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Analysis of core samples from ground water boreholes in Rhode Island

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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ABSTRACT

Ten cores from boreholes in the Wood River Junction area, Rhode Island, were analyzed for physical and petrologic properties. The samples were characterized chiefly by sand containing almost equal proportions of quartz and feldspar (mainly plagioclase) and by accessory heavy minerals that suggest mechanical weathering of arkosic metamorphic terrains. From the textural analysis, we conclude that three samples represent tills and five, outwash (glacial) deposits; and that two clayey cores were deposited in a low-energy depositional environment such as a glacial lake. The analyzed cores had a porosity between 33 and 46 percent, and all but one are highly permeable sands that could indicate good aquifer materials.

INTRODUCTION and METHODOLOGY:

A series of ten split spoon-core samples from boreholes (Table 1) at the United Nuclear Corporation site, Wood River Junction, Rhode Island were analyzed for water content and porosity, mineral grain specific gravity (Table 2), grain size (Figs. 1-11), and x-ray mineralogy (Table 3). Measurements were performed for B.J. Ryan, Water Resources Division, U.S. Geological Survey, Providence Rhode Island.

A brief summary of techniques includes:

Water content: Samples were oven dried at 110°C.

Calculated Porosity: $\phi = \frac{W}{\frac{1-W}{M} + W}$ where ϕ is porosity, W is water as a fraction of wet weight, and M is mineral grain specific gravity.

Mineral grain specific gravity: This parameter is determined by a Beckman air pycnometer, using helium as flushing gas.

Grain size distribution: According to standard procedures: Gravels - sieving; sands - modified Woods Hole rapid sediment analyzer (Schlee, 1966); and silts and clays - coulter counter.

X-ray mineralogy: Randomly oriented and oriented aggregate powdered specimens were run on a Phillips X-ray diffractometer. Semi-quantitative estimates of the minerals present were made by a comparison of peak intensities with a collection of standards. Relative percents of the clay minerals were estimated by a method modified from Biscaye (1965).

It was necessary to resaturate core samples to obtain water content because many of the samples were already partially dried on arrival. This was done on six out of ten samples under vacuum overnight. Other parameters are derived from the above data by standard calculations.

The designation and depths of the samples are given in Table 1.

Table 1.--Location and depths of samples.

Sample No.	Local Well No.	Lat. N.	Long. W.	Depth Below Land Surface	
				Feet	Meters
1.	CHW 508	41°26'0"	71°40'52"	20-23	6.1-7
2.	CHW 508			32-35	9.8-10.7
3.	CHW 559	41°26'03"	71°40'50"	16.5-18	5.0-5.5
4.	CHW 559			21-23.5	6.4-7.2
5.	CHW 559			31-32.5	9.4-10.2
6.	CHW 559			41-43.5	12.3-13
7.	CHW 559			51-53.5	15.3-16
8.	CHW 566	41°26'06"	71°41'00"	78-80	23.4-24
9.	CHW 566			170	61
10.	CHW 568	41°25'56"	71°40'50"	unknown, from auger bit	

Table 2.--Physical and mineral properties of Wood River Junction cores. Specific gravity is defined as weight per equivalent weight of displaced water at 20° C. Dashes signify not determined.

Sample No.	Water content fraction		Porosity vol. fraction	Bulk density of wet sample	Mineral sp. gravity
	As rec'd	Reconst.			
1.	<.01	.196	.391	1.99	2.63
2.	.009	.174	.358	2.06	2.65
3.	.017	.177	.363	2.05	2.65
4.	.046	.244	.462	1.89	2.66
5.	.020	.159	.333	2.09	2.64
6.	.093	.186	.376	2.02	2.64
7.	.099	-	-	-	2.65
8.	.177	-	-	-	2.65
9.	.098	-	-	-	2.65
10.	.10	-	-	-	2.65

Bulk Density (D) was computed from the formula:

$$D = \frac{1}{\frac{1-W}{M} + W} = \phi/W$$

Where W = water content (g/g)
ϕ = Porosity
D = Bulk Density (g/ml)
M = Specific Gravity of mineral

Mineral composition data (Table 3) were generated by X-ray powder diffraction. Illite and/or mica dominates the clay mineralogy; minor amounts of chlorite and vermiculite and traces of mixed layer illite-smectite and kaolinite also occur. Analyses of the clay mineral fraction were not attempted for most samples because of contamination by drilling mud. For those samples where the clay mineralogy was not determined, the layered silicate category contains all clay minerals, any coarser phyllosilicates (>2 μm mica flakes), and any possible drilling mud contamination. Smear-slide examination under a petrographic microscope detected vermiculite, biotite, chlorite, and traces of muscovite in the coarse phyllosilicate suite. These samples contained a low to medium-grade metamorphic, heavy-mineral assemblage composed mainly of blue-green hornblende, opaques, zircon, garnet, and tourmaline.

Table 3.--Mineral composition. M/L=mixed layer illite-smectite, I/M=illite and/or mica, CHL=chlorite, VER=vermiculite, KAO=kaolinite, L/S=layer silicates, QTZ=quartz, FELD=feldspars, AMPH=amphiboles, SID=siderite.

Well No.	Sample No.	M/L	I/M	CHL	VER	KAO	L/S	QTZ	FELD	AMPH	SID	COMMENTS
CHW 508	20-23							5	41	53	T	K<NA+CA FELD
CHW 508	32-35							8	46	45	T	K<NA+CA FELD
CHW 559	16.5-18							7	47	45	1	K<NA+CA FELD
CHW 559	21-23.5		T	8	1	1	T	10*	38	49	2	K<NA+CA FELD
CHW 559	31-33.5							5	46	48	1	K>NA+CA FELD
CHW 559	41-43.5							9	36	54	1	K<NA+CA FELD
CHW 559	51-53.5							12	39	48	1	K>NA+CA FELD
CHW 566	78-80							5	38	56	1	K=NA+CA FELD
CHW 566	170							10	46	43	1	K=NA+CA FELD
CHW 566	AUGER		T	10	1	2		13*	36	46	2	K<NA+CA FELD

*Breakdown of layer silicates at left.

DISCUSSION

Most of the samples are dominated by sand characterized by almost equal proportions of quartz and feldspar. The mineralogical suite (quartz, feldspar and the heavy and clay mineral assemblages) clearly suggest mechanical weathering of arkosic metamorphic terrains. In sample No. 1, sand and gravel are 99.8 percent of the total. This compositional dominance is reflected by the mineral grain densities, which vary only a little from 2.65 g/ml. Many intervals in these cores appear to be highly permeable and the sands represent good aquifer materials. Only sample No. 4 and the auger sample No. 10 contained mostly silt and clay sized material. Based on mineralogy and grain size distributions, we conclude that samples 4 and 10 were deposited in a low energy environment such as a glacial lake; samples 2, 8 and 9 are tills, and samples 1, 3, 5, 6 and 7 are from outwash deposits.

REFERENCES

Biscaye, P. E., 1965, Mineralogy and sedimentation of recent deep-sea clay in the Atlantic Ocean and adjacent seas and oceans: Geological Society of America Bulletin, v. 76, no. 7, p. 803-832.

Schlee, John, 1966, A modified Woods Hole Rapid Sediment Analyzer: Journal of Sedimentary Petrology, v. 36, no. 2, p. 403-413.

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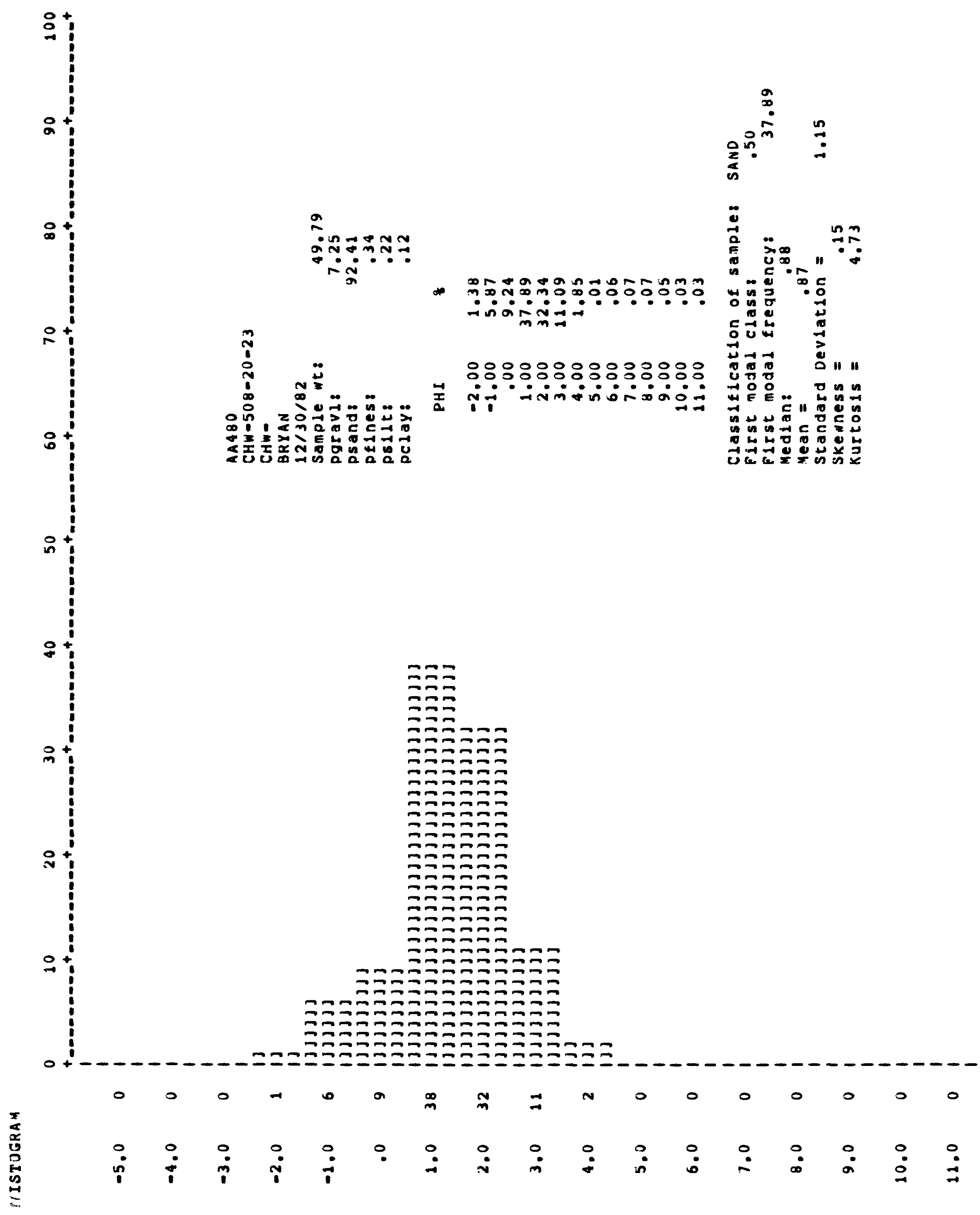


Figure 1a. Well No. 508, depth 20-23'. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

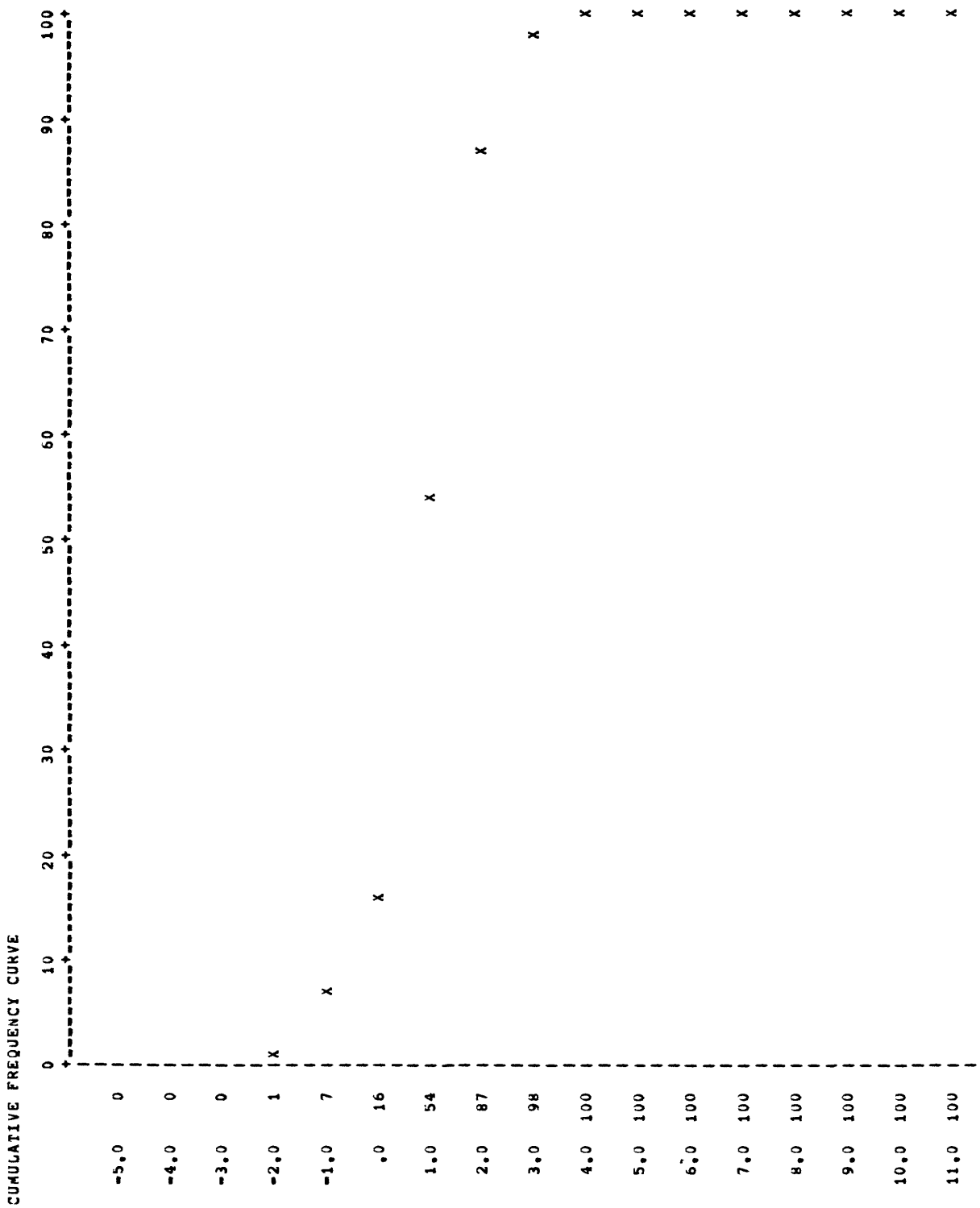


Figure 1b. Cumulative frequency curve for 1a.

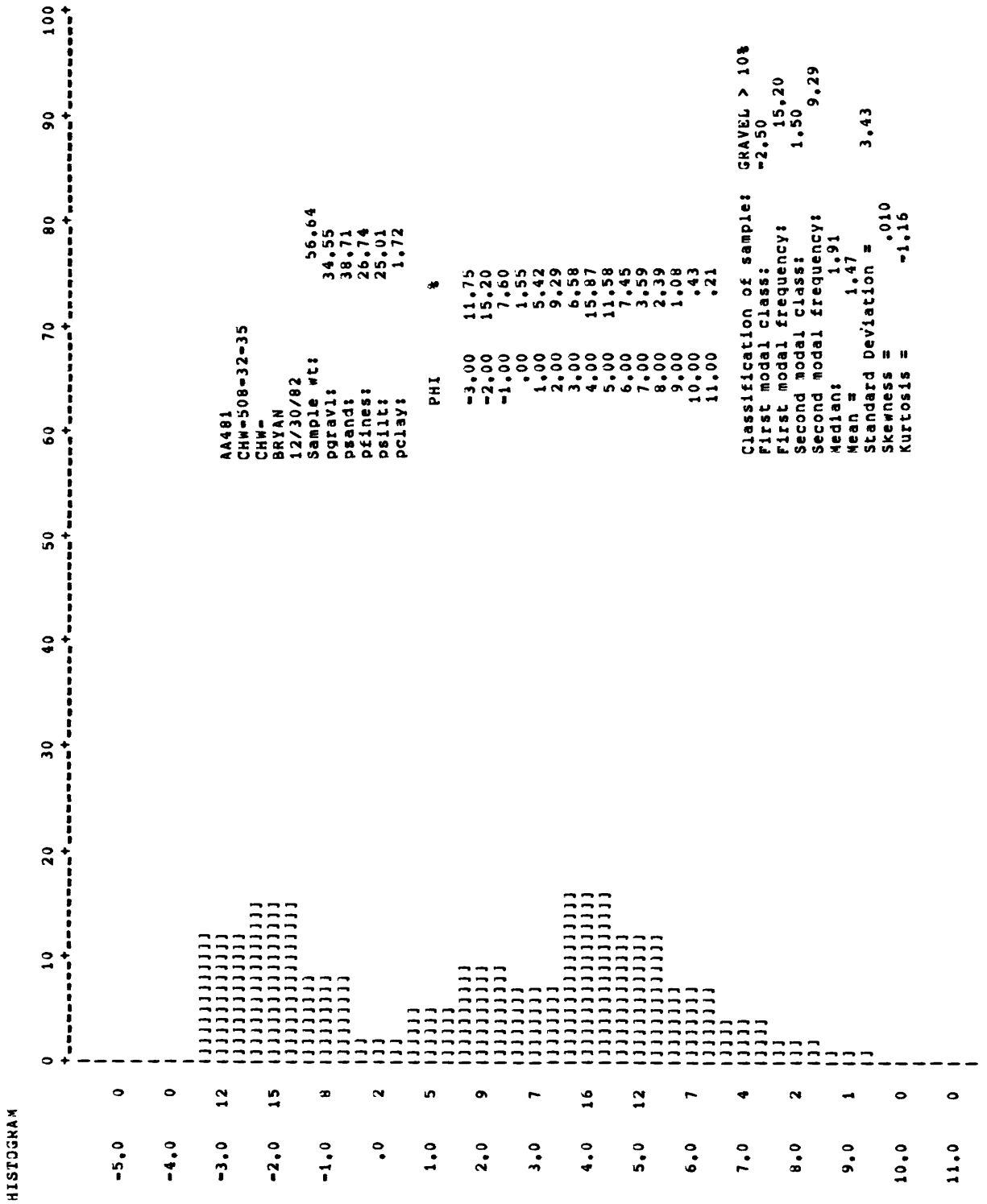


Figure 2a. Well No. 508, depth 32-35'. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

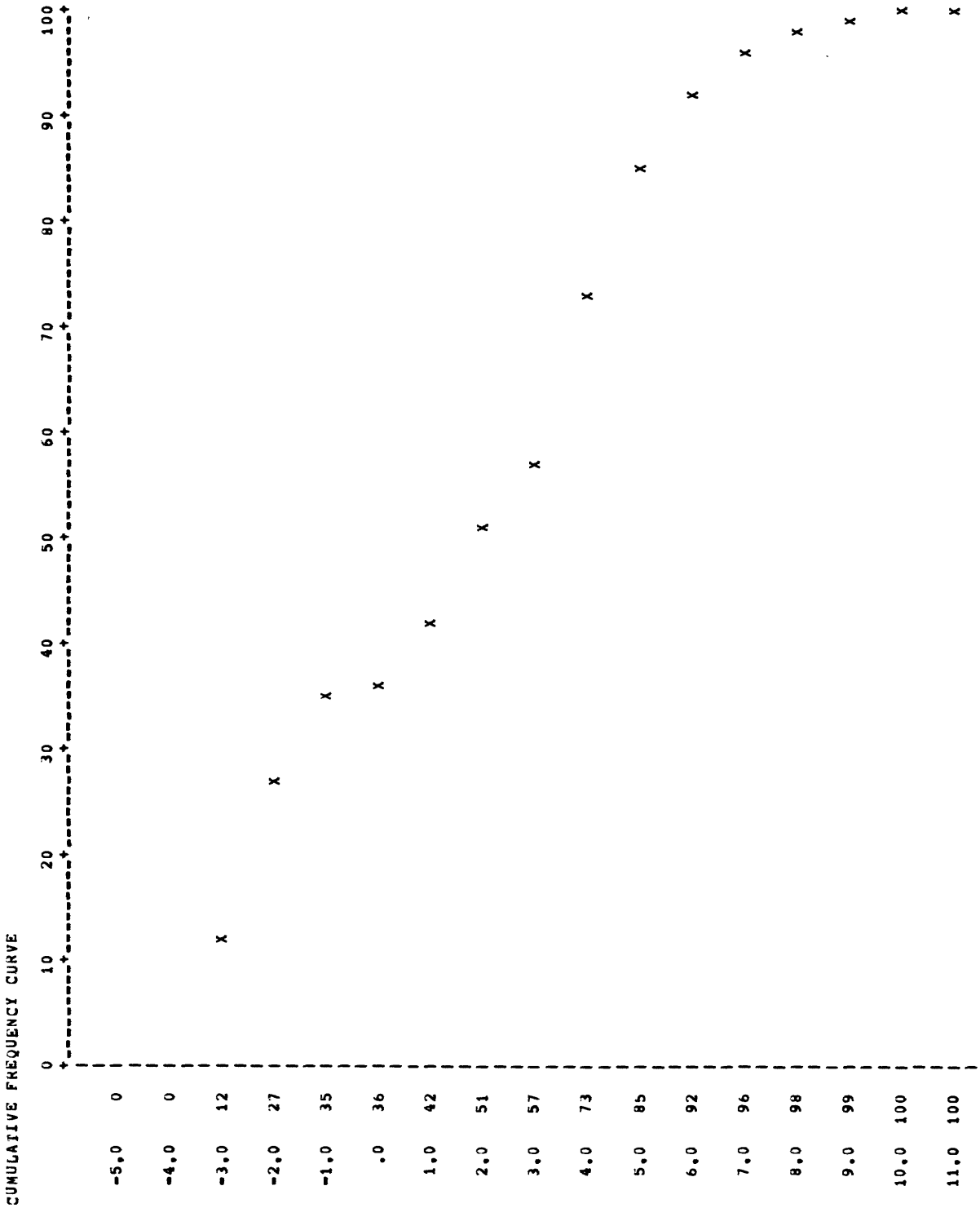


Figure 2b. Cumulative frequency curve for 2a.

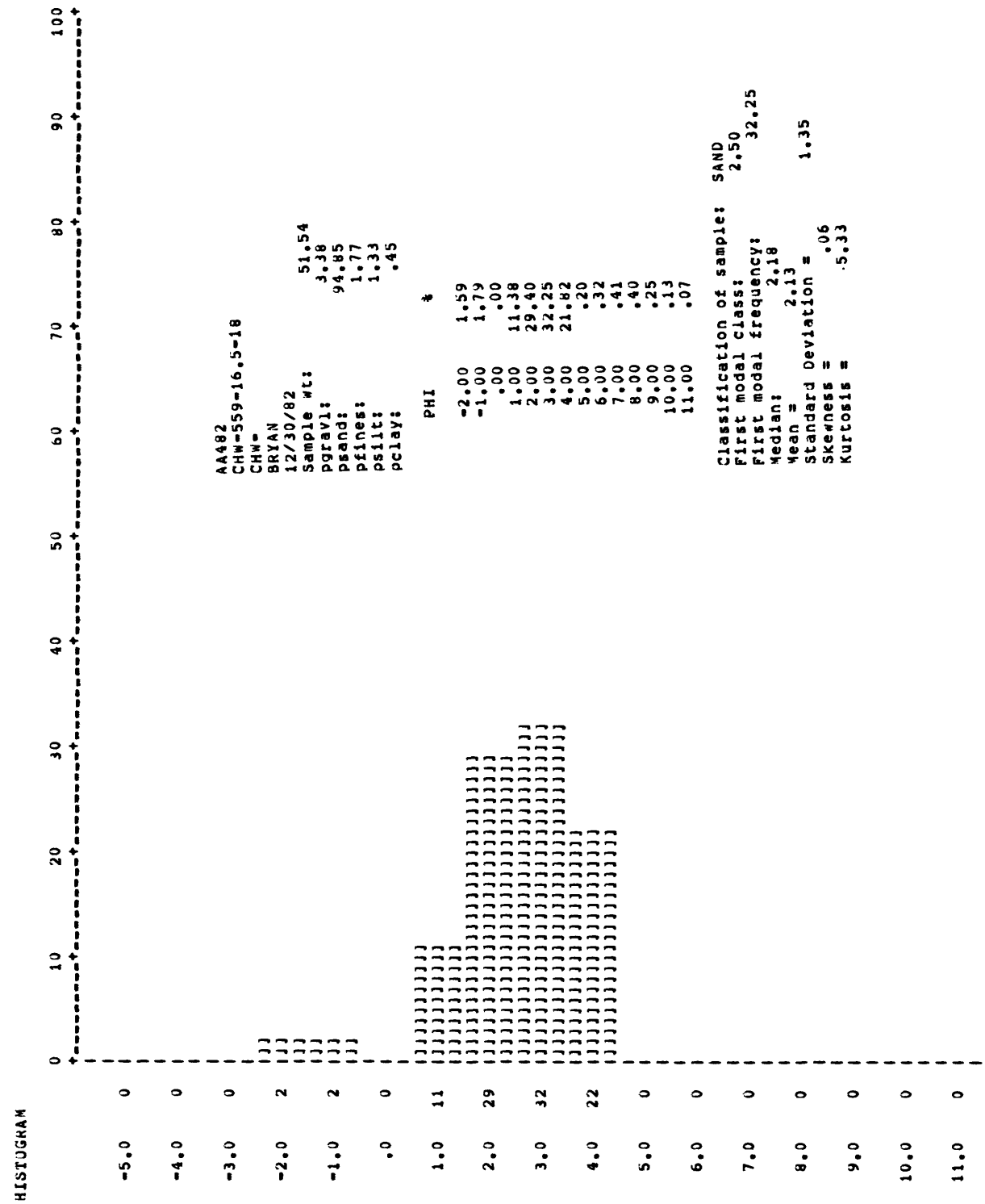


Figure 3a. Well No. 559, depth 16.5-18'. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

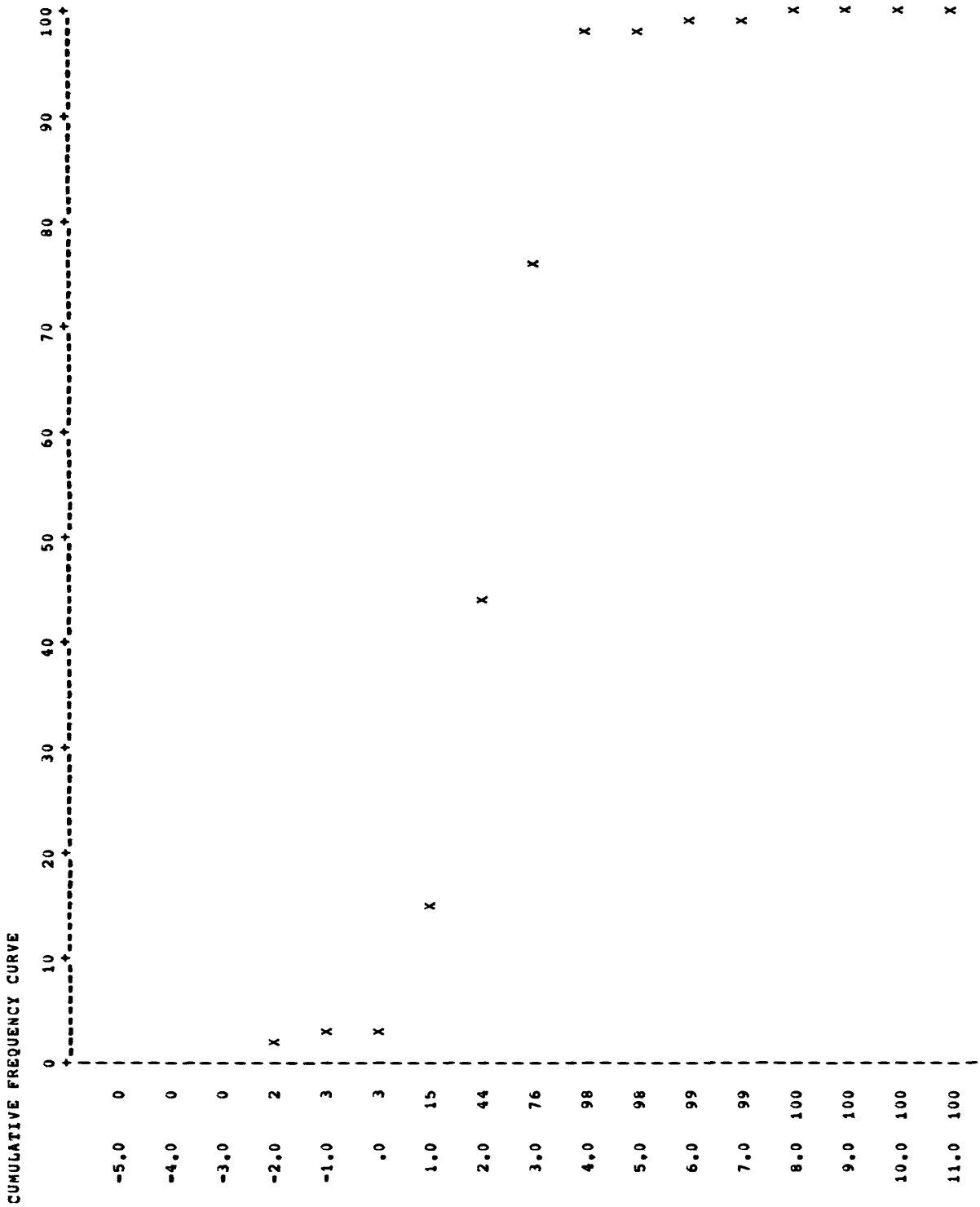


Figure 3b. Cumulative frequency curve for 3a.

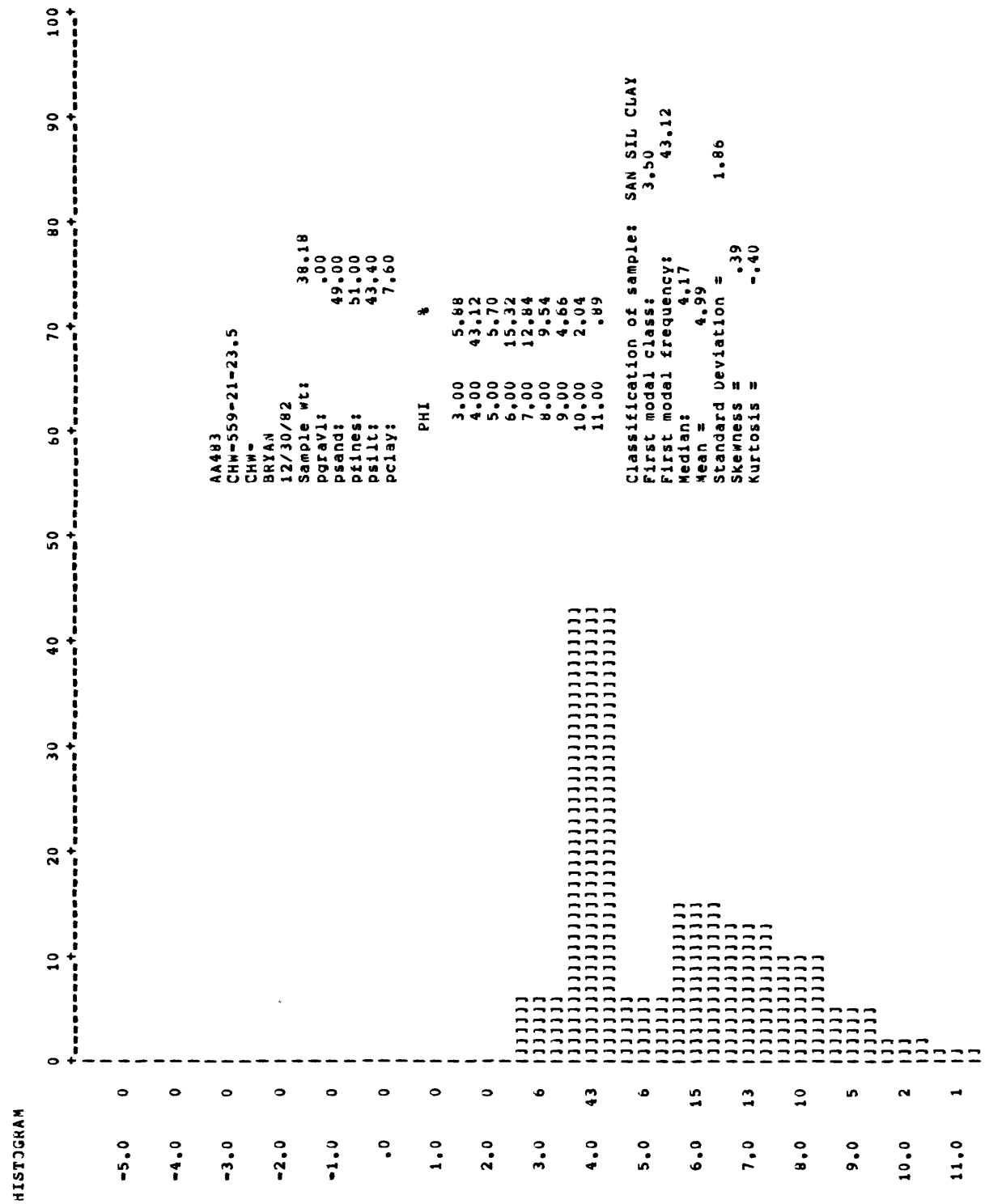
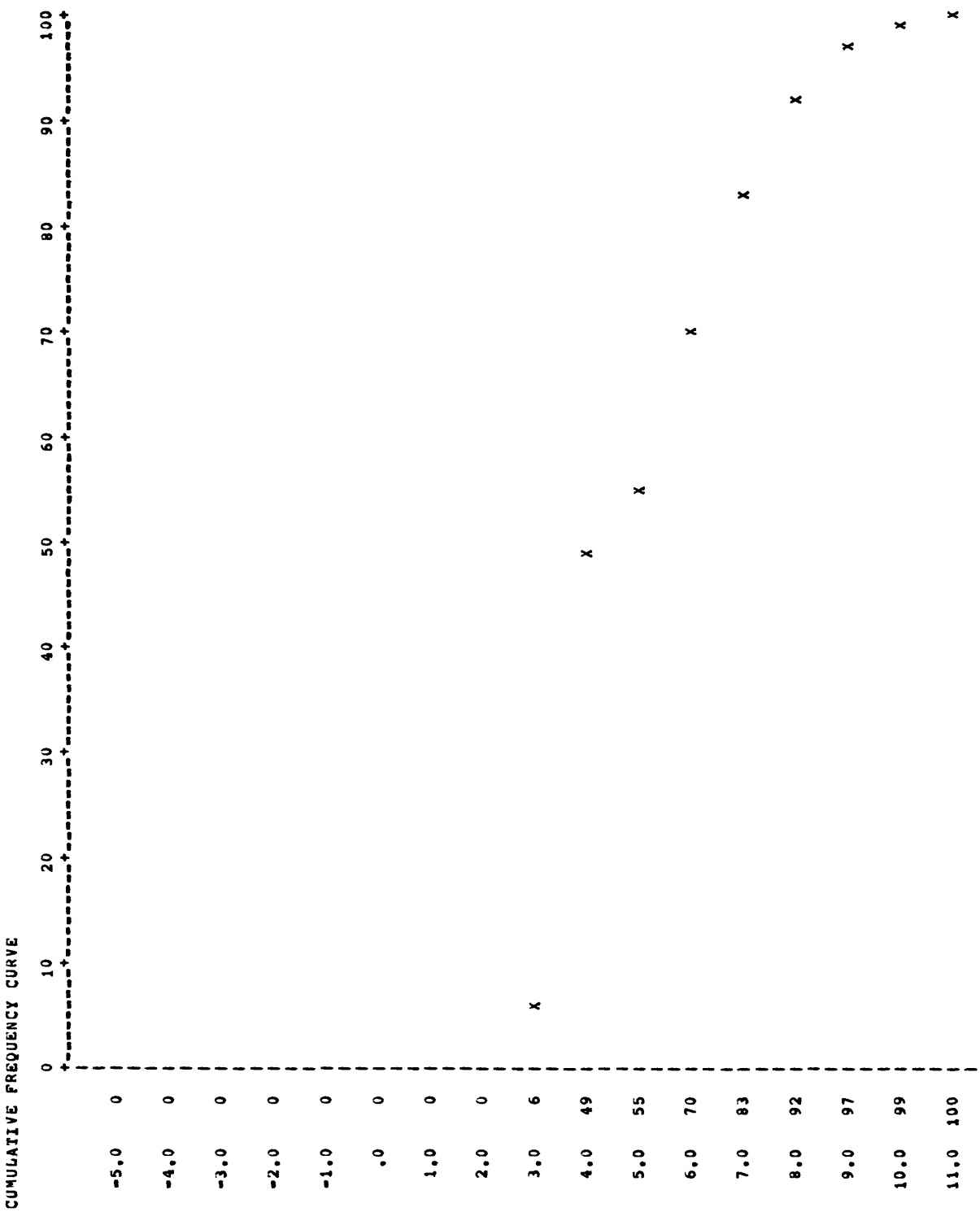


Figure 4a. Well No. 559, depth 21-23.5. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.



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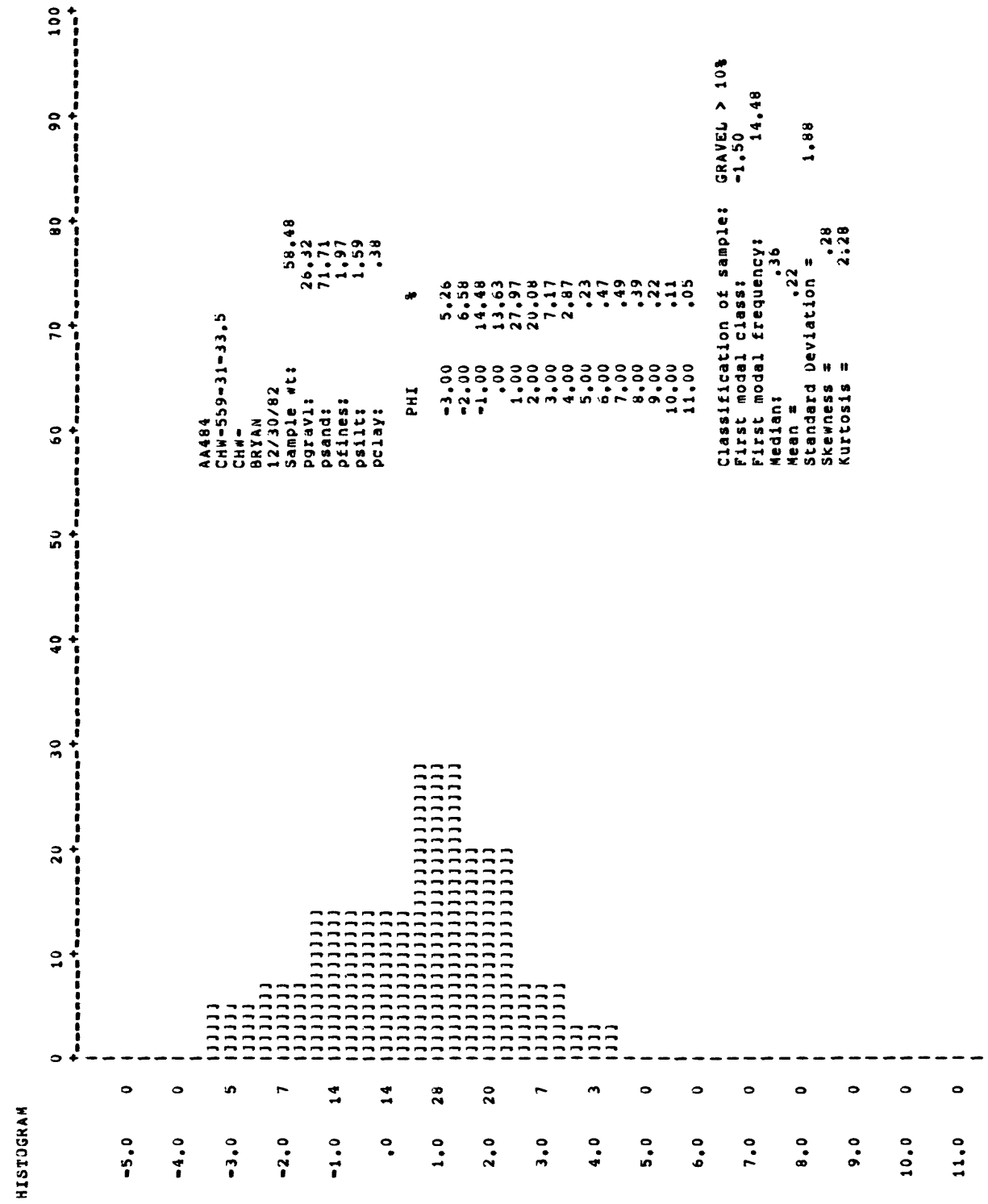


Figure 5a. Well No. 559, depth 31-33.5. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

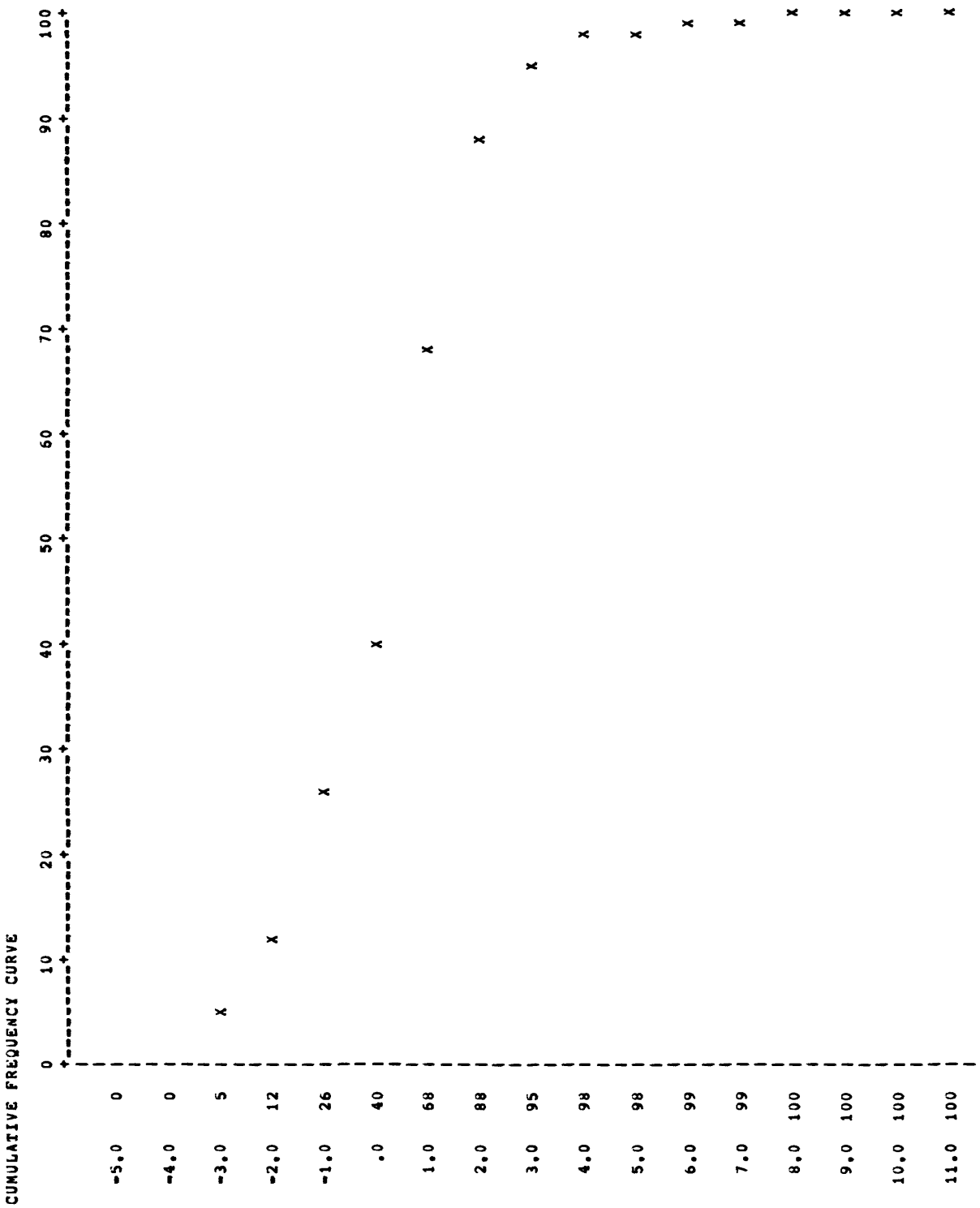


Figure 5b. Cumulative frequency curve for 5a.

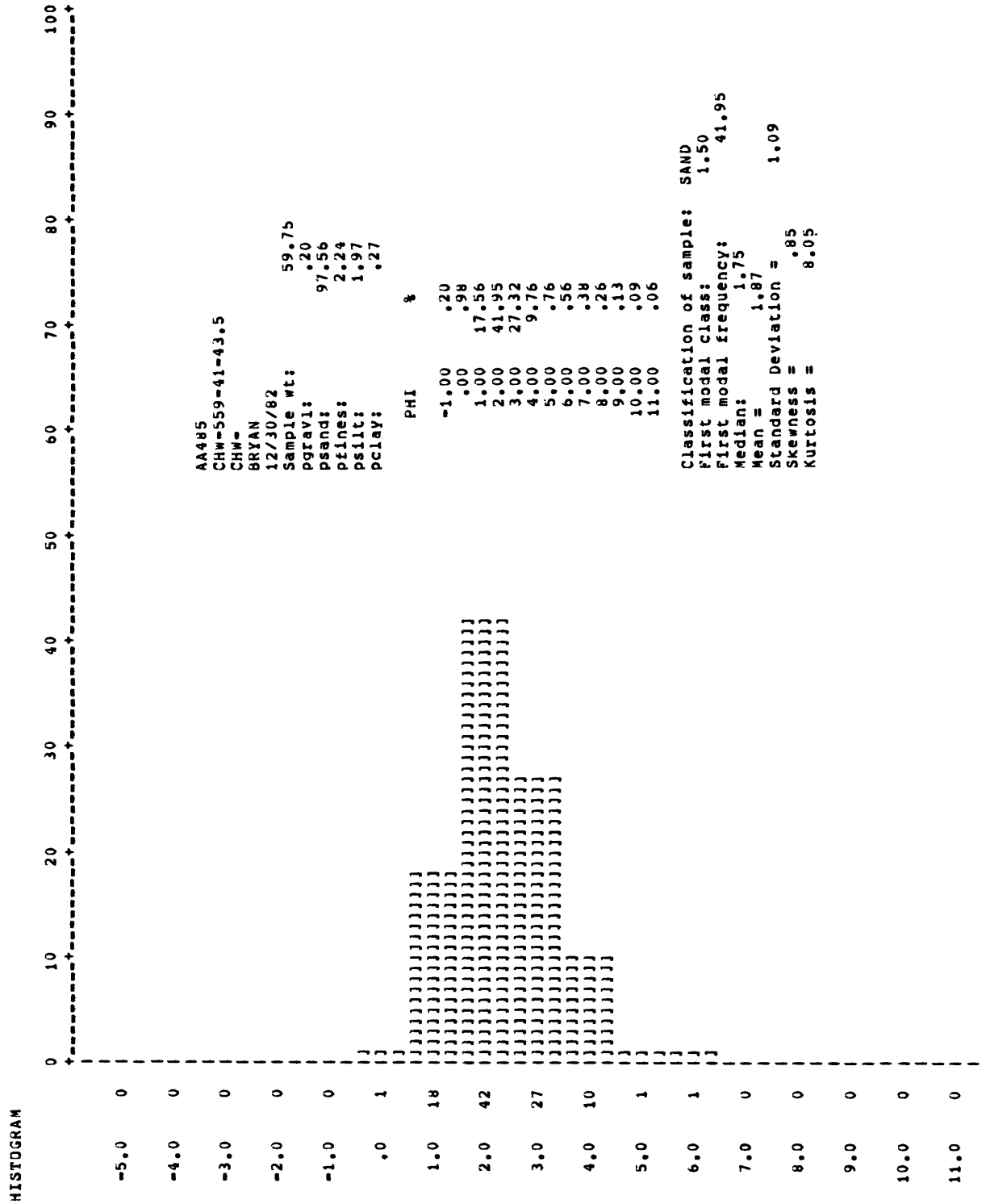


Figure 6a. Well No. 559, depth 41-43.5. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

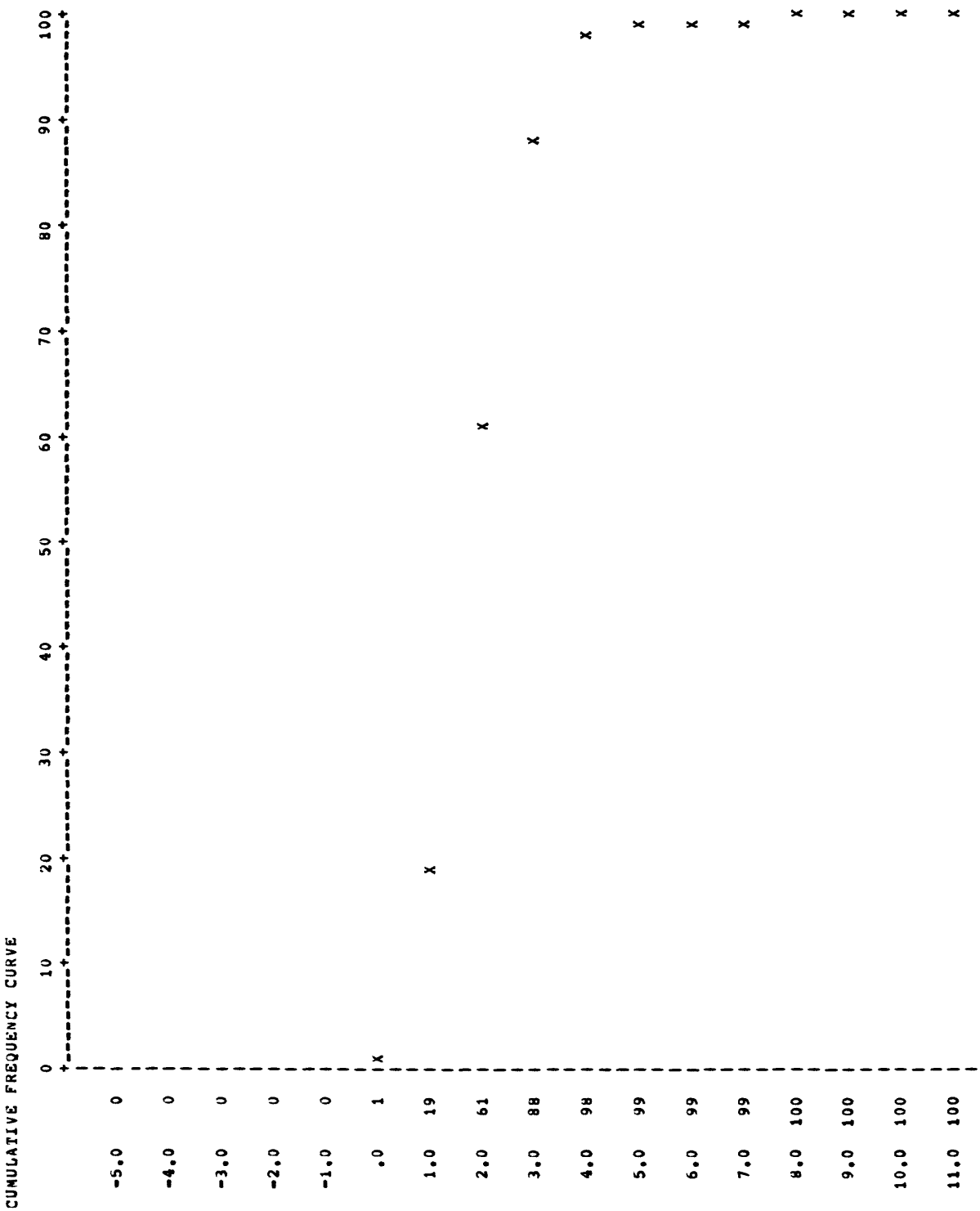


Figure 6b. Cumulative frequency curve for 6a.

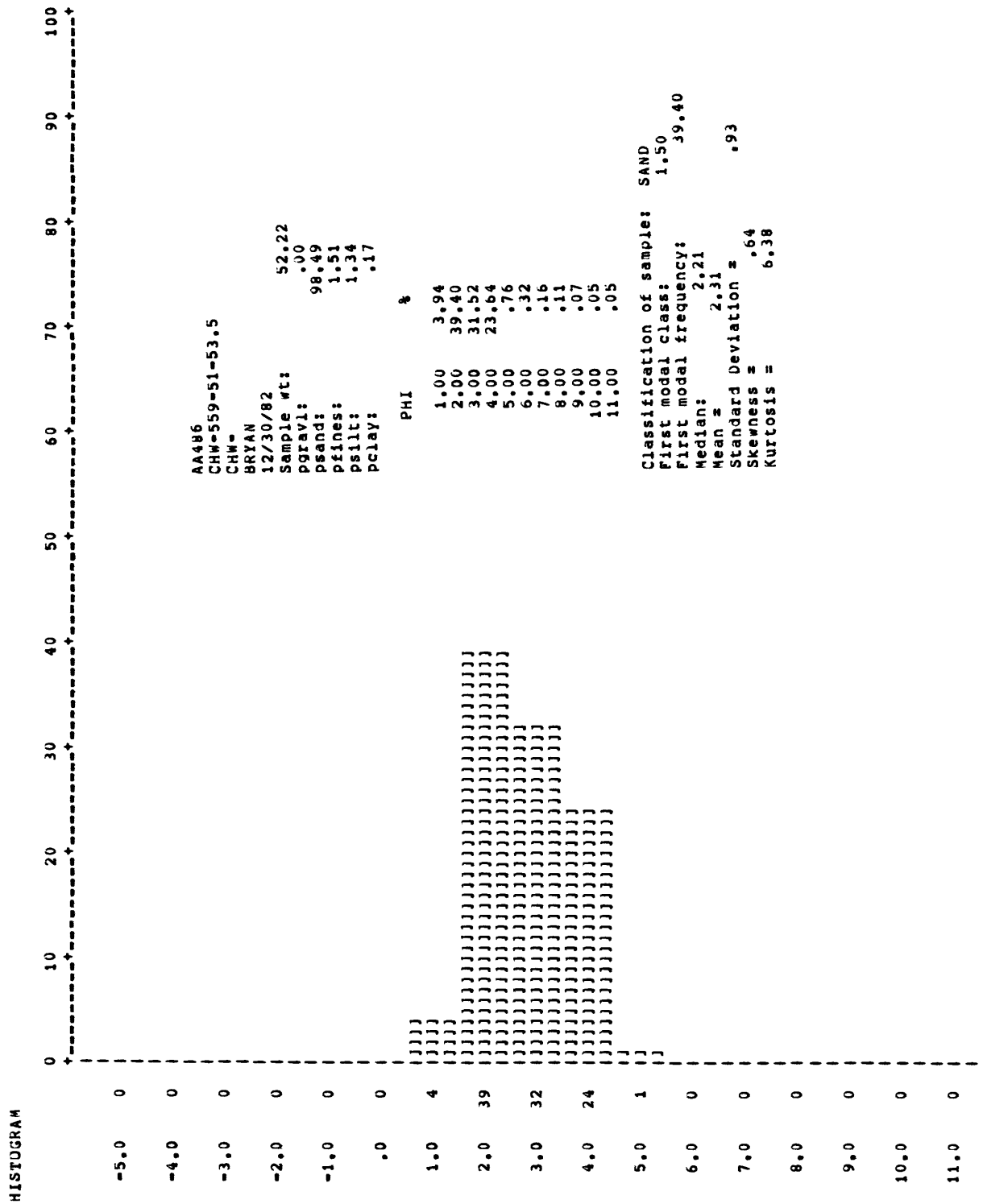
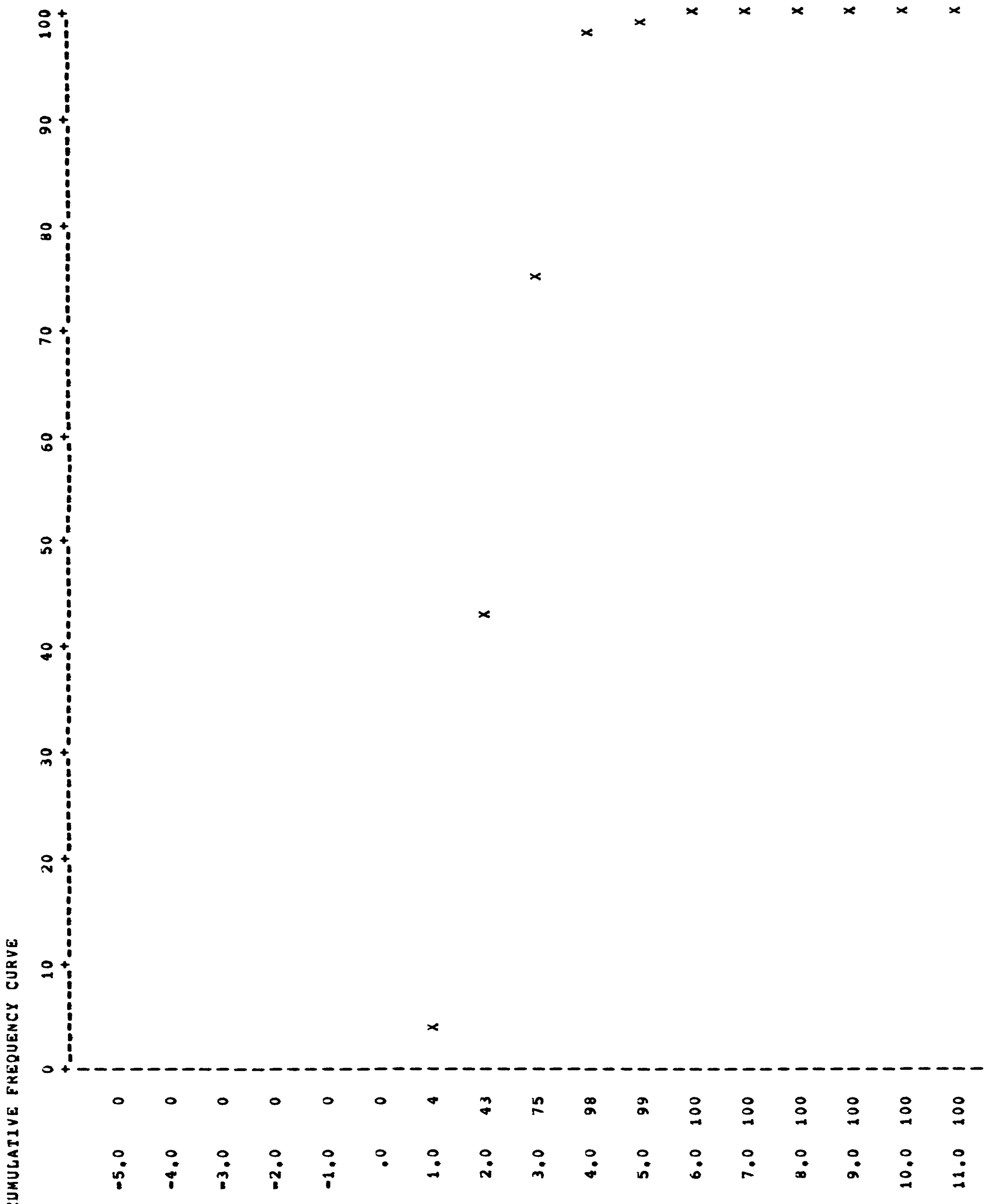


Figure 7a. Well No. 559, depth 51-53.5. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.



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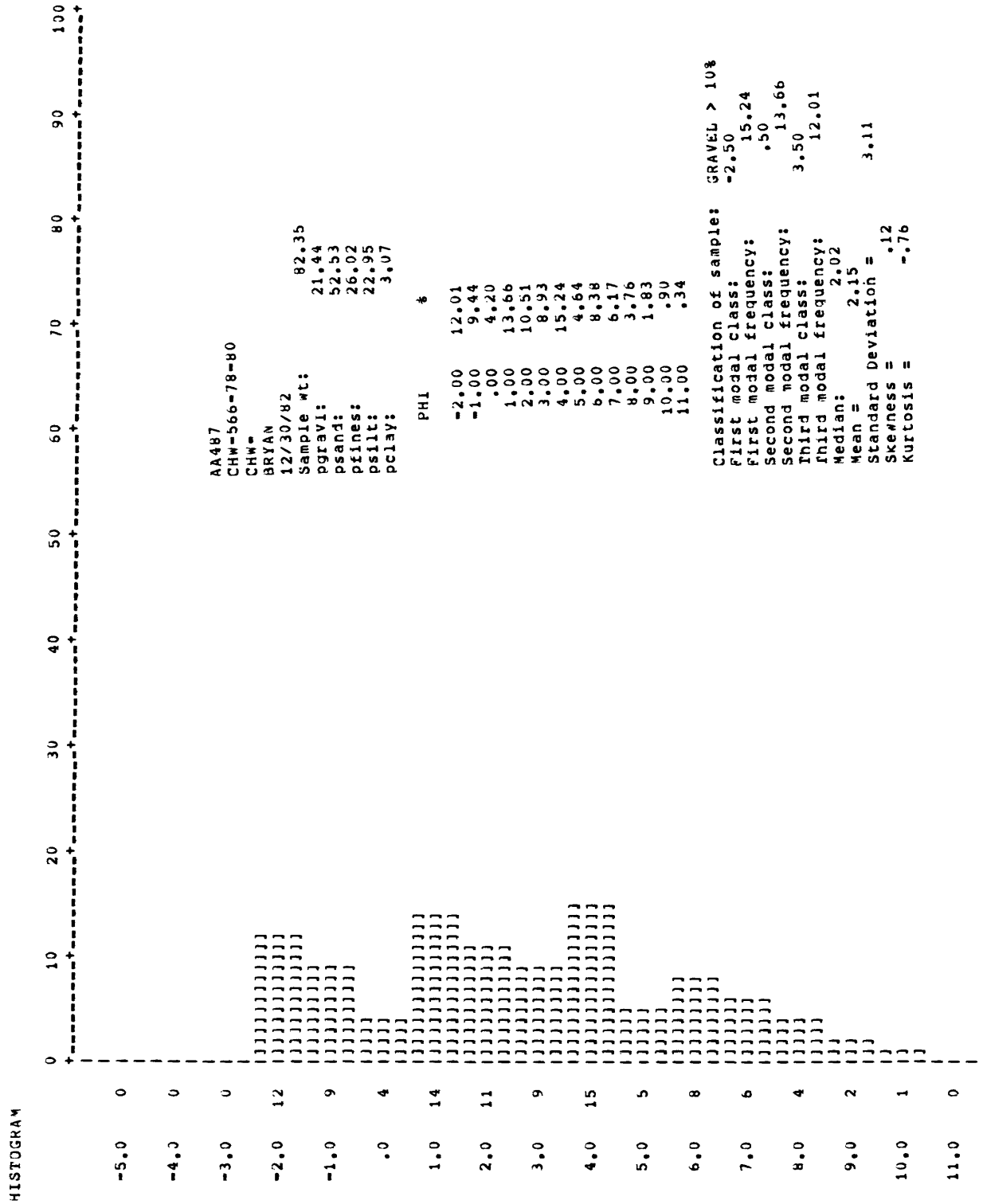

Figure 8a. Well No. 566, depth 78-80'. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

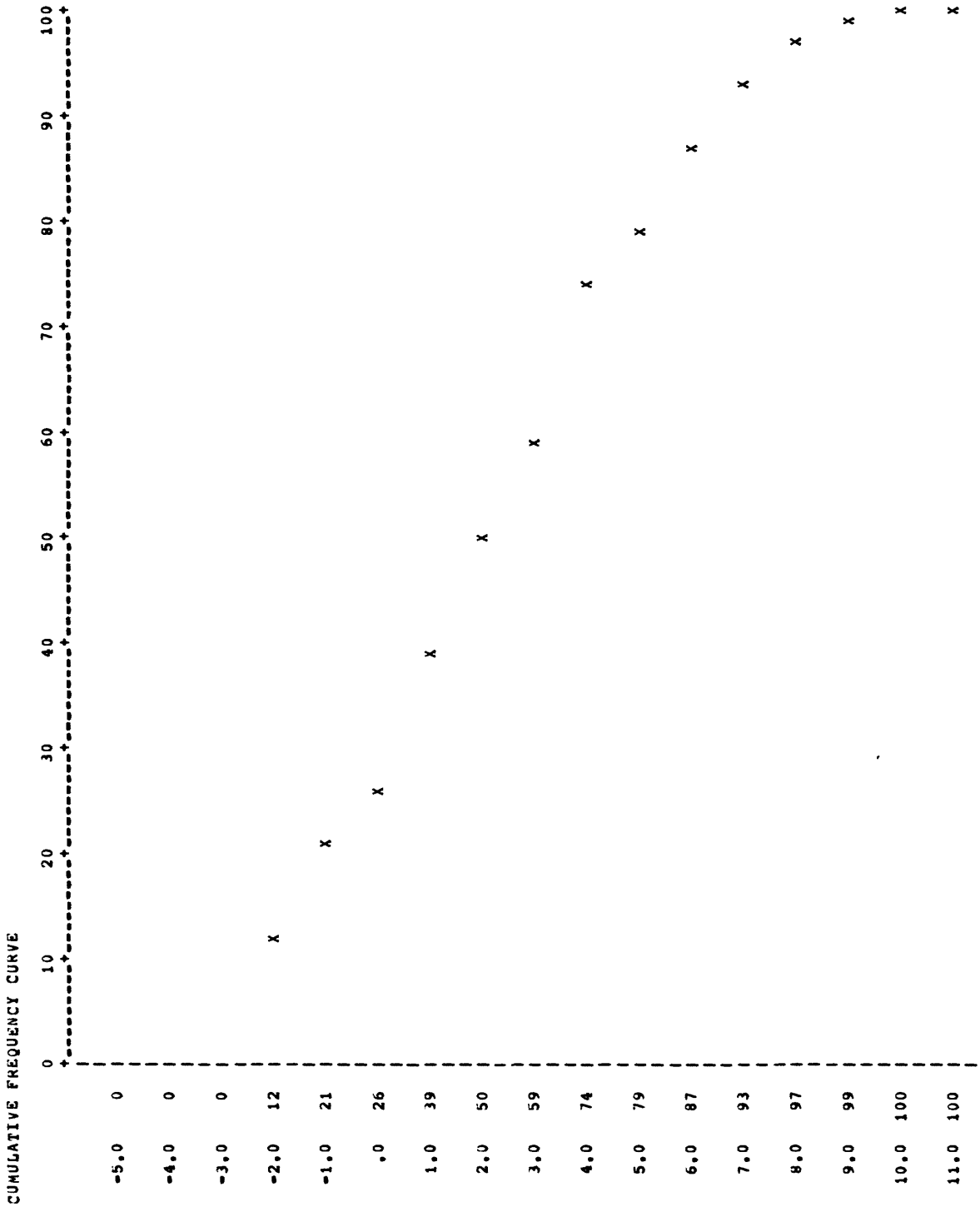

Figure 8b. Cumulative frequency curve for 8a.

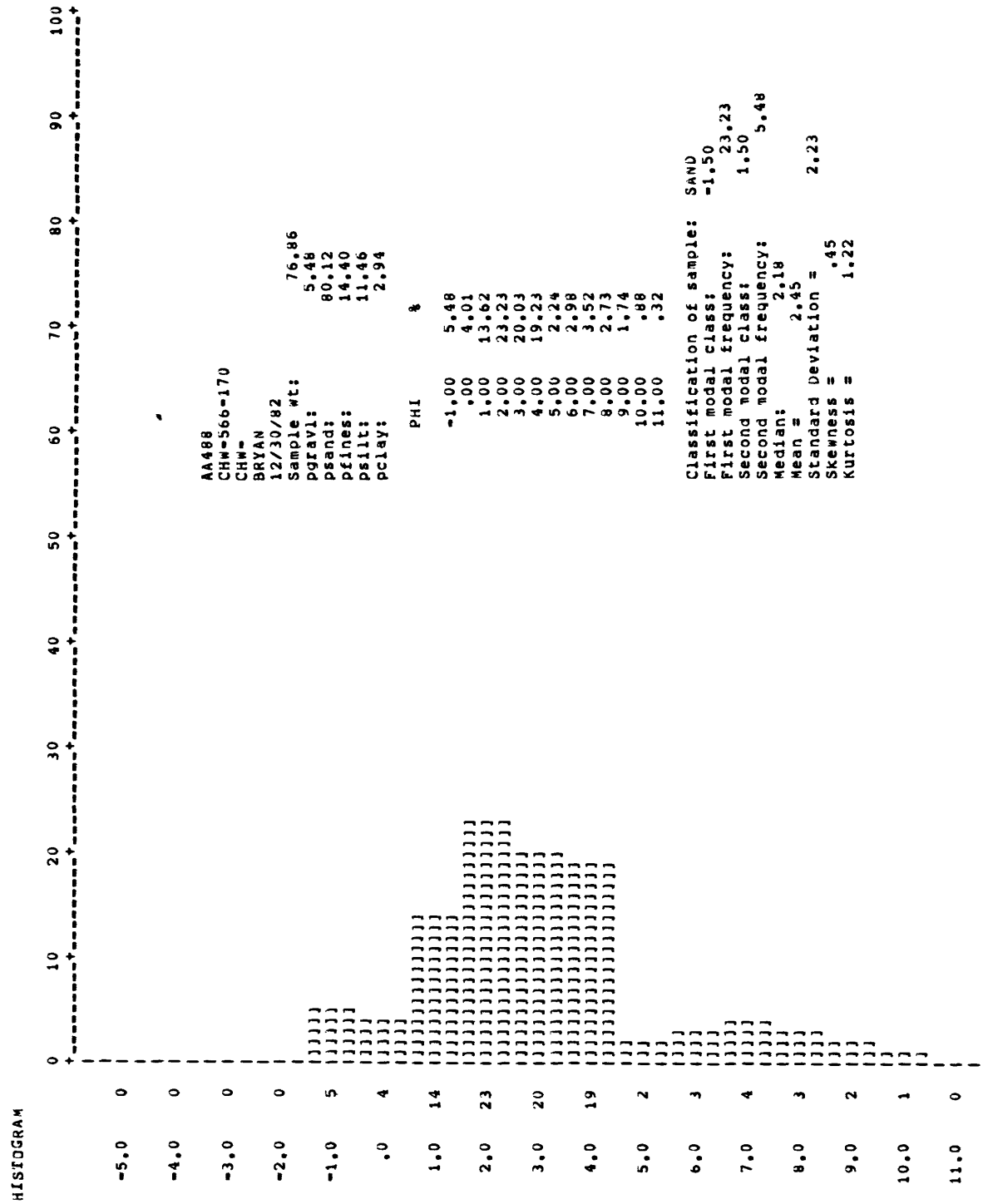

Figure 9a. Well No. 566, depth 170'. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

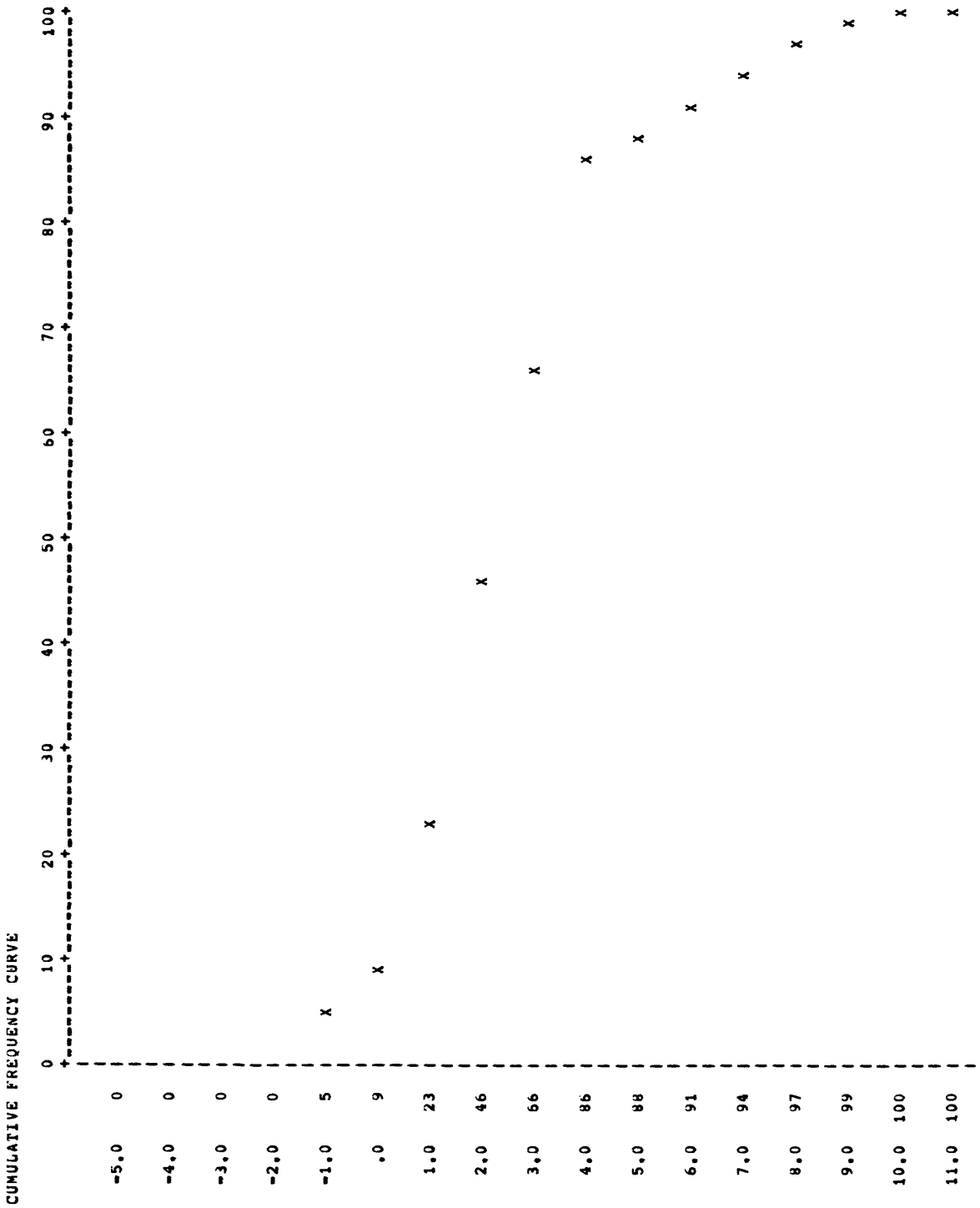

Figure 9b. Cumulative frequency curve for 9a.

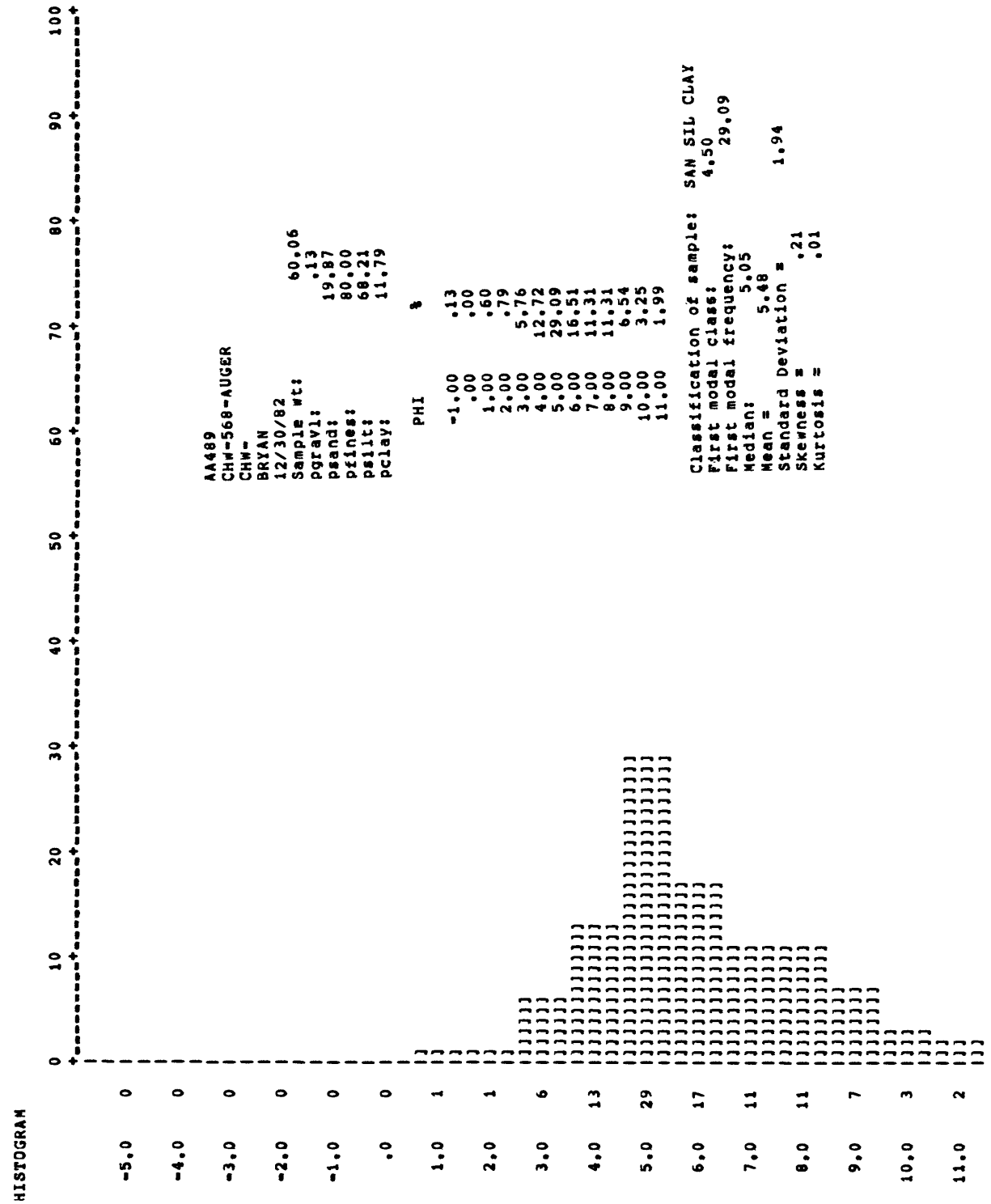

Figure 10a. Well No. 568, auger bit sample. Histogram scale shows grain size distribution in phi units. Abbreviations refer to: pgravl = percent gravel; psand = percent sand; pfines = percent silt and clay; psilt = percent silt; and pclay = percent clay.

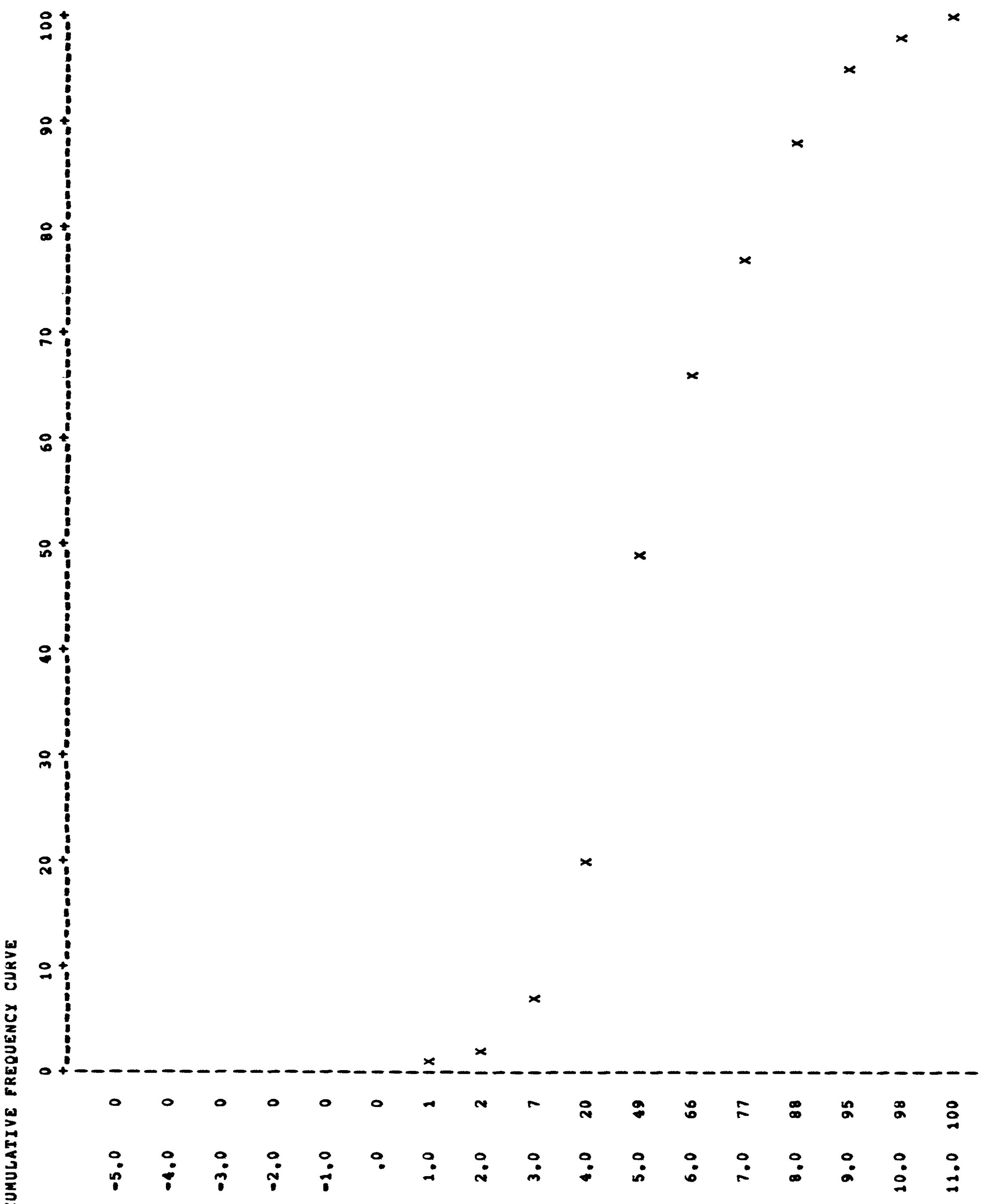

Figure 10b. Cumulative frequency curve for 10a.