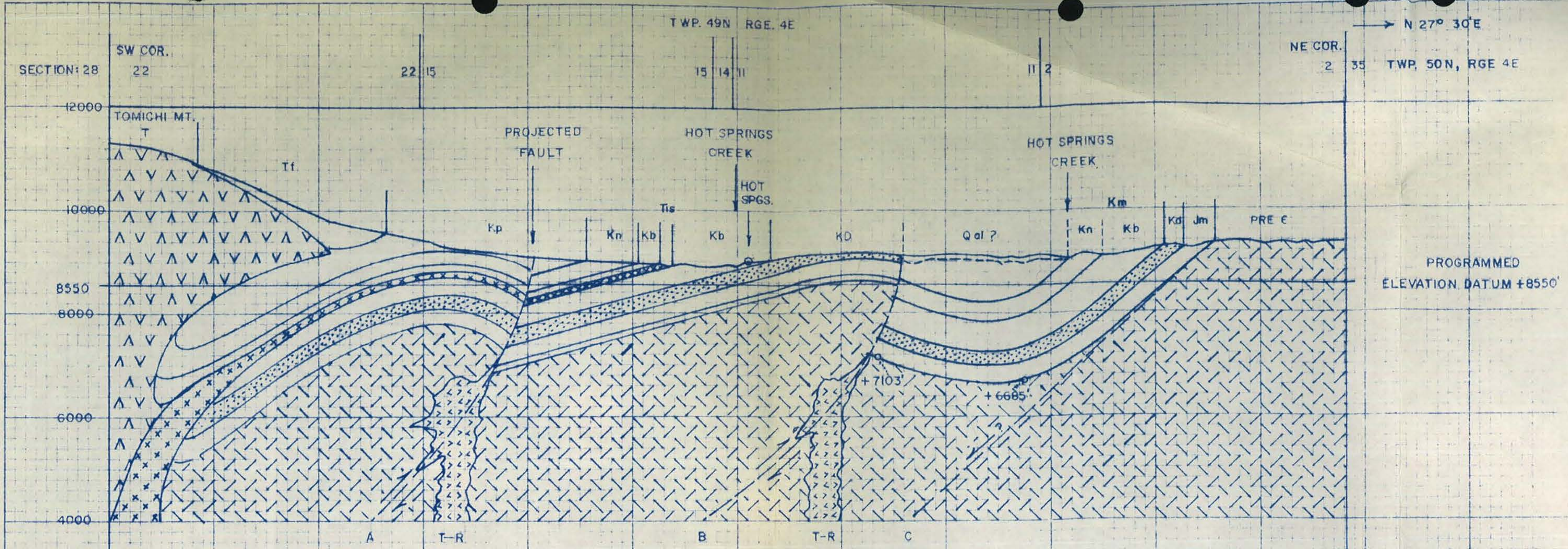
The Precambrian metamorphic rocks consist chiefly of red and gray granite cut by dikes of pegamatite and diabase, and other intrusives of rhyolite.

The Jurassic and Cretaceous shales and sandstones in the sedimentary section of the profile should not present an abnormal drilling problem. The Precambrian granites and Tertiary intrisives would present relatively hard drilling. Comparative densities of the rocks are as follows: (See next page.)

ERA	FORMATION	DENSITY
Cretaceous	Shale	1.98 to 2.20
and	Sandstone	2.35 to 2.50
Jurassic	Limestone	2.60 to 2.70
	Granite	2.56 to 2.74
	Diabase	2.73 to 3.12
	Rhyolite	2.35 5o 2.65

The depth of the sedimentary northeast of Fault B (+7,103 ft. and +6,685 ft.) was determined from ray path length time (T) and velocity (V) from the seismometer stations to the hypocenter locations (D). A velocity of 9,000 ft./sec. (V_1) was assigned the sedimentary section, and 20,000 ft./sec. (V_2) to the granitic section of the ray path. Then the distance traveled in the sedimentary section (d_1) is calculated from the equation $d_1 = V_1(VT-D)/(V_2-V_1)$. The depth to the d_1 point is then computed from the emergent angle of the ray path, and the distance traveled in the 9,000 ft./sec. section. These depths and the surface outcrops southeast of the depths points indicate the presence of the thrust Fault B.

The actual position and conformation of the intrisive T-R's at either faults B or A is not clear since they have been placed on the profile by projection. The magma at Fault B may be further northeast than is shown, and in contact with the Dakota Sandstone aquifer; otherwise faults A and B would provide the channel for the contact of the magma with the water supply thus forming the thermal cell.



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FAULTS:

A FAULT AT SURFACE PROJECTED 600 FEET TO THE SOUTH TO INTERSECT THE PROFILE

B FAULT DESCRIBED IN A PREVIOUS REPORT ADJUSTED TO SURFACE OUTCROPS

C FAULT SHOWN ON THE TECTONIC MAP OF THE U.S., BY THE U.S.G.S. AND THE A.A.P.G. THE NATURE OF DISPLACEMENT IS UNKNOWN

INTRUSIVES: T–R TERTIARY TO RECENT VOLCANIC PIPES OR DIKES INFERRED FROM MICROEARTHQUAKE HYPOCENTER CLUSTERS 2500 FT. NORTHWEST OF FAULT B, AND ON EITHER SIDE OF THE PROFILE AT FAULT A

DATA COMPILED FROM PROJECT MAP BY H.B. RENFRO AND COMPANY, AND "GUIDE TO THE GEOLOGY OF COLORADO" PUB BY G.S.A., R.M.A.G. AND COLO. SCIENTIFIC SOC.

LEGEND

Q a.		ALLUVIUM
T–R		TERTIARY TO RECENT INTRUSIVE MAGMAS
Tis		TERTIARY SILL, INTRUDED THE BENTON FORMATION
T		TOMICHI MOUNTAIN LACCOLITH OF MICROGRANITE OR RHYOLITE
Tf		VOLCANIC TUFF
Kp		PIERRE SHALE: PREDOMINANTLY SHALE AND SANDY SHALE
Km	{ Kn, Kb	MANCOS INCLUDES THE NIOBRARA CALCAREOUS SHALE AND LIMESTONE AND THE BENTON SHALE, SANDSTONE AND CALCAREOUS SANDSTONES WITH STREAKS OF BENTONITE
Kd		DAKOTA SANDSTONE WITH LENSES OF CONGLOMERATE, SHALE AND SANDY SHALE (AQUIFER)
Jm		MORRISON FORMATION CONTAINS; SHALE, SANDY SHALE, CALCAREOUS SHALE, SILTSTONE AND SOME LIMESTONE
PRE Є		PRECAMBRIAN, GRANITE AND METAMORPHICS

SUPPLEMENTAL REPORT on the WAUNITA PROJECT FOR AUSTRAL NUCLEAR ENGINEERING CORP. BY SENTURION SCIENCES INC.

GEOLOGICAL PROFILE
WAUNITA HOT SPRINGS AREA
GUNNISON COUNTY
COLORADO

SCALE: 1in = 2000 ft.