DRILLING AND PUMP TESTS OF PILOT WELLS

WAWONA, CA.

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Introduction

Prior studies conducted in the small valley at Wawona showed that there were at least three fracture zones in the Gateway Granodiorite. If these fractures were open, they could provide permeability required for flow of water to wells. It was recommended that pilot wells be drilled into the three fracture zones found in seismic survey studies.

Pilot Wells

Three pilot wells were drilled during the period September 5 through 9, 1983. Johnson Drilling Company of Fresno, CA. drilled the pilot holes using a Gardner Denver rig and a 6 1/8" downhole hammer bit. Air with a small amount of water was used to bring the drill cuttings to the surface.

The exact locations for the pilot wells were spotted on the ground by engineers from Dewante and Stowell Engineering and National Park Service staff. It was not possible to locate Well No. 1 any closer to Highway 41 without disturbing an archaeological site. However, the location of the boring was satisfactory and it did penetrate the southern portion of the fracture zone indicated by the seismic survey.

The exact location for Pilot Wells No. 1 and 2 were based on measurements from land marks described in the field notes of the seismic line run by R. H. Kleinfelder and Associates.

The seismic study was not run on the line shown on Plate 1 of the June 1983 report "United States National Park Service, Yosemite National Park, Wawona Development Area--Water Supply". A survey was made of the seismic line as described in the field notes using a Brunton Pocket Transit and a 100' tape. The location of this line is shown on Figure 1, Seismic Survey Line Wawona Project Well Locations. The location of each seismic run number are also shown on this line and correspond to the numbers used by Kleinfelder in the seismic survey.

Based on the above survey, the location of Well No. 2 indicates that it was very close to Station 1300 and within the outer portion of the fracture zone as shown on Figure 2. It was not possible to get exactly on the seismic line without removal of numerous trees.

The above survey shows that Well No. 3 was drilled about 70 ft. west of the landmarks described in the seismic survey report and was outside of the fracture zone (see Figures 1 and 2). Again, the location of this well was governed by access to the area without removal of trees.

Well Description

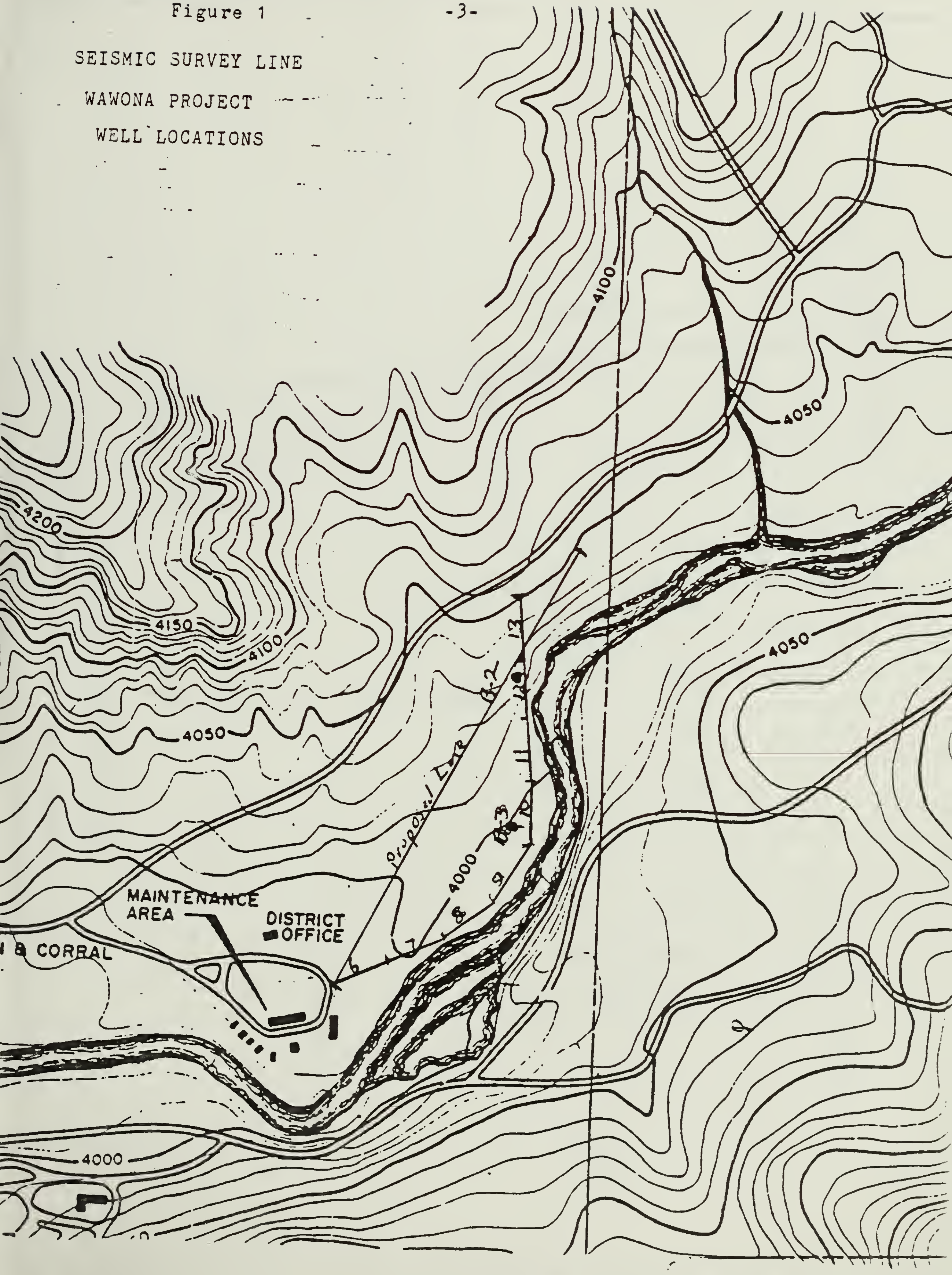
The Gardner Denver drill rig used to bore the wells is a percussion drill which "pounds" on the rocks while at the same time rotating. There is a loud hammer sound while drilling through hard rock. When a fracture zone or a softer rock is encountered, the pounding noise subsides and the rate of

Figure 1

SEISMIC SURVEY LINE

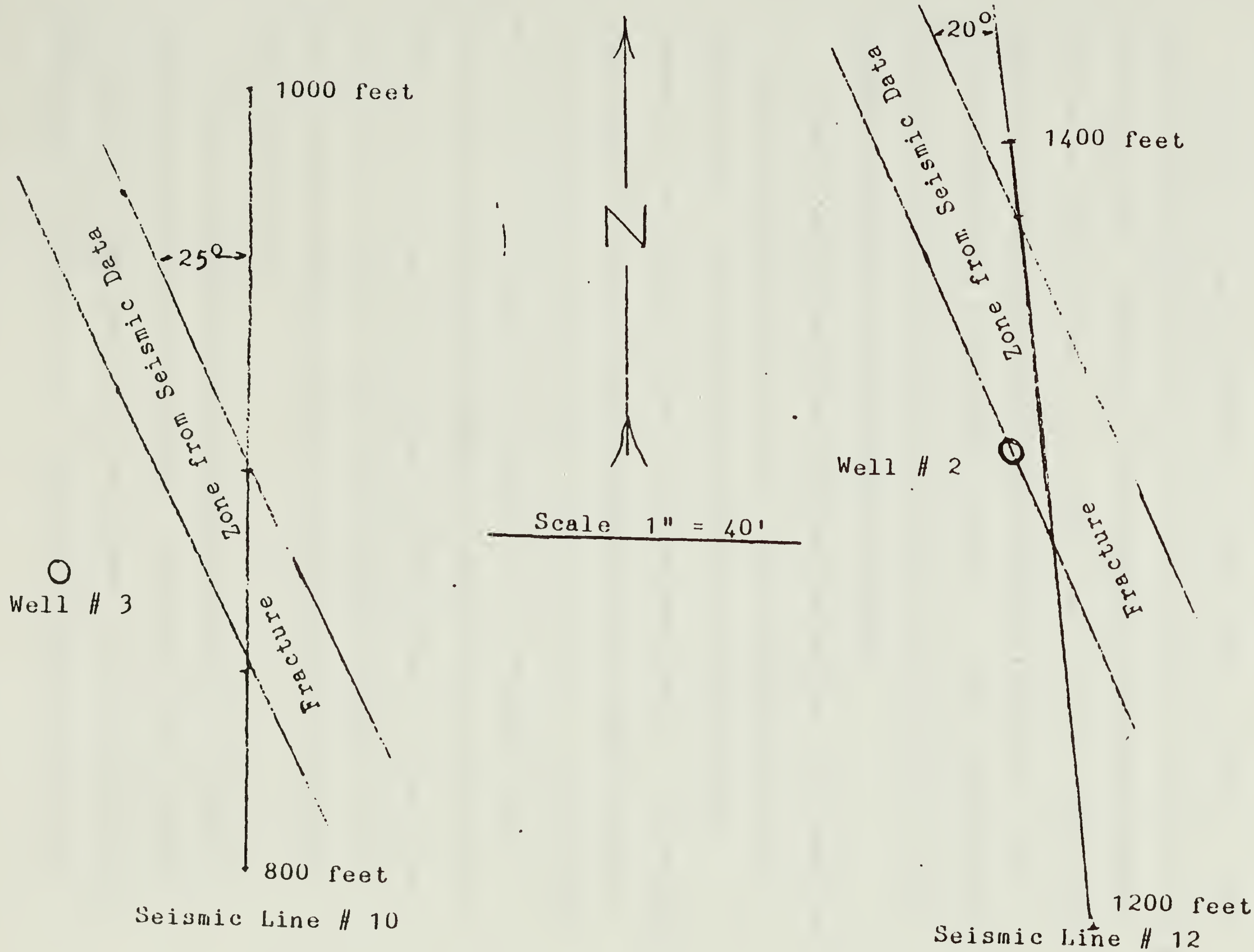
WAWONA PROJECT

WELL LOCATIONS



U. S. NATIONAL PARK SERVICE WAWONA PROJECT:

TEST WATER WELL LOCATIONS



drilling increases at the same time. This decrease in sound and increase in rate is interpreted as penetrating through a fracture zone of softer rock and is recorded on the drill log.

Well No. 1 was drilled to a total depth of 400 ft. The surface casing was set at 17 ft. in decomposed granitics using a driving shoe; The base of the weathered decomposed granodiorite was found to be 70 ft. below the surface. This depth confirms the depth to unweathered bedrock (62.5 ft.) found near the north end of seismic line No. 3. This confirms the existence of the fractured zone between Stations 780 and 900 as shown on Plate 2 of the June 1983 report.

A small amount of water entered Boring No. 1 at about 60 ft. depth from about the base of the weathered zone in the granodiorite. Five fracture zones were drilled through between 75 and 132 feet that produced some water. All outside water source to the air was stopped and flow from the fractures measured in the air return at 10 gal/min. No fractures were detected during drilling between 135 and 230 feet. A small amount of water was added to the air while drilling to help lift cuttings and to keep the hole clean. Three large and two small fracture zones were detected between 230 and 400 ft. depth. These zones did not produce any additional water to the well.

After completion of the boring to 400 ft., the flow of water from the well was measured. The drill water was shut off and water from the boring was blown to the surface by air pumped down the drill stem. Production was measured at 12

gal/min after 20 minutes of pumping and stabilized at 14 gal/min after 25 minutes of pumping (See Drill Log in appendix).

It took 45 minutes to remove the drill stem and bit from the hole. The water level was measured at 20.4 ft. from ground surface at that time. It was measured 50 minutes later at 20 ft. from the surface. A cap was welded on the casing and the rig moved to the next drill hole location.

Pilot Well No. 2 was drilled to a total depth of 300 ft. Surface casing was driven to 17.5 ft. into the weathered granitic material. The weathered decomposed granodiorite extended to 60 ft. below the surface. Plate No. 2 for the June 1983 study shows that there was a change in velocity from 1275 ft/sec to 4700 ft/sec at a depth of 37.5 ft. at Station 1350. The indicated 60 ft. of easy drilling shows that the boring is located in a fractured zone with broken weathered material to a depth of at least 60 ft.

An estimated inflow of 1 gal/min was entering the boring at the base of the fractured/weathered zone at 60 ft. The cuttings from the rig were blown to the surface in a dry condition to a depth of about 96 ft. where the first major fracture zone was encountered. Some inflow from this zone resulted in wet, muddy cuttings being blown to the surface. A total of 4 fracture zones were found between 96 and 120 ft. below the surface. Measured flow from the air return from the drill rig was 7 gal/min. at this depth. Seven additional fractured zones were found from this depth to 226 ft. No

additional flow entered the boring from these fractures. No large fracture zones were found from 226 to 300 ft. One zone of softer drilling with maffic cuttings was found between 260 and 269 ft. There was no increased flow of water from this zone. Drilling was terminated at 300 ft. based on findings at Boring No. 1. Drill stem pumping, as previously described, showed a stablized flow of 6 gal/min. from Boring No. 2.

Pilot Boring No. 3 was drilled to a total depth of 280 ft. Surface casing was driven to 24 ft. through overburden to unweathered granodiorite. The only water encountered was in the two fracture zones above 65 ft. Five small fractures were found in the zone 85 to 187 ft. There was no new water flowing to the boring from these fractures. The rock was unfractured between 187 and 280 ft. when drilling was terminated. The pump tests, as previously described using drill stem and air, stablized at 3 gal/min.

Geohydrology

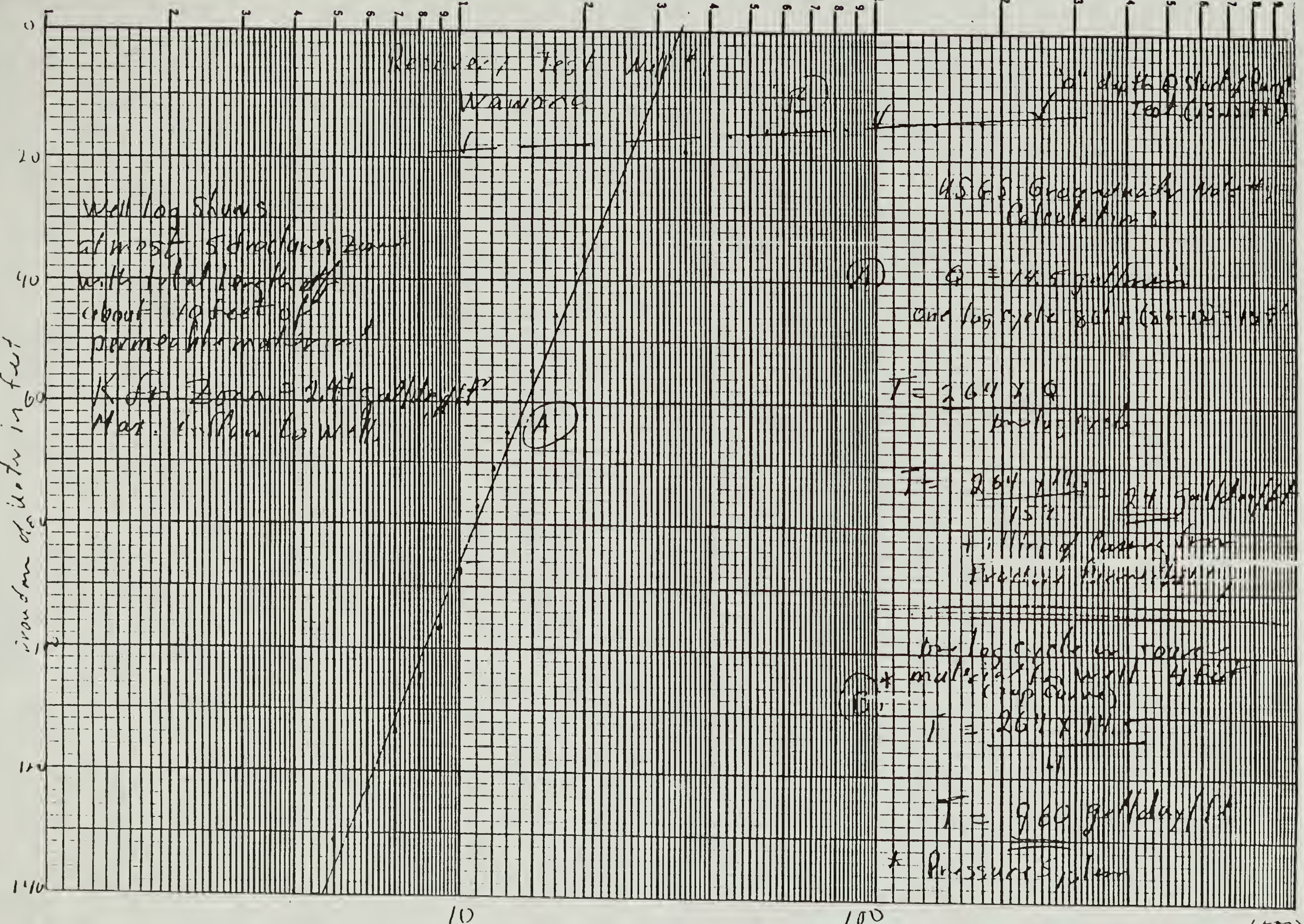
Data obtained from the three borings and the drill stem pump test would indicate that the three fracture zones found in the seismic survey do exist. The fracturing and/or faulting occurred during uplift of the Sierra Nevada block millions of years ago. The material in the fractured zones have weathered and decomposed resulting in a filling or partial filling of the zones with clay-like materials that do not provide for rapid flow of water to a boring. The only possibility of obtaining higher yield from wells would be to locate a more recent fracture/fault zone that has not had time

to fill in with weathered materials. Information obtained from the geologic mapping by Dallas Peck of the U.S. Geologic Survey did not show any faults in the immediate vicinity of Wawoma. Based on this information, it would be highly unlikely that a recent fault could be found in the area that could produce the open fractures required for large well production.

Pump Test

One pump test was conducted on Pilot Well No. 1 to determine transmissivities of the fracture zones and to characterize the hydrogeologic system. No pump tests were run on test Wells 2 and 3 because of the low yield indicated in the drill stem pump testing. The water level prior to start of pumping was 15.15 ft. from the top of the casing. The pump was started at 10:20 a.m. on September 20, 1983. Initial pumping rate was 40 gal/min., decreasing to 15 gal/min. in 20 minutes with a drawdown of 195.5 ft. This is about 60 ft. below the elevation of the fracture zone from which the last water entered the hole during drilling. Pumping continued for a total of 5 hours with the rate of extraction of about 14.5 gal/min. Drawdown was maintained at about 200 ft. below the surface which was 14 ft. above intake of the pump.

The pump was shut off at 3:20 p.m. and recovery of the water level in the boring hole recorded for 180 minutes (3 hrs.). This information is recorded on Figure 3 along with calculations of transmissivity for the fracture zones and the pressure aquifier system providing recharge to the fractures.


Recovery Test well #
Wawona
0" depth @ start of pump test (13-15 ft)
Well log shows
almost 5 fractures zones
with total length of
about 10 feet of
permeable material
K for Zone = 24 gal/day/ft
Max. […] flow to well
(A)
(B)
USGS Groundwater Notes
Calculation:
(A) Q = 14.5 gal/min
One log cycle
T = 264 x Q
T = 264 x 14.5 / 15.7 = 24 gal/day/ft
filling of fractures
(B) One log cycle
* multiply […] 4 feet
T = 264 x 14.5 / 4
T = 960 gal/day/ft
* Pressure system
drawdown depth to water in feet
0
20
40
60
80
100
120
140
10
100
1000

These calculations show that permeability of the 10 ft. of fractures that produced water is about 2.4 gal/day/sq. ft. (curve A). Calculations of the transmissivity of the pressure system providing water to the well indicates that transmissivity of 960 gal/day/ft. It is unknown how thick this system is so a permeability cannot be calculated. The curve shape would indicate that the fractures are under artesian pressure from a source that was not apparently affected by the withdrawal of the small amount of water extracted during the pump tests (4,600 gals.)

Conclusions

It can be concluded from information obtained from drilling of the pilot hole and pump tests that the fracture permeability in the Gateway Granodiorite is low compared to fracture permeability in other areas. This low permeability is probably the result of weathering and decomposition of the materials in the fracture zone into a clay-like material which reduced the original fracture permeability.

The pump test at Well No. 1 would indicate that this 6 inch pilot hole could produce a constant yield of about 14 gal/min. with a pump lift of about 140 ft. The permeability of the fracture zones averages about 2.5 gal/day/sq. ft. An increase in the diameter of the hole would increase the yield from the well to some extent based on the number and extent of fracturing found to exist in the larger diameter hole. Additional borings within the zone would also provide for yields equivalent to that found in Pilot Hole No. 1. There