Memorandum Report No. 10

ELECTRIC WELL LOGGING ON OAHU

PROGRESS REPORT

by

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Electric Well Logging on Oahu

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The Water Resources Research Center has begun an investigation of the uses of lectric well-logging in Hawaiian hydrogeologic conditions. Partial financial suport and much field assistance have been provided by the Honolulu Board of Water upply, and cars and additional field assistance have been provided by the U. S. eological Survey and the Hawaii Division of Water and Land Development. The quipment used has included the following:

1. Portable electrical logging device: Logmaster Model LMR-D, dual pen, dual channel recorder, 1500 feet capacity power winch with 3-conductor armored cable, powered by gasoline generator.

2. Downhole logging tools:

   Point Resistivity sonde: Logmaster Model LME-2A, used for point resistivity and Spontaneous Potential surveys.

   Multi-electrode sonde: Logmaster Model LME-2N, used for 6' lateral resistivity and Spontaneous Potential.

   Cable Electrode Assembly: Logmaster Model LME-2-CE, used with LME-2N to obtain 16" Short Normal resistivity, 64" Long Normal resistivity, and Spontaneous Potential.

   Conductivity Sonde: Beckman Instruments Model DWSM-2 Deepwell Solumeter, temperature compensated 3 cell bridge assembly with constants of .2,2, and 20 and thermistor for obtaining temperature, used with surface command set Beckman Instruments Model DWSM-CS-2.

Since the arrival of the electric well logger in April, 1966, 32 producing lls and test wells plus 2 small diameter test holes have been surveyed on Oahu. cations of these wells, the types of logs obtained, and pertinent remarks are esented in Table 1. Additional data in the form of driller's logs, method of illing, production data and especially conductivity logs of in-place water are ginning to permit interpretations of the hydrogeologic character of the formaons from the electric logs. Increased experience and familiarity with the uipment is also facilitating the process of obtaining better logs and interetation of results.

The correlation between the interpretation of electric logs made on sediints and actual drilling cores is excellent. This was demonstrated in a well at uloa (T-134) which penetrated 509 feet of sediments and to a lesser degree in lls at Ewa Beach (T-133-1 and T-133-2) despite suppressed resistivity due saline formation water. Figures 2, 3, and 5 in the report (Cox and Lao, 1967) these wells show the comparison of the lithologic log versus the electric gs and also the construction of these wells.

Electric logs obtained on wells in basalt generally display good electric contrasts but their interpretation is more difficult than is the case with the logs in sediments. At present, no cores are available for direct correlation with electric logs. It is presently possible to qualitatively differentiate permeable from impermeable zones and accurately and routinely to define zone thickness, casing depth, total depth of hole and water level. Quantitative interpretations of expected yields from likely permeable zones cannot be made at present, although before long with more data and experience, usefull approximations will be possible. An example of the interpretation of the electric logs taken on well No. 200-4 at Pearl City is presented as Figure 1 of this report. A driller's log is shown alongside to illustrate the similarities and the differences of detail. Although the electric logs cannot yield properties such as color or consistency of the wall rock materials, valuable information about the water bearing properties and quality of the water can be obtained in some detail. Note the differences between the driller's log and the interpreted log: where the driller's log indicates soft red rock between 42 and 52 feet MSL, the electric log shows the zone is made of soft strata up to 3 feet thick alternating with four harder and less permeable zones; other intervals in the logs show similar differences in detail. A conductivity log when run of the water in this well will give a better picture not only of the lithology but also of the water-bearing properties of the rock.

The long awaited downhole conductivity device finally arrived late in 1966. After adaption to our Logmaster logging unit, the sonde was tried in Well No. 202-2C at Pearl City. A leaky seal allowed water to enter and short out a portion of the sonde circuit. Also the output of the bridge was insuffidient to drive the recorder to full scale and the desired resolution. Although the seal was repaired and the bridge modified for a higher output, intermittent circuit problems have prevented extensive use of the sonde. It will receive a thorough examination by the manufacturer. Nevertheless, a very successful survey was subsequently run on the same well in Pearl City. The results of the survey and also of previous resistivity and spontaneous potential survey are presented as Figure 1. A comparison of the thief sampling made by the BWS three months earlier in September, and the conductivity log is very good considering the time lag. The deviation ranges from 10 to 43 micromhos, averages about 20 micromhos. In addition, the conductivity sonde shows a continuous record of the in-place quality of water with less disturbance of the water column than thief sampling. Therefore the location of the changes can be found accurately.

Through the combined use of conductivity logs of in-place borehole fluids and other electric logs, drillers logs, and production data, we hope to provide

useful estimates of expected yields on the basis of resistivity of the aquifer zones. For example, it seems clear from the conductivity log and the resistivity log for Well No. 202-2C that if the casing of this well had not been perforated and if it had been seated in the dense basalt at 300 feet MSL then the poorer quality upper water would have been shut off, and the overall quality of the water would have been better.

References

Cox, D. C. and C. Lao. 1967. Progress in the development of deep monitoring stations in the Pearl Harbor Ground Water area, Oahu, Hawaii.

TABLE 1. SUMMARY OF ELECTRIC WELL LOGGING ON OAHU

LOCATION	DATE	WELL I.D. NUMBER	TYPE OF LOG OBTAINED					REMARKS
			SP*	PR	SHORT 16" NORMAL	LONG 64" NORMAL	6' LATERAL	
KALAUAO	4/29/66	T-118	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
HOAEAE	5/4/66	236-3D	X	X	X	X	X	OIL IN WELL.
PEARL CITY	5/10/66	201	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
EWA BEACH	5/18/66	T133-2	X	X	X	X	X	PERMEABLE ZONES IDENTIFIED.
AIEA	5/25/66	191-3B	X				X	LOGGING NOT COMPLETED.
AIEA	5/25/66	191-2	X	X	X	X	X	OIL IN WELL, SOME CONTRASTING ZONES.
MANANA	6/1/66	SHAFT #9	X	X	X	X	X	INCONCLUSIVE.
PUNALUU	6/2/66	402-2A	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
PUNALUU	6/2/66	402-2B	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
PUNALUU	6/2/66	401	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
HOAEAE	6/14/66	236-3B	X				X	OIL IN WELL, INCONCLUSIVE.
WAIPAHU	6/14/66	241	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
EWA BEACH	6/25/66	T-133(#1)	X	X	X	X	X	BASALT DEFINED FROM CORAL AND CLAYS.
PUULOA	7/9/66	T-134	X	X	X	X	X	PERMEABLE ZONES ON LOG CONFIRMED BY CORE.
AIEA	7/12/66	191-3A	X	X	X	X	X	GOOD CONTRAST.
WAIMANALO	8/4/66	DH #1	X	X			X	INCOMPLETE, DRILLING STILL IN PROGRESS.
MOKULEIA	9/27/66	T-116	X	X	X	X	X	INCONCLUSIVE, WILL BE RE-RUN.
MOKULEIA	9/26/66	T-117	X	X	X	X	X	GOOD RESISTIVITY CONTRASTS, UNUSUALLY FLAT SP.
WAIMANALO	9/27/66	DH #3	X	X			X	INDICATES WATER QUALITY CHANGE, DEFINES TWO FORMATIONS.
MOKULEIA	10/5/66	325-2	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
WAIALUA	10/5/66	T-30	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
PEARL CITY	10/6/66	202-2C	X	X	X	X	X	GOOD CONTRASTS OBTAINED, CONDUCTIVITY LOG ALSO RUN. 12/16/66
PEARL CITY	10/7/66	200	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
PEARL CITY	10/7/66	200-4	X	X	X	X	X	GOOD MATCH WITH DRILLER'S LOG.
WAIHEE	10/14/66	T-114	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
WAIHEE	10/14/66	T-115	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
PEARL CITY	10/17/66	198-3	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
IOLEKAA	10/17/66	407-17	X	X	X	X	X	GOOD CONTRASTS OBTAINED.
KUNIA	12/19/66	330-8	X	X	X	X	X	VERY HIGH NOISE LEVEL FOR PR AND 6' LATERAL.
PEARL CITY	1/10/67	191-3B	X	X	X	X	X	COMPLETION OF LOGGING ON DEEPENED HOLE.
PUNALUU	1/16/67	402-2B	X	X	X	X	X	RELOGGED BECAUSE PREVIOUS WINCH FAILED.
PUNAHOU	1/17/67	37	X	X	X	X	X	DETECTED BREAK IN THE CASING AND CHANGE OF WATER QUALITY.
HONOLULU	2/1/67	36A	X	X	X	X	X	WELL CAVED TO WITHIN FEW FEET OF CASING.
WILDER P.P. PEARL CITY	2/2/67	T-118	X	X	X	X	X	SEASONAL CHANGE OF WATER QUALITY INDICATED CLEARLY IN LOGS.

*SPONTANEOUS POTENTIAL IS SIMULTANEOUSLY RECORDED WITH ALL ELECTRODE SPACINGS AND CONFIGURATIONS FOR RESISTIVITY.

Interpretation of Electric Logs, Well No. 200–4
Pearl City, Oahu

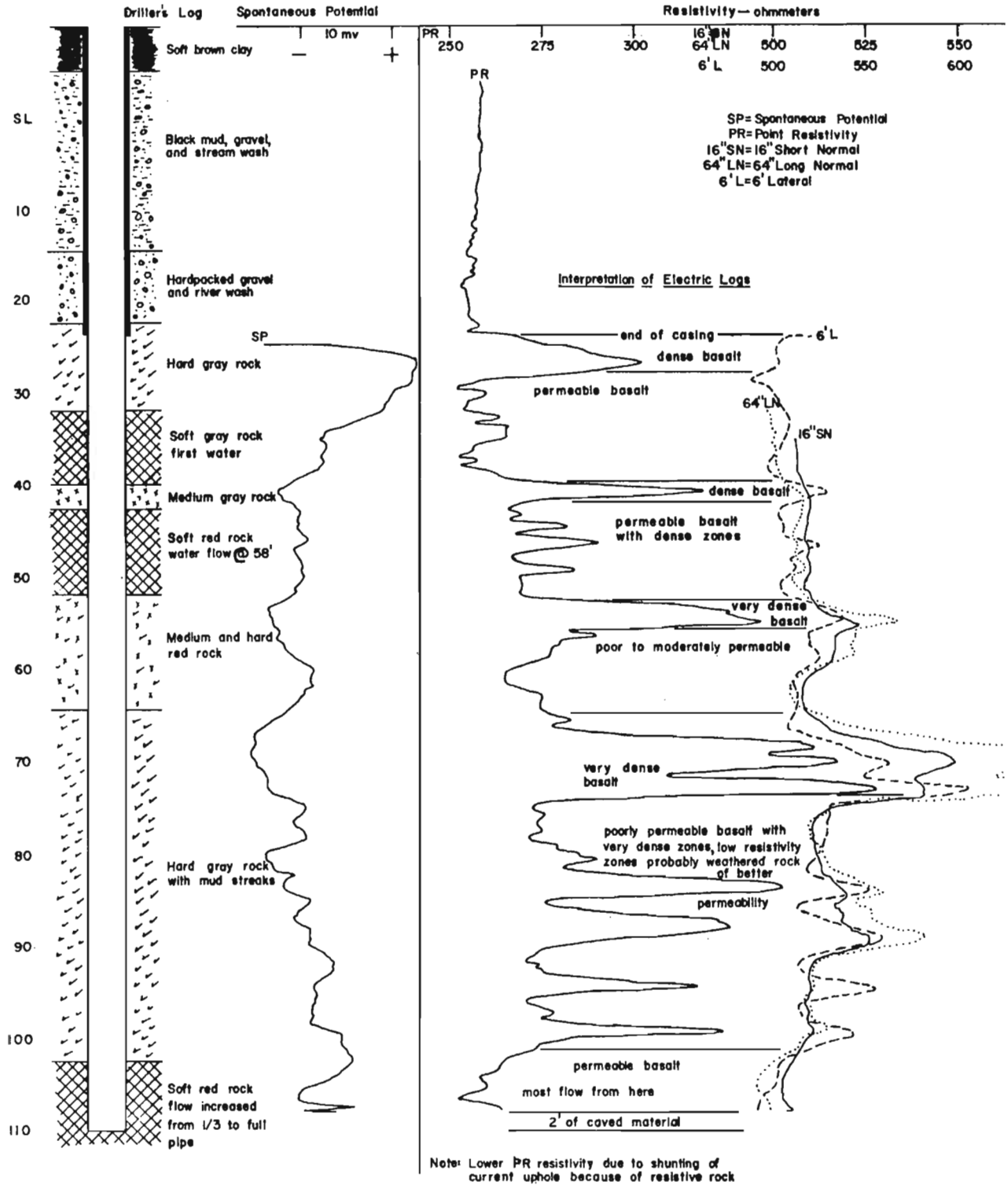

FIGURE 1

Interpretation of Electric Logs of Well No. 202-C
Pearl City, Oahu

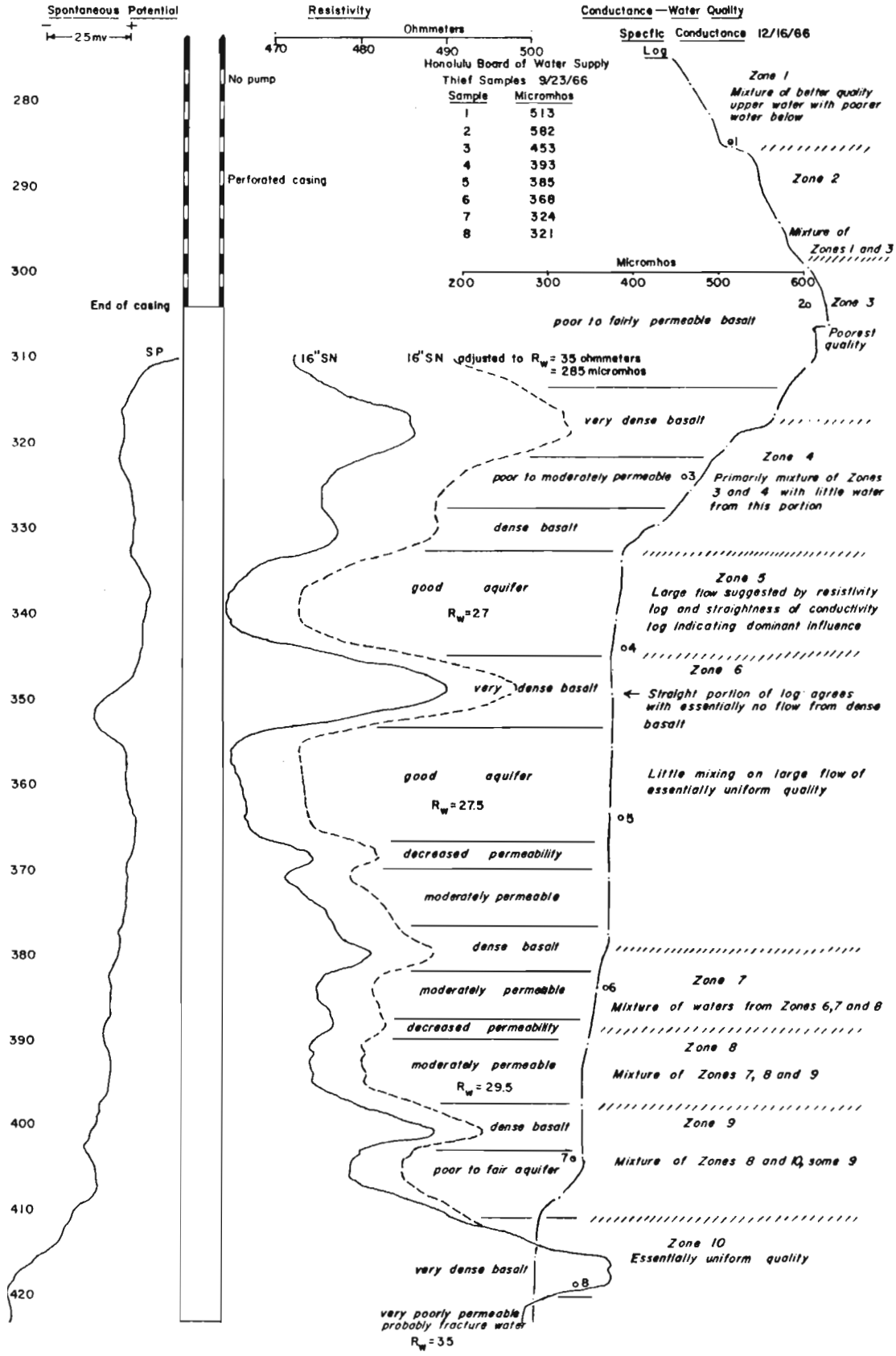

FIGURE 2