

SHELL DEVELOPMENT COMPANY

TO: ALASKA EXPLORATION DIVISION

DATE DECEMBER 6, 1976

ATTN: GRANT VALENTINE

FROM GEOCHEMICAL SERVICE

*Pyrolysis/
Vitrinite Reflectance*

SUBJECT SOURCE ROCK AND MATURITY STUDY, STANDARD OF CALIFORNIA NORTH FORK UNIT NO. 41-35, SEC. 35 T4S R14W, SEWARD BM., ~~SEWARD~~ COOK INLET BASIN, ALASKA

I attach a letter that you may use to transmit the results of our geochemical study to the State of Alaska. This information should suffice to comply with our agreement to release the results of our studies to the public.

J. R. Castaño
J. R. CASTAÑO Bel Air Lab.
663-2603

Attachment

JRC/v1

cc: J. R. Castaño (w/attachments)

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SOURCE ROCK AND MATURITY STUDY
STANDARD OF CALIFORNIA NORTH FORK UNIT NO. 41-35
SECTION 35 T4S R14W, SEWARD B & M.,
COOK INLET BASIN, ALASKA

DECEMBER 6, 1976

Vitrinite Reflectance Study

A total of 13 ditch samples were prepared for vitrinite reflectance study. For the shale samples, the vitrinite was concentrated by non-oxidative acid solution of the inorganic matrix. Standard A.S.T.M. procedures are followed for polishing and examining the specimens.

The results of the study are summarized on the individual histograms and on the table shown below. On the histograms, each vitrinite reflectance reading is shown to the nearest 0.01% reflectance in oil (%Ro), and the values are summed up for each 0.1% Ro group. In the table, the maximum and minimum reflectance give the extremes in the readings, the (arithmetic) mean Ro is given with the limits of uncertainty calculated for 95% confidence limits.

TABLE 1
VITRINITE REFLECTANCE STUDY

<u>DEPTH, FT.</u>	<u>LAB. NO.</u>	<u>SAMPLE TYPE</u>	<u>MAX RO%</u>	<u>MIN RO%</u>	<u>MEAN RO±95% CONFIDENCE LIMITS</u>
11990-12110	13116	Ditch	.54	.28	.39±.02
11990-12000	13107*	Ditch, Coal	.45	.31	.38±.01
12090-12100	13108*	" "	.63	.32	.45±.02
12230-12240	13109*	" "	.62	.43	.53±.01
12230-12420	13117	" "	.67	.27	.42±.03
12240-12250	13110*	" Coal	.67	.27	.49±.03
12330-12340	13111*	" "	.58	.39	.51±.02
12400-12410	13112*	" "	.66	.36	.53±.02
12540-12590	13118	" "	.80	.26	.43±.03
12570-12580	13113*	" Coal	.62	.37	.53±.01
12670-12680	13114*	" "	.58	.37	.50±.01
12670-12810	13119	" "	.60	.31	.39±.02 ✓
12730-12740	13115*	" Coal	.69	.36	.51±.02

* These samples are coals, which were prepared without using any acid treatment.

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In order to obtain better data from the very small samples, we hand picked coal chips from several intervals. The data from the coals provide good data needed to determine the burial history.

Some of the methods used to determine the burial metamorphic history are summarized in the attached table taken from a publication by Hood and Castaño. These methods are related through the use of the LOM (Level of Organic Metamorphism) scale reported by Hood et al in the AAPG Bulletin. The techniques for measuring the level of organic metamorphism reflect the irreversible effects of temperature and time, hence, of thermal history. Therefore, the reflectance data can be tied readily into the LOM or coal rank scales.

Source Rock Richness Study

To evaluate the organic richness of the ditch samples, we determined both their organic carbon (C_{org}) and the effective carbon (C_{eff}) contents. Organic carbon, or acid-insoluble carbon, represents the total amount of organic matter in the rock, and it is determined by measuring the total amount of carbon dioxide evolved during combustion of an acid-treated sample.

On the other hand, effective carbon reflects the fraction of organic carbon which is thermally convertible to petroleum. As estimates of effective carbon, we used two laboratory pyrolysis procedures. One method, pyrolysis-fluorescence (PF) is a rapid means of evaluating the petroleum generating potential, by measuring (in arbitrary PF units) the amount of fluorescing bitumen generated on heating. PF values in rocks can range from zero to several thousand units. For additional data, refer to Heacock and Hood (1970). The second method, pyrolysis-FID (P-FID) provides a measure of the amount of organic matter which can be converted thermally to hydrocarbons. A small amount of sample (less than 200 milligrams) is heated in a flowing stream of pure nitrogen at temperatures increasing from room temperature to 750°C at a rate of 25°C per minute. The volatile organic compounds are distilled at temperatures less than about 300°C. At higher temperatures nonvolatile organic matter is pyrolyzed to form volatile hydrocarbons. The distillation (D) and pyrolysis (P) products are carried (by nitrogen) to a hydrogen flame ionization detector (FID). The FID signal can be converted to percent hydrocarbons or percent carbon by calibration with a petroleum wax. For further data on the method and instrumentation see Eggertsen and Stross (1972).

Non-carbonate carbon was run on sixteen ditch samples, (Table 2). These samples were mostly shale and siltstone, as most of what little coal there is was utilized for other studies.

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TABLE 2

NON-CARBONATE CARBON ANALYSIS

<u>DEPTH, FT.</u>	<u>LEACHING FACTOR(1)</u>	<u>WT. % ORGANIC CARBON, CORG(2)</u>
11900-11910	.8057	2.29
11910-11920	.7558	1.65
11990-12000	.8223	1.86
12000-12010	.7609	1.58
12090-12100	.7716	1.54
12240-12250	.7732	1.45
12330-12340	.8013	2.48
12340-12350	.7714	2.42
12400-12410	.7752	3.09
12410-12420	.8157	2.30
12540-12550	.7830	2.02
12550-12560	.7289	2.23
12570-12580	.7525	2.16
12580-12590	.7790	2.22
12680-12690	.7722	1.68
12800-12810	.7562	1.74

(1) $\frac{\text{WT Leached Sample}}{\text{Wt Original Sample}}$

(2) $\frac{\text{Wt. Carbon}}{\text{Wt. Original Sample}} \times 100$

Pyrolysis -FID Data are summarized on the attached source rock log plotted at a scale of one inch equals 100 feet and on Table 3. As shown on Table 3, we ran coal and shale samples separately for P-FID. However, we ran the original unpicked sample for pyrolysis-fluorescence. And, as only a few coal chips ran gave a very high reading, the PF and FID values do not correspond in all cases.

TABLE 3
 PYROLYSIS-FID STUDY

<u>DEPTH, FT.</u>	<u>SAMPLE TYPE</u>	<u>D/P RATIO</u>	<u>TOTAL HC YIELD WT %</u>
11900-11910	Ditch, picked shale	.044	1.939
11910-11920	" " "	.031	2.550
11990-12000	" " Coal	.018	5.545
12000-12010	" " Shale	.020	1.912
12090-12100	" " "	.030	0.417
12100-12110	" " "	.033	0.497
12230-12240	" " Coal	.009	2.564
12240-12250	" " Shale	.48	0.197
12330-12340	" " "	0.037	0.838
12340-12350	" " "	.028	1.455
12400-12410	" " "	.038	.768
12410-12420	" " "	.031	1.225
12540-12550	" " "	.024	0.707
12550-12560	" " Coal	.044	0.929
12570-12580	" " Shale	.067	0.324
12580-12590	" " "	.022	1.773
12670-12680	" " "	.019	.624
12680-12690	" " "	.023	1.464
12730-12740	" " "	.020	1.234
12790-12800	" " "	.035	1.031
12800-12810	" " "	.113	.349

References

Eggertsen, F.T. and Stross, F.H., 1972, Flame Detection Method for Determining Organic Carbon in Water, Anal. Chem. V.,44 P709-714.

Heacock, R.L., and Hood, A., 1970, Process for Measuring the Live Carbon of Organic Samples, U. S. Patent 3,508,877, April 28, 1970.

Hood, A., and Castaño, J. R., 1974, Organic Metamorphism: Its Relationship to Petroleum Generation and Application to Studies of Authigenic Minerals, CCOP Tech. Bulletin, Vol. 8, P.85-118.

COMPANY - STANDARD OF CALIFORNIA

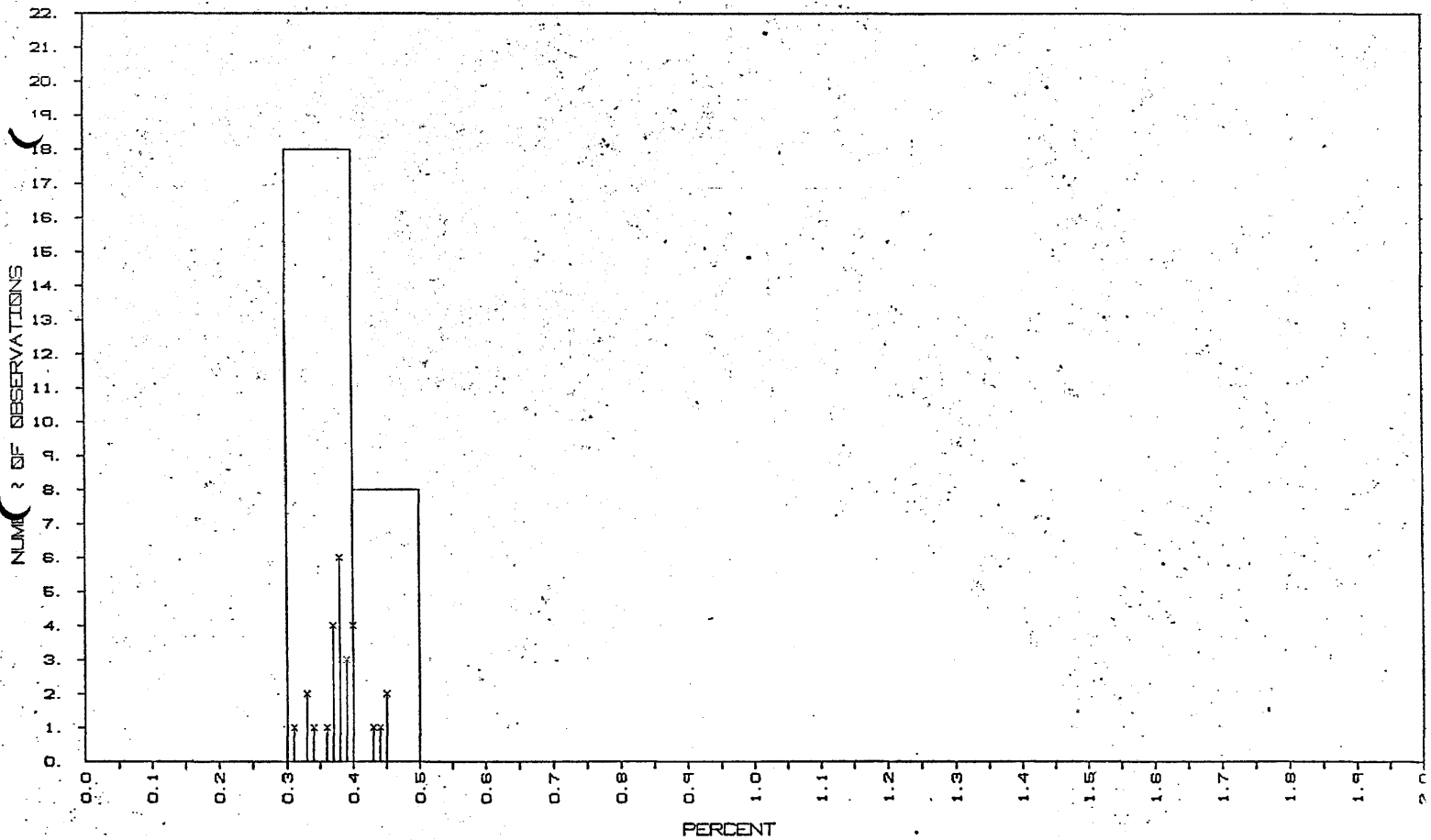
LAB NO. - 13107

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 11990 12000

STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

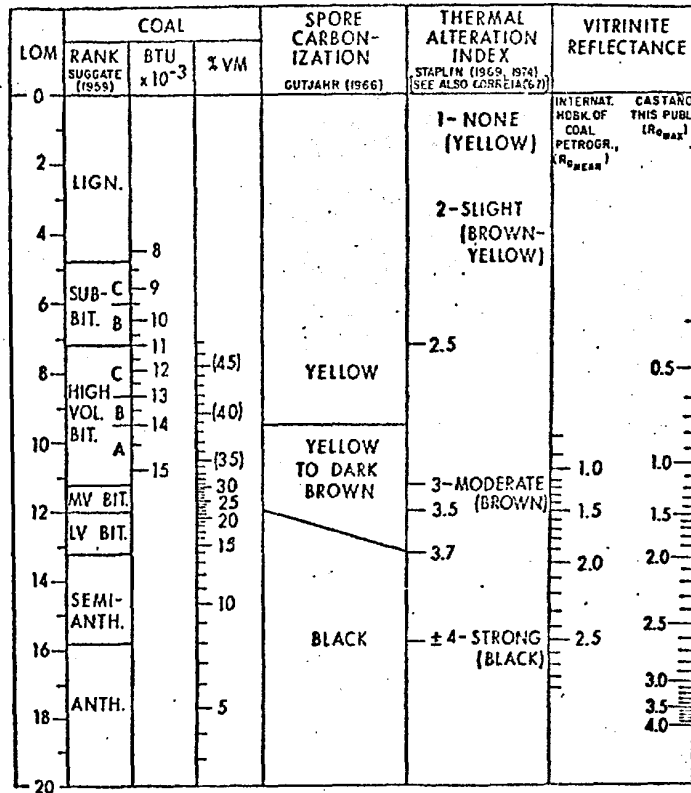


Figure VII-4. Some scales of organic metamorphism (Hood *et al.*, in press).

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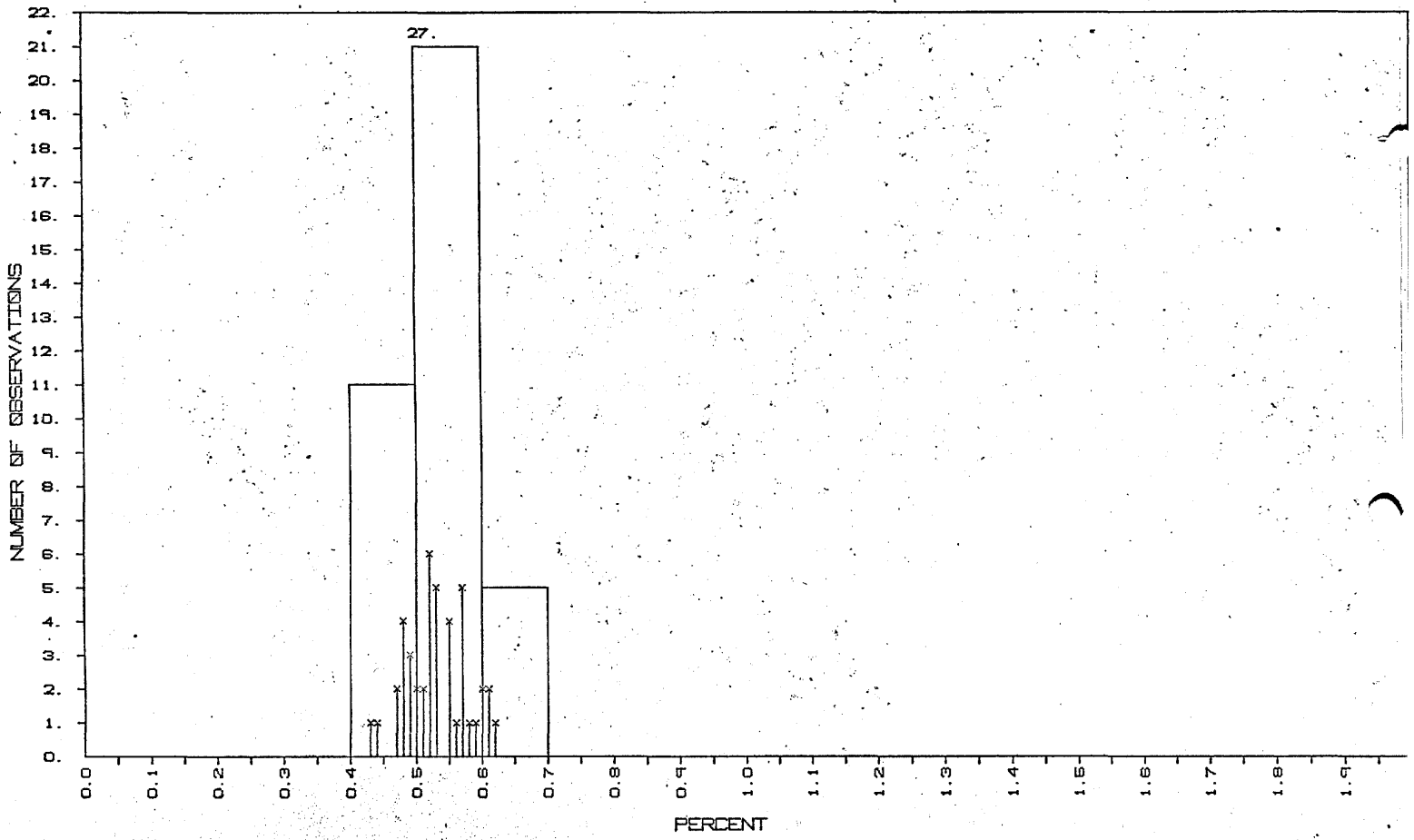
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WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12230 12240

STATE - AK



VARIABLE PERCENT HISTOGRAM

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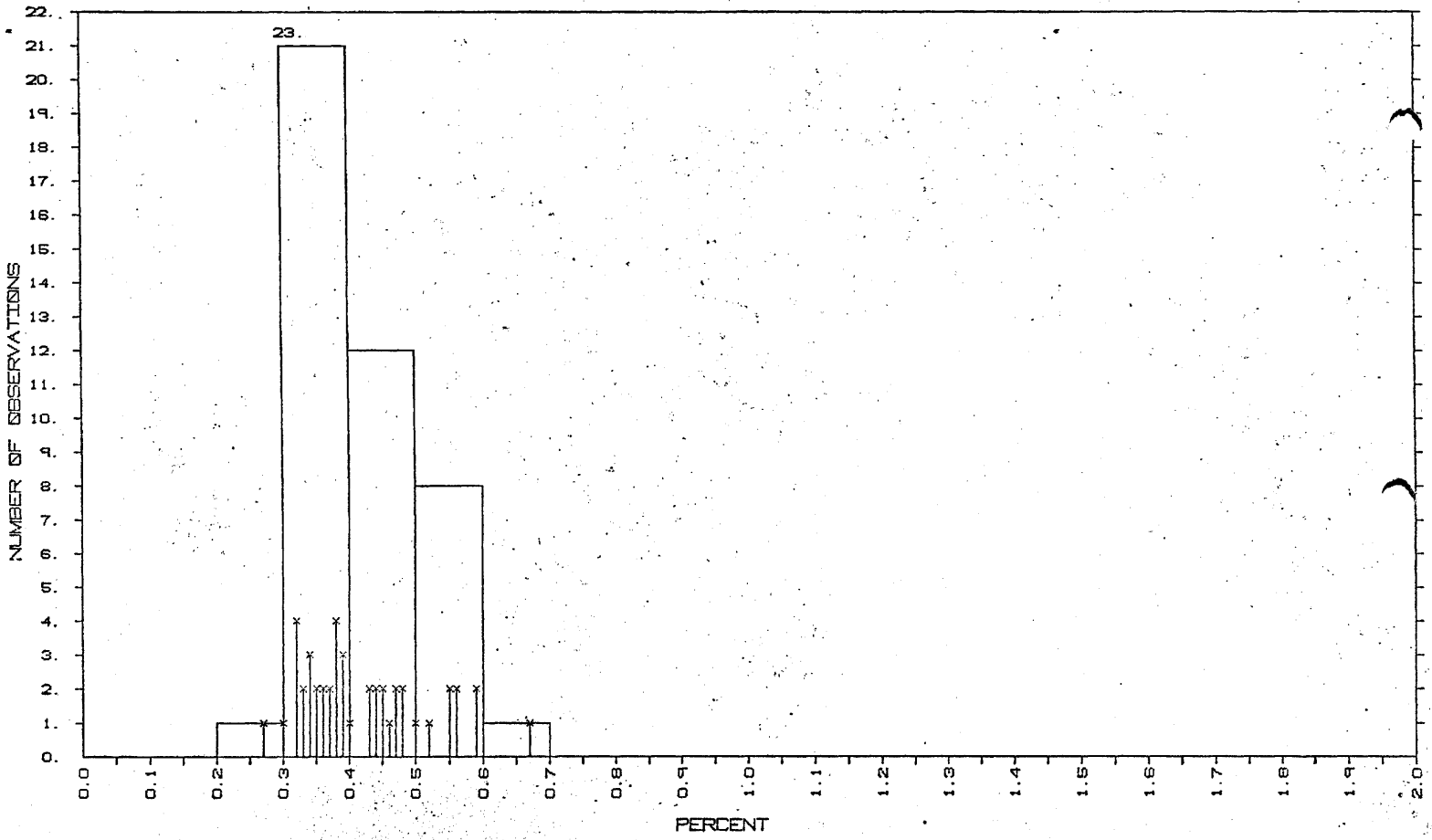
LAB NO. - 13117

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12230 12420

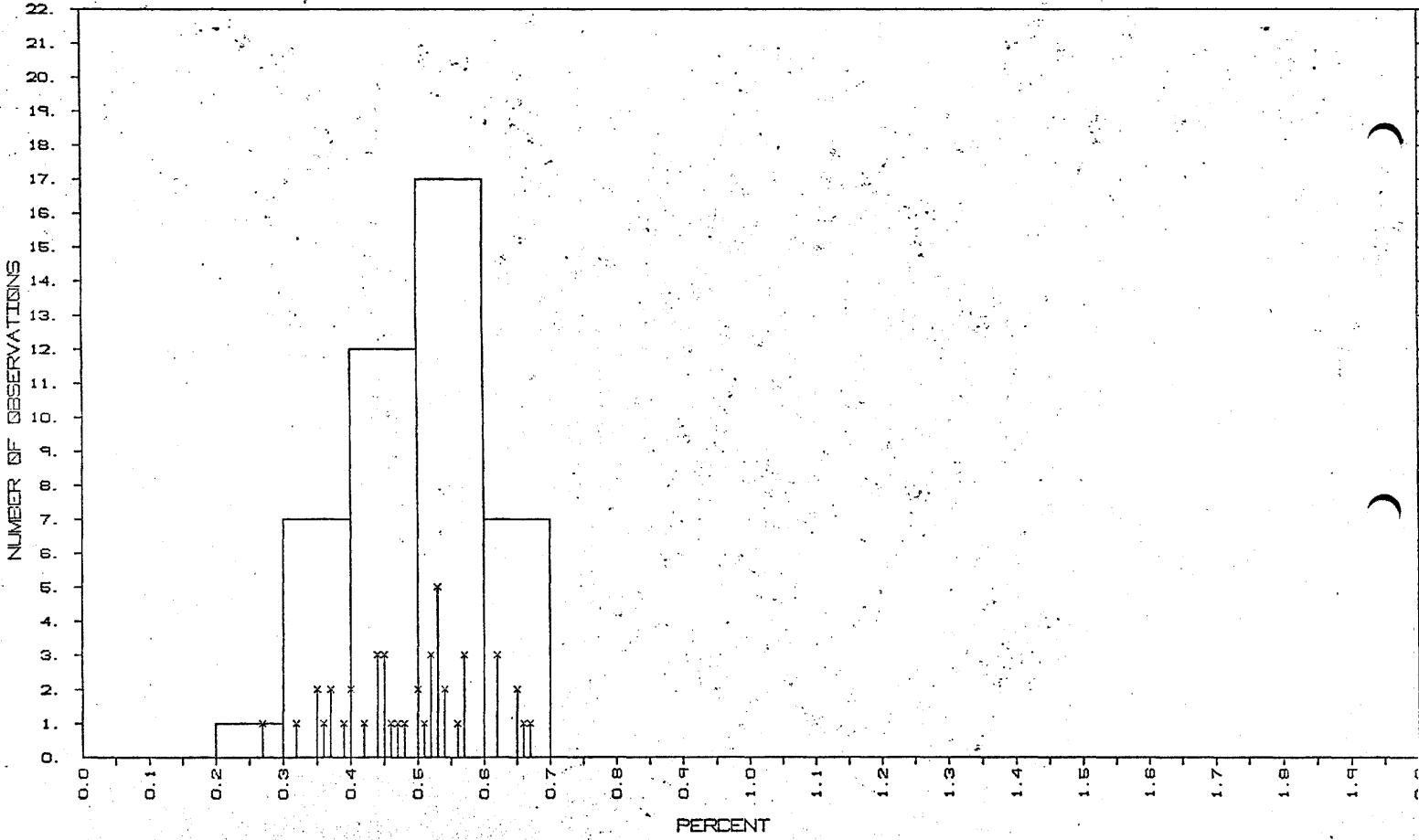
STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

COMPANY - STANDARD OF CALIFORNIA
WELL OR OUTCROP - NORTH FORK NO. 41-35
DEPTH OR SAMPLE NO. - 12240 12250

LAB NO. - 13110
LOCATION - 35 4S 14W
STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

COMPANY - STANDARD OF CALIFORNIA

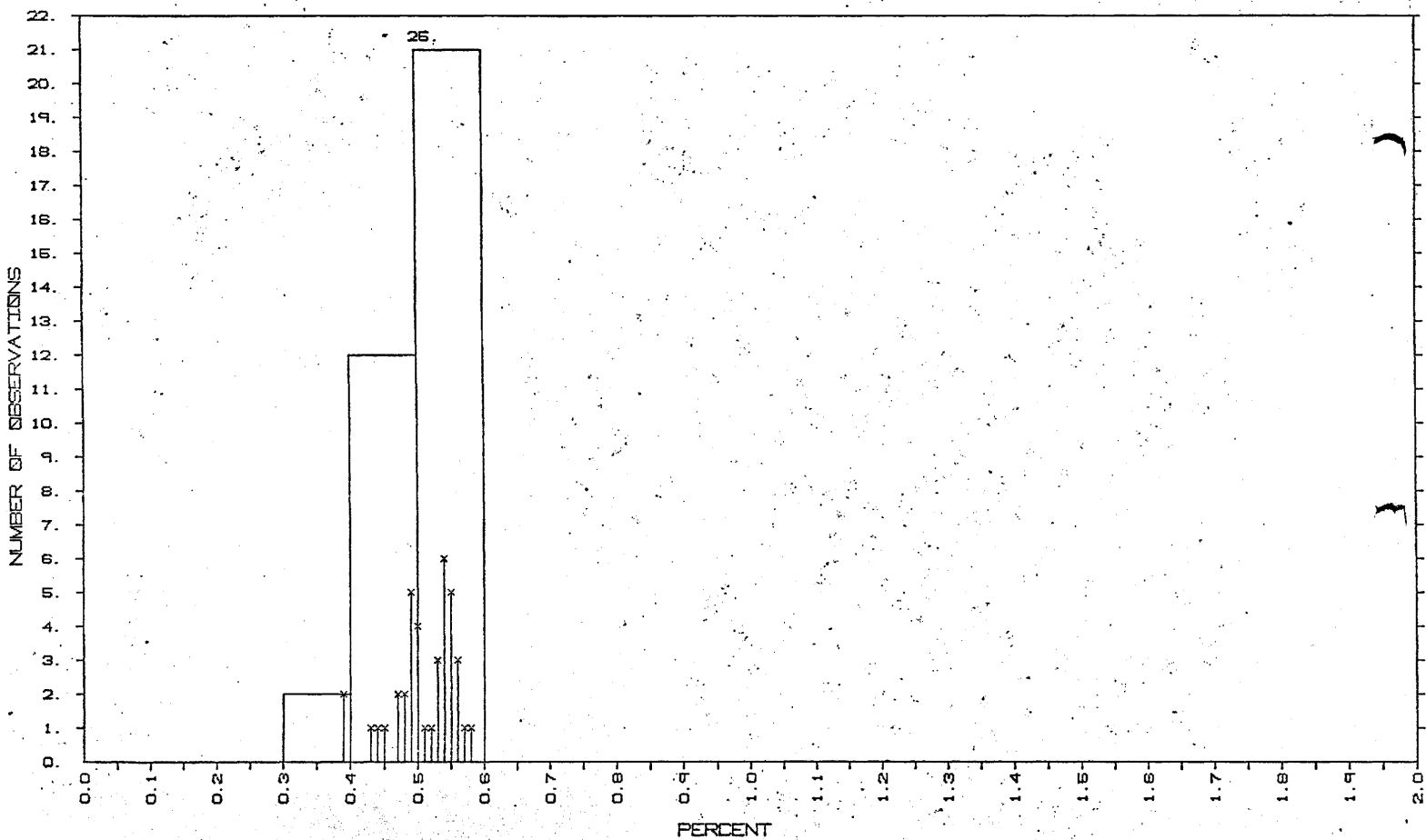
LAB NO. - 13111

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12330 12340

STATE - AK



COMPANY - STANDARD OF CALIFORNIA

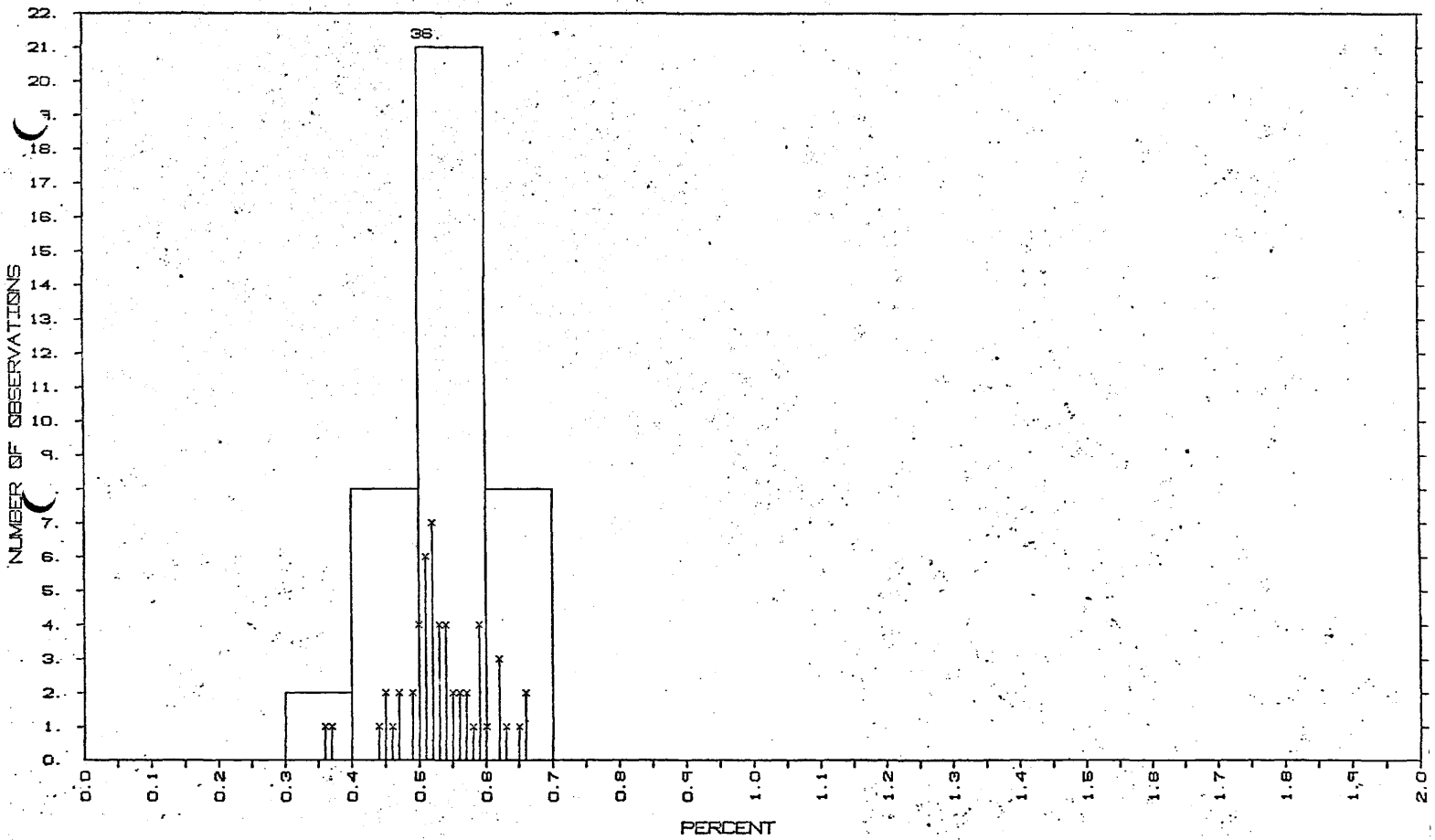
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WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12400 12410

STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

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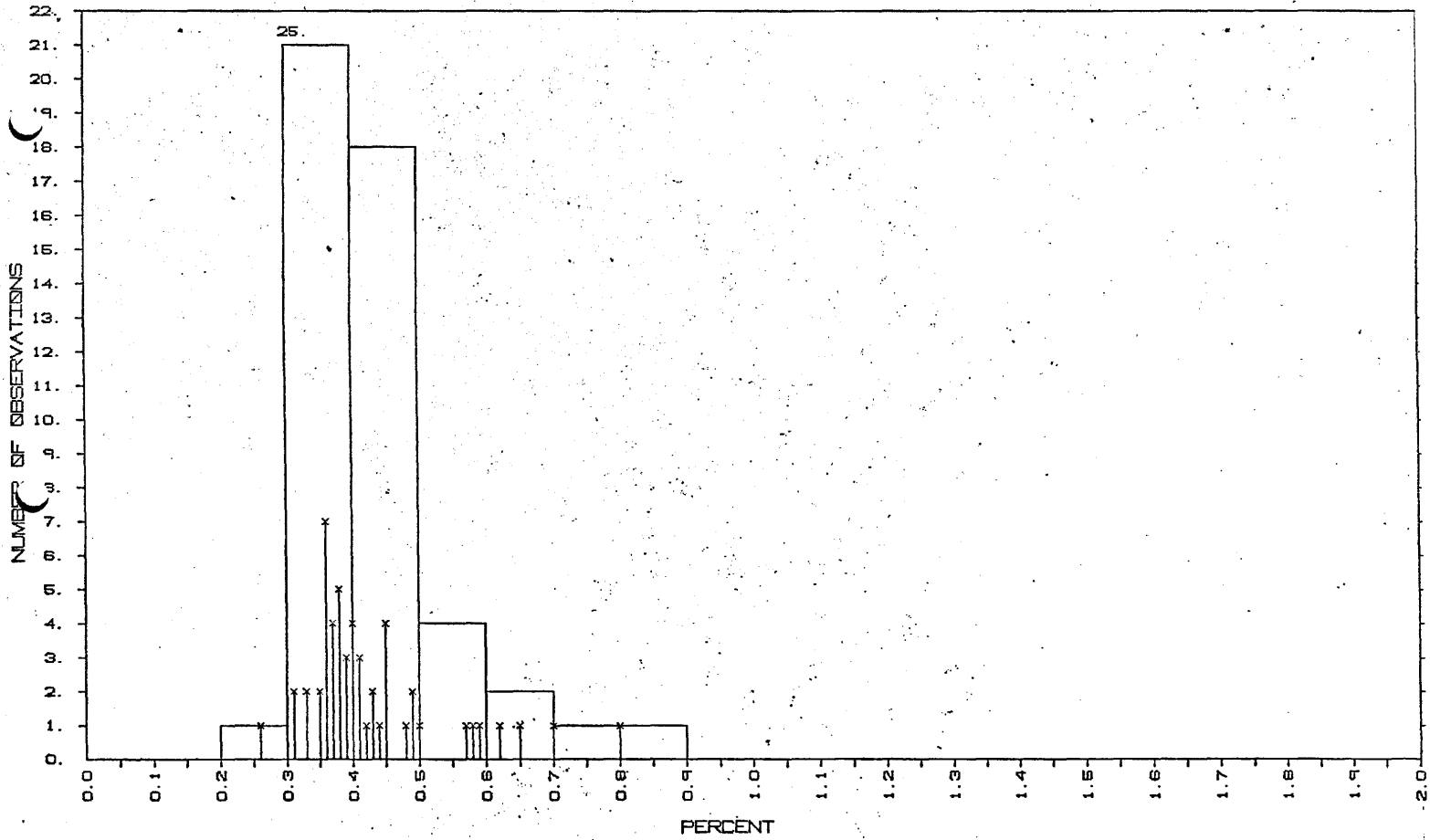
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WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12540 12590

STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

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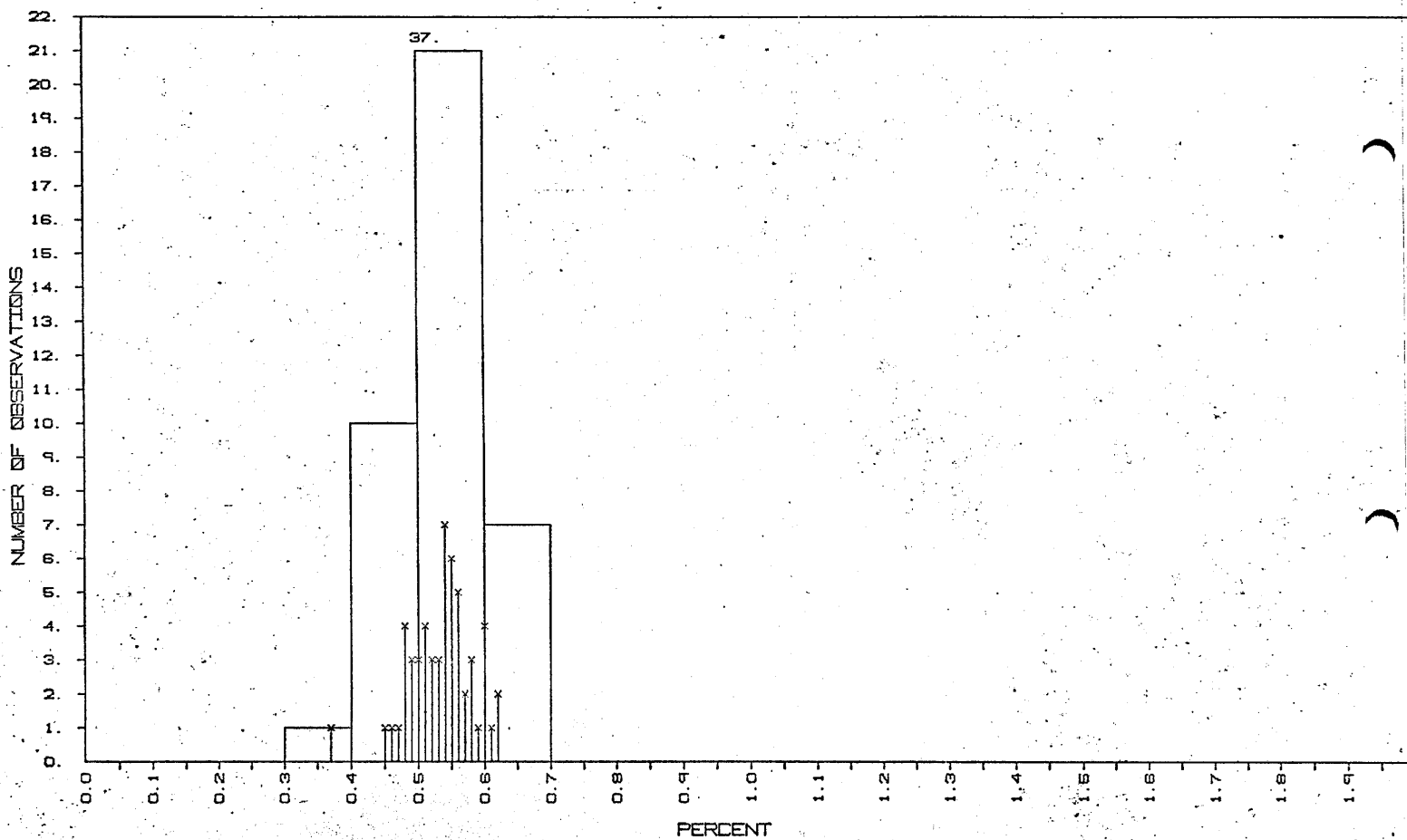
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WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12570 12580

STATE - AK



VERTICAL REFLECTANCE HISTOGRAM

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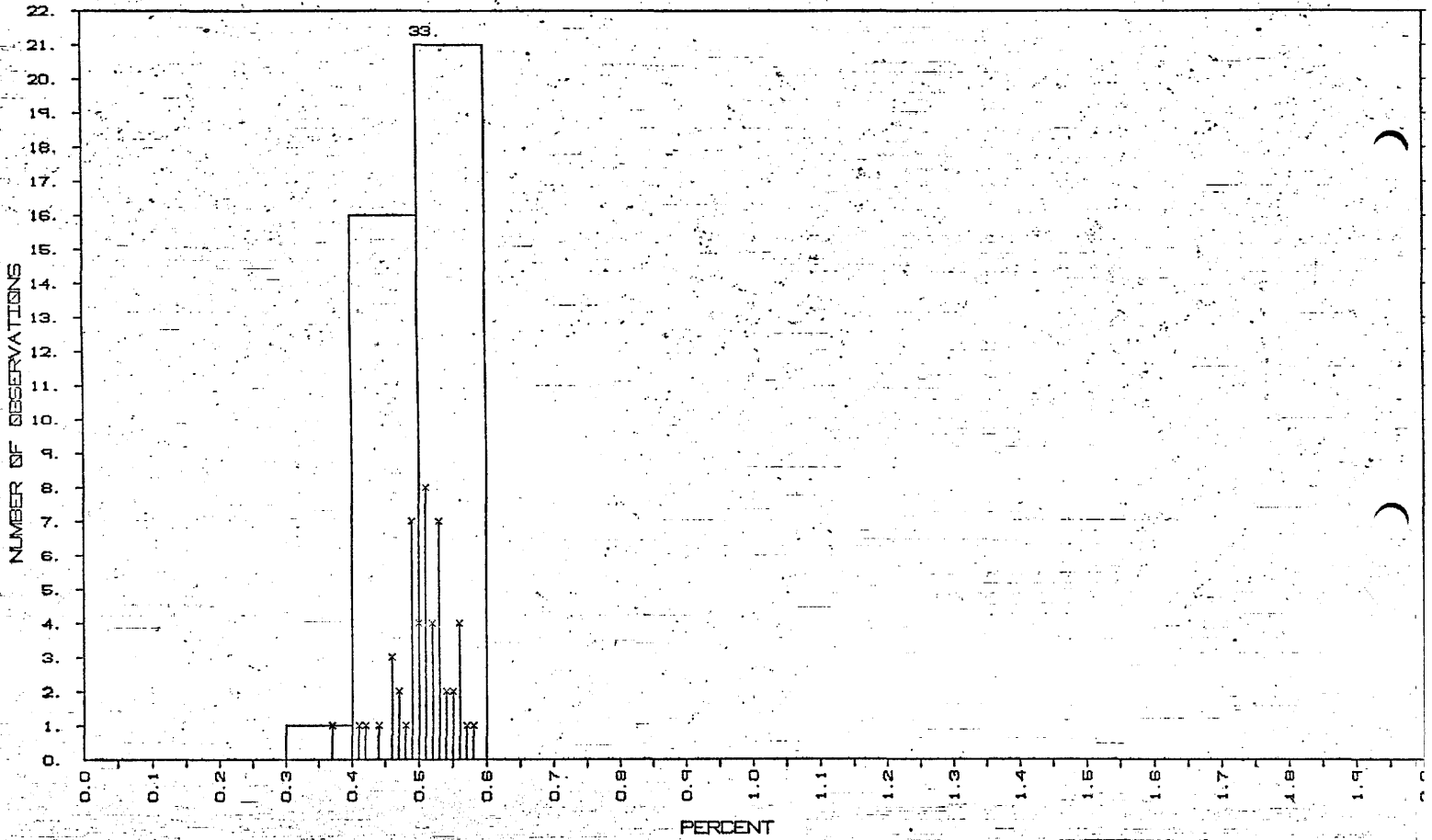
LAB NO. - 13114

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12670 12680

STATE - AK



VITRINITE REFLECTANCE HISTOGRAM

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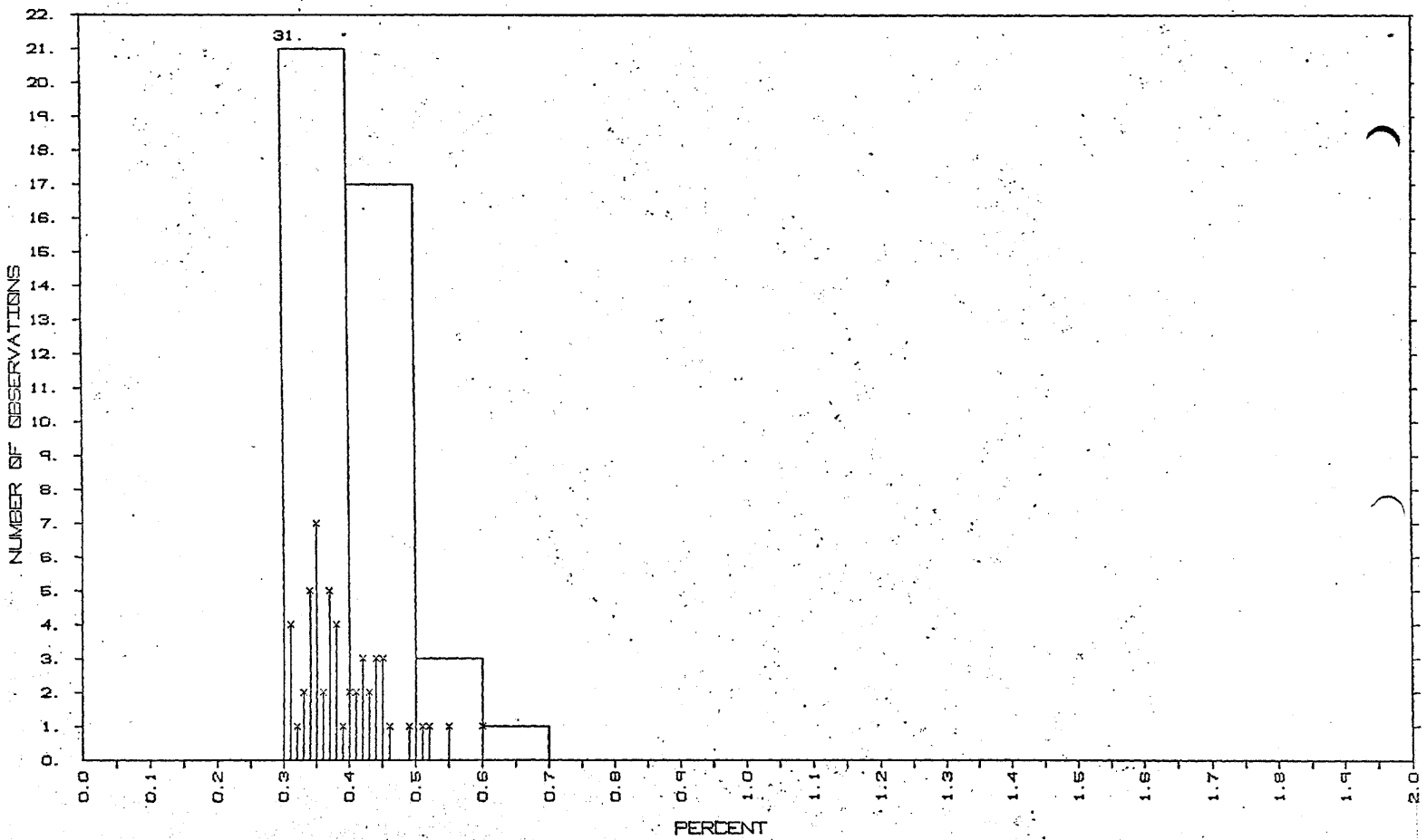
LAB NO. - 13119

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12670 12810

STATE - AK



VARIABLE FREQUENCY HISTOGRAM

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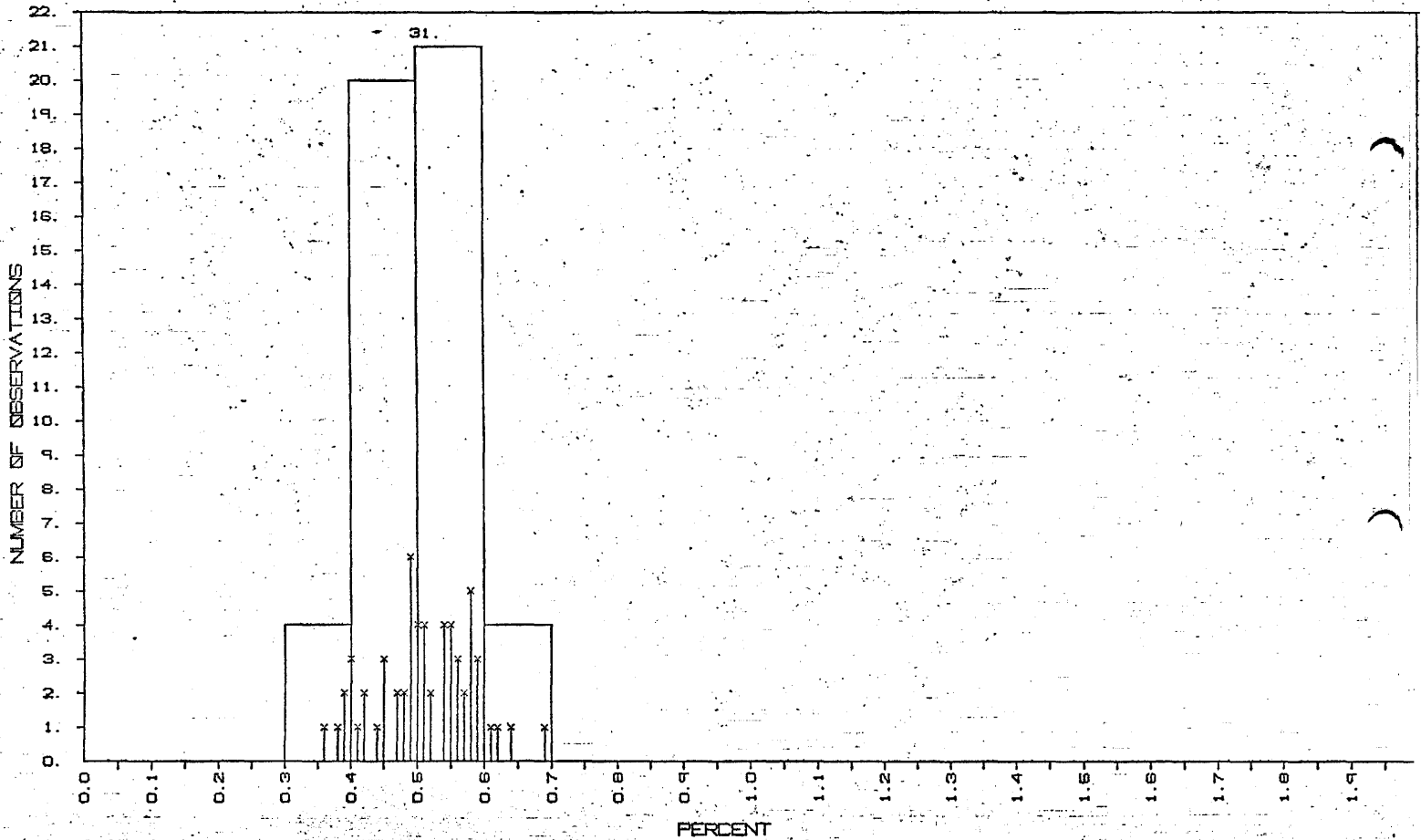
LAB NO. - 13115

WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 12730 12740

STATE - AK



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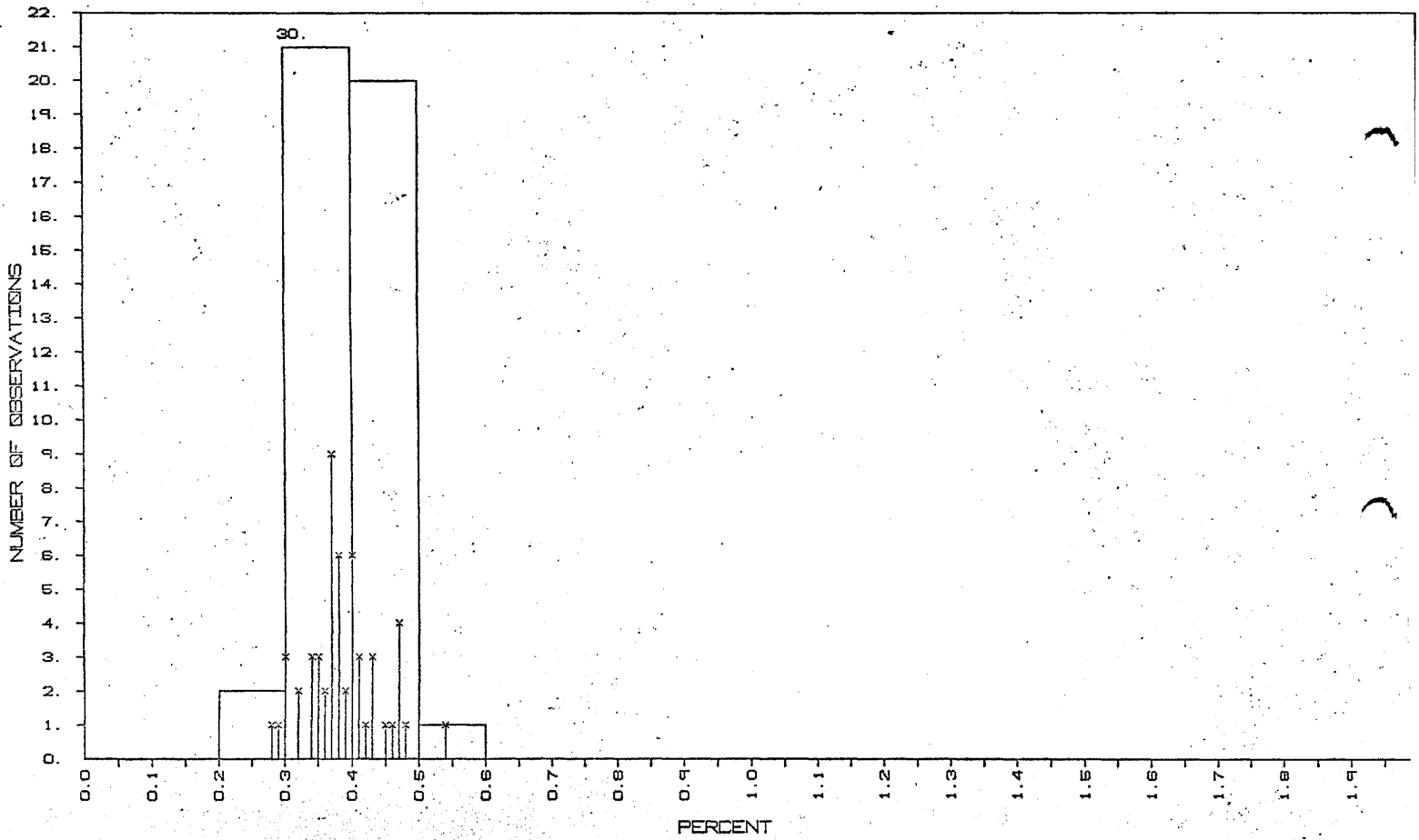
LAB NO. - 13116

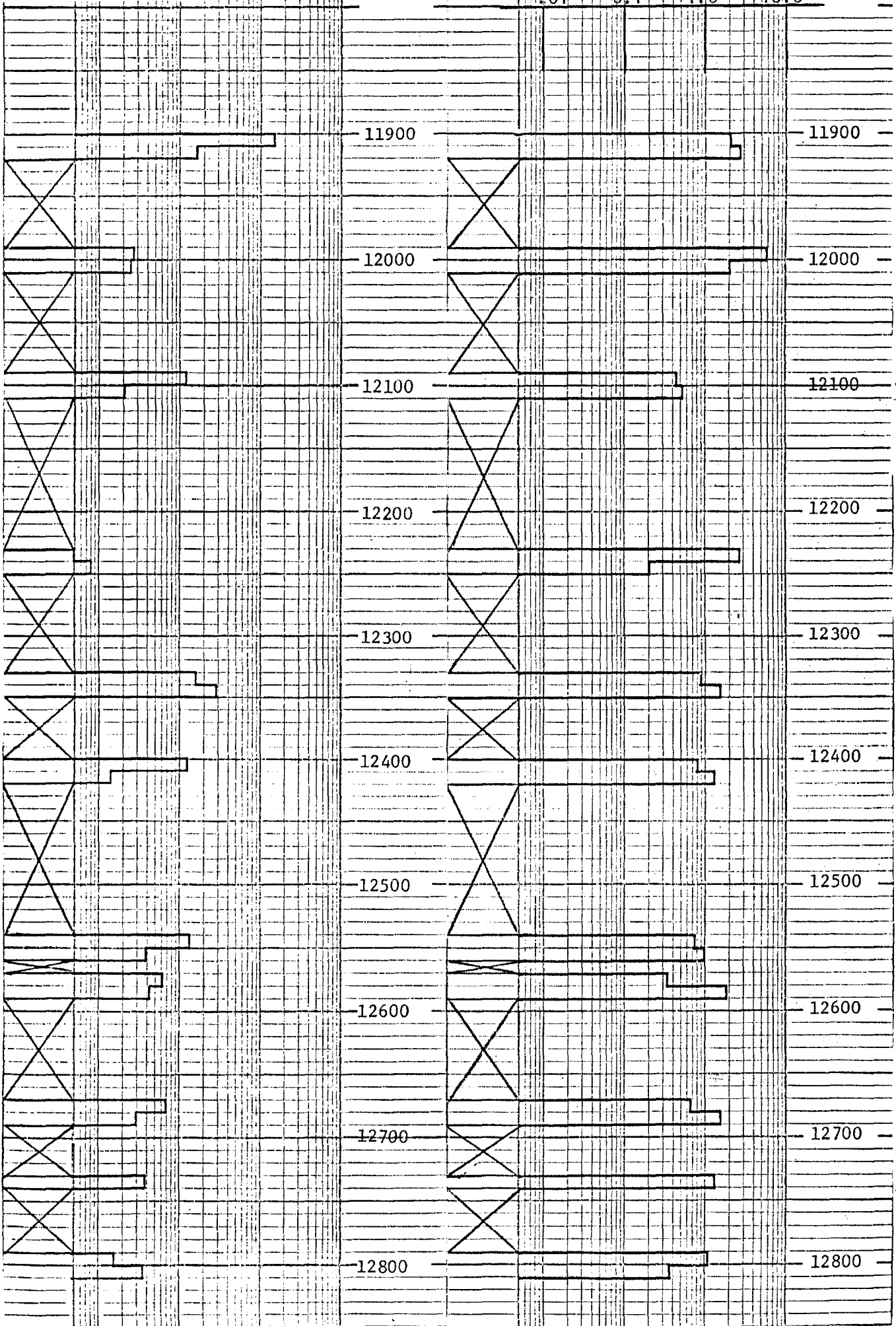
WELL OR OUTCROP - NORTH FORK NO. 41-35

LOCATION - 35 4S 14W

DEPTH OR SAMPLE NO. - 11900 12110

STATE - AK





RM-100 (4-71)
SHELL OIL COMPANY
SOURCE ROCK LOG

RM-100 (4-71)
SHELL OIL COMPANY
SOURCE ROCK LOG

STATE OR PROV. Alaska
 COUNTY Standard of California COMPANY
 North Fork Unit NO. 41-35
 Anchorage Basin
 FIELD OR AREA

T. R.

SURVEY BLK.

STATE OR PROV. Alaska
 COUNTY Standard of California COMPANY
 North Fork Unit NO. 41-35
 Anchorage Basin
 FIELD OR AREA

T. R.

SURVEY BLK.

ELEV. COMM. COMP. SEC.
 T.D. ELEC. LOG RADIOACTIVE MICROLOG LATEROLOG
 PRODUCTION
 REMARKS Std. = 36 ± 2 units. Scale is 1" = 100'. Zero to five is plotted as five by plotter.
 SAMPLED BY: DATE
 ANALYZED BY: J. Mohundro DATE
 PLOTTED BY: N. West DATE

RGE. 14W
 TWP. 4S
 SEC. 35

BLK. TWP.
 SURVEY RGE.

ELEV. COMM. COMP. SEC.
 T.D. ELEC. LOG RADIOACTIVE MICROLOG LATEROLOG
 PRODUCTION
 REMARKS Scale is 1" = 100'.
 SAMPLED BY: DATE
 ANALYZED BY: M. L. Weiss DATE
 PLOTTED BY: N. West DATE

RGE. 14W
 TWP. 4S
 SEC. 35

BLK. TWP.
 SURVEY RGE.

