A STUDY OF THE DEPOSITIONAL ENVIRONMENTS OF THE HALFWAY FORMATION BRITISH COLUMBIA

BY

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ABSTRACT

The upper sands of the discontinuous Halfway Formation to the northeast of Fort St. John were formed as barrier islands deposited perpendicular,or nearly perpendicular to the dip of the paleoslope of the Western Canadian Sedimentary Basin. These upper sands of the area of study were deposited during a transgressive phase of the Triassic sea to the northeast,and formed the basal unit of an onlapping sequence comprising the Halfway and the Charlie Lake Formations that disconformably overstepped the erosional surface on the silty dolomite of the Doig Formation. The Weasel sand body was deposited during a pause in the transgression,and then was submerged by a rapid rise in sea level. The Wildmint to Beatton barrier islands trend was deposited during a second pause in the transgression.These barrier islands would appear to have been deposited under arid conditions resulting in restricted lagoonal environments. The lower sands of the discontinuous Halfway Formation which only occur at a few locations in southern Willow and Wildmint ,would appear to have resulted from tidal inlet action that eroded channels into the Doig Formation below the base of the upper sands forming the barrier island complex. These later were filled with sand .

Then this barrier island trend was submerged by renewed transgression of the Triassic sea.The source of the sediments comprising the discontinuous Halfway Formation probably was to the north and northeast of the area of study.

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(See back pocket)

INTRODUCTION

The Halfway Formation of Triassic age outcrops for about 300 miles (482 km) along the Foothills belt of northeastern British Columbia, between the Chischa River in the northwest(Pelletier,1964),and the Alberta border in the southeast (Brass et al,1964),and extends northeastward from the Foothills for about 100 miles (161 km) in the subsurface (Fig.1)

The Halfway Formation consists of the continuous Halfway (Armitage,1962) and the discontinuous Halfway Formation (Clark, 1961). The continuous part of the formation forms a wedge-shaped deposit of sandstone and carbonate which thickens southwestward in the subsurface from about 40 miles (64 km) northeast of Fort St.John towards the Foothills where it is exposed at the surface. The discontinuous part of the formation occurs to the east and is separate from the continuous Halfway Formation; it consists of a series of elongated ,southeast trending and isolated sand bodies. These sand bodies are up to 8.3 miles (13.3 km) in length and 3.3 miles (5.3 km) in width, and attain a maximum thickness of 61 feet (18.4 m.) at Willow b-10-H.

The study area is located 65 miles (104.5 km) north -

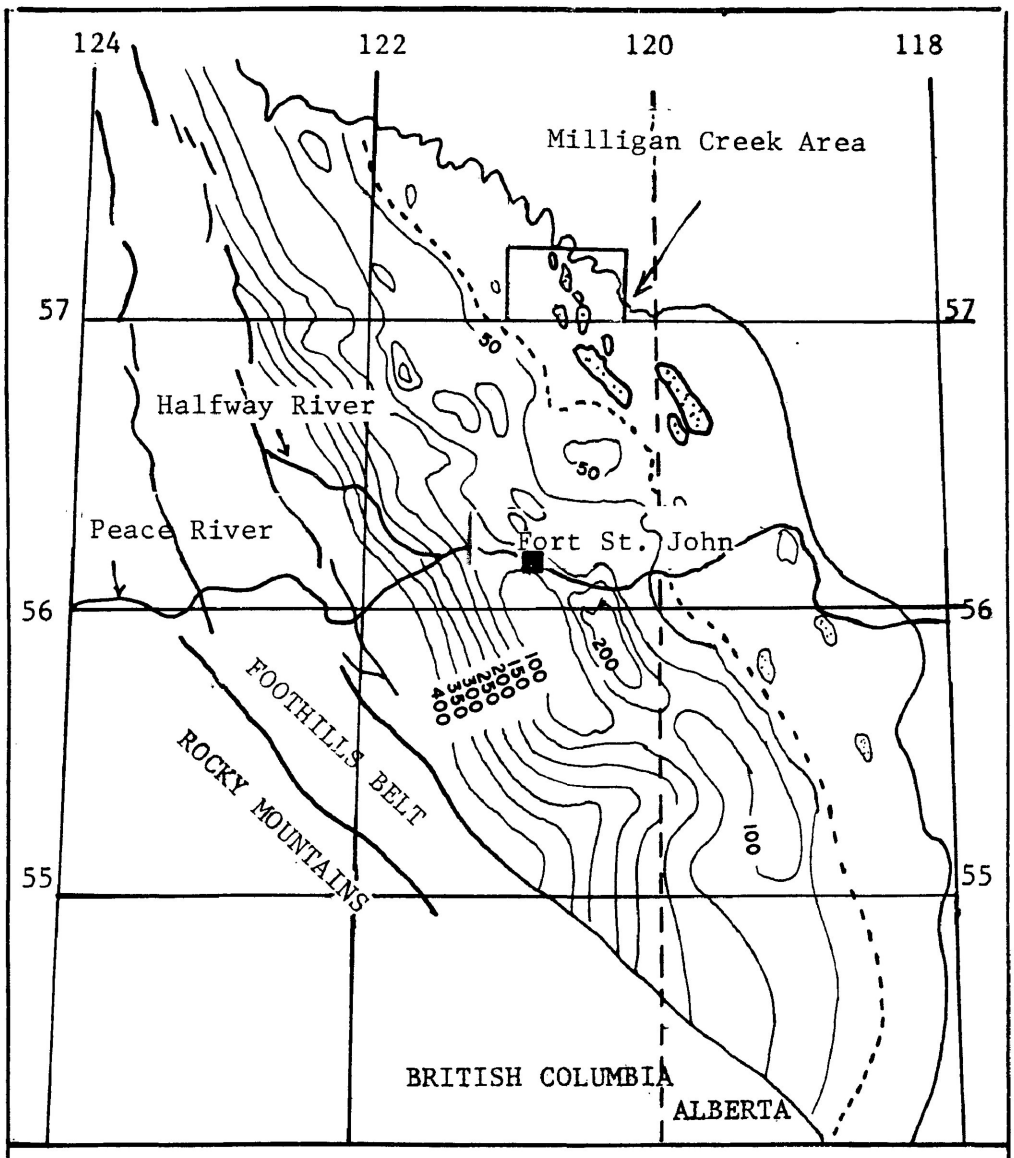
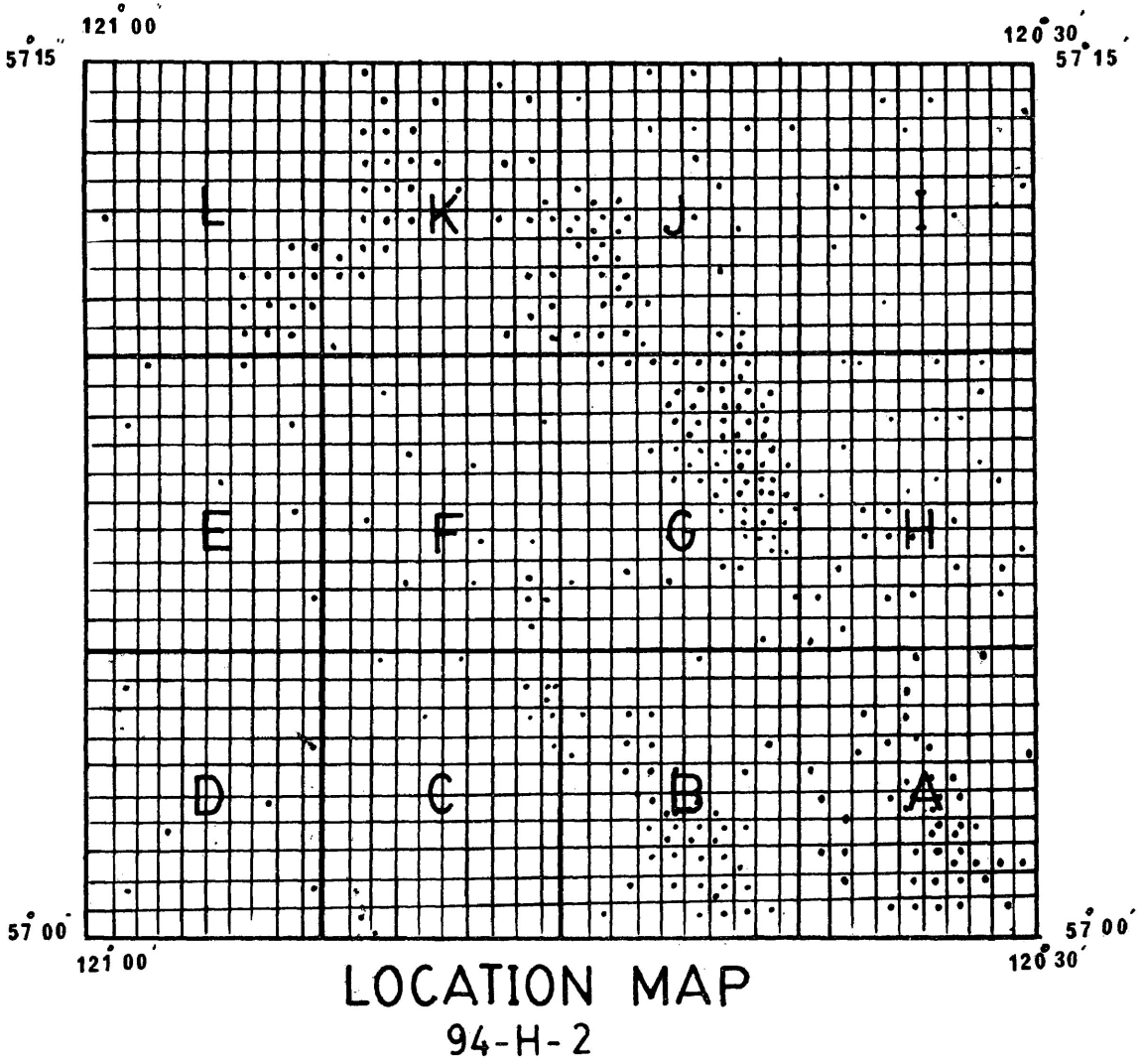


Fig.1 Regional distribution of the Halfway Formation

northeast of Fort St.John between co-ordinates 120 30 and 121 00 west longitude, and 57 00 and 57 15 north latitude,forming a rectangle 19 miles (30.5 km) in an east-west direction,and 17.4 miles (28 km) in a north - south direction (Fig.2). The discontinuous Halfway Formation occurs in the subsurface of the study area,and consists of the Beatton, Milligan,Willow,Wildmint, and Weasel sand bodies.

The objectives of this study were to determine the depositional environment or environments of these sand bodies, and to determine whether they were deposited during a transgressive or regressive phase of the Triassic sea.



LOCATION MAP
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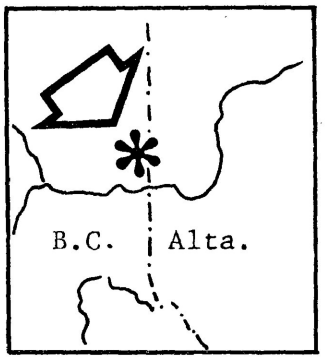

MILLIGAN CREEK
AREA

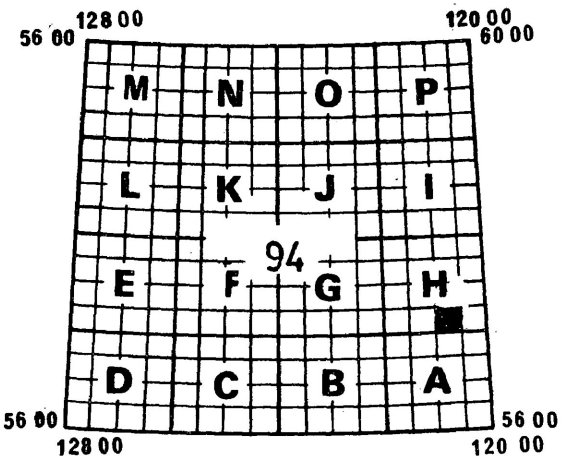

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Fig.2 Location and index map in the Milligan Creek area

• Oil well

PREVIOUS STUDIES

McLearn (1917) examined strata of the Triassic Age in the vicinity of the Peace River, and in 1921, he applied the name Schooler Creek to a series of upper Triassic sedimentary beds in the Foothills of northeastern British Columbia. McLearn continued his Triassic studies of the Peace River foothills in 1923,1937 and 1938. McLearn (194Ø and 1947) subdivided the Schooler Creek Formation into four lithological units which were in ascending order: Flagstones, Dark Siltstones, Grey Beds and Pardonet Beds. McLearn, 195Ø, established a table of formations and faunal zones for the Triassic strata (Fig.3) exposed in outcrop in the Peace River area.

Hunt and Ratcliffe (1959) designated the Schooler Creek Formation of McLearn (1921) as the Schooler Creek Group in the subsurface (Fig.3), and subdivided it into three formations which were in ascending order: the Halfway, the Charlie Lake , and the Baldonnel. Armitage (1962) suggested that the Pardonet Formation was present as the upper formation of the Schooler Creek Group in the subsurface of the Peace River area and that the beds underlying the Schooler Creek Group of Hunt and Ratcliffe (1959) be named the Diaber Group. In the subsurface, he divided the Diaber

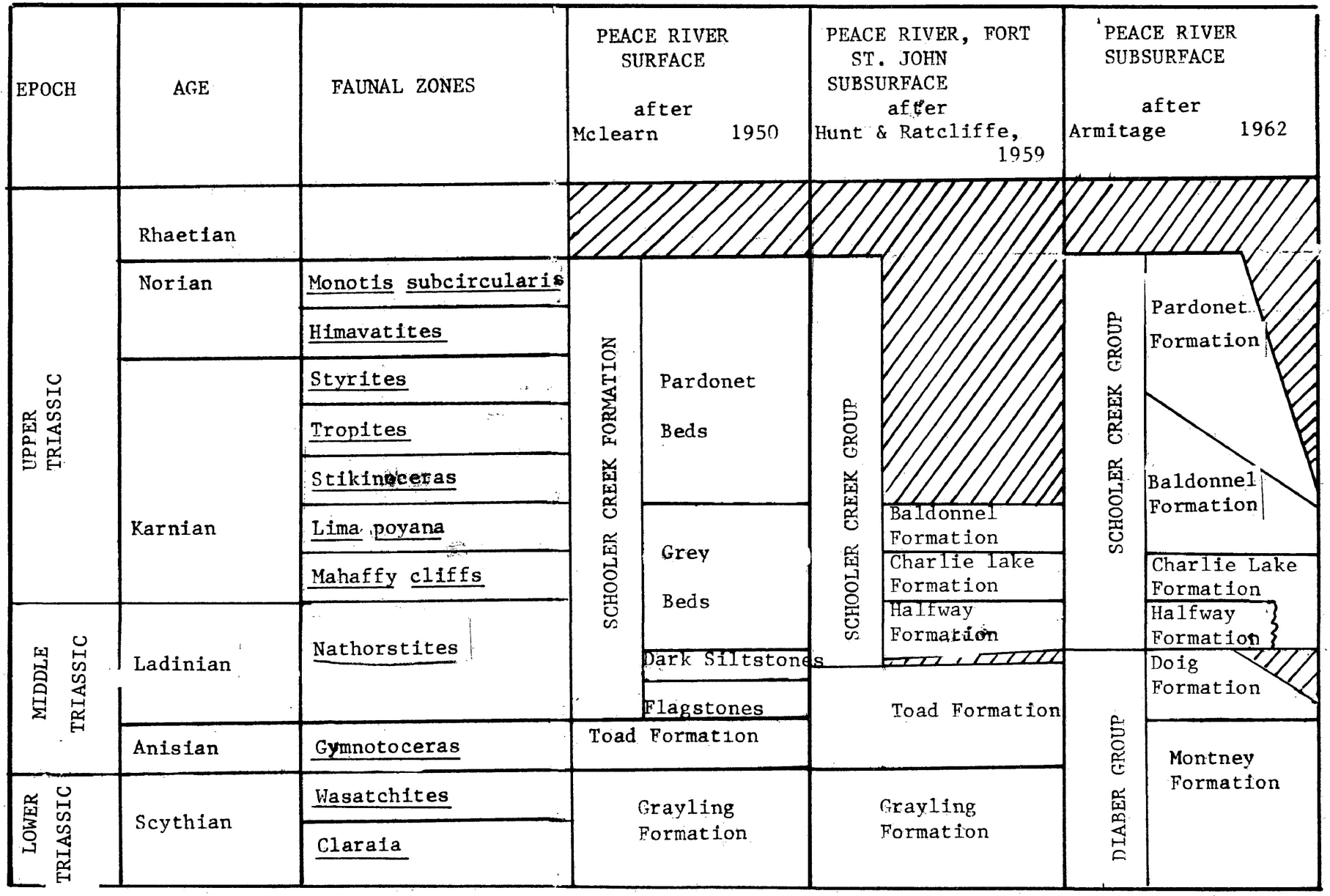


Fig.3 Table of formations in the area of study

Group into two lithological units: a lower argillaceous siltstone,which he called the Montney Formation , and an upper dark grey,bituminous siltstone unit,which he called the Doig Formation. Pelletier (1962) completed a paleocurrent study of the Triassic of the Rocky Mountains Foothills of northeastern British Columbia. His report,based on directional features such as cross-bedding , ripple marks,and flow casts, proposed that the direction of sedimentary transport was toward the west and southwest. He also indicated that the marine transgression which took place in a northeastly direction early in the Triassic Period was followed by marine regression and transgression again late in the Triassic Period. His proposals were based on an analysis of the regional stratigraphy.

Clark (1961) suggested that the discontinuous Halfway Formation in the Milligan Creek area was a series of barrier bars,based on a study of primary structures.He indicated that the barrier bars were formed during a transgression of the sea to the northeast. Brass, Best and Meyer (1964) suggested that the discontinuous Halfway Formation was deposited during a regressive phase as the sea withdrew to the southwest.In their study,based on the chert granules zones that occur at the top and the bottom of the sand bars, they suggested that there was no indication of a

nonconformity between the Halfway Formation and the underlying Doig Formation. However, Hunt and Ratcliffe (1959), Clark (1964), Armitage (1962), and Mothersill (1967, 1968) concluded that the sand bodies of the discontinuous Halfway Formation were deposited during a transgressive phase of the Triassic sea. Mothersill (1967, 1968) suggested that the sand bodies of the Halfway Formation in the subsurface of the Milligan Creek area were deposited as longshore bars and barrier beaches, and that the depositional shape of the discontinuous Halfway sand bodies was probably formed on a gentle basinward slope during pauses in the northeastern transgression of the Triassic sea. Torrie (1973) proposed that longshore currents transported the sand of the Halfway Formation, probably from a Permian and Pennsylvanian clastic strata source in a south-west direction. His proposal was based on a study of the sedimentary structures in the area of outcrop.

METHODS OF STUDY

The study of the discontinuous Halfway Formation began in October of 1980, when induction - electrical logs of approximately 300 wells in the study area were evaluated (Fig.2). The well logs were used to determine the A Marker, a high resistivity zone above the Halfway Formation, and the top and the base of the Halfway Formation. From these data (Appendix A), structural contour maps were constructed on the top of the Halfway Formation (Map 1) and the base of the Halfway Formation (Map 2), as well as an isopach map of the thickness of the formation (Map 3). In May, 1981, cores of the Halfway Formation from 59 wells (Fig.4) were examined at the British Columbia Government Corehouse at Charlie Lake. The examination of the cores included a detailed description of the lithology, the upper and lower formation boundaries, measurements of the dip angle of the foresets of cross-bedded intervals, and granular zones within the formation. During the examination of the cores, samples were taken for later laboratory analyses.

Grain size analysis of sand samples was carried out on 73 samples from the 59 wells by breaking up a sample (from 25 to 50 grams in weight) by pestle and mortar to pieces less than 5 mm in diameter. The crushed sample was treated

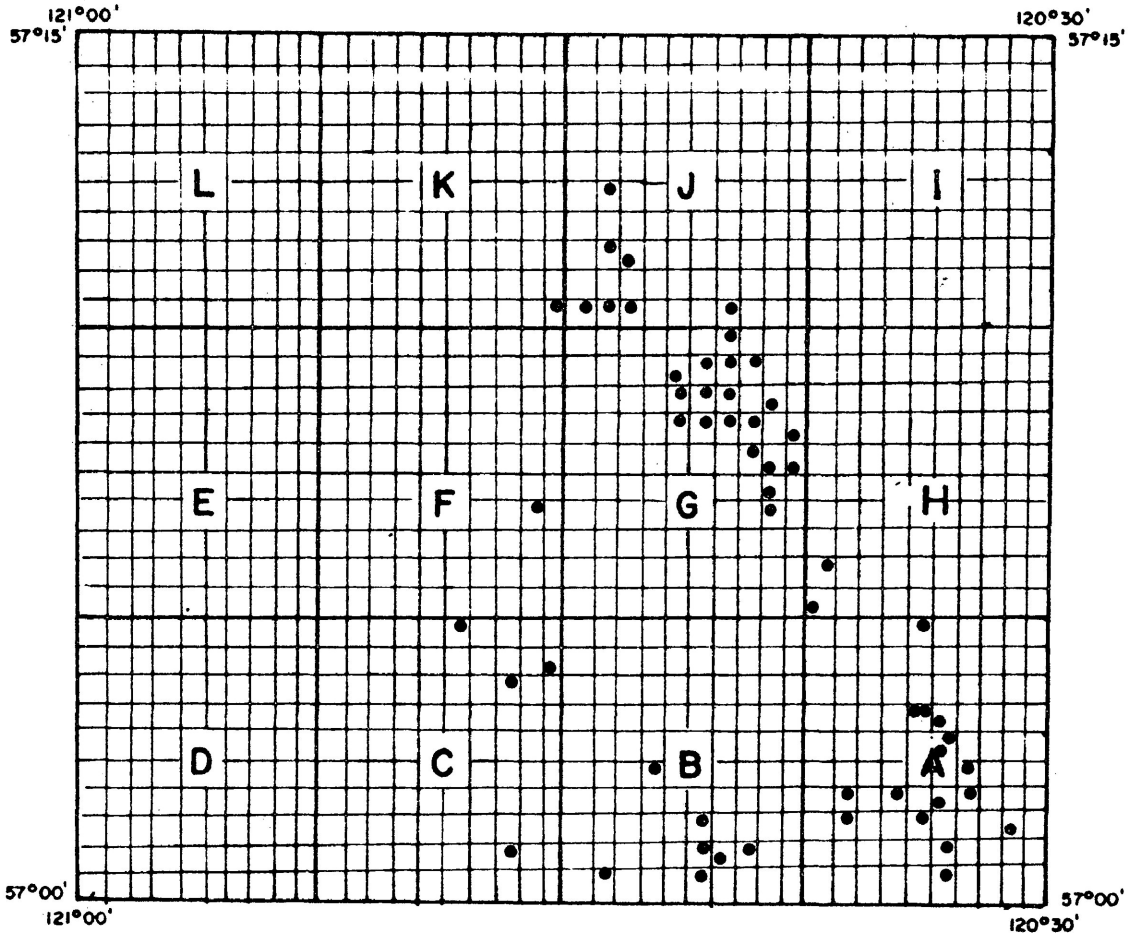


Fig.4 Location map of the well cores examined in the area of study

with hot 50 percent hydrochloric acid for approximately 24 hours to dissolve the calcite and dolomite cement. The hydrochloric acid was then filtered off, and the sample was washed with water, and dried. Because of pressure solution and the resulting aggregation of some of the quartz grains, the sample was spread out between two thick sheets of packing paper, and gently rolled with a plastic cylinder to complete the disaggregation. Then the sample was weighed and sieved on an electrical sieve shaker for ten minutes using a set of 8 inch diameter sieves at half phi (0.50 phi) intervals from 1.00 phi to 4.00 phi. Each sieve fraction was checked by binocular microscope,and those fractions which contained sand aggregate clusters were placed again between two thick sheets of packing papers, were gently rolled with a plastic cylinder,and were checked again under a binocular microscope to ensure that the disaggregation was complete,and were then sieved once again. After each sample was completely disaggregated,the sieve fractions were weighed to an accuracy of 0.01 gram (Appendix F1). The percentage of the various sieve fractions was calculated,and the cumulative percentage curves were constructed on arithmetic probability paper. All the grain size results were compiled in Appendix E.

Swan, Clague and Luternauer (1978) conclude that a 1.00

phi sieve interval is sufficient ,if graphic grain size measures are used. In 1979, they suggested that for grain size parameters derived from moment measures, a decrease from 1.ØØ phi to Ø.25 phi intervals resulted in an improvement in accuracy.In 1967,Friedman used either 4.25 or 6.ØØ phi as the pan fraction in his calculations in determining the grain size parameters,and,in 1979,he considered the pan fraction as 6.ØØ phi. Moiola and Weiser (1968) used quarter,half and whole phi intervals in their studies to distinguish between different environments.Sevon (1966) considered half phi (Ø.5Ø) sufficient to distinguish samples from different environment using moment measure.

The graphic grain size parameters mean size, standard deviation, skewness and kurtosis (Table 1), were calculated using the equations of Folk and Ward (1957),with values taken from the cumulative frequency curves (Appendix.E2). The grain size parameters,based on the moment measures, were computed on a VAX 11/78Ø computer,utilizing a program developed at Lakehead University after Friedman's (1961) equations (Table 2). Other grain size parameters, such as simple sorting measure and simple skewness measure, were calculated (Appendix E1) after Friedman (1967).

Visher (1969), and Glaister and Nelson (1974) found a relationship between the shape of the tractive, saltation

TABLE 1

Equations for Graphic Parameters
(after Folk and Ward 1957)

MEAN

$$M\phi = \frac{\phi 16 + \phi 84 + Md\ \phi}{3}$$

STANDARD DEVIATION

$$Sd\ \phi = \frac{(\phi 84 - \phi 16)}{4} + \frac{(\phi 95 - \phi 5)}{6.6}$$

SKEWNESS

$$Sk\phi = 1/2\ \frac{(\phi 84 + \phi 16 - 2Md\phi)}{\phi 84 - \phi 16} + \frac{(\phi 95 + \phi 5 - 2Md\phi)}{\phi 95 - \phi 5}$$

KURTOSIS

$$K\phi = \frac{\phi 95 - \phi 5}{2.44(\phi 75 - \phi 25)}$$

TABLE 2

Equations for Statistical Moment Measures
(after Friedman 1961 and 1967)

Statistical Measure	Symbol	Formula
Mean	$\overline{X}\,\phi$	$4/100\Sigma fm$
Standard Deviation	σ	$(\Sigma f(m\phi - \overline{X}\phi)^2 /100)^{\frac{1}{2}}$
Skewness (Third moment)	$\alpha_3\phi$	$1/100\sigma^{-3}\phi\Sigma f(m\phi - \overline{X}\phi)^3$
Kurtosis (Fouth moment)	$\alpha_4\phi$	$(1/100)\ \sigma^{-4}\phi\Sigma f(m\phi - \overline{X}\phi)$
Simple sorting measure	Sos	$1/2(\phi 95 - \phi 5)$
Simple skewness measure	α_s	$(\phi 95 + \phi 5) - 2(\phi 50)$

and suspension populations in the grain size distribution probability plots, and in the depositional environments such as dune and beach. The probability plots of the Halfway Formation samples were compared to these 'type' plots.

Vertical profiles were established of the Halfway sections to show the variation in lithology, the lower and upper contacts, the location of the granular zones, the variation of the angle of dip of the foreset beds of cross-bedded units, and the vertical variation in mean size, standard deviation, skewness, and kurtosis based on the moment of measure after Friedman (1961).

X-ray diffraction analysis was carried out on representative samples for the Charlie Lake,Halfway and Doig Formations, using a Cu k_{α} radiation (8ØØ watt intensity, and a focusing monochrometer at a scanning rate of two degrees per minute),with mineral identification based on tables from Berry (1972), Brindley (1951), Grim (1968),and Griffin (1971).

The Q mode factor analysis has been used after Klovan (1966), in order to obtain a clear discrimination between sediments deposited under different energy conditions. The Q mode factor analysis method considers each grain size distribution of a sample as a vector in a space having as many dimensions as the number of the classes (half-phi

intervals used in this study). The position of each vector in this space was determined by the amount of sediment in each size range. Every vector was then compared with the other vectors, and the degree of proportional similarity between two vectors was defined as $\cos\theta$ by Imbrie and Purdy (1962), The $\cos\theta$ matrix table, which express the degree of similarity of each vector to every other vector,was obtained. This table of coefficients was analyzed by factor analysis.The object was to find factor,or factor axes, which explain the degree of similarity between all the sample vectors which were contained in the $\cos\theta$ matrix,and which were arranged in decreasing order of importance (eigen values of the $\cos\theta$ matrix). From this data the principal components factor matrix tables were obtained.The table of coefficients was analyzed by factor analysis by rotating the factor axes so that the sample vectors could be projected onto the axes.This projection (factor loading) was expressed by numbers whose values were an indication of how much a sample is affected by each factor. This method was described in detail by Imbrie and Van Andel (1964).

Linear discriminant function analysis has been applied to the Halfway Formation samples by using the moment of measure data obtained after Friedman (1961), and the technique of Sevon (1966),who applied three discriminant

functions, R1,R2 and R3, where R1 was a linear discriminant function to distinguish between beach and dune,R2 to distinguish between beach and river,and R3 to distinguish between river and dune (Table 3).

Discriminant function analysis was applied after Sahu (1964),who established four discriminant functions,based on the graphic parameters of Folk and Ward (1957). This discrimination analysis has been applied to the Halfway Formations samples, using the functions :

1- Discriminant function (Y1) to differentiate between aeolian and beach environments.

$Y1 = -3.5688\ Mz + 3.7016\sigma_1^2 - 2.0766\ Sk + 3.1135\ KG$

2- Discriminant function (Y2) to differentiate between beach and shallow agitated marine environments.

$Y2 = 15.6534\ Mz + 65.7091\sigma_1^2 + 18.1071\ SK + 18.5043\ KG$

3- Discriminant function (Y3) to differentiate between shallow marine and the fluvial process.

$Y3 = 0.2852\ Mz - 8.7600\sigma_1^2 - 4.8932\ SK + 0.0482\ KG$

4- Discriminant function (Y4) to differentiate between fluvial and turbidity currents.

$Y4 = 0.7215\ Mz - 0.4030\sigma_1^2 + 6.7322\ SK + 5.2927\ KG$

TABLE 3

Linear Discriminant Functions (R) to Distinguish between beach and dune (R1), beach and river (R2), and, dune and river (R3) sands by means of their grain distribution characteristics:

R1 = -Ø.Ø662 Mz + Ø.Ø2842 SD - Ø.ØØ672 SK + Ø.ØØ399 K

R2 = Ø.ØØ152 Mz - Ø.Ø4371 SD - Ø.ØØ624 SK + Ø.ØØ375 K

R3 = Ø.Ø46Ø1 Mz - Ø.Ø4993 SD + Ø.ØØ97 SK + Ø.Ø192 K

NOTE:

M =Mean Size

SD = Standard Deviation

SK = Skewness

KG = Kurtosis

NOTE:

Mz = Graphic mean size

σ = Variance

SK = Graphic skewness

Kg = Graphic kurtosis

Petrographic microscopic examination of 1Ø2 thin sections from 59 wells were made to determine the major constituents,the accessory minerals, the roundness,and the sphericity of the sand particles. Heavy mineral separations were carried out on the 4.ØØ phi fractions using tetrabromoethane (specific gravity,2.94),and sample slides were then prepared for mineral identification, using a petrographic microscope.

Forty eight samples (2 cm^3),oriented relative to the vertical direction of the cores,were prepared for paleomagnetic determinations on a Schonstedt DSM.2 Digital Spinner Magnetometer at the University of Western Ontario,and on a Minispin 2A Spinner Magnetometer at Lakehead University.The paleoinclination values were valid because the vertical orientation of all the samples was known. However,the paleodeclination values could not be determined as there was no reference azimuth for the cores taken from the Halfway Formation.

RESULTS

Distribution of the Halfway Formation in the Study Area

The discontinuous Halfway Formation in the subsurface of the Milligan Creek area consists of isolated sand bodies ,which are be up to 8.3 miles (13.3 km) in length, and up to 3.3 miles (5.3 km) in width.The depositional strike of the sand bodies range in direction from north 30 west - south 30 east, at Wildmint and Willow, to north 25 west-south 25 east at Milligan,and the sand body at Beatton is very irregular in shape. From Beatton to Wildmint, the sand bodies form an en echelon trend (Mothersill,1967). The orientation of the sand body at Weasel is north 25 west - east 25 west; it lies subparallel and to the west of the Wildmint- Beatton trend,as shown in Map 3 .

The electrical - induction well log of the Wildmint b-55-A is a typical well log of the Halfway Formation in the area of study (Fig.5). The spontaneous potential curve appears on the left side of the log, with millivolt values increasing to the left. The right side of the log consists of the resistivity curve with resistivity values expressed in ohm-meters increasing to the right.The Halfway Formation can be defined from the well log as being the porous and permeable sand interval occurring between the 'A' Marker bed

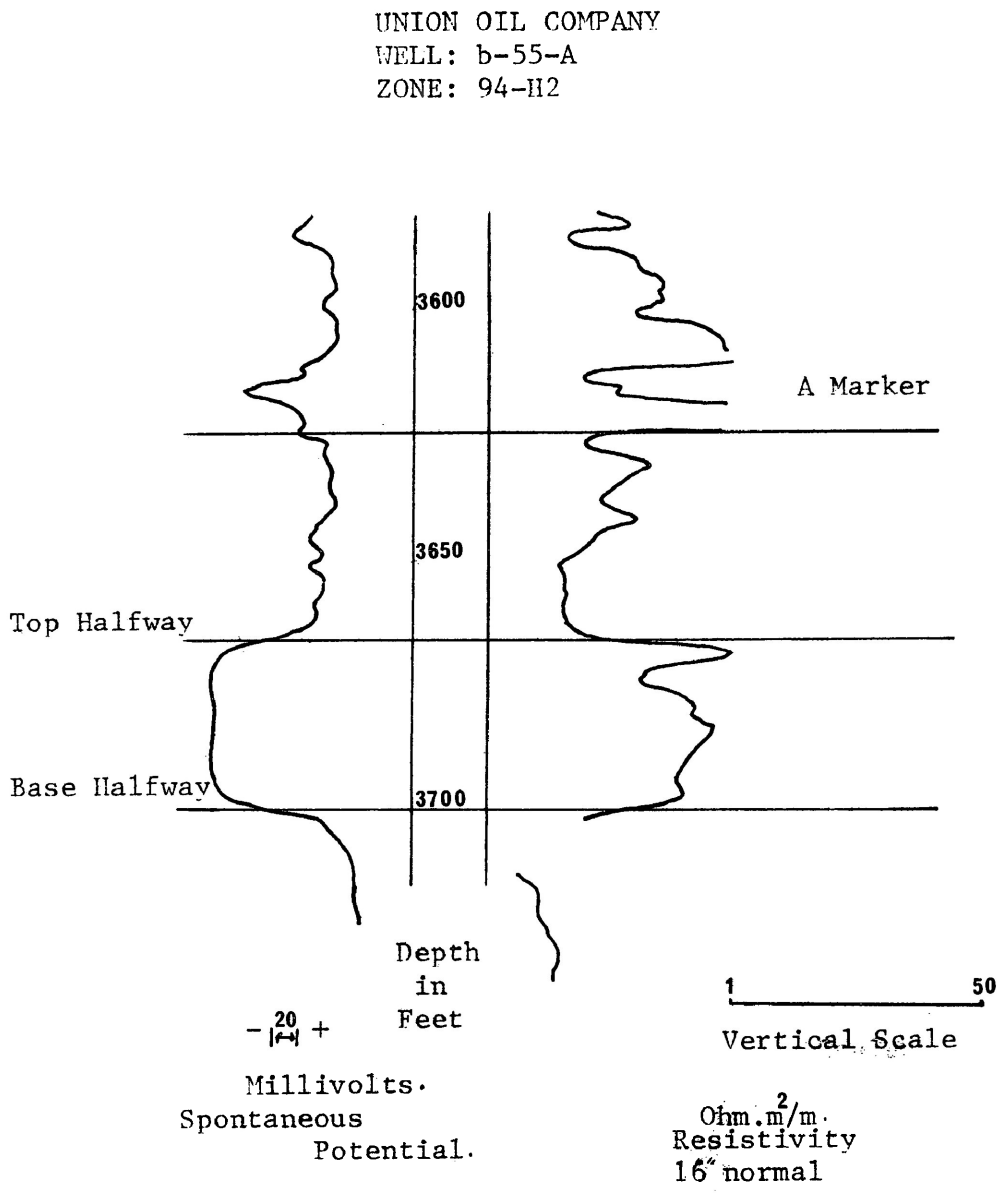


Fig. 5 Electrical-induction log of the Halfway Formation at Wildmint b-55-A

and the top of the underlying Doig Formation (Fig.5).

Figure 6,and 7,show cross-sections of the 'A' Marker bed, the discontinuous Halfway Formation,and the underlying Doig Formation based on the electrical-induction logs (Map 3).The 'A' Marker bed in the electrical-induction well logs is shown in figure 5; it is found to be consistent in all well logs of the area of study,and consists of microcrystalline to microgranular limestone,and dolomitized limestone,that is brown to dark brown in colour.The thickness ranges between 1Ø to 15 ft.(3 to 4.5 m),after Fulton (1966). Unfortunately,the marker bed was not cored in any of the well cores examined. These cross-sections show the lateral stratigraphic relationship between the Charlie Lake Formation and the Halfway Formation.

The structural contour maps for the top and the base of the formation using sea level as a datum plane and the isopach map of the Halfway Formation were constructed utilizing data obtained from well logs (Appendix. A). The structural contour map for the top (Map 1) and base (Map 2) of the Halfway Formation show areas of low relief sloping to the southwest.The paleoslope would have been toward the southwest,assuming that it was parallel to the present day slope. The isopach map (Map 3) shows that the Halfway Formation of the study area consists of isolated sand bodies (Wildmint, Willow, Milligan, Beatton, and Weasel; and the depositional strike of these sand bodies would have been

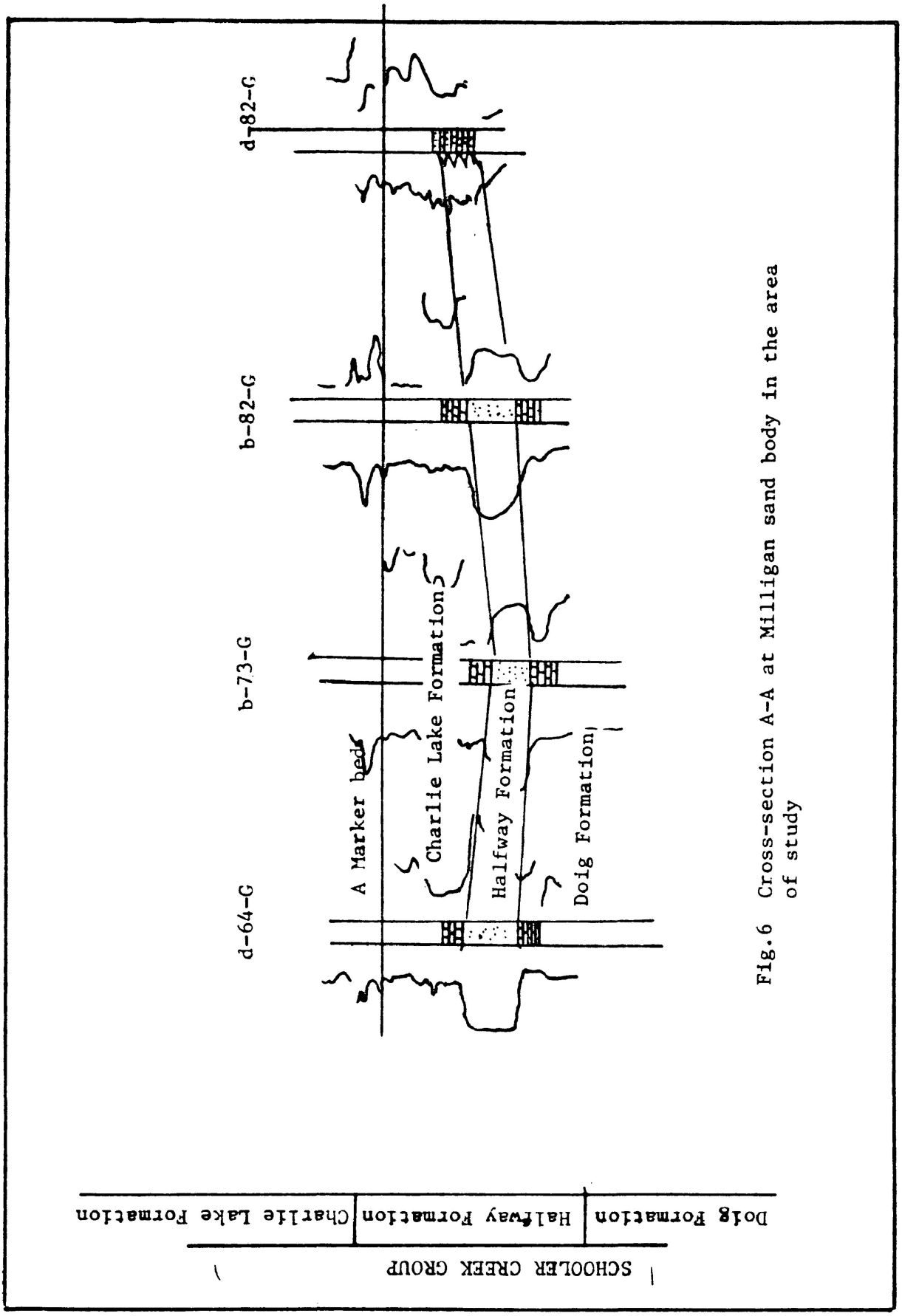


Fig.6 Cross-section A-A at Milligan sand body in the area of study

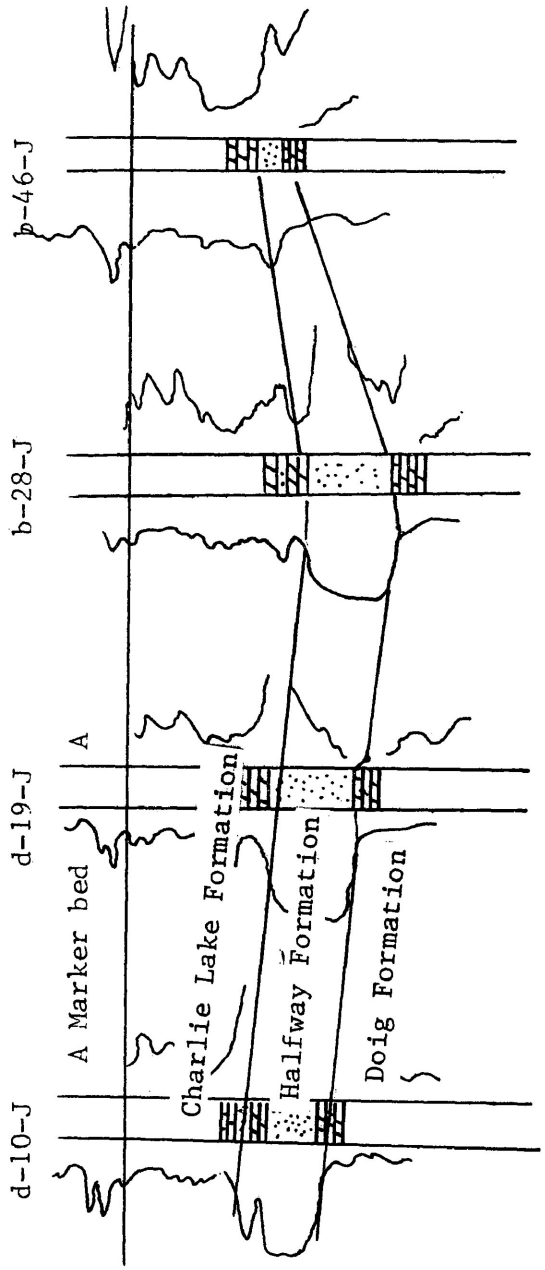
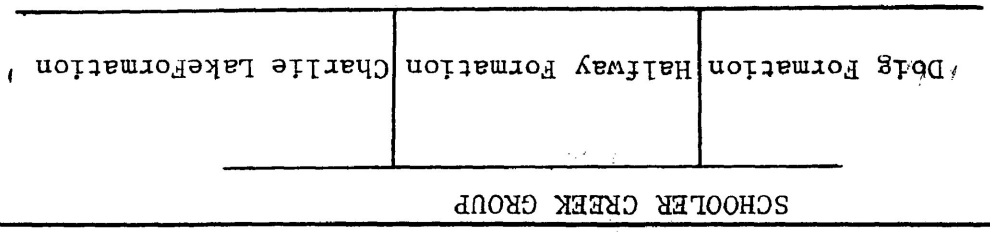


Fig.7 Cross-section B-B at Beatton sand body in the area of study



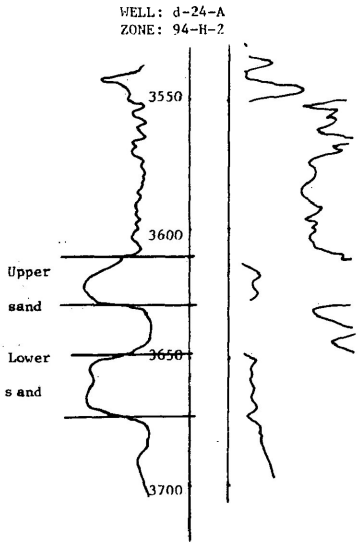


Fig. 8d Electrical-induction log of Wildmint d-24-A

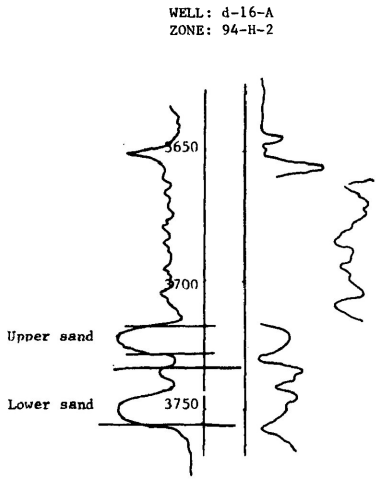


Fig. 8c Electrical-induction log of Wildmint d-16-A

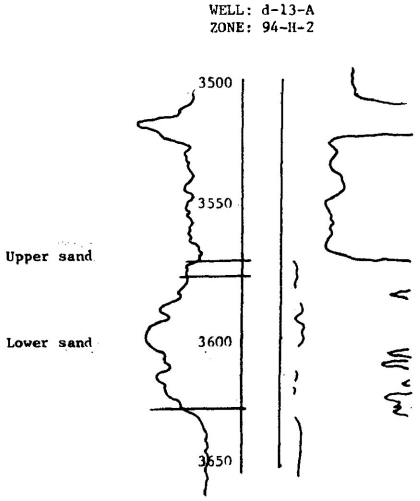


Fig. 8b Electrical-induction log of Wildmint d-13-A

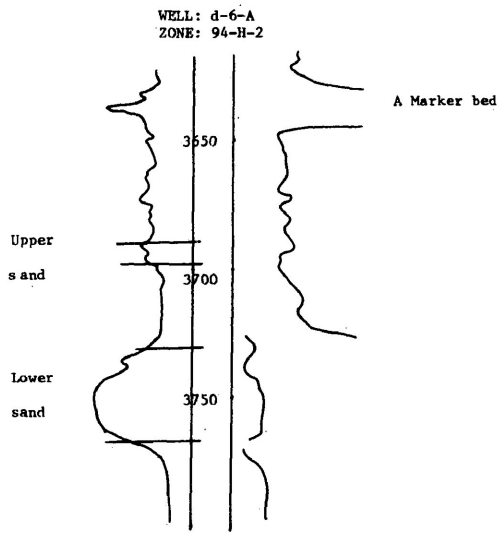


Fig. 8a Electrical-induction log of Wildmint d-6-A

Fig.8

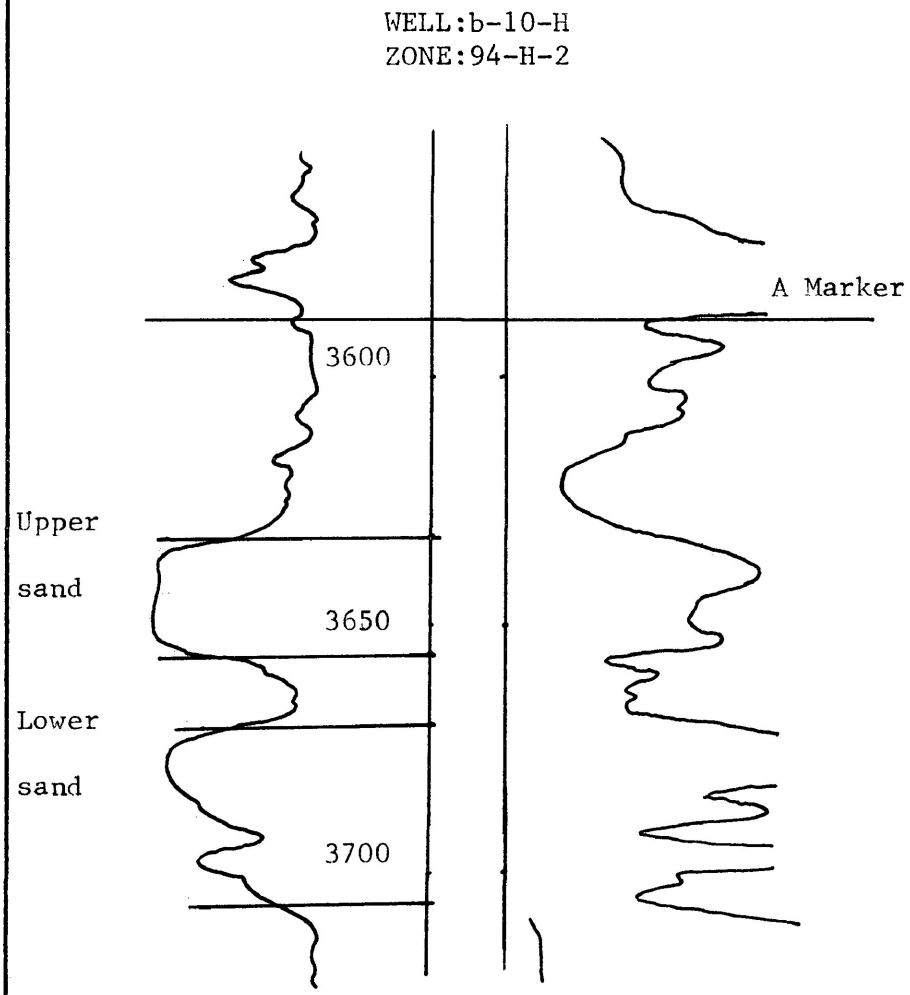


Fig. 9 Electrical-induction log of Willow b-10-H

approximately at right angles to the paleoslope direction. The Milligan sand body is 3 miles (4.8 km) in length and 2.5 miles (4 km) in width, the Wildmint sand body is 8.3 miles (13.3 km) in length and from 1.5 (2.4 km) to 3.3 (5.3 km) miles in width,the Weasel sand body is 5.4 miles (8.6 km) in length and 1.6 miles (2.5 km) in width, and the Beatton sand body was up to 5.2 miles (8.3 km) in length and 1.7 miles (2.7 km) in width. Mothersill (1968) pointed out that using the A marker as a datum,show that the sand bodies of the Halfway Formation are convex downward in shape, which might indicate that the sand bodies of the Halfway Formation had been deposited in lows on the Doig erosional surface. Figures 8a,8b,8c,8d,and 9 based on the electrical-induction well log, show that the Halfway Formation consists of lower and upper sands at four locations in the southern part of Wildmint (d-6-A (Fig.8a),d-13-A (Fig.8b),d-16-A (Fig.8c), and d-24-A (Fig.8d), and at one location in the southern part of Willow b-10-H (Fig.9). At four of these locations the upper and lower sands were separated by silty dolomite,as described at well b-10-H,which was the only well core available for examination.In the electrical-inducation logs of all other wells examined the Halfway consists only of the predominant upper sand.

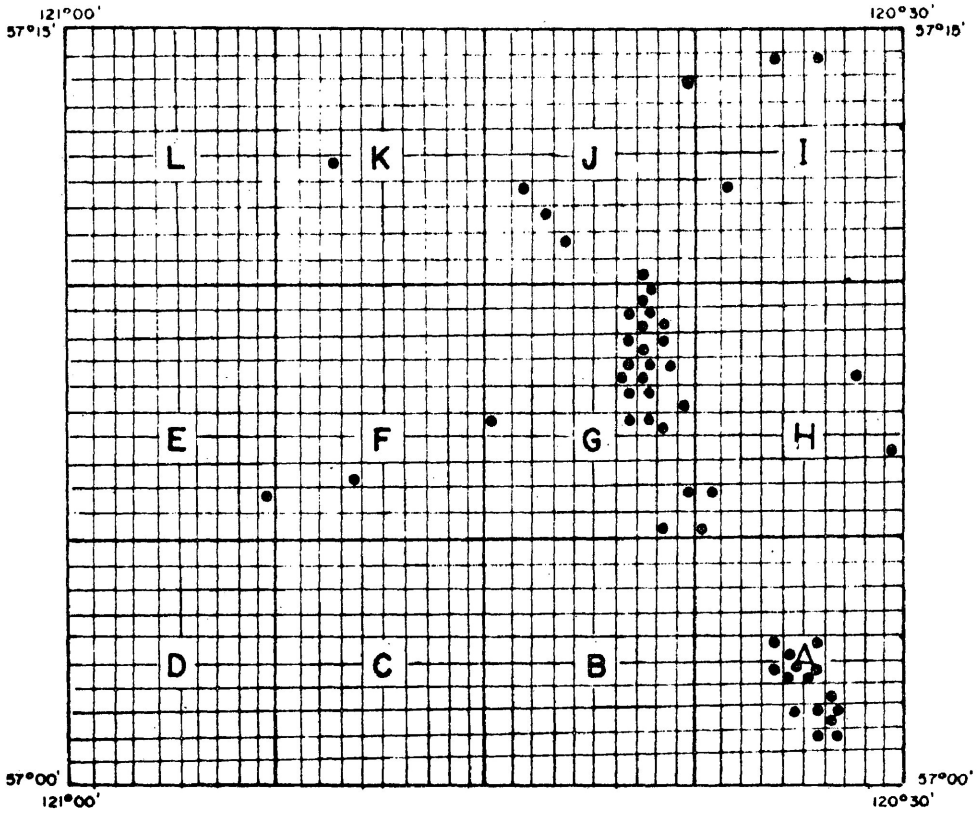


Fig.10a The location of the well cores of Mothersill (1967) in the area of study

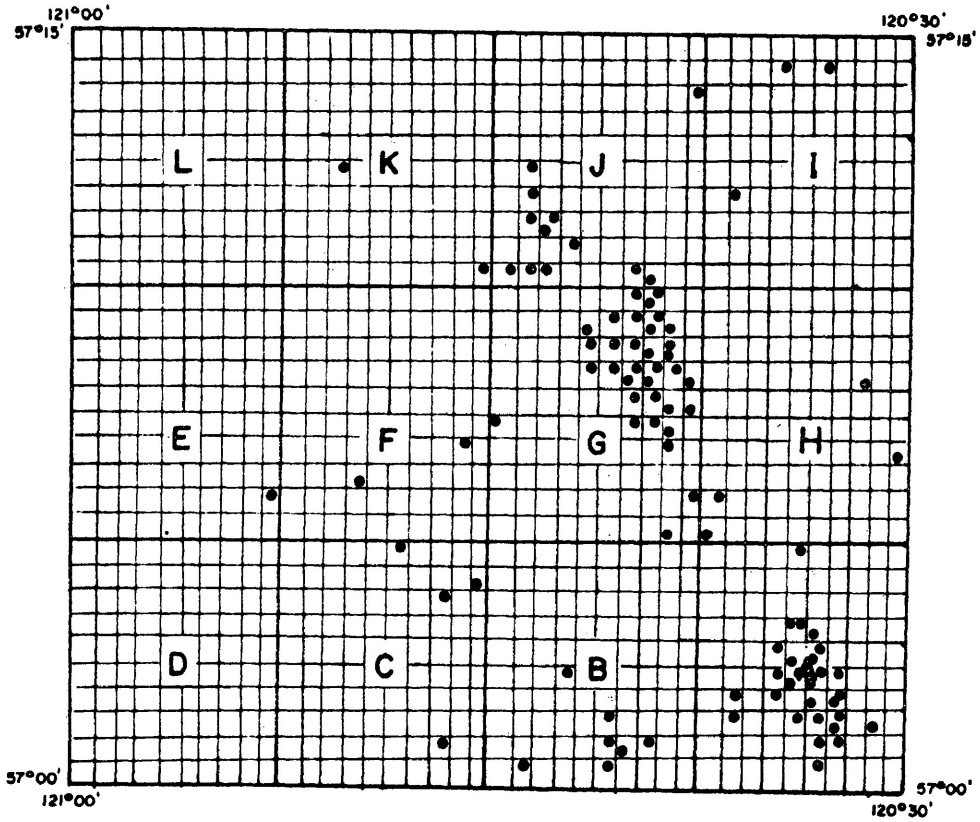


Fig.10b The location of the well cores in this study and Mothersill (1967)

Lithology

The lithology of the upper sand bodies of the discontinuous Halfway Formation was determined from the study of cores from 59 wells. Figure 10a shows the location of 55 well cores in the study area that Mothersill (1967) examined. Figure 10b shows the location of the well cores examined in this study,and those of Mothersill (1967). These sand bodies of the discontinuous Halfway Formation consist of grey, fine to very fine grained, calcareous sandstone that is cross-bedded in part. The thickness of the foreset beds ranged from 0.1 to 2.50 cm, and the angle of dip of the foreset beds ranged from 5 to a maximum of 30. Figure 11 shows the location of the cross-bedding in the study area from this study and Mothersill (1967). It was not possible to determine the azimuth of the maximum dip of the foreset beds because none of the well cores examined were directional. The details of the cross-bedding have been compiled for each of these wells in Appendix J. Thin granule zones occur at the base of the Halfway Formation,as well as throughout the formation in many of the wells. The granule zones consist of grains of lithic,quartz,chert, and silty dolomite granules in a sandstone matrix,and are usually less than 0.50 cm in thickness. Figures 12a, and 12b shows the location of granule zones found in the well cores examined in this study and in the well cores from

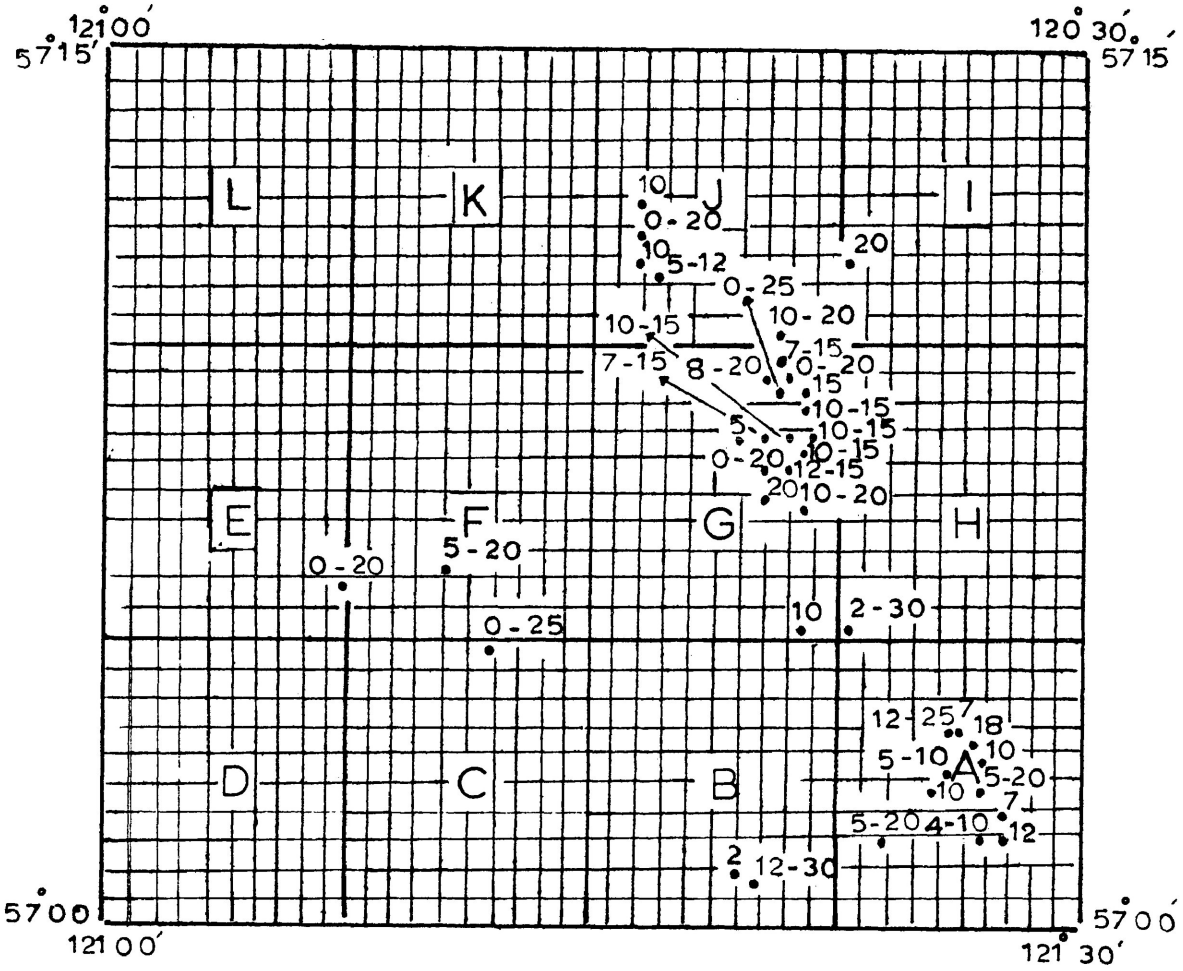


Fig. 11 The location and the angle of dip of foreset cross-bedded sections in the Halfway Formation

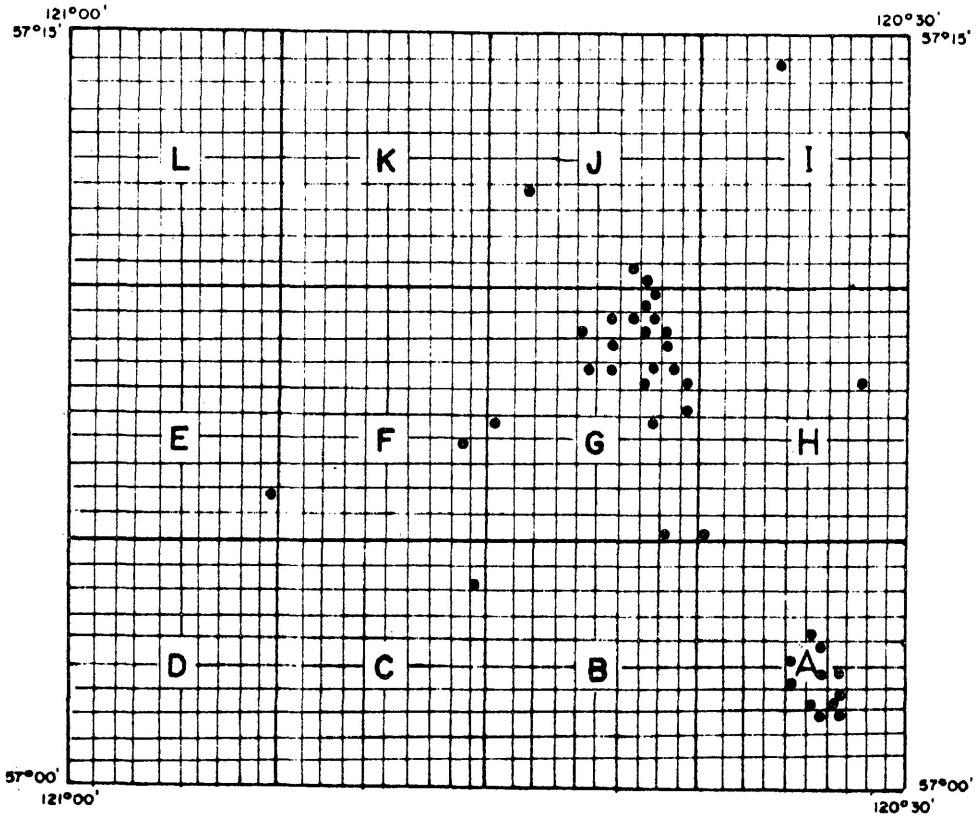


Fig.12a The location of the basal granule zones in the area of study

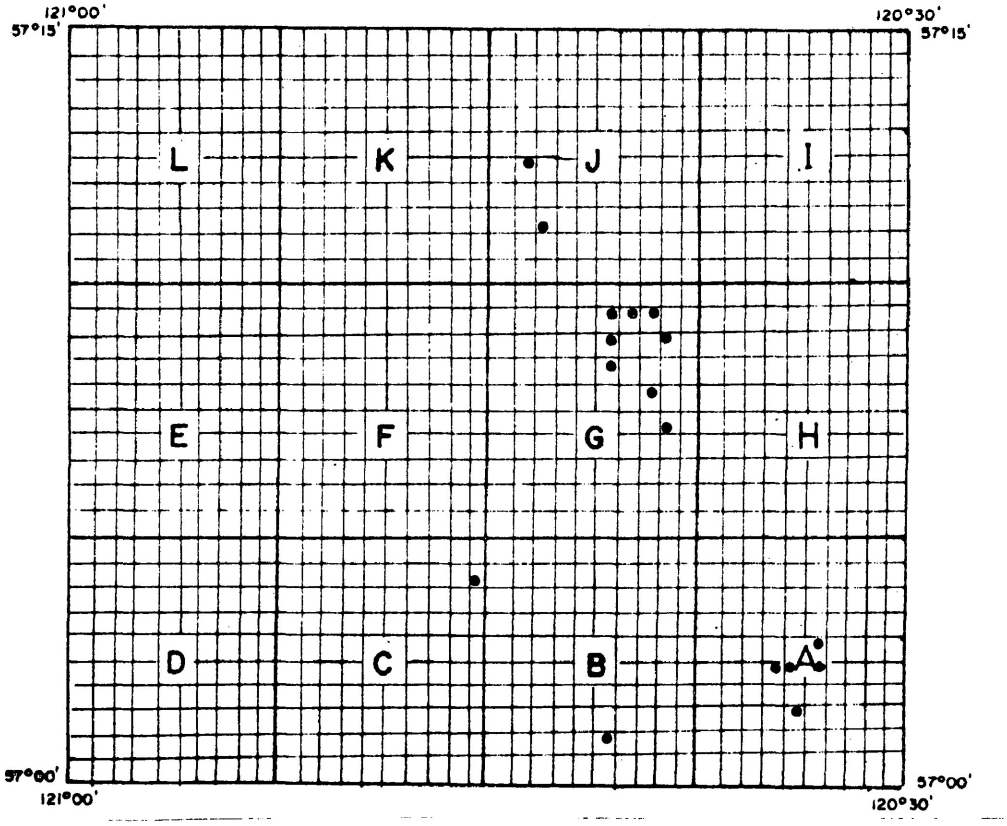


Fig.12b The location of the upper granule zones in the area of study

Mothersill (1967). The lithological break between the Halfway Formation and the underlying silty dolomite of the Doig Formation is quite sharp (Fig.13a), and, in some cases, is an irregular surface. The sharp basal contact,and the presence of the basal granule zone is indicative that the contact between the Halfway Formation and the underlying dark grey to black dolomite of the Doig Formation is unconformable (Mothersill, 1967,1968). The overlying Charlie Lake Formation is characterized by calcareous, dark grey, laminated silty dolomite and limestone, which shows a gradational and interfingering contact (Fig.13b) with the Halfway Formation suggesting a conformable relationship.

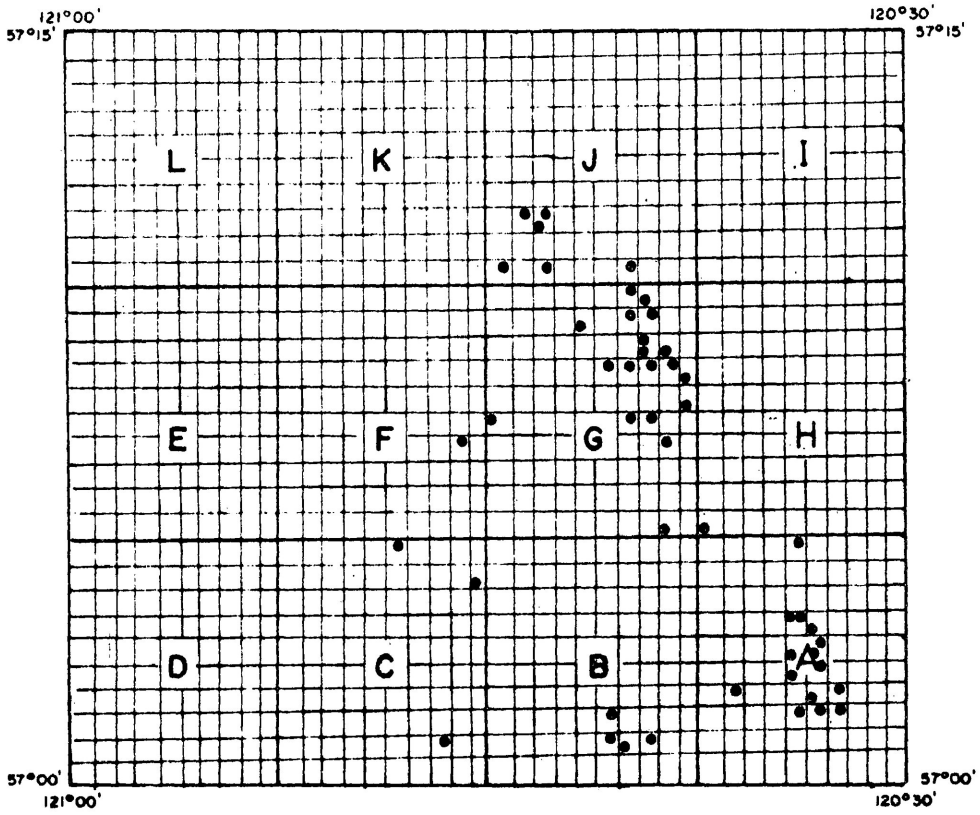


Fig.13a The location of the sharp basal contact with the underlying Doig Formation in the area of study

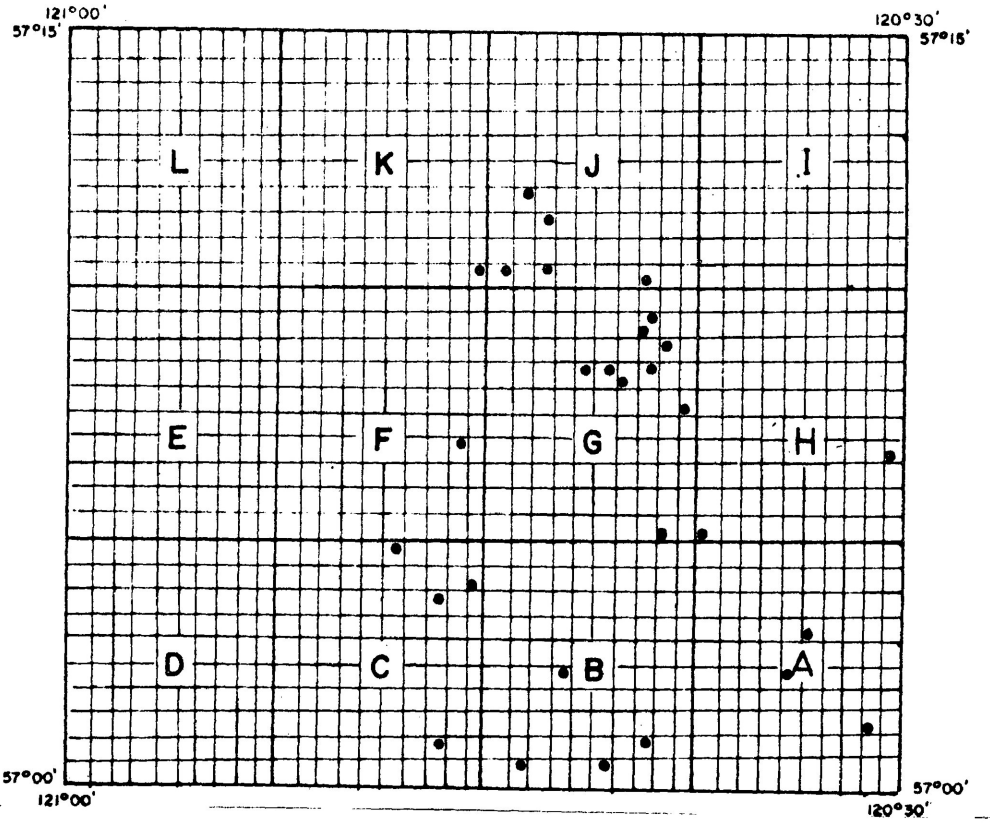


Fig.13b The location of the gradational upper contact with the overlying Charlie Lake Formation in the area of study

Petrology

The upper sands of the discontinuous Halfway Formation consist of fine to very fine grained sand,with quartz comprising up to 95 percent of the sand grains (Appendix B).

The quartz grains are subrounded to subangular,and the roundness values range from Ø.4 to Ø.6,based on the visual chart of Krumbein and Sloss (1963),after a new improvement of the visual chart of Powers (1953).The sphericity values of the quartz grains ranged from Ø.4 to Ø.6,based on the same chart. Some grains show a development of secondary overgrowth and diagensis. Lithic sand grains composed of interlocking quartz comprise between 2 to 5 percent of the Halfway sandstone. Chert grains, usually rust-brown in colour, probably as a result of iron oxide coating, comprise up to a maximum of 5 percent of the Halfway sands. The range size of the chert grains (from 1 to 2.25 cm) might show that the chert was derived from outside the area of study. Ooids comprise about 1 percent of the sandstone .The diameter of the ooids ranged between Ø.1Ø to Ø.25 mm, and usually consisted of a central quartz grain surrounded by collophane.Dolomite rhombs and silty dolomite form up to a maximum of 1Ø to 2Ø percent of the sandstone adjacent to the Charlie Lake Formation. The dolomite grains were similar lithologically to the silty dolomite of the underlying Doig Formation, and probably were derived from it.

The heavy accessary minerals (Appendix C) consist of tourmaline, zircon, pyroxene, leucoxene and ilmenite.The percentage of heavy minerals comprised less than 3 percent of the 4.ØØ phi sieve size. Tourmaline is well rounded or elongated, and pleochroic in brown and green.Zircon grains are elongated and pleochroic in yellow and brown,with some grains showing characteristic zoning and inclusions. The opaque ilmenite grains were identified by reflected light. Pyrite occurs in patches as an interstitial cement for the sand. Coquina beds consisting of the external molds of pelecypoda,and,in some cases, partly replaced by recrystallized calcite in a matrix of very fine grained quartz and silty dolomite,are found in a number of wells.

X-ray diffraction techniques were used in this study as a supplementary method for mineral identification. Analyses were carried out on representive samples from the Charlie Lake,Halfway,and Doig Formations to identify the most common minerals present in these formations. The peaks in the X-ray diffraction charts were measured by using the computer, with the exception of 6 sample charts,for which peak angles were measured,d-spacing and the common minerals were identified, (the d-spacing was in Angstrom($\mathring{A}$) units).The d-spacing values were based on the Bragg's equation ($n\lambda = 2\ d \sin \theta$), where d is the interplanar distance of the crystal, theta is the angle of incidence , λ is the wavelength for the X-ray beam,and n is the

number of the wavelengths used.

Appendix D ,shows the X-ray diffraction results. The most common minerals identified in the Halfway Formation were quartz, dolomite,and calcite.In the Charlie Lake Formation were dolomite,calcite quartz and plagioclase and in the Doig Formation dolomite, quartz,calcite and plagioclase were the most common.

Grain Size Analysis

Appendix E shows the results of the grain size analysis of 117 samples ,using the method of moments after Friedman (1961, 1962, 1967, 1979), and the graphic method after Folk and Ward (1957). Table 4,5,6,and 7 summarizes the average and the range values for the grain size parameters,using both the graphic and moment measures for samples analyzed from the upper sand of Wildmint,Willow,Milligan,Beatton and Weasel. Nearly all the Halfway Formation sands were fine to very fine grained and the average mean size (Table 4) ranged from 2.74 to 3.75 phi, (after Friedman,1961), and from 2.5Ø to 3.78 phi (after Folk and Ward, 1957). The standard deviation (Table 5) values showed moderately to well sorted sands (Ø.27 to Ø.94 phi), based on the moment measures classification of Friedman (1962), and moderately sorted to well sorted (Ø.2Ø and Ø.86 phi) based on the graphic measures (after Folk and Ward,1957). Using the moment measures the skewness of the Halfway sand samples (Table 6) ranged from low negative to high positive values (-Ø.14 to 2.31) when the pan fraction was considered as 4.25 phi,and from -Ø.11 to 3.5Ø when the pan fraction was considered as 6.ØØ phi. Using the graphic method the skewness ranged from low negative to high positive values (-Ø.Ø3 to Ø.72). The Halfway sands (Table 7) were platykurtic to leptokurtic by both the moment measures (1.55 to 5.12),and by the graphic

TABLE 4

The mean size by moment and graphic measures of sand samples of the Halfway Formation.

Location	First Moment (Friedman,1961)		Graphic Mean Size (Folk and Ward,1957)	
	Range (phi units)	Mean (phi units)	Range (phi units)	Mean (phi units)
Wildmint	2.8Ø-3.68	3.15	2.9Ø-3.57	3.Ø4
Willow	2.53-3.58	3.14	2.5Ø-3.67	3.12
Milligan	2.65-3.7Ø	3.Ø1	2.64-3.72	3.Ø6
Beatton	2.85-3.46	3.12	2.86-3.48	3.Ø7
Weasel	2.81-3.75	3.18	2.77-3.78	3.18

TABLE 5

The standard deviation by moment and graphic measures of sand samples of the Halfway Formation.

Location	Second Moment (Friedman,1961)		Graphic Standard Deviation (Folk and Ward,1957)	
	Range (phi units)	Standard Deviation (phi units)	Range (phi units)	Standard Deviation (phi units)
Wildmint	Ø.36-Ø.94	Ø.5Ø	Ø.34-Ø.71	Ø.43
Willow	Ø.4Ø-Ø.78	Ø.56	Ø.27-Ø.75	Ø.48
Milligan	Ø.34-Ø.87	Ø.5Ø	Ø.27-Ø.86	Ø.47
Beatton	Ø.27-Ø.58	Ø.44	Ø.2Ø-Ø.44	Ø.35
Weasel	Ø.35-Ø.94	Ø.69	Ø.28-Ø.81	Ø.7Ø

TABLE 6

The skewness by moment and graphic measures of sand samples of the Halfway Formation.

Location	Third moment (Friedman, 1961)	Inclusive Graphic Skewness (Folk and Ward, 1957)
	Range	Range
Wildmint	-Ø.14 to 2.31	-Ø.Ø3 to Ø.67
Weasel	Ø.5Ø to 1.84	Ø.21 to Ø.72
Milligan	Ø.Ø6 to 1.22	-Ø.Ø1 to Ø.35
Beatton	-Ø.Ø4 to 1.89	-Ø.Ø5 to Ø.3Ø
Willow	Ø.78 to Ø.92	-Ø.Ø1 to Ø.6Ø

TABLE 7

The kurtosis by moment and graphic measures of sand samples of the Halfway Formation.

Location	Fourth Moment		Graphic Kurtosis	
	Range	Mean	Range	Mean
Wildmint	2.45-4.7Ø	3.57	1.Ø4-2.16	1.47
Willow	3.2Ø-5.12	4.16	1.ØØ-2.98	1.6Ø
Milliagn	2.Ø4-4.7Ø	3.37	Ø.72-1.92	1.16
Beatton	2.Ø3-4.2Ø	3.11	Ø.67-1.67	1.11
Weasel	1.55-4.95	3.25	1.Ø7-1.94	1.34

Grain size analysis has been used by many sedimentologists as an indicator of depositional environments. Mason and Folk (1959), and Friedman (1961, 1967, 1979), have shown that dune sands were positively skewed, while beach sands tended to be negatively skewed. Duane (1964) indicated that the sign of skewness is environmentally sensitive.Mason and Folk (1958) have shown that dune sands were generally better sorted than beach sands,and Friedman (1961) reported that dune sands tended to be better sorted than river sands.Moiola and Weiser (1968) have pointed out that several grain size plots such as mean size versus skewness and mean size versus standard deviation were environmentally sensitive when calculated from quarter,half and one phi intervals of the grain size distribution. All of the samples analysed were plotted using different combinations of bivariate grain size parameters,by both graphic parameters,according to Folk and Ward (1957),and the moment measures computed after Friedman (1961). These graphs are: skewness versus mean size (Fig.14 and 15), mean size versus standard deviation (Fig.16 and 17), skewness versus standard deviation (Fig.18,and 19), skewness versus kurtosis (Fig.2Ø), simple skewness measure versus simple sorting measure (Fig.21).

Skewness versus Mean Size

It has been suggested that skewness versus mean size graphs were the most effective relationship to discriminate between beach and dune sands (Friedman,1961;Moiola and Weiser,1968).It should be noted that Friedman's boundary to differentiate between the beach and the dune fields was based on the moment of measures,while Moiola and Weiser (1968) utilized the graphic grain size parameters of Folk and Ward (1957).

Figure 14 shows the plot of the upper sand samples of the discontinuous Halfway Formation on a graph of skewness versus mean size,using the moment measures after Friedman (1961) with the pan fraction treated as 4.25 phi. More than 94 percent of the Halfway samples were located in the dune field of Friedman(1961),and the remaining samples such as: d-44-G (37Ø5), b-72-G (3688), b-82-G (3677),d-84-G (3731),and d-49-J (3733) were located in the beach field

An attempt was made to study the samples in the beach field by means of the shape of the probability plots as environmentally indicated according to Visher (1969),and Glaiser and Nelson (1974),and will be discussed later.

Figure 15, a plot of the skewness versus mean size of the upper sand samples,was based on the graphic grain size parameters. Moiola and Weiser's (1968) boundary to differentiate between dune and beach environments was

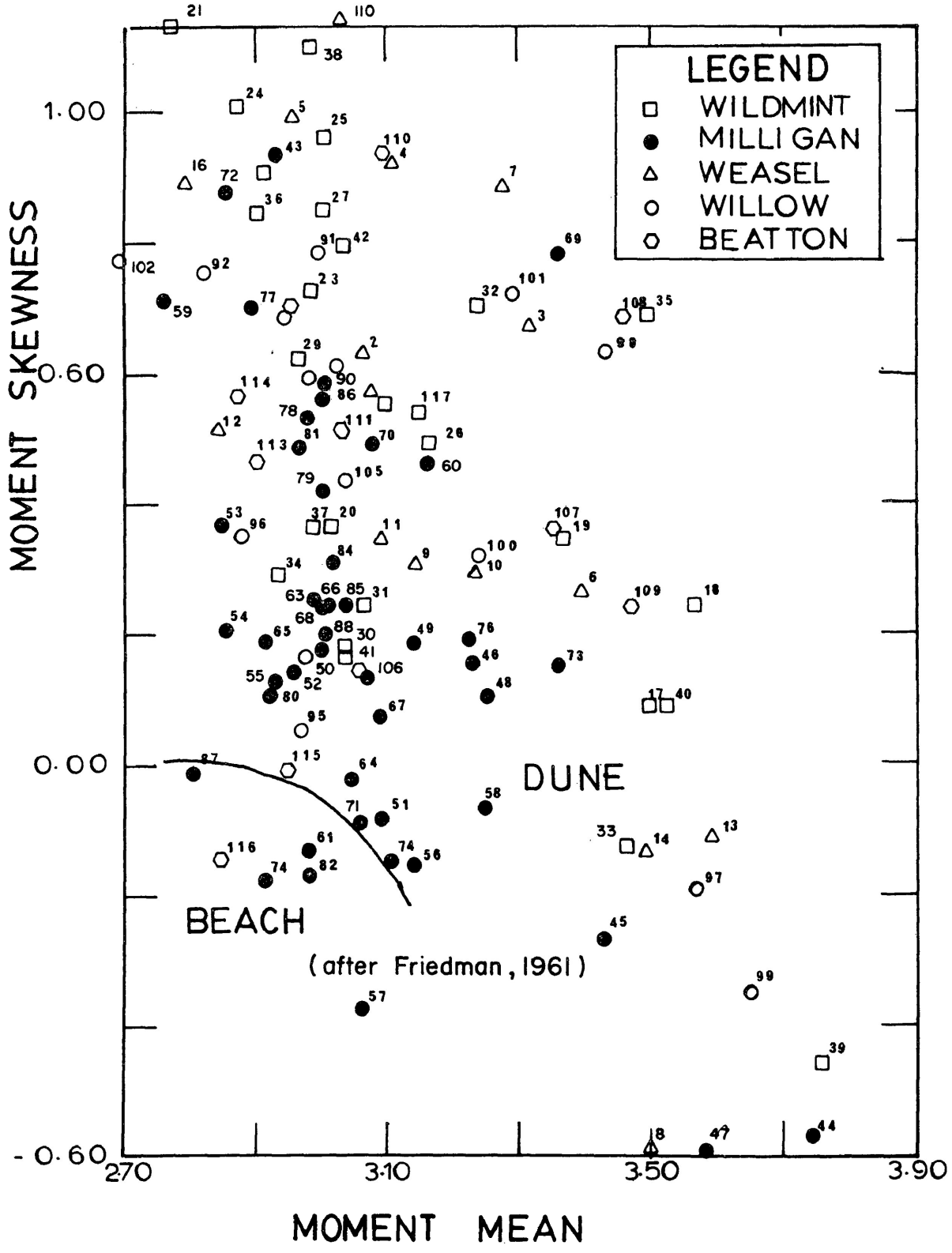


Fig. 14 Plot of skewness versus mean size, after Friedman (1961)

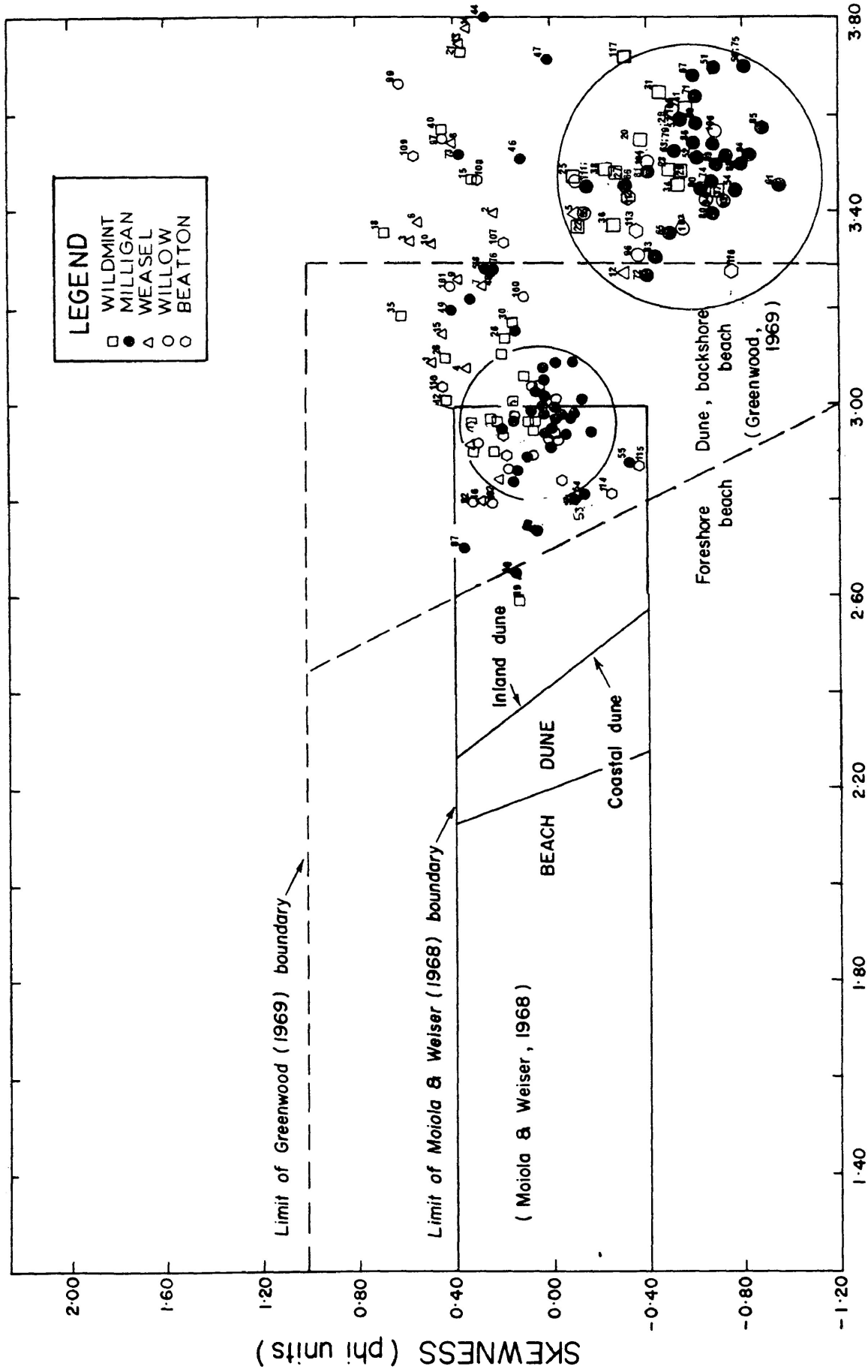


Fig.15 Plot of skewness versus mean size, after Moiola and Weiser (1968), and Greenwood (1969).

superimposed on this graph, and showed that the Halfway samples were located in the dune field. These authors applied another boundary to differentiate between coastal dune and inland dune; when this boundary was applied to the Halfway data, nearly all the samples were located in the inland dune field plots. Greenwood (1969) differentiated between foreshore beach with dune and backshore beach;and when his boundary was applied to the Halfway samples,nearly all the samples were located in dune and backshore fields, with the exception of d-26-A (3694),and d-53-G (3699).

Mean Size versus Standard Deviation

The mean grain size has been considered as a function of the energy conditions of the transporting medium. Standard deviation is a measure of sorting which depends upon uniformity of wave or current conditions.

The graph of mean size versus standard deviation has been found by Friedman (1961) and Moiola and Weiser (1968) to be an effective method to differentiate between dune and river sands. Greenwood (1969) found that the graph could separate, to some extent,deposits of dune and backshore beach and foreshore beach sands,although he pointed out that overlapping might occur in the sample plots from these environments.

Figure 16 shows this relationship using moment measures

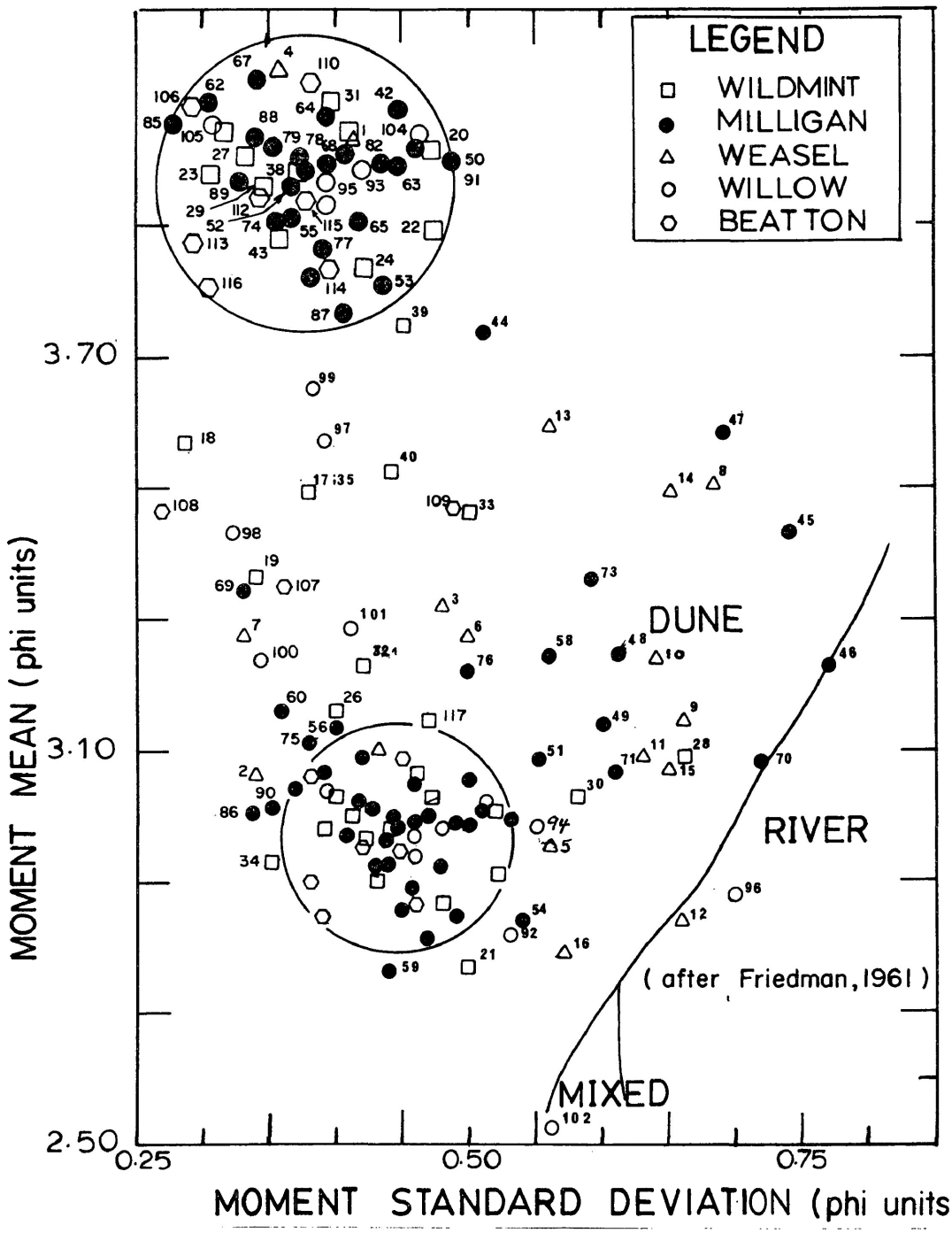


Fig. 16 Plot of mean size versus standard deviation, using phi (ϕ) scale, after Friedman (1961).

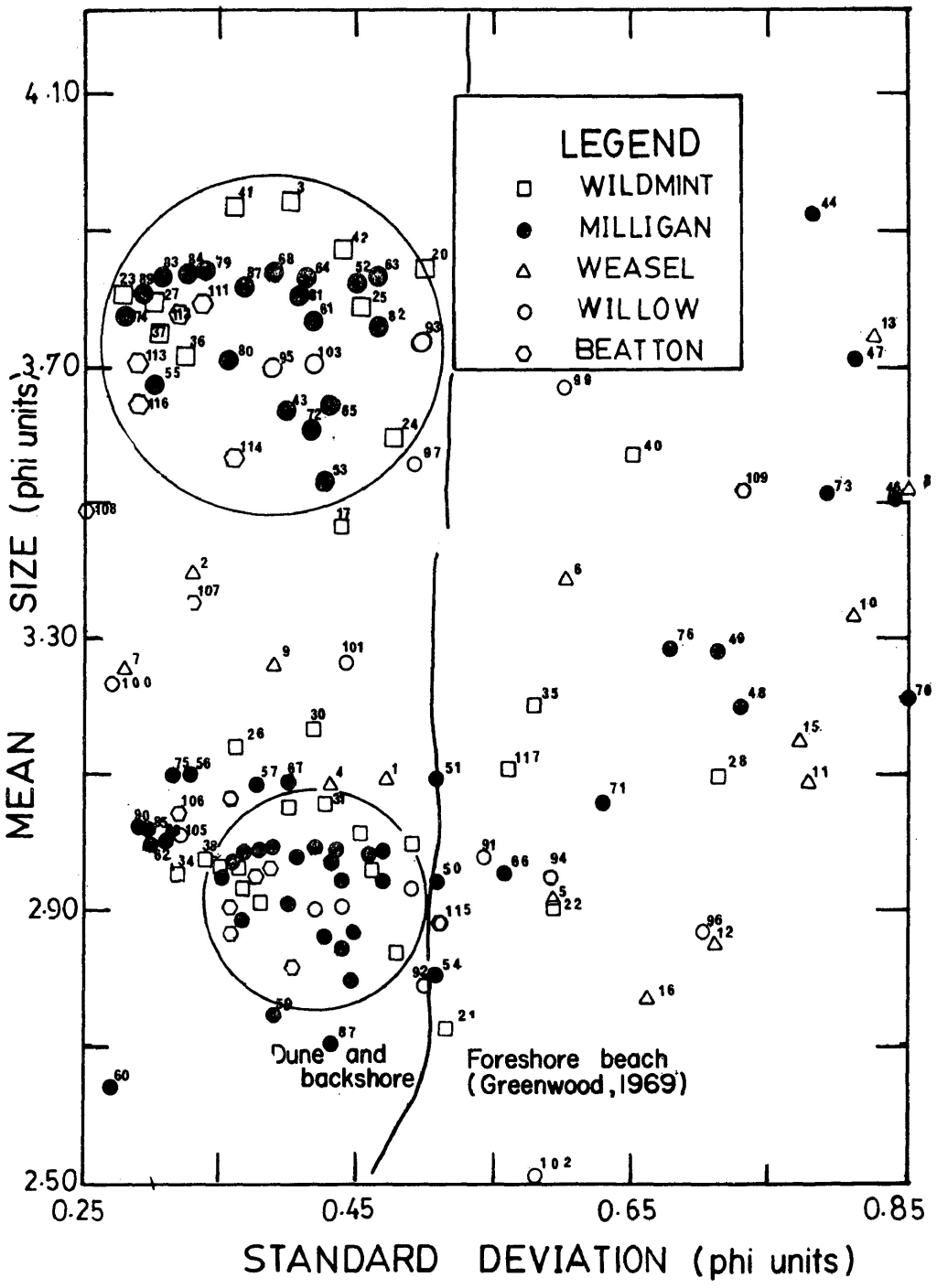


Fig.17 Plot of mean size versus standard deviation, after Greenwood (1969)

and nearly all the Halfway sample plots were located in the dune field of Friedman (1961). In Figure 17 the grain size parameters of the Halfway data were calculated according to Folk and Ward's (1957) equations. Greenwood's (1969) boundary to distinguish between foreshore beach with dune and backshore beach shows that more than 75 percent of the Halfway samples plot in the dune and backshore , and the remainder plot in the foreshore field.

Standard Deviation versus Skewness

Friedman (1979) introduced a graph of standard deviation versus skewness to differentiate between beach and inland dune samples based on moment measures,in which he classed the mid point of the pan fraction as 6.ØØ phi. More than 95 percent of the Halfway samples,when calculated in this manner plotted in the inland dune field (Fig.18), with the remaining samples b-31G (3699), c-32-G (37Ø7), b-72-G (3688), d-84-G (3731), and d-49-J (3733), located in the beach field.

Figure 19 shows the relationship based on the graphic parameters using Greenwood's (1969) boundaries to differentiate between foreshore beach from dune and backshore; more than 75 percent of the Halfway samples plot in the dune and backshore field. Friedman (1979) introduced two additional scatter plot graphs based on the graphic standard deviation and the graphic skewness (after Folk and

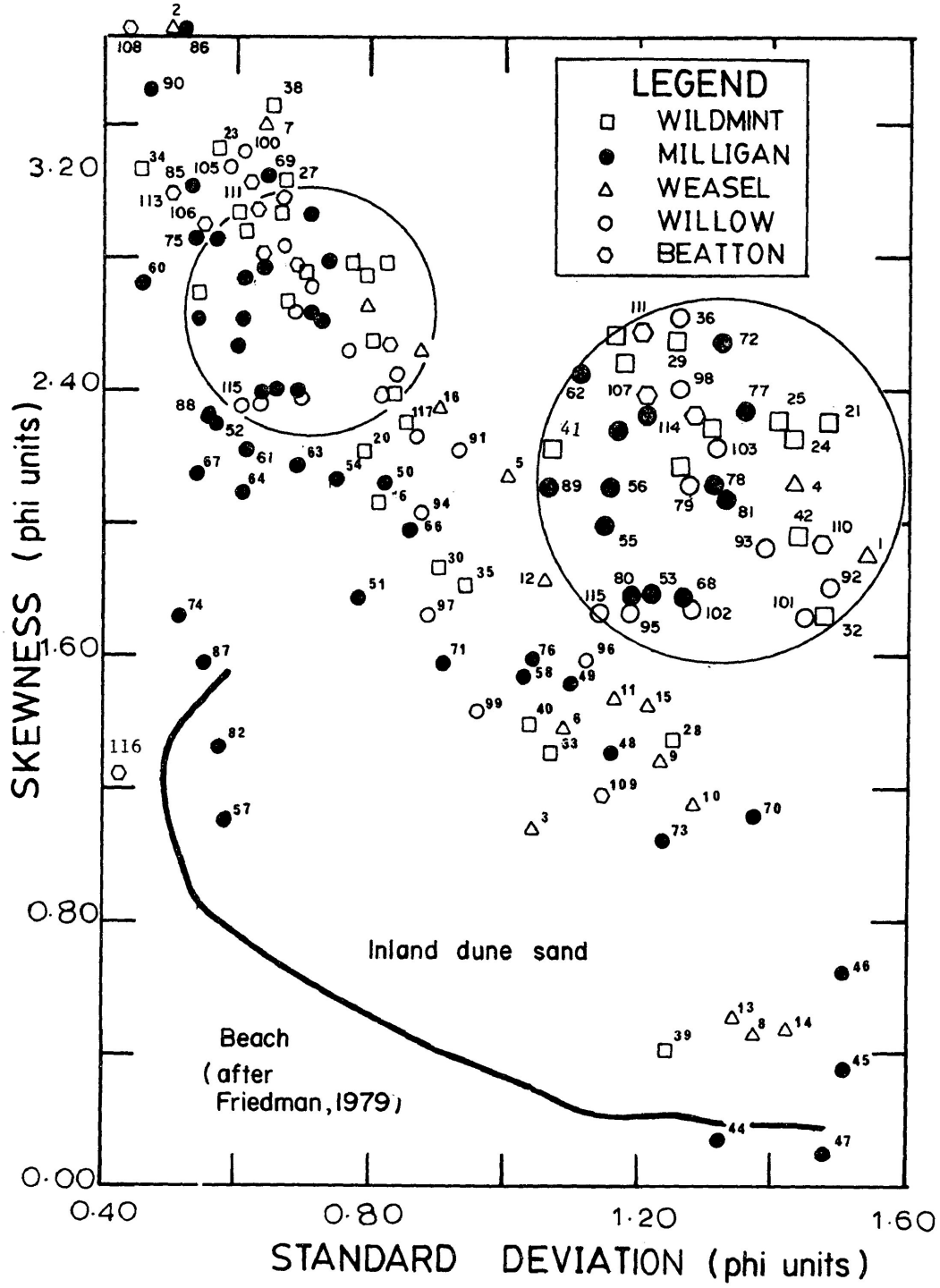


Fig. 18 Plot of skewness versus standard deviation using 6.00 phi for the fraction less than 4.00 phi, for beach sand and inland dune sand, after Friedman (1979).

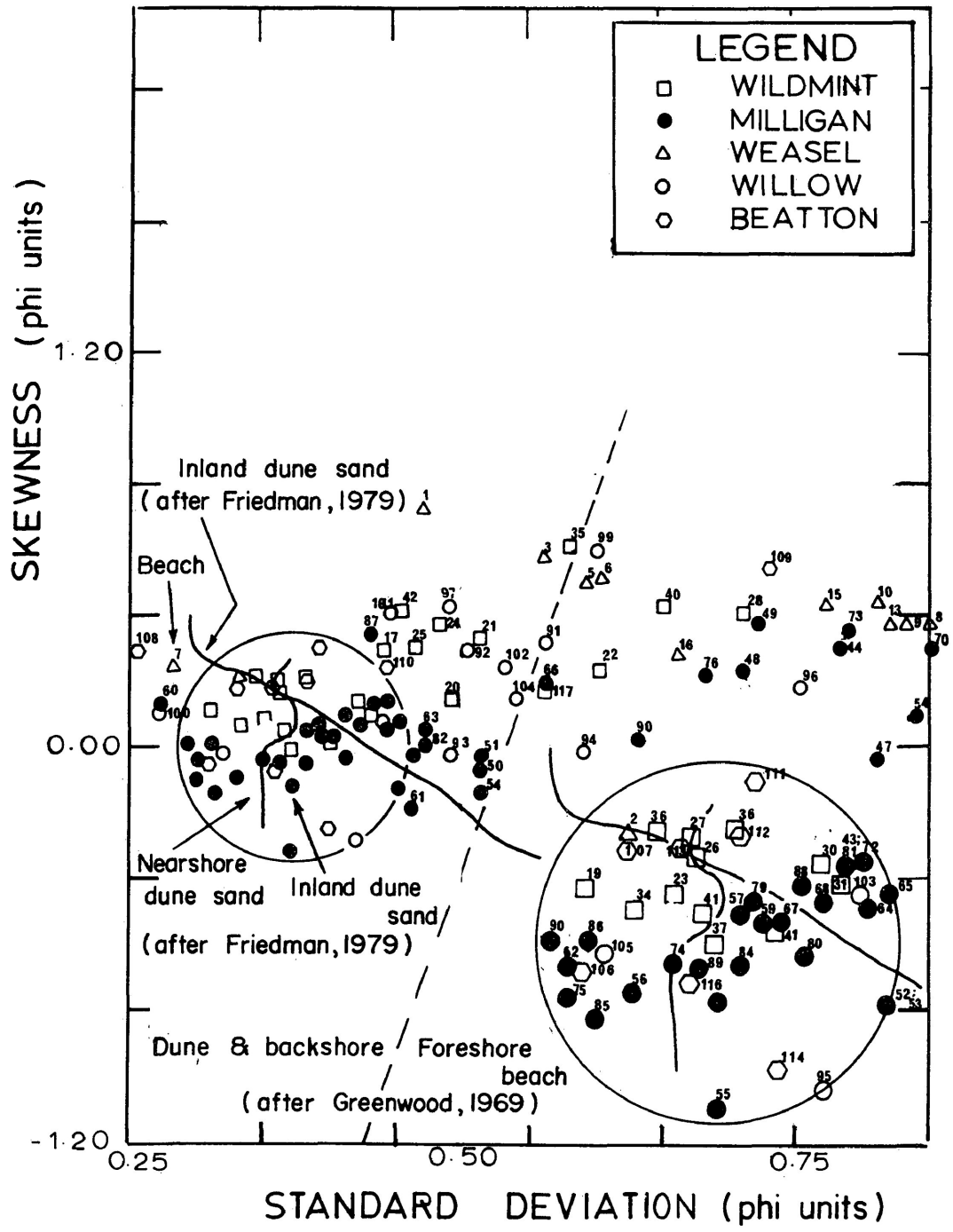


Fig. 19 Plot of skewness versus standard deviation, for foreshore beach and dune with backshore sands, after Greenwood (1969), and for inland dune, nearshore, and beach sands, after Friedman (1979).

Ward,1957) to differentiate between inland dune and nearshore dune samples. When the Halfway Formation samples were plotted using the graphic standard deviation versus graphic skewness (Fig.19), more than 8Ø percent of the Halfway samples plotted in the inland dune field,and the remainder plotted in to the nearshore dune field. When Friedman (1979) using this same graph constructed a boundary to separate inland dune and beach sands environments approximately 7Ø percent of the Halfway samples were located in the inland dune field.

Figure 19 with both of the Friedman (1979) boundaries plotted showed that there was an overlapping with the nearshore and inland dune fields of the first graph falling in the beach field of the second graph. However over 5Ø percent of the Halfway sands plot in the inland dune field common to both graphs.

Skewness Versus Kurtosis

Skewness versus kurtosis graphs have been utilized to differentiate beach , dune,and aeolian flat fields according to Mason and Folk(1958). However,these results were of little use because the majority of the upper sand samples either fell outside the fields,or within the zone of overlapping field boundaries (Fig.2Ø). Moiola and Weiser(1968) suggested that the skewness and kurtosis

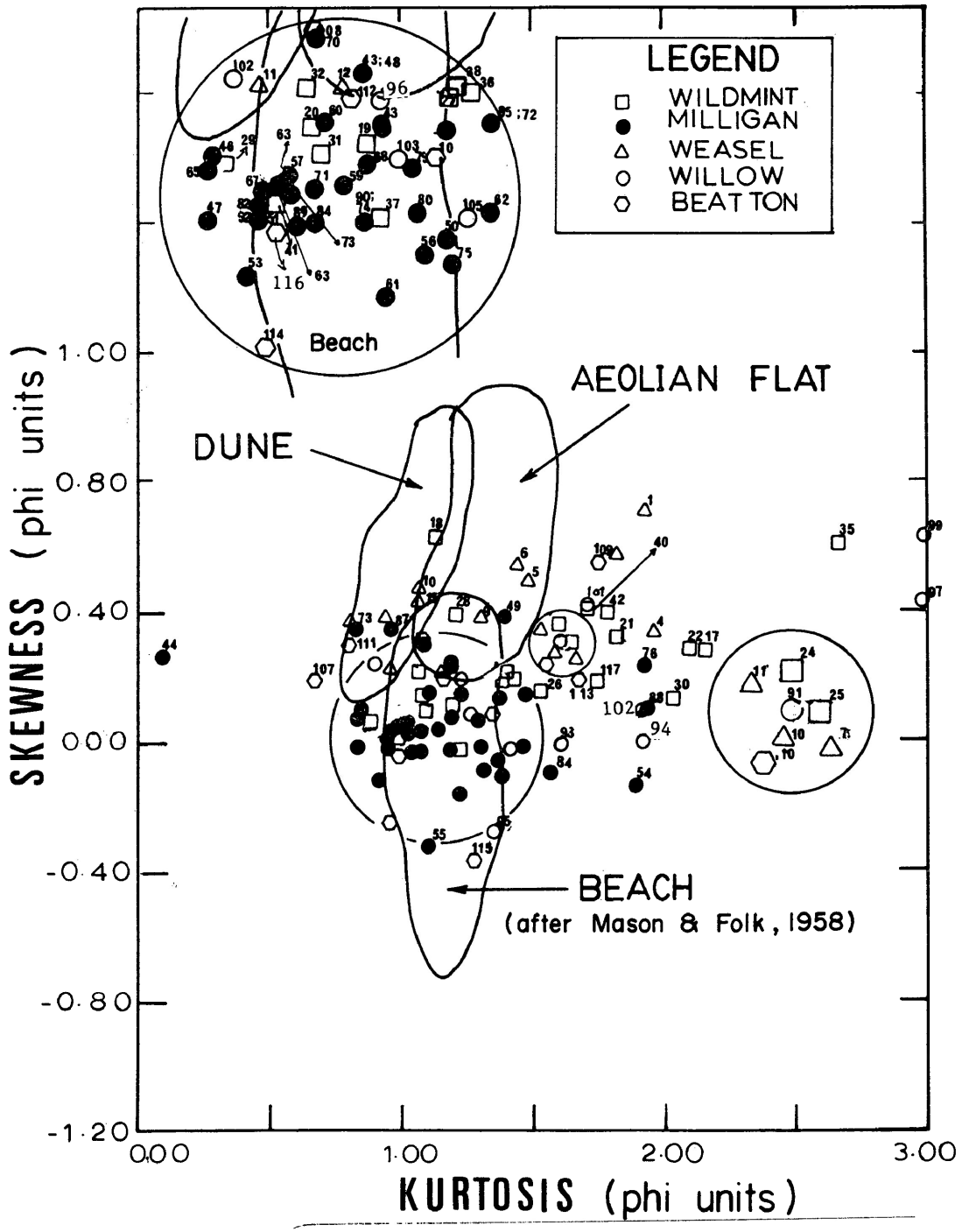


Fig. 20 Plot of skewness versus kurtosis, after Mason and Folk (1958), for beach, dune, and aeolian flat sands.

relationship, based on the graphic parameters, was ineffective to differentiate between beach and coastal dune because of the overlap of samples plots from both environments.

Friedman (1961) concluded that the kurtosis provides a second dimension for the plot,but does not give any information to predict the depositional environments of the sand deposits.

Simple Skewness Measure versus Simple Sorting Measure

Friedman(1979) introduced one boundary to separate inland dune and nearshore dune fields and another boundary to separate inland dune and beach fields (the simple skewness measure and simple sorting measure calculated from the cumulative frequency graphs). These boundaries cross resulting in some overlap of these environment fields. Figure 21 shows the plots of the Halfway sand samples with most of the sand samples plotted in the inland dune field with three samples b-42-G (37Ø5), d-54-G (37Ø8), and d-63-G (3719) plotting in the beach field, and samples d-15-B (3846), d-2Ø-H (3646), and d-8-J (3726) plotting in the inland dune - nearshore dune overlap, and the remaining samples plotting in the nearshore dune - beach overlap field(b-14-B(3813), d-15-B(3846), b-22-A(3577), d-44-A(3546), d-55-A(3646), d-43-G(3695, and 37Ø5), d-44-G(37Ø5), d-53-G(3699), c-72-G(3888), b-82-G(3681, and

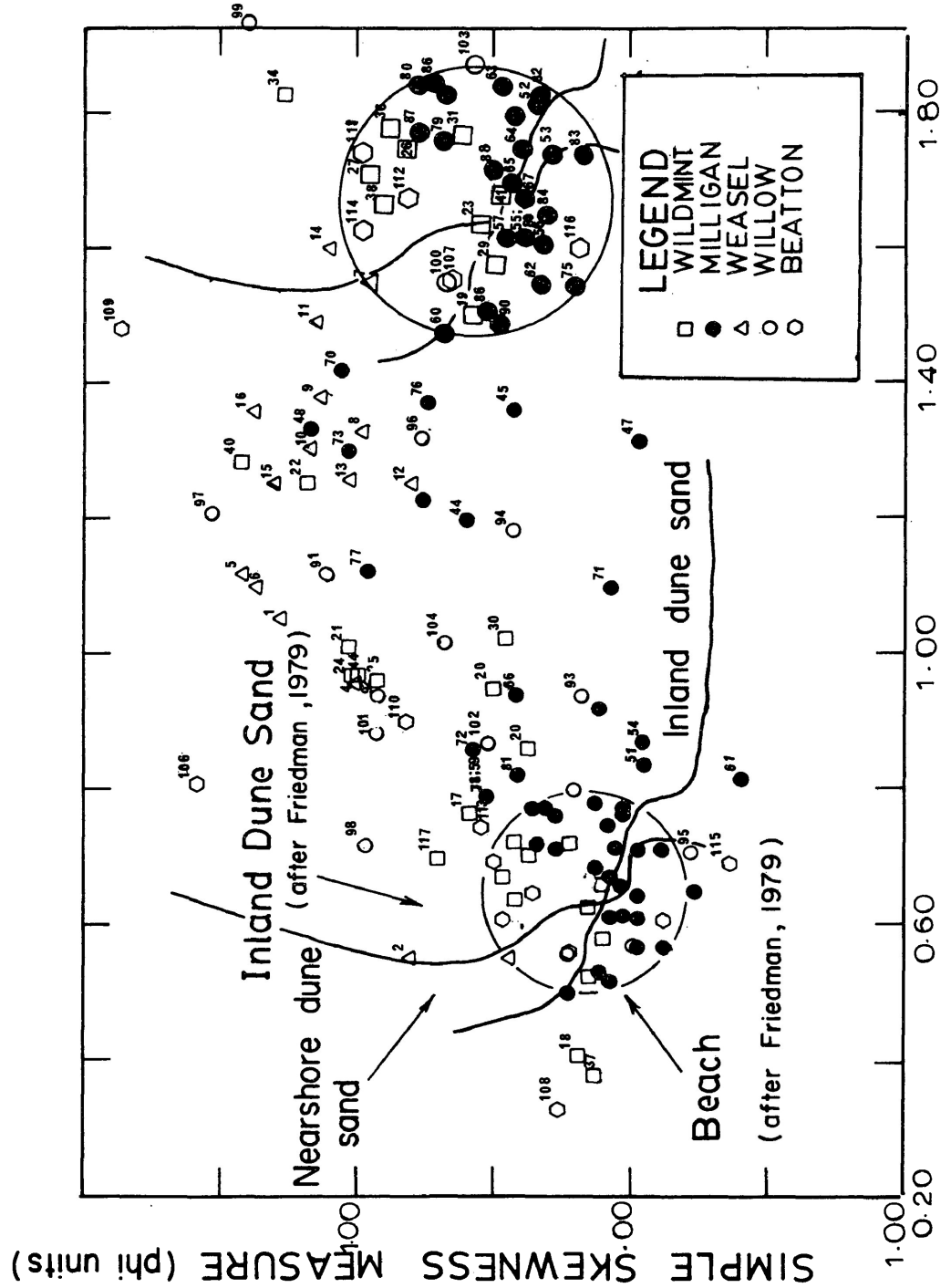


Fig. 21 Plot of simple sorting measure versus simple skewness measure, after Friedman (1979), for nearshore dune and inland dune sands, and beach and inland dune sands.

3684), d-83-G (367Ø), d-94-G(369Ø, and 37ØØ), b-1Ø-H(3653), d-1Ø-J(3743), d-39-J(374Ø), d-49-J(3733)).

Grain Size Distribution

Visher (1969) utilized the shape of log probability curves as a method for interpreting the environment of deposition of modern and ancient sands. The saltation, suspension and traction populations comprising sediments can be inferred from the shape of log probability plots. Figure 22 represents three types of curves (the frequency histogram (graph 1), the cumulative frequency plot (graph 2), and the log probability plot (graph 3), after Visher (1969). Glaister and Nelson (1974) also analyzed the grain size distribution of samples from different environments and these authors determined that the log probability plot provided the most reliable information concerning the subpopulations comprising a sediment. They based their conclusion on an analysis of samples from various environments such as braided stream, point bar, beach, tidal flat, dune, stream mouth bar, distributary channel, interdistributary beach and density and debris flow after utilizing moment measures, factor analysis, and graphic plots. It should be noted that they determined the grain size frequency by thin sections point count method rather than by sieving as used in this study.

The log probability curves of the upper sand of the

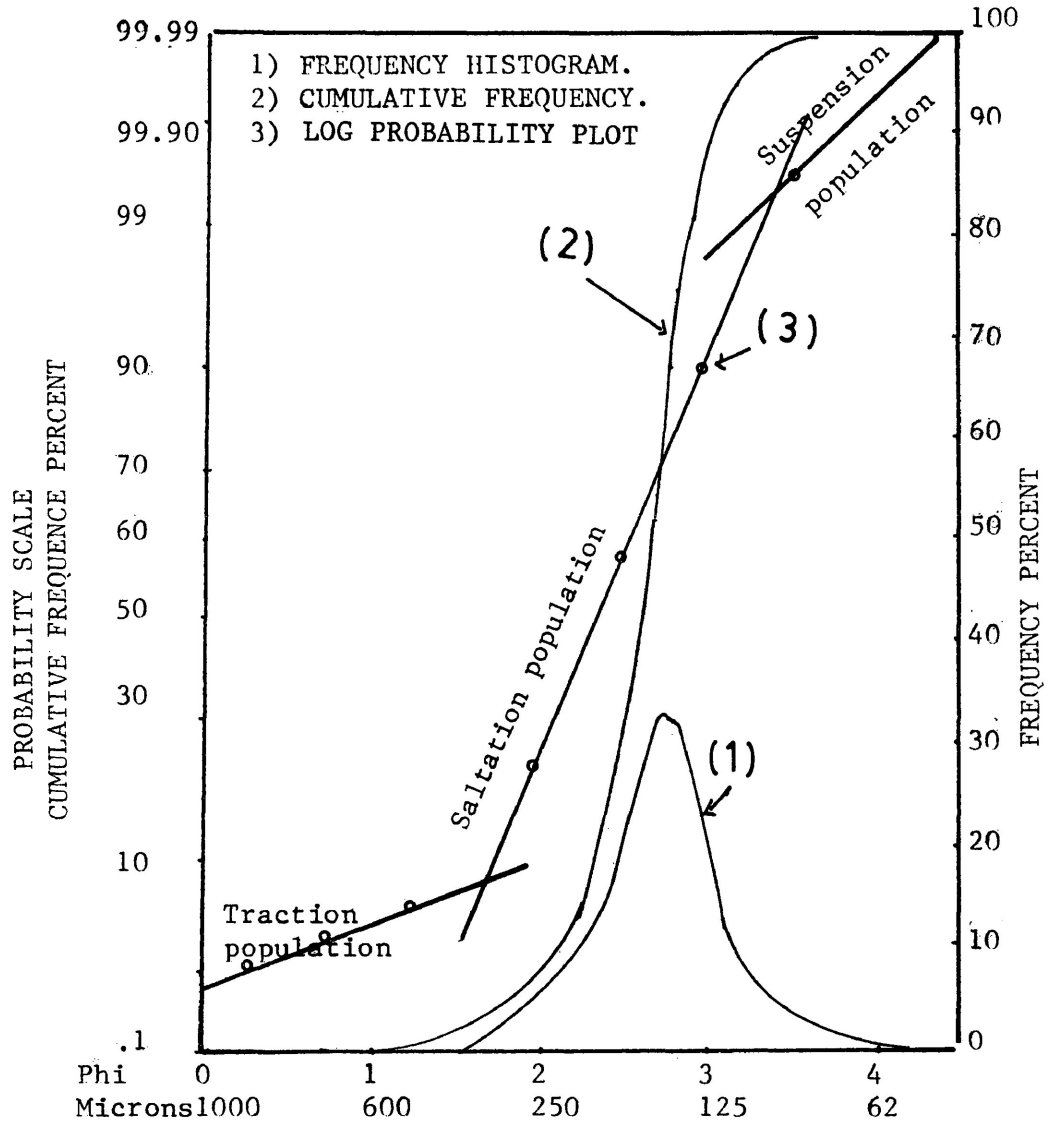


Fig.22 Comparison of grain size distribution curves, after Visher (1969)

discontinuous Halfway Formation have been interpreted based on the work of Visher(1969),and Glaiser and Nelson (1974).The log probability plots selected to represent the main types of grain size distribution encountered in this study showed that the saltation population dominated the size distribution of the Halfway Formation samples (Fig.23). The saltation population comprised from 90-95 percent of the total grain size population and formed the steep slope part of the cumulative curve. The percentage of the suspension and the traction populations was very small,and never exceeded 5 percent of the entire population.The inflection point between the suspension and the saltation populations generally occurred in the 3.00 to 3.50 phi range; and between the saltation population and the coarser traction population in the 2.00 to 2.50 phi range.The shape of the log probability plots of most of the Halfway Formation samples (Fig.23) was very similar to that of the beach dune ridges of Visher (1969) shown in Fig.24, and the dune deposits of Glaister and Nelson (1974) shown in Fig.25.

Figure 26 represents other types of log probablity plot shapes encountered during the study of the Halfway samples. These samples would appear to have been composed of three or four populations, of which two of the populations would

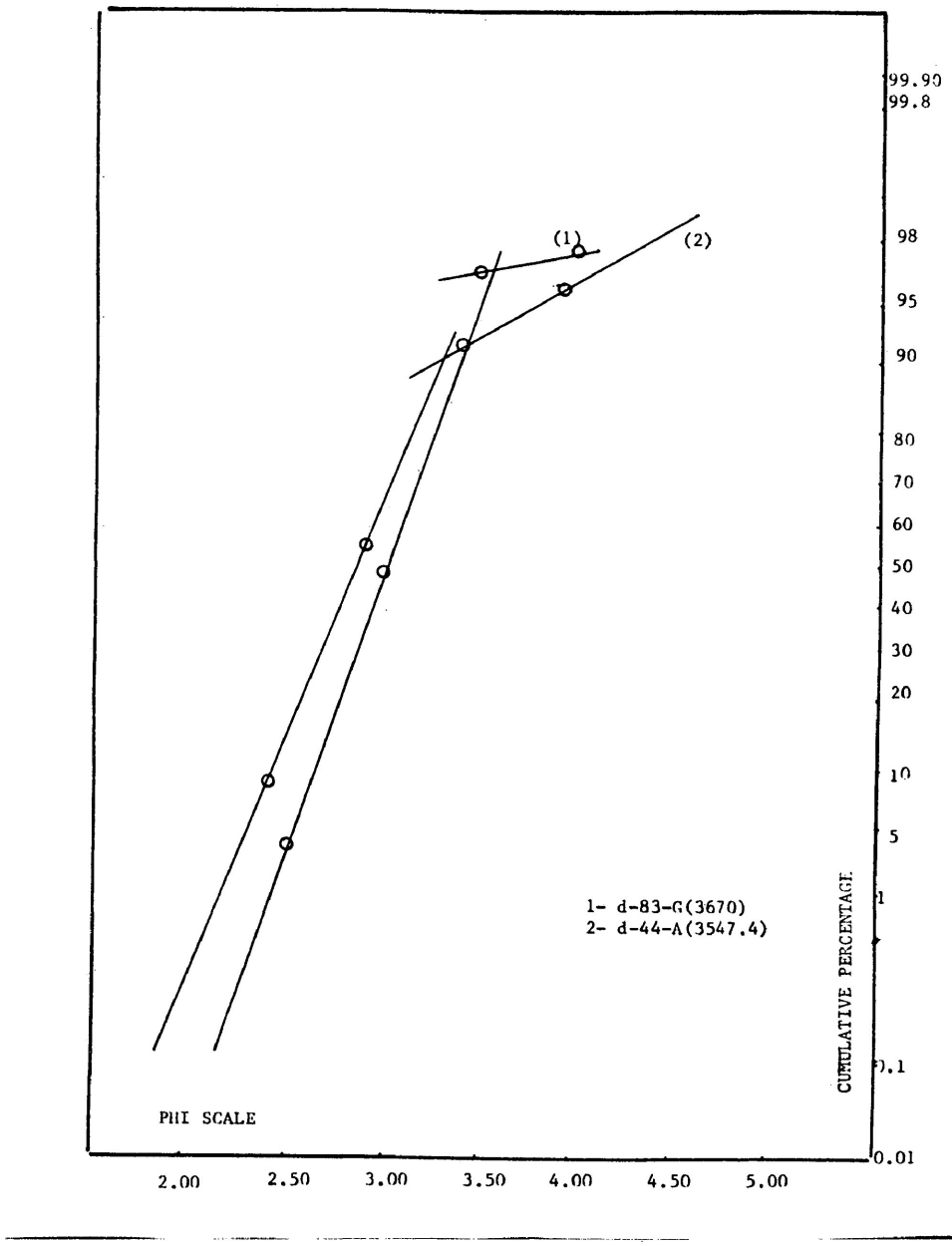


Fig.23 The log probability plots for the predominant type of the grain size distribution of the Halfway Formation

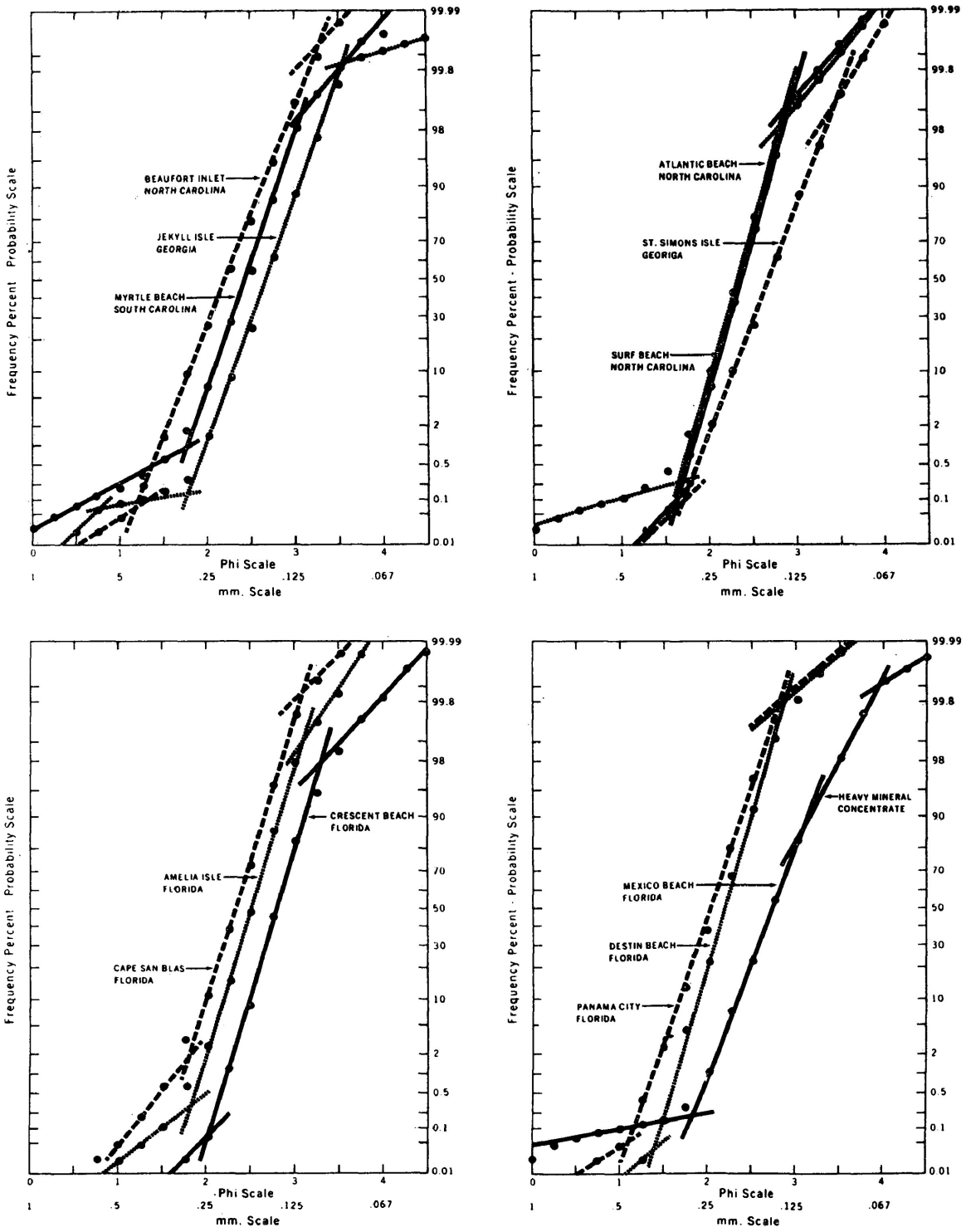


Fig.24 Examples of the log probability plots from dune ridges, after Visher (1969)

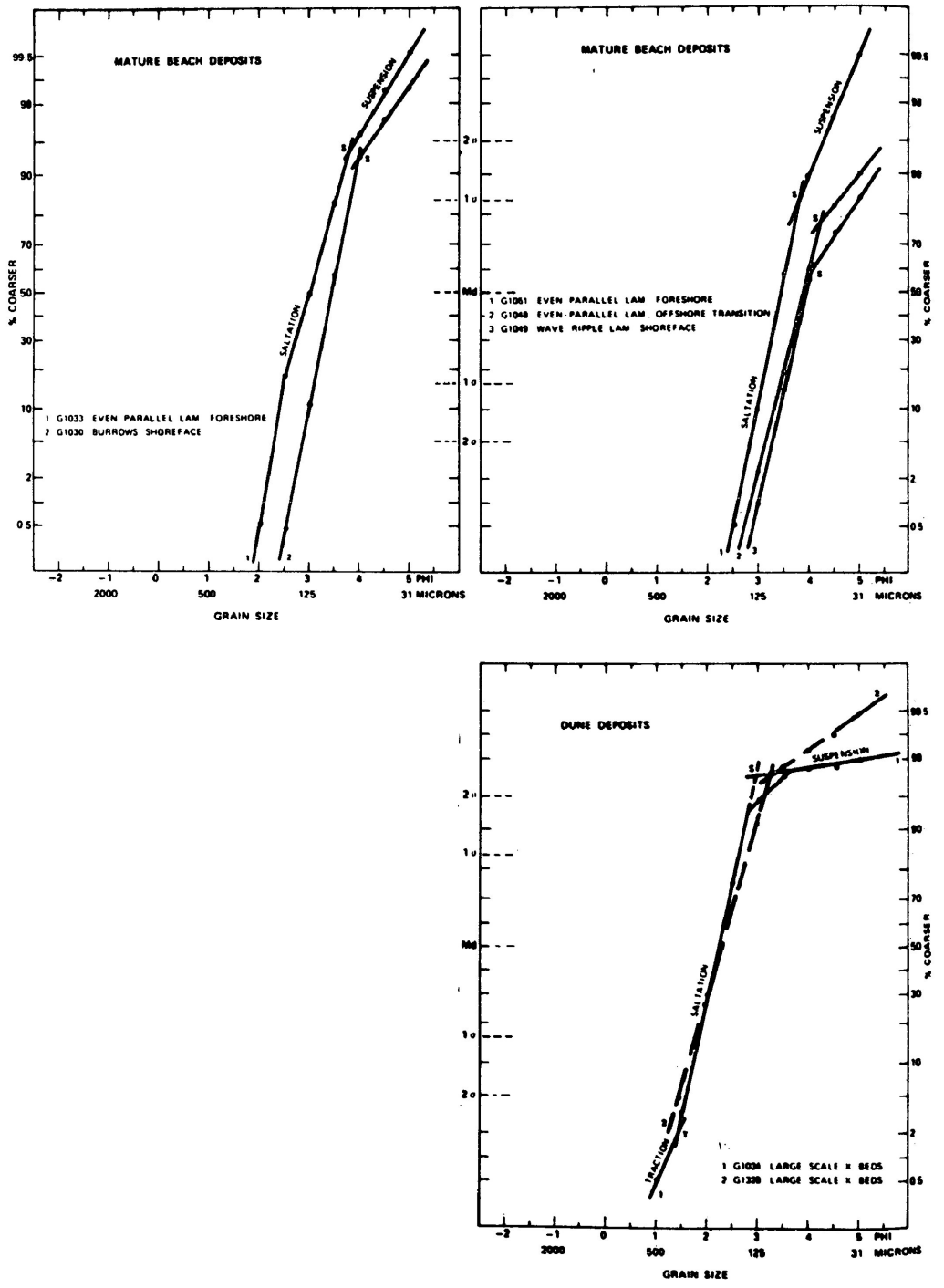


Fig.25 Examples of the log probability plots from nearshore dune,and dune deposits,after Glaister and Nelson (1974)

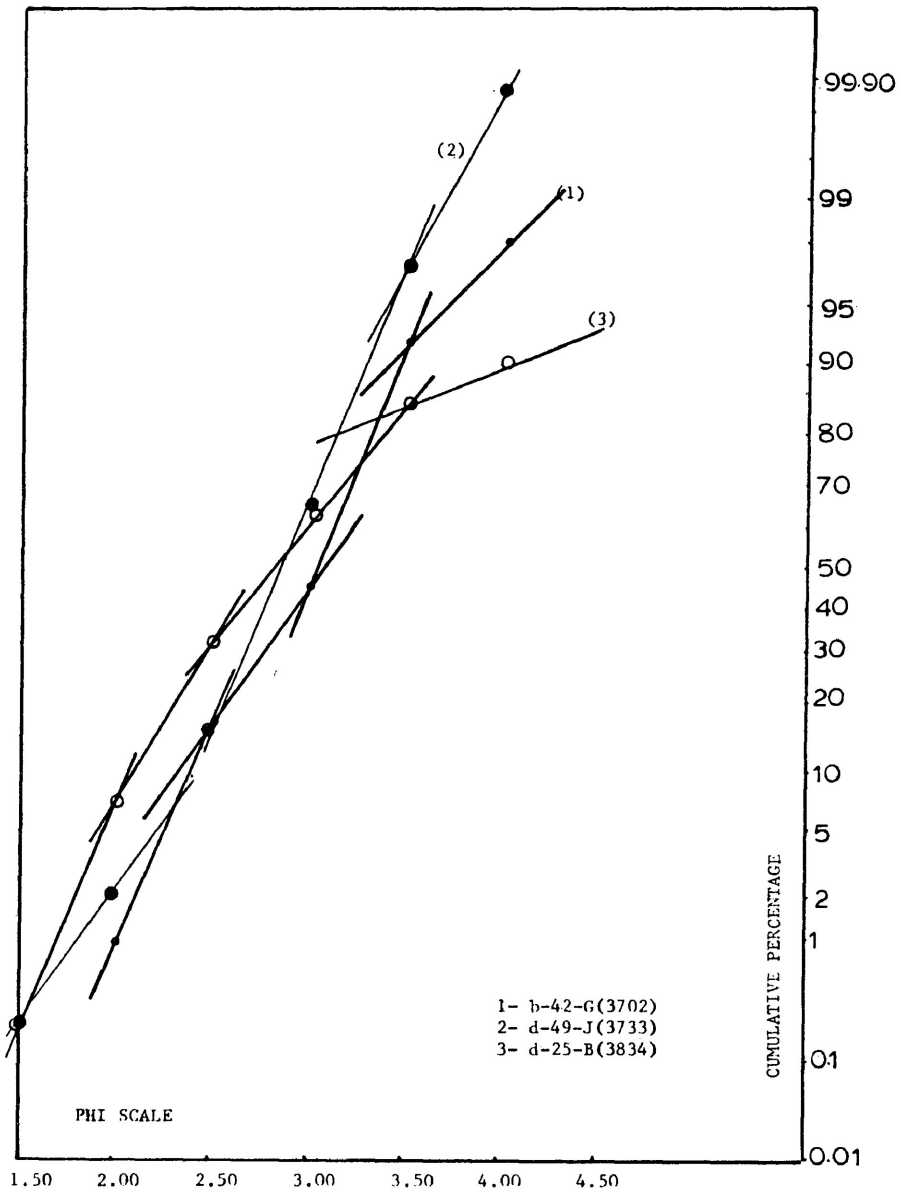


Fig.26 Examples of log probability plots from the Halfway samples composed of three or four subpopulations

appear to be have been saltation populations. Visher (1969) suggested that two saltation populations probably would have resulted from swash and backswash action on the shoreface, or from the mixing of separate provenances. The probability plots of these upper sand samples were very similar in shape to the beach foreshore sands (Fig.27) described by Visher (1969).

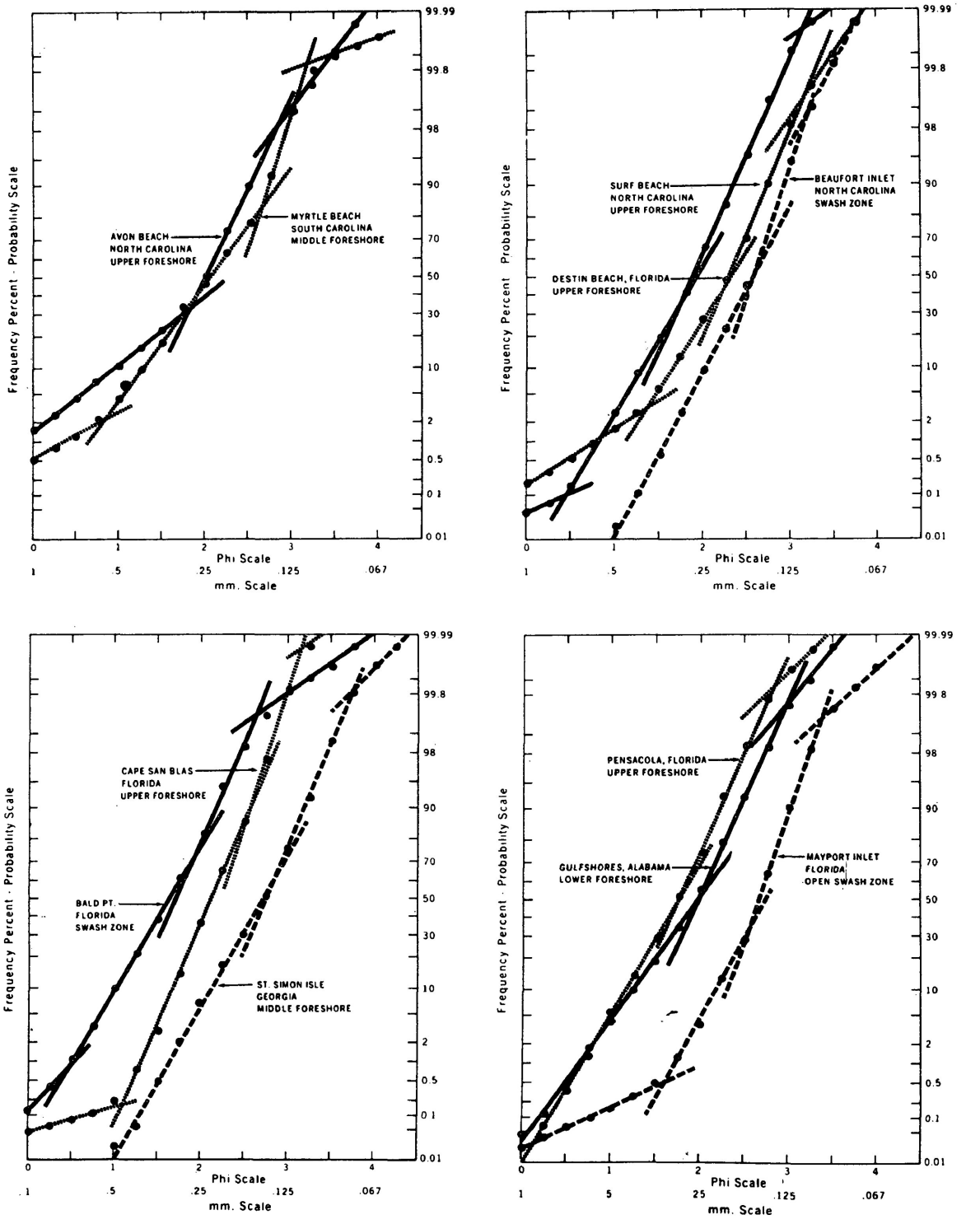


Fig.27 Examples of the probability plots from beach foreshore sands,after Visher (1969)

Vertical Stratigraphic Variation

Vertical profiles have been compiled for one well from each of the five sand bodies which comprise the discontinuous Halfway Formation of the area of study in order to show stratigraphic relationships and grain size distribution. Figure 28 shows information for the Halfway Formation encountered in d-25-B from the Weasel area which showed a sharp basal contact with the underlying Doig Formation and a gradational and interfingering contact with the overlying Charlie Lake Formation. The grain size of the Halfway Formation which ranged from fine to very fine grained, showed fining upward;with standard deviation showing a decrease from Ø.63 to Ø.67 phi upward, and the skewness values changing from positive to negative values upward. A total of seven wells from the Weasel sand body were examined in this study.The basal contact between the Halfway and the Doig Formation varied between an irregular surface and an interbedded contact and the upper contact with the Charlie Lake Formation was gradational and interfingering.

In well b-1Ø-H (Fig.29) from the Willow area, the Halfway Formation consisted of an upper and lower sand separated by dolomite siltstone. The upper 24 foot thick

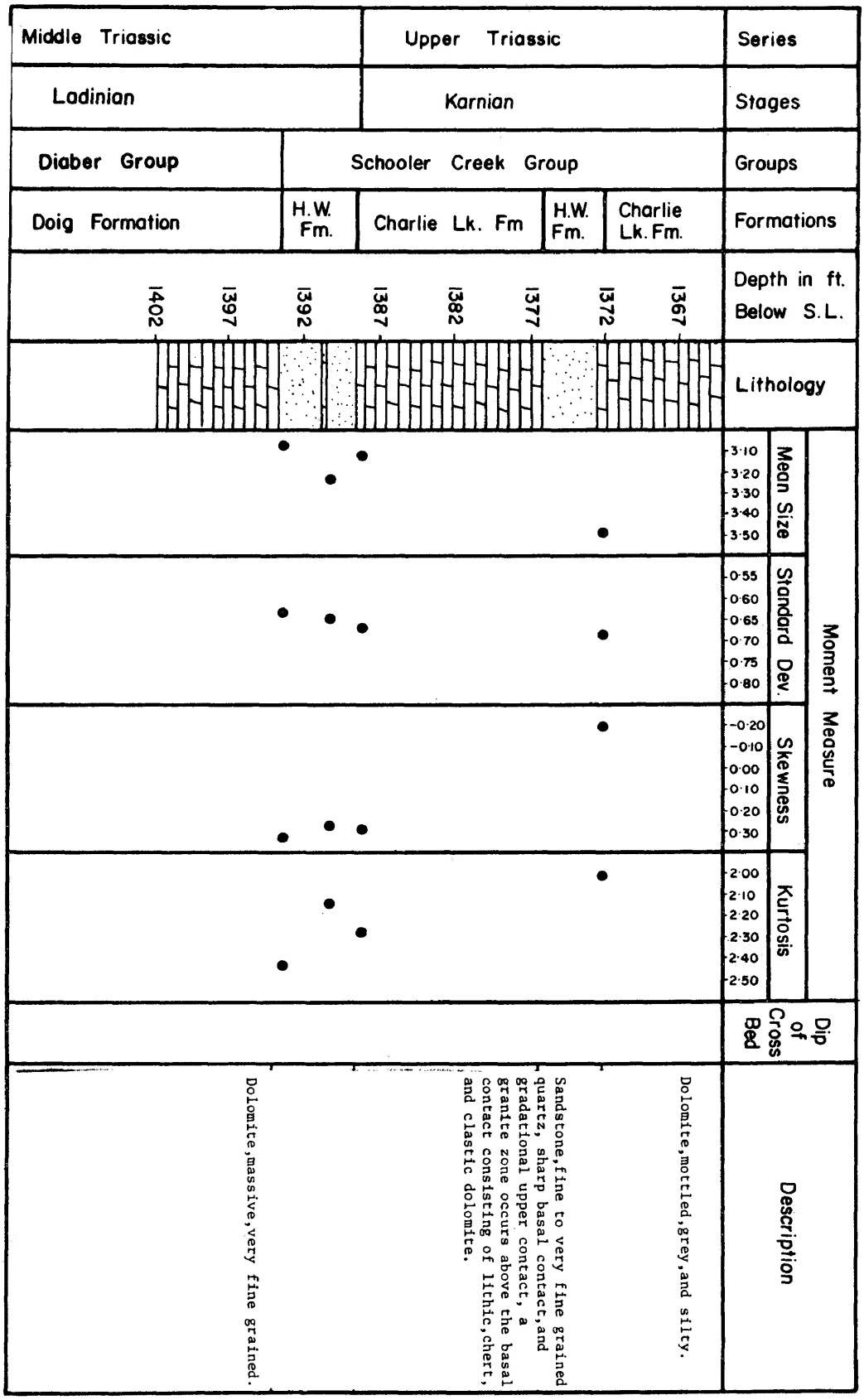


Fig.28 Vertical profile to show the stratigraphic relationship and the grain size distribution at Weasel d-25-B

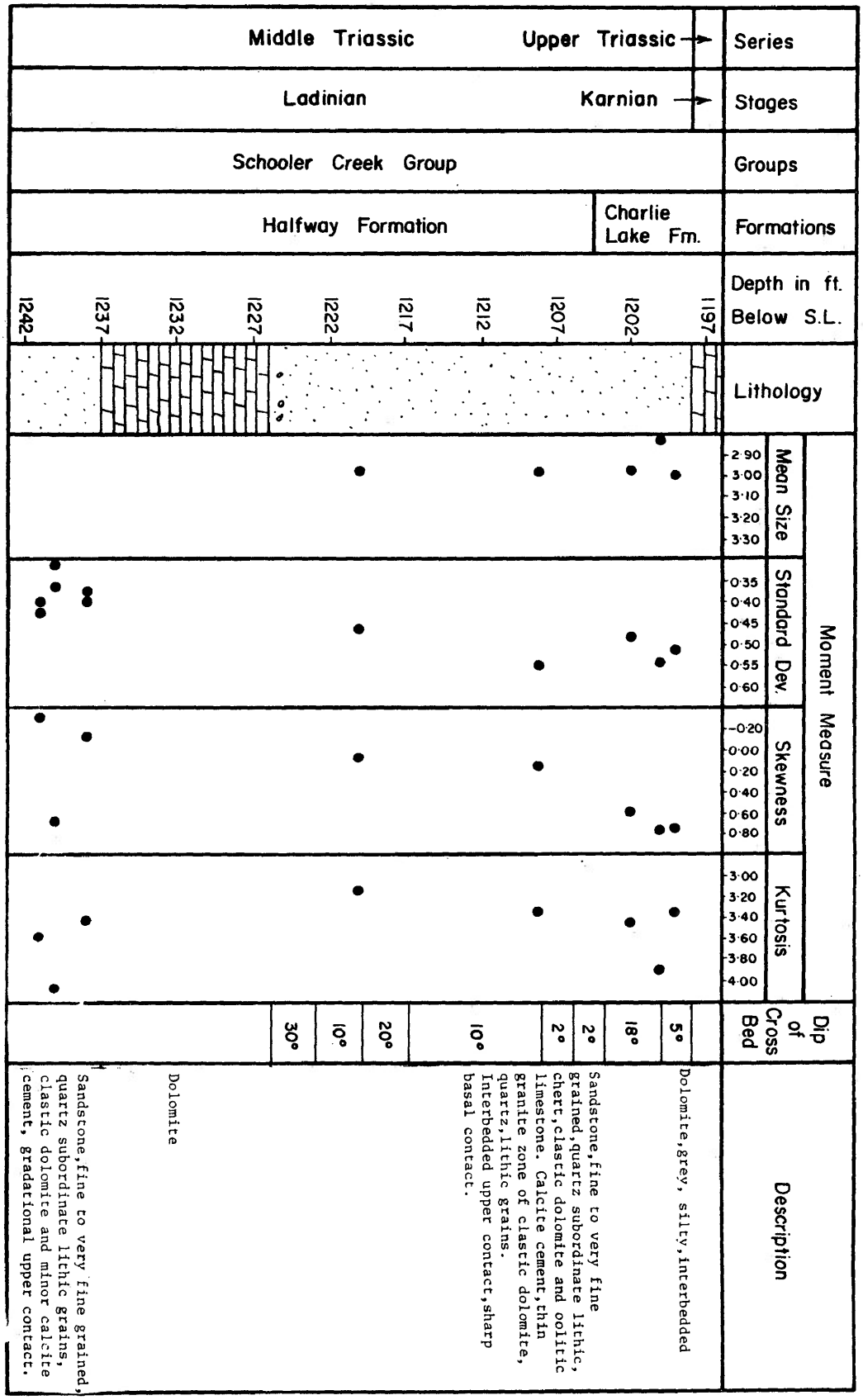


Fig.29 Vertical profile to show the stratigraphic relationship and the grain size distribution at Willow b-10-H

sand was composed of fine to very fine grained sand which was cross-bedded in part; the dip angle of the foreset beds ranged from 5 to 3Ø. The basal contact of the upper sand was sharp, and was overlain by a granular zone consisting of silty dolomite. The upper contact of the upper sand member was interbedded with the silty dolomite of the Charlie Lake Formation. The mean grain size ranged from 2.88 to 2.96 phi, and fined upward.The standard deviation indicated moderate sorting upwards, skewness ranged from positive to negative,and kurtosis changed from platykurtic to leptokurtic upward. Unfortunately, only the upper 5 feet of the lower sand member had been cored. The lower sand consisted of very fine grained, well sorted sand which was negatively skewed and leptokurtic and not cross-bedded.A total of four wells from the Willow sand body were examined. A thin granule zone occurred above the basal contact of the upper sand with the underlying Doig Formation for all wells,and the upper contact of the upper sand with the Charlie Lake Formation varied between a sharp contact at d-2Ø-H,and a gradational contact at b-1Ø-H,and b-31-H.

In well d-34-A (Fig.3Ø) from Wildmint sand body there was a sharp lithological break between the dolomite of the underlying Doig Formation and the sand of the Halfway Formation. A thin granule zone which consisted of silty

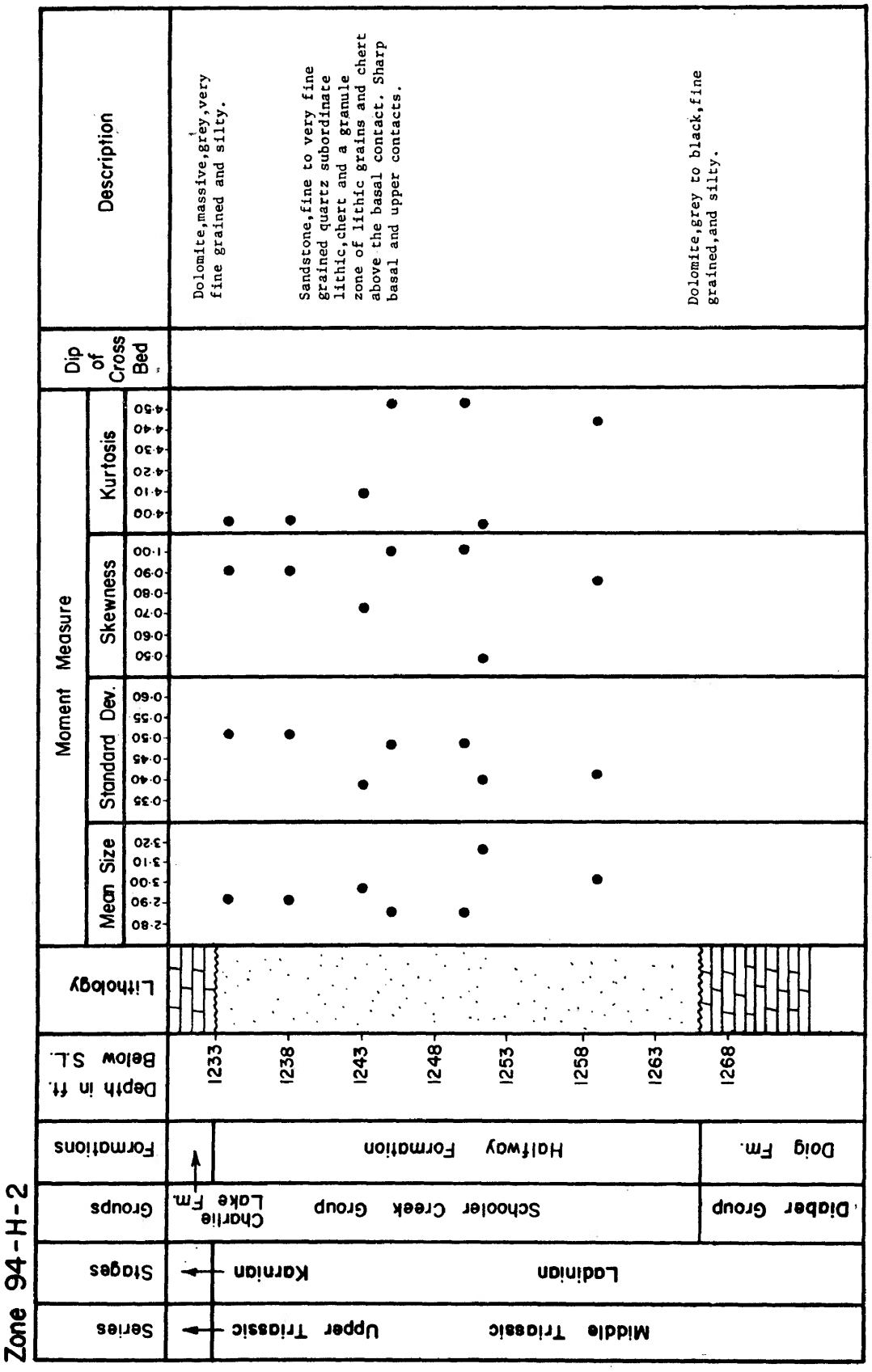


Fig.30 Vertical profile to show the stratigraphic relationship and the grain size distribution at Wildmint d-34-A

dolomite, lithic grains, and chert occurred above the basal contact. The upper contact was sharp with the overlying Charlie Lake Formation. The upper sand was a fine to very fine grained, well sorted sand based on the standard deviation (Ø.39 to Ø.53 phi) after Friedman (1961). The sand shows a general decrease in grain size upward, positive skewness and is leptokurtic. Of the 28 wells from Wildmint which were examined in this study,15 wells showed a sharp basal contact, 11 wells showed an erosional surface, and 2 wells showed gradational basal contact between the Halfway Formation and the underlying Doig Formation (Fig.31). The upper contact with the Charlie Lake Formation was gradational and interfingering for all wells examined. The location of wells containing granule zones and cross-bedding can be noted. Generally, the upper sands were fine grained, well sorted,positively skewed,and leptokurtic.

In well b-42-G (Fig.32) from Milligan, the upper contact between the dolomite of the overlying Charlie Lake Formation and the Halfway Formation was an irregular surface. Unfortunately, the basal contact between the Doig Formation and the Halfway Formation sands was not cored. Thin granule zones were found throughout the well,and consisted of lithic, chert,and silty dolomite grains.The Halfway sands consisted of fine to very fine grained sands

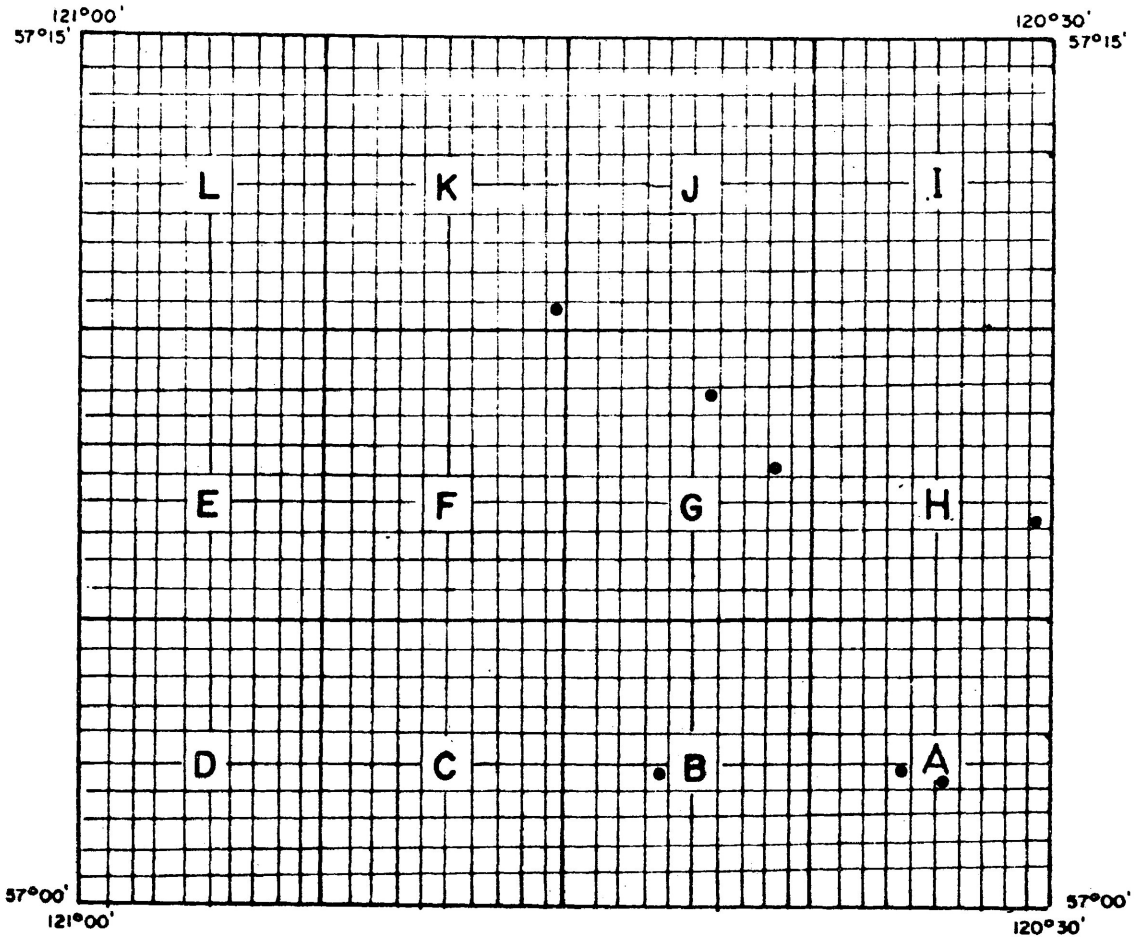


Fig.31 The location of the gradational basal contact in the area of study

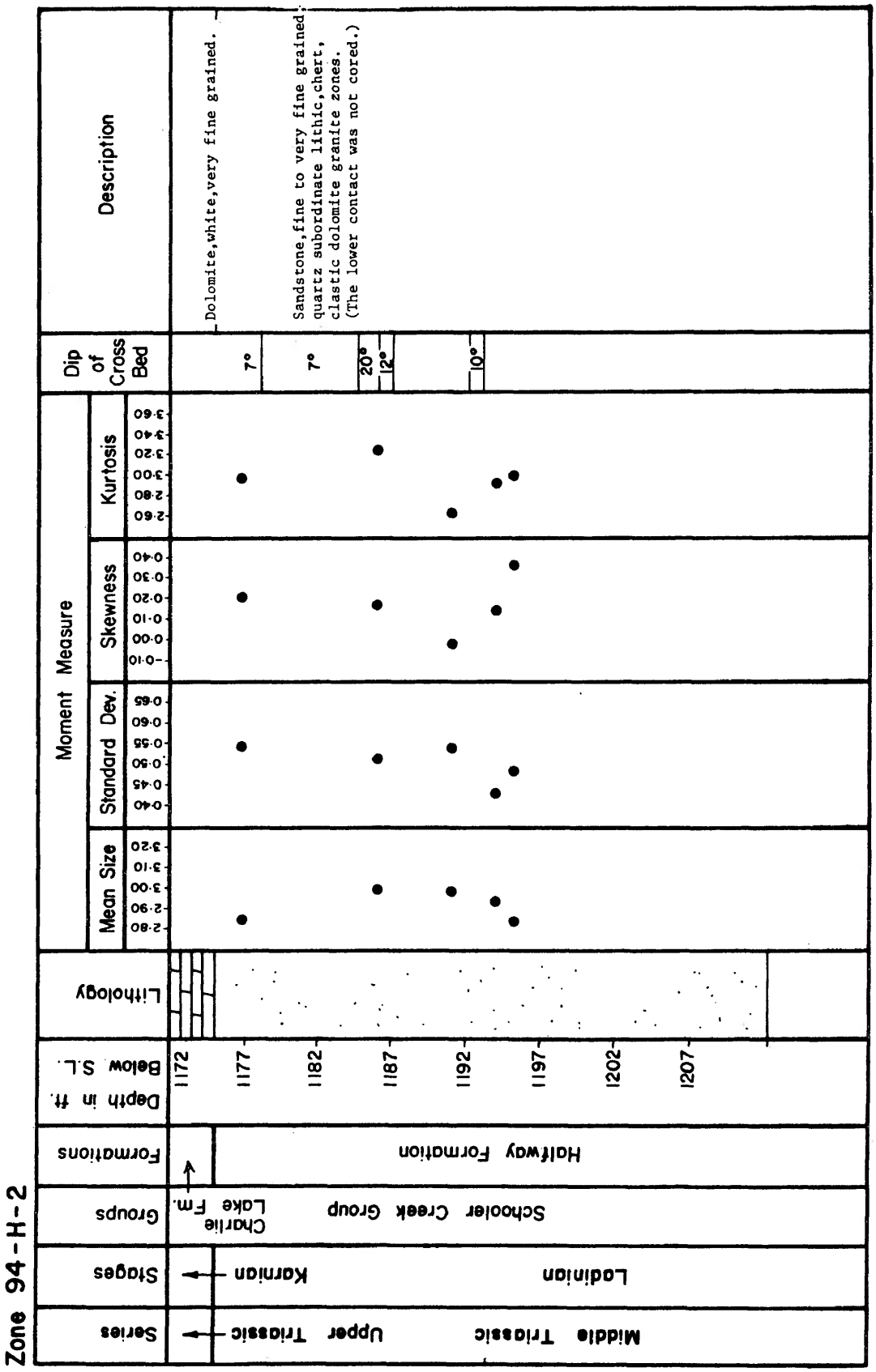


Fig.32 Vertical profile to show the stratigraphic relationship and the grain size distribution at Milligan b-42-G

which were fined slightly upward, and were cross -bedded in part with the dip angle of the foreset beds ranging from 5 to 3Ø. The standard deviation showed moderate sorting, the skewness changed from positive to negative, and the kurtosis changed from leptokurtic to platykurtic upward. A total of 34 well cores were examined from the Milligan sand body. Nineteen of these well cores showed sharp basal contact, seven well cores showed erosional surface, and two wells showed basal gradational contacts between the Halfway Formation and the underlying Doig Formation, and in three wells the contact was not cored. The upper contact between the Halfway Formation and the overlying Charlie lake Formation varied from sharp surfaces (Fig.33) to a gradational and interfingering contact. The location of the granule zones in the Milligan sand body in the area of study are shown in figures 12a and 12b, and the location of cross-bedded beds in Milligan in Figure 11.

In well d-8-J from the Beatton (Appendix J, page 314), the basal contact between the Halfway Formation and the Doig Formation was quite sharp, and the upper contact with the Charlie Lake Formation was gradational. The Halfway consisted of very fine, well sorted sands that were positively skewed and leptokurtic. A total of 12 wells were examined in the Beatton sand body. The basal contact between

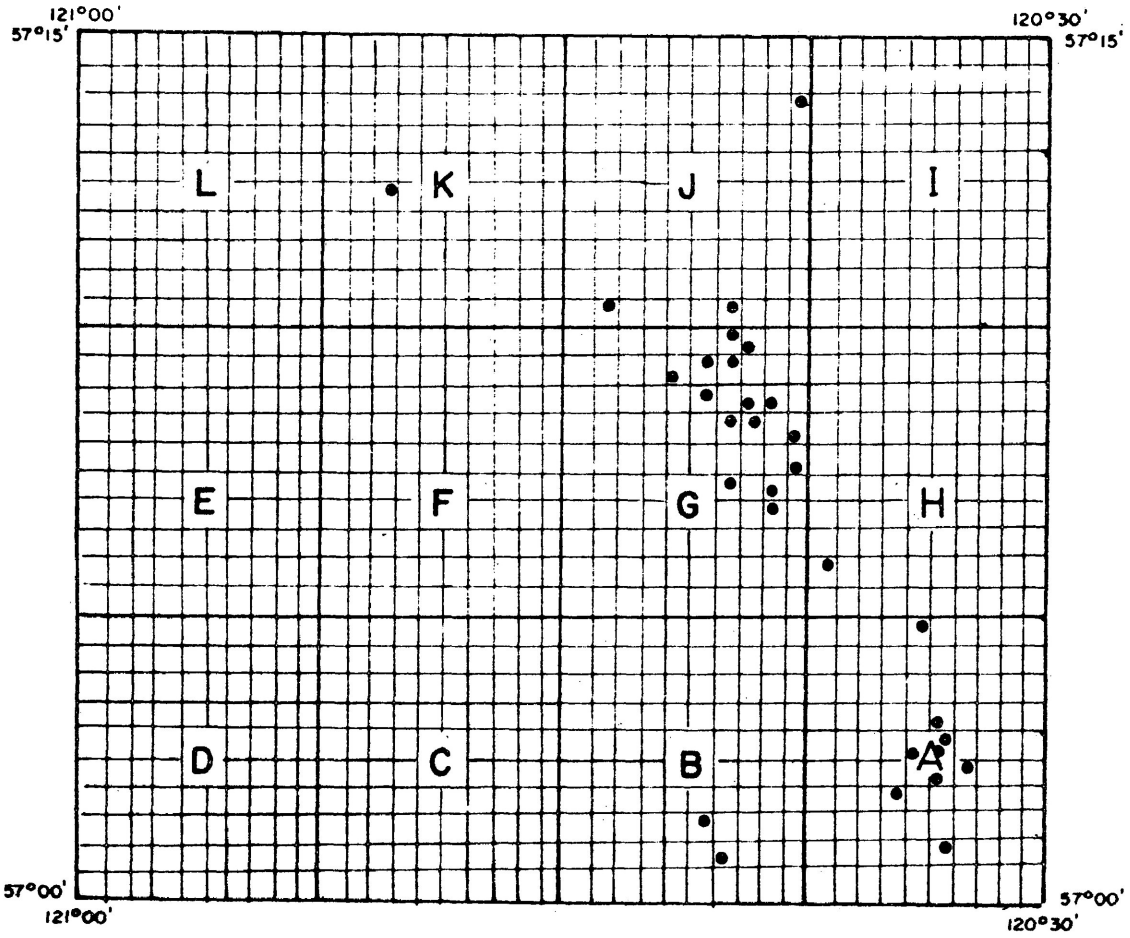


Fig.33 The location of the sharp upper contact with the overlying Charlie Lake Formation in the area of study

the Halfway Formation and the Doig Formation was quite sharp (Fig.13a), and the upper contact between the Halfway Formation and the overlying Charlie Lake Formation was gradational and interfingering contact for all wells (Fig.13b). The location of granule zones found overlying the Doig Formation can be seen in Figure 12a. Granule zones also were found in the upper portion of the Halfway Formation, just below the contact with the overlying Charlie Lake Formation (Fig.12b).

Discriminant Function Analysis

Sahu (1964) designated four discriminant functions to differentiate between the depositional environments of aeolian,beach,shallow agitated marine,fluvial(deltaic),and turbidite deposits,based on the graphic parameters after Folk and Ward(1957). Sahu's equations provided four discriminant functions which could be used to identify the depositional environments of the Halfway Formation (Appendix G).

1-Discriminant function (Y1),to differentiate between aeolian and beach environment,with values less than (-2.7411) indicating an aeolian environment, and greater than (Ø2.7411) indicating a beach environment.The Y1 values for the upper sand samples with the exception of Milligan c-5Ø-G(37Ø3),and Willow b-1Ø-H(3674) were less than (-2.7411) indicating an aeolian environment.

2-Discriminant function (Y2),to differentiate between beach and agitated marine environment, with values less than (65.365Ø), indicating beach deposits ,and greater than (65.365Ø),indicating shallow agitated marine. The upper sand samples values were greater than 65.365Ø suggesting a shallow agitated marine environment.

3-Discriminant function (Y3),to differentiate between

shallow marine and fluvial samples,with values less than -7.419Ø indicating fluvial (deltaic) deposition ,and values greater than -7.419Ø,indicating shallow agitated marine. The Y3 values for upper sand samples except for samples d-47-B (386Ø),c-32-G (37Ø6) indicate a shallow agitated marine environment.

4-Discriminant function (Y4),to distinguish between fluvial and turbidite currents.Nearly,half of the upper sand samples were predicted as fluvial and the other half of the samples were predicted as turbidite current.

From the results obtained after the equation of Sahu (1964),most of the the Halfway samples would appear to have been deposited either in an aeolian or shallow marine environment.

Linear Discriminant Function

Sevon (1966) applied three linear discriminant functions (R1,R2,and R3) to the moment of measures parameters (mean size,standard deviation ,skewness and kurtosis),and compared the R values to a discriminant frequency polygon, in order to distinguish between beach,river and dune sands (Fig.34). The moment measures for the Halfway Formation samples were computed ,and the R1,R2 and R3 values were obtained,and then compared with the discriminant frequency polygon (Appendix H).

Sevon (1966) considered that R1 values greater than Ø.Ø25 indicated beach sands.The values for all the Halfway Formation samples were negative, and therefore were located outside the dune and beach field in the frequency polygon (Fig.26).

He calculated R2 values to distinguish between beach and river sands,where positive values usually were beach sands. When R2 values were calculated for the Halfway Formation samples,most of the values were negative, and were located outside the river field in the frequency polygon (Fig.26),with the exception of 19 samples which were positive but located in the overlapping field between beach and river (Fig.34,Appendix H).

Sevon (1966) pointed out that R3 values could distinguish between dune and river sands,with values greater than Ø.19 indicating dune sands,less than Ø.13 indicating river sands and with values in between not being diagnostic.Nearly 6Ø percent of the R3 values for the Halfway Formation samples were located in the overlapping field of dune and river in the frequency polygon (Fig.34),and the remaining samples plotted in the dune field.

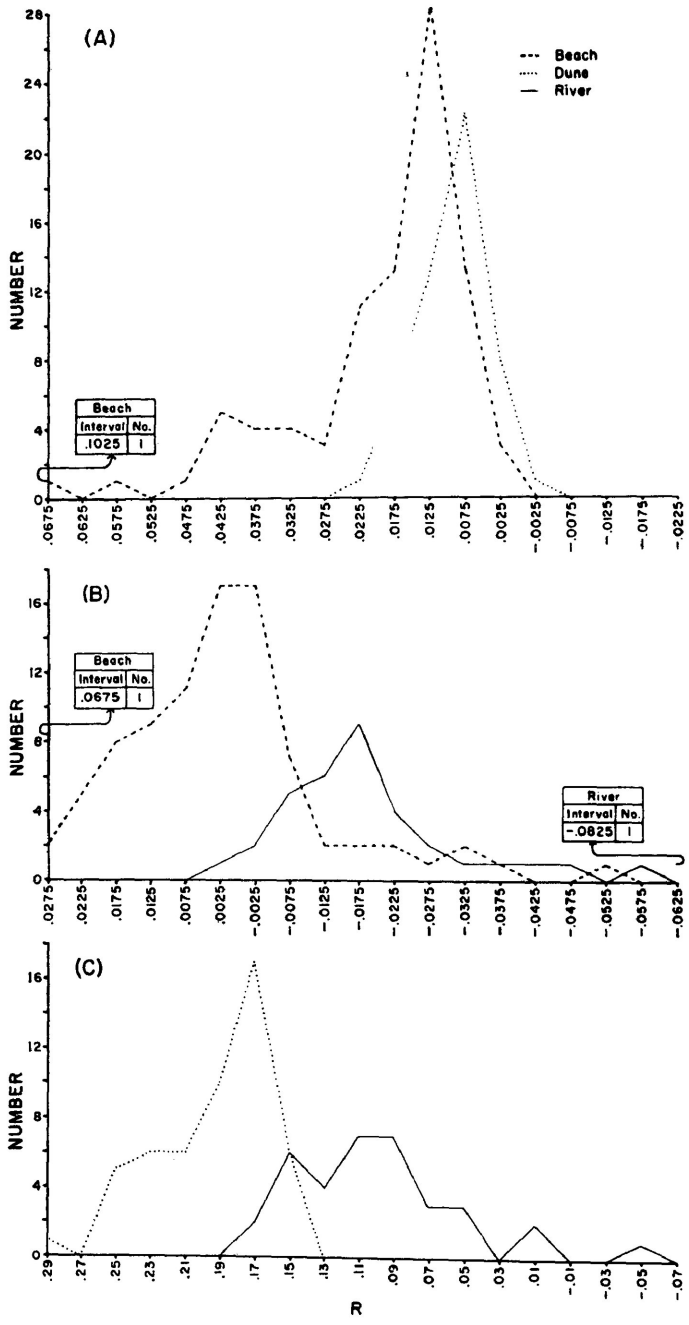


Fig.34 Frequency polygon of the "R" values, to differentiate between samples of (A) beach and dune sands, (B) beach and river sands, and (C) dune and river sands, after Sevon (1966)

Factor Analysis

Klovan (1966) proposed using Q mode factor analysis as a method for determining the depositional environments of samples from the grain size distribution. He applied this method to the recent sediments of Barateria Bay, and found a clear separation of sediments deposited under different conditions.

Q mode factor analysis was carried out on 117 samples, with the input variables being the weight percentage for each of the sieve sizes (Appendix F1). Table 8 represents the eigen values, and appendix F2 represents the cumulative percent sums of squares for the six factors comprising the Halfway Formation samples. In order to transform varimax factor matrix (Appendix F3) to usable form, the three major factors accounting for 97 percent of the variability of the grain size distribution of the Halfway Formation samples (Factor I = 84 percent, Factor II = 9 percent, and Factor = 4 percent) were chosen to describe all samples. Appendix F4 represents the varimax factor matrix after having been recalculated for the three factors, and Appendix F5 shows the normalized varimax factor matrix as described by Klovan (1966), to describe the energy of depositional environments.

Factor I, which accounts for 84 percent of variability

TABLE 8

Eigen Values of the Halfway Formation

FACTOR 1	Eigen Values =	98.35559845	FOR 84.06	PER CENT
FACTOR 2	Eigen Values =	10.86354637	FOR 93.35	PER CENT
FACTOR 3	Eigen Values =	4.59940910	FOR 97.28	PER CENT
FACTOR 4	Eigen Values =	1.85653126	FOR 98.87	PER CENT
FACTOR 5	Eigen Values =	1.26533794	FOR 99.95	PER CENT
FACTOR 6	Eigen Values =	0.08212504	FOR 100.02	PER CENT

shows a strong association for all but 36 of the samples as shown in Appendix F4. Factor II,which accounts for nine percent of the variability shows a strong association of 26 samples of the Halfway Formation, and Factor III,which accounts for four percent of variability,shows a moderate to strong association for seven samples of the Halfway Formation (Appendix. F5). Normalized varimax factor components values were presented in a triangle ,where Factors I,II,and III are the apices of the triangle, in order to show the relationship of the Halfway sands to these three main factors (Fig.35). There is a concentration of the sample plots between Factor I, and Factor II with a resulting small number of the samples plotting in the Factor III field.There is a decrease in grain size and standard deviation and a change to a nearly gaussian normal distribution from Factor I to Factor II (Fig.36).It may also be noted that the skewness of the samples became negative in the Factor III field.

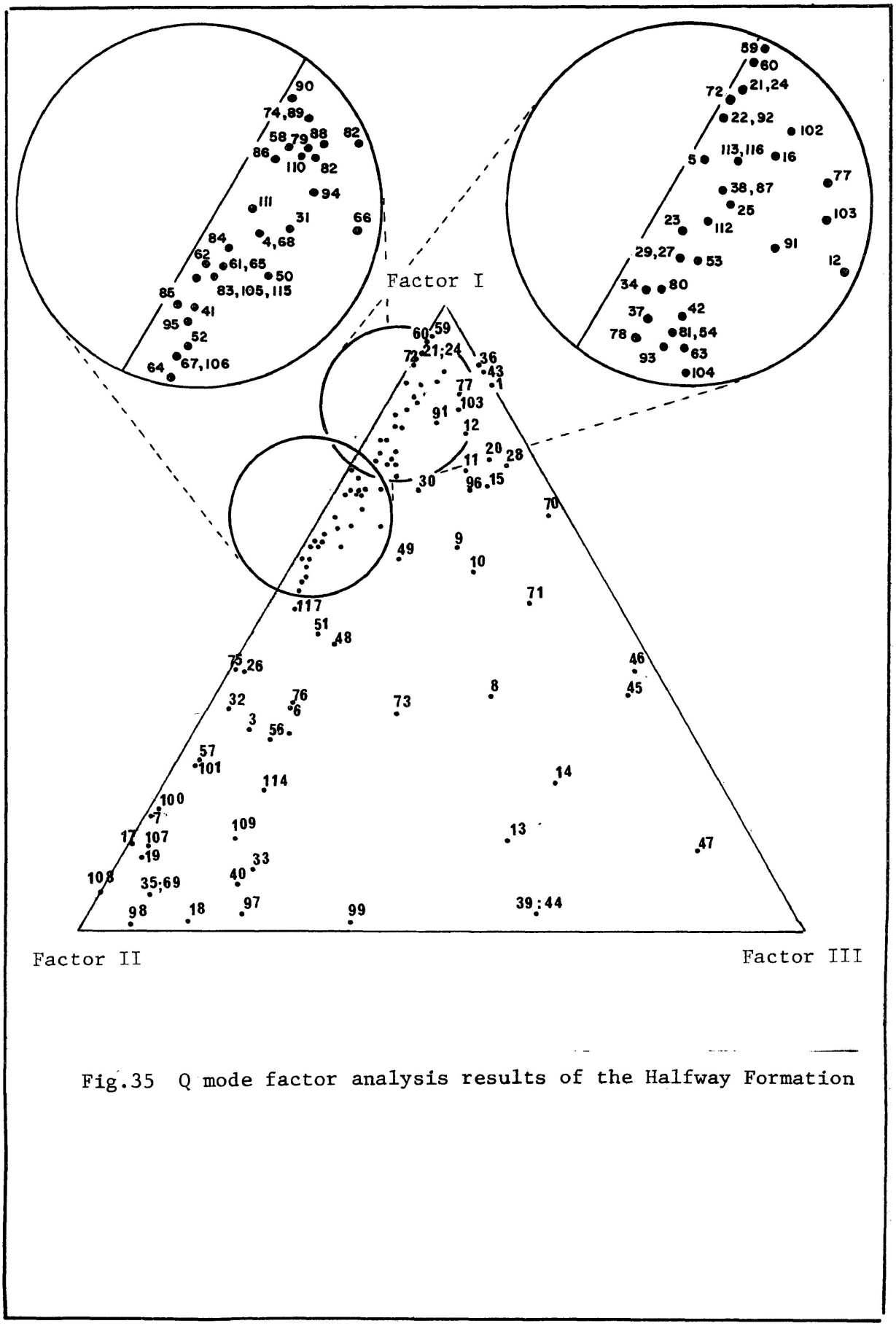


Fig.35 Q mode factor analysis results of the Halfway Formation

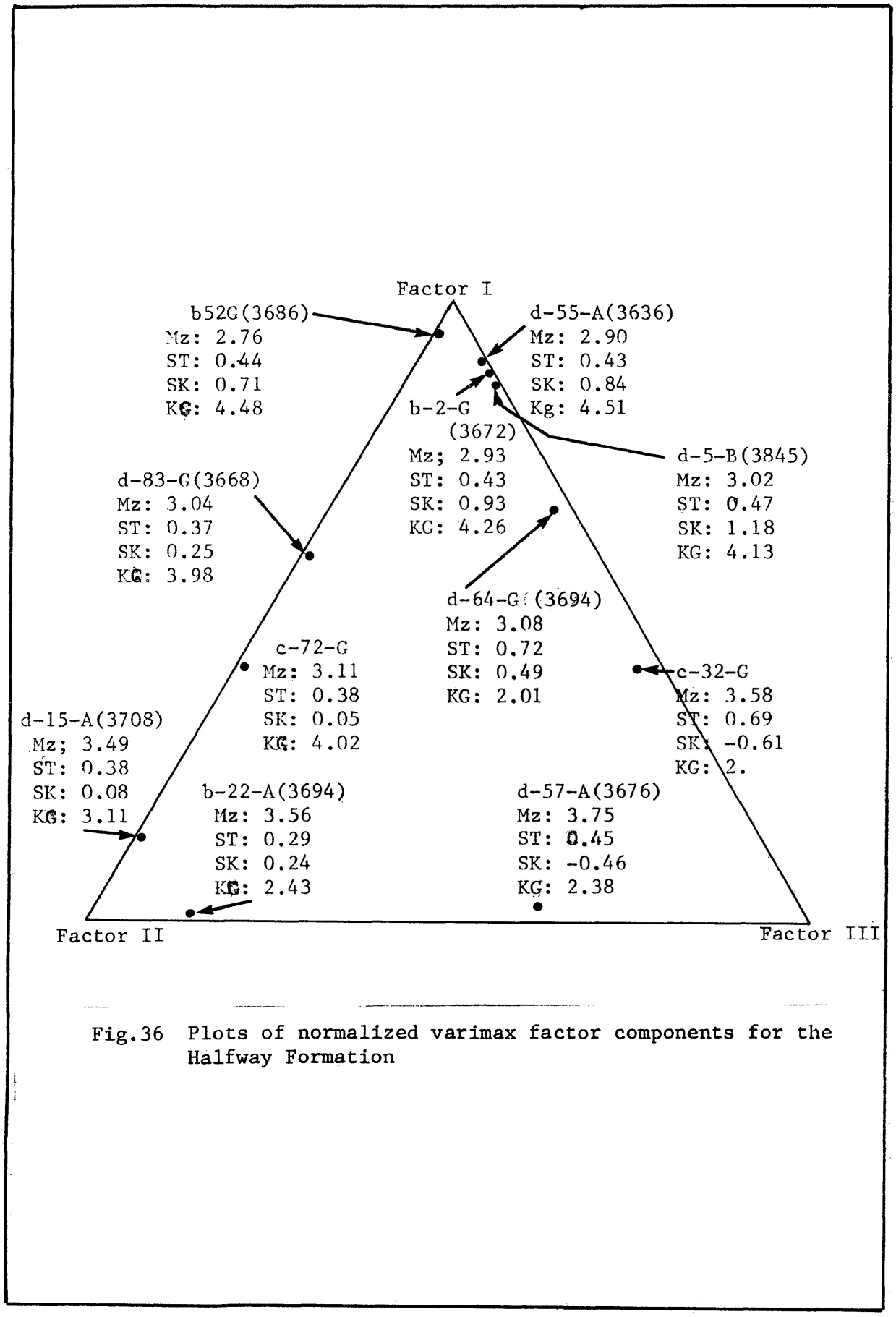


Fig.36 Plots of normalized varimax factor components for the Halfway Formation

Paleomagnetism

The paleoinclination values based on natural remanent magnetic directions were determined for 48 samples from 21 wells of the Halfway Formation (Appendix. I), to document whether any substantial change in the paleoinclination values occurred through the vertical stratigraphic sequence.

Figure 37 shows a compilation of the paleoinclination data from the 21 wells of Wildmint, Willow, Milligan, Beatton, and Weasel.It is evident from these data that a magnetic reversal had taken place during the time of deposition of the discontinuous Halfway Formation of the area of study.

The paleoinclination values for the Weasel sand body at d-15-B are positive,indicating normal magnetic polarity conditions. At Weasel d-13-B,the paleoinclination values also are positive for the lower part of the Halfway Formation,but are negative,indicating reversed polarity conditions for the upper part.This would indicate that during the time of deposition of the Weasel Halfway sequence, reversed polarity conditions occurred after normal polarity conditions. The paleoinclination values of samples from Willow b-1Ø-H,and Milligan d-94-G change from positive to negative upward,which substantiate the conclusion that

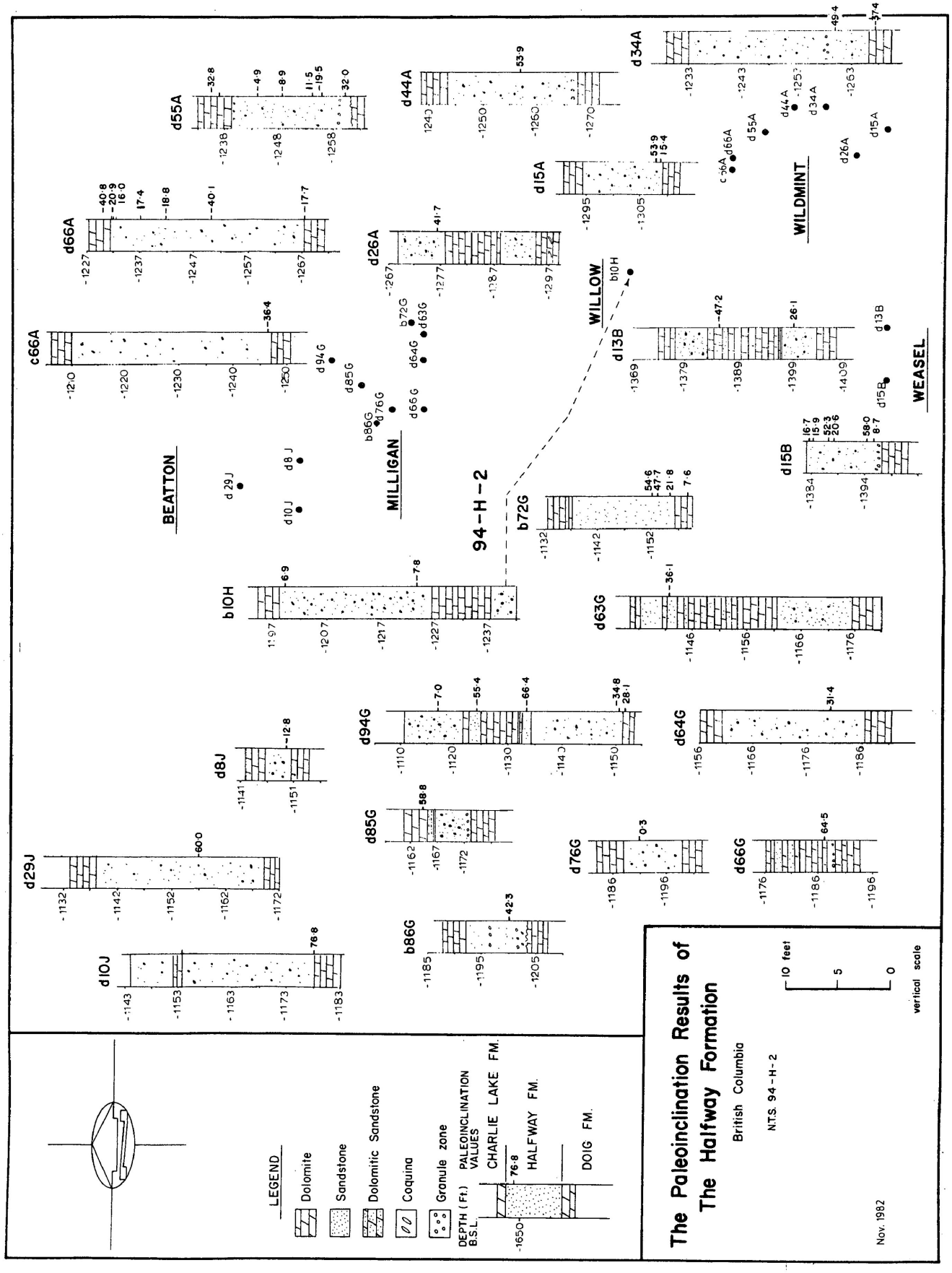


Fig.37 The paleoinclination results of the Halfway Formation

reversed polarity occurred after normal polarity conditions and that those samples that show negative paleoinclination values are younger than those samples those that show positive paleoinclination values. In the Wildmint sand body samples from wells d-15-A, d-26-A,and d-44-A show positive paleoinclination values but samples from wells d-34-A, d-55-A,d-66-A, and c-66-A, show negative values indicating younger strata.Those samples of the Halfway sequence analysed for paleoinclination directions which show negative values should be considered to be younger than those which show positive values.In the main upper sand at Milligan,samples from wells d-64-G, d-66-G, b-72-G, d-76-G and d-86-G show positive paleoinclination values, whereas samples from d-94-G show negative paleoinclination values indicating relatively younger strata. In the Beatton sand body samples from wells d-9-J, and d-29-J show positive paleoinclination values,but sample from well d-8-J shows negative paleoinclination values which indicate relatively younger strata.

DISCUSSION OF RESULTS

The Halfway Formation consists of sand bodies up to 8.3 miles (13.3 km) in length,and 3.3 miles (5.3 km) in width which form an en echelon trend from Beatton to Wildmint with the Weasel sand body lying to the southwest of this trend. Pettijohn, Potter and Siever (1972) have pointed out that alluvial,fluvial,deltaic, turbidite and tidal sand bodies tend to be parallel to the paleoslope; but that longshore bars, barrier islands and beaches tend to occur perpendicular to the paleoslope. The discontinuous sand bodies of the Halfway Formation are oriented parallel or nearly parallel to the strike of the structural contours of the top and the base of the Halfway Formation (Map 1 and 2) and would appear to have been deposited perpendicular to the paleoslope of the Western Canadian sedimentary basin. Therefore ,the discontinuous Halfway Formation would appear to have been deposited in a barrier environment where the sand bodies were formed perpendicular to the paleoslope.Such environments as longshore bars,barrier beaches or barrier islands as defined after Shepard (1960) would be possibilities for the environment of deposition of the sand bodies of the area of study.

In some locations the Halfway Formation is composed of

a lower and an upper sand separated by silty dolomite. The lower sand only has been identified in four well locations in the southern Wildmint sand body (d-6-A, d-13-A, d-16-A, and d-24-A) as well as in the Willow sand body at b-10-H based on electrical- induction log identification.

The upper sand is predominant in the area of study forming the substantial sand bodies at Weasel, Wildmint,Willow,Milligan, and Beatton.These sand bodies are similar lithologically, consisting of fine to very fine, well sorted sands that are cross - bedded in part. The basal contact with the underlying Doig Formation is quite sharp,and,in some cases,is an obvious irregular surface of erosion. Although the sand bodies appear to have been deposited in depositional lows on the Doig surface if the A marker is used as a datum,it is more likely that the sand bodies were deposited on a fairly planar surface. Mothersill (1968) pointed out that differential compaction of the silty dolomite of the Charlie Lake Formation between the top of the Halfway Formation and the A marker would result in a convex downward shape of the base of the Halfway sand bodies,if the A marker was used as a datum. The Halfway sand bodies probably were deposited on the gently sloping Doig surface. These sand bodies may have sunk slightly into the Doig Formation because of their weight

similarly to the situation of the Chandeleur barrier islands in the Gulf of Mexico (Shepard, 1960). However the later differential compaction exaggerates the basal shape of the formation if the A marker is used as a datum. Thin granule zones sometimes occur above the basal contact as well as throughout the Halfway Formation. The upper and lateral contacts of the Halfway Formation with the Charlie Lake Formation are usually gradational or interbedded. These stratigraphic relationships can be considered as evidence that the Halfway Formation disconformably overlies the silty dolomite of the Doig Formation and forms a transgressive onlapping relationship with the Charlie Lake Formation. The transgressive aspects of the discontinuous Halfway Formation - Charlie Lake Formation overstepping the erosional surface of the Doig Formation also has been clearly substantiated by the relative time sequence indicated by the paleoinclination data that the en echelon Beatton to Wildmint sand body trend is younger than the Weasel sand body.

The upper Halfway sand is composed of fine to very fine grained ,well sorted sand, which is cross-bedded in part. The thickness of the foreset beds ranges from 0.1 to 2.5 cm,and the angle of dip of the foreset beds range from 5 to a maximum of 30. The high angle of dip of the foreset beds(>25) of some of the cross-bedded sections is

indicative of aeolian deposition.

The upper Halfway sand is composed predominantly of quartz grains,which comprise up to 95 percent of the formation with lithic ,feldspar, and detrital silty dolomite grains forming minor percentages. The major heavy accessory detrital minerals of the upper sand consist of well rounded tourmaline,zircon, leucoxene,ilmenite and pyroxene.The sphericity of the sand grains range from Ø.4 to Ø.6, and the roundness range from Ø.4 to Ø.6. The predominance of such minerals as quartz,chert,tourmaline,and zircon as well as the rounding and sphericity of the grains would indicate that the sands were derived from a distal source, and probably were reworked sediments.

Grain size analyses of samples from the upper sands of the Halfway Formation were studied in detail as a method of determining the depositional environments of the sand bodies,based on plots after Friedman (1961,1979),Folk and Ward (1957),Moiola and Weiser (1968),and Greenwood (1969). Scatter plot graphs designed to differentiate between river and dune environment,and river and beach deposits, were not used extensively because the orientation of the sand bodies would appear to preclude the possibility of a fluvial origin. A plot of mean size versus standard deviation used

to differentiate between dune and river environments fields after Friedman (1961),was assessed (Fig.16). The upper sand samples plotted in the dune field,which is additional proof that the upper sand bodies were not deposited in a fluvial environment. Using the relationship of simple skewness measure versus simple sorting measure to differentiate between inland dune and nearshore dune sand after Friedman (1979),nearly 8Ø percent of the upper sand samples plot in the inland dune field (Fig. 21). Utilizing the skewness versus mean size graphs to differentiate dune and beach samples after Friedman (1961) and Moiola and Weiser (1968), nearly all the samples plotted in the dune field (Figs 14 and 15). Similarly in using mean size versus standard deviation based on Greenwood's (1969) boundary,nearly 75 percent of the upper sand samples plot in the dune and backshore field and the remainder in the foreshore beach field (Fig.17). Standard deviation versus skewness graphs using the boundaries of Friedman (1979) to differentiate for beach and inland dune fields by moment measures show that in excess of 9Ø percent of the upper sand samples plot in the inland dune field (Fig.24 and by graphic parameters in excess of 7Ø percent in the inland dune field (Fig.25). These various graphs substantiate that a large percentage of the upper sand samples would appear to have been deposited

in dunes. The remaining samples plot reasonably consistantly in the beach field from graph to graph. These upper sand samples ,which tend to plot in the beach field (Fig.33) correspond to the samples showing typical beach probability plot shapes after Visher (1969).

The application of the four discriminant functions of Sahu (1964) indicate that the samples of the upper sand, were deposited either in an aeolian or shallow marine environment.The R1 and R2 linear discriminant functions of Sevon (1966), grouping failed to give any support to the depositional environments, as the Halfway samples plotted outside the fields for R1 or plotted in the overlapping area for R2.However,in utilizing the R3 discriminant function for distinguishing between river and dune samples, 40 percent of the Halfway samples plotted in the dune field and the remainder in the overlapping field.

Factor analysis was applied to the samples of the upper sands of the discontinuous Halfway Formation using the technique of Klovan (1966). Three major factors accounted for 97 percent of the variability of the grain size distribution (Factor I = 84 percent,Factor II = 9 percent, and Factor III = 4 percent). Factor I shows a strong to moderate association for all samples except Wildmint d-15-A (3708), b-22-A (3577), d-26-A (3694), d-57-A (3676), and

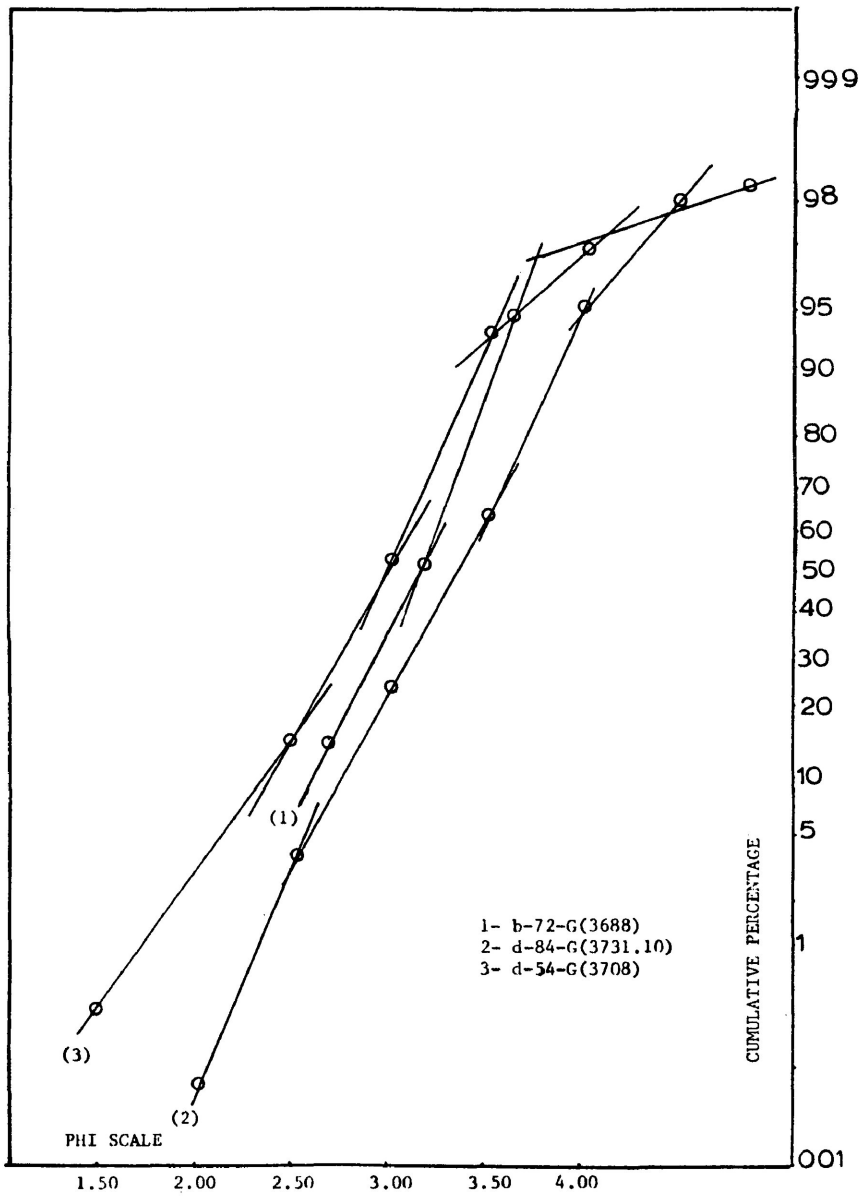


Fig.38 The log probability plots from the Halfway Formation samples showing which correspond to the samples showing beach plots,after Visher (1969)

Willow b-10-H (3674). Factor II accounts for 9 percent of the variability of the grain size distribution of the Halfway samples,and shows a strong association for 26 samples. Factor III, which accounts for 4 percent of the variability shows a moderate to strong association for only 7 samples.

A comparison of the factor analysis grouping of the upper sand samples,and the depositional environments suggested for the samples based on the results obtained from the grain size parameters (Fig.39),these grain size plots show that the samples with a strong association in Factor I plot in the dune field environments in the grain size plots. This would suggest that Factor I represents the samples from a dune environment. Factor II should be considered as the beach environment factor,because the samples that show a strong association in Factor II occur in the beach field in the grain size plots. Factor III might be considered as sand deposited as the sea level rose which reworked the sediments at the top of the barrier islands.

Armitage (1962) suggested that the sand bodies forming the discontinuous Halfway Formation were beach deposits; Clark (1961) suggested that they were a barrier environment, and Mothersill (1967, 1968) suggested that the sand bodies may have been deposited as longshore bars, and barrier

Fig.39
Comparison of the factor analysis,and the depositional environments suggested for the Halfway samples based on the results obtained from the grain size parameters

Abbreviations

Factor analysis:

I Factor I

II Factor II

III Factor III

Grain size plots:

1- Plot of skewness versus mean size (Fig.14),after Friedman (1961)

2- Plot of skewness versus mean size (Fig.15),after Greenwood (1969) boundary

3- Plot of mean size versus standard deviation (Fig.17), after Greenwood (1969) boundary

4- Plot of skewness versus standard deviation using 6.00 phi for the fraction less than 4.00 phi,for beach and inland dune sands (Fig.18),after Friedman (1979)

5- Plot of skewness versus standard deviation,for inland dune ,nearshore dune,and beach sands, (Fig. 19),after Friedman (1979)

6- Plot of skewness versus standard deviation,for foreshore beach and dune with backshore sands (Fig.19), after Greenwood (1969)

7- Plot of simple skewness measure versus simple sorting measure (Fig.21),after Friedman (1979)

+ Beach.
• Beach-nearshore dune overlap.
- Beach-inland dune overlap.
+ Nearshore dune-inland dune overlap

FACTOR ANALYSIS

SAMPLE	LOC.		I	II	III
1	d05B3845	0.9422	0.7066	0.2734	0.2133
2	b14B3813	0.9749	0.7802	0.6037	0.0609
3	b14B3814	0.9697	0.5617	0.7720	0.2414
4	b14B3819	0.9737	0.7919	0.5218	0.1402
5	d15B3836	0.9940	0.9311	0.1516	0.3139
6	d15B3839	0.9742	0.5864	0.7267	0.3198
7	d15B3846	0.9789	0.4256	0.8920	0.0455
8	d25B3815	0.9811	0.5906	0.5136	0.6071
9	d25B3831	0.9975	0.7821	0.4096	0.1670
10	d25B3833	0.9840	0.7490	0.4173	0.4988
11	d25B3836	1.0000	0.8517	0.3257	0.1043
12	d25B3834	0.9953	0.8585	0.2451	0.3582
13	d47B3856	0.9512	0.3563	0.5806	0.6980
14	d47B3860	0.9422	0.4681	0.4655	0.7116
15	d47B3870	0.9913	0.8430	0.2739	0.4534
16	d47B3878	0.9069	0.8929	0.1236	0.3072
17	d15A3708	0.9787	0.2114	0.9219	0.2901
18	b22A3577	0.8275	0.0473	0.8389	0.3486
19	d26A3694	0.9933	0.3327	0.9263	0.1569
20	b34A3639	0.9871	0.8608	0.4257	0.2549
21	d31A3576	0.9816	0.9525	-0.0179	0.2720
22	d34A3580	0.9903	0.9452	0.1837	0.2513
23	d34A3585	0.9723	0.8929	0.3966	0.1329
24	d34A3587	0.9882	0.9585	0.1401	0.2231
25	d34A3592	0.9673	0.9021	0.3497	0.1754
26	d34A3593	0.9920	0.6431	0.7532	0.1049
27	d34A3601	0.9673	0.8831	0.4091	0.1417
28	d44A3544	0.9951	0.8589	0.2112	0.4613
29	d44A3547	0.9886	0.8948	0.1106	0.1392
30	b46A3706	0.9750	0.8261	0.4413	0.3127
31	d46A3716	0.9871	0.9003	0.3599	0.1824
32	d46A3711	0.9848	0.5930	0.7833	0.1396
33	d47A3704	0.9970	0.3084	0.8983	0.1270
34	b55A3694	0.9877	0.8809	0.4479	0.1057
35	d55A3635	0.9894	0.3313	0.9382	0.2330
36	d55A3636	0.9893	0.9449	0.2601	0.1700
37	d55A3646	0.9992	0.8750	0.4623	0.1409
38	d55A3651	0.9534	0.9029	0.3460	0.1358
39	d57A3676	0.9959	0.9478	0.3138	0.1853
40	c66A3680	0.9948	0.2416	0.8680	0.4277
41	d66A3688	0.9980	0.7702	0.6304	0.0867
42	d66A3671	0.9872	0.8702	0.4390	0.1931
43	b02G3672	0.9758	0.9367	0.2513	0.1836
44	b31G3699	0.9504	0.1031	0.5999	0.7615
45	c32G3701	0.9675	0.6011	0.2400	0.7382
46	c32G3704	0.9596	0.6318	0.1625	0.7308
47	c32G3707	0.9643	0.3163	0.5233	0.8720
48	c32G3711	0.9970	0.6710	0.5846	0.4528
49	c32G3712	0.9914	0.7702	0.5228	0.3578
50	b42G3694	0.9879	0.7823	0.5843	0.1858
51	b42G3699	0.9692	0.6800	0.6583	0.3712
52	b42G3702	0.9735	0.7449	0.6383	0.1061
53	b42G3703	0.9390	0.8474	0.3333	0.1734
54	c43G3685	0.9367	0.8417	0.4370	0.1939
55	d43G3695	0.9877	0.9326	0.5321	0.1063
56	d43G3705	0.9907	0.6298	0.7681	0.0642
57	d44G3705	0.8705	0.4904	0.7831	0.1296
58	c50G3702	0.9991	0.5632	0.7503	0.3451
59	b52G3686	0.9856	0.9683	0.0771	0.2049
60	d53G3699	0.9566	0.9492	-0.0888	0.2186
61	d54G3708	0.9965	0.7887	0.6036	0.1004
62	d54G3716	0.9924	0.7798	0.6151	0.0772
63	d54G3720	0.9814	0.8533	0.4477	0.2300
64	d54G3730	0.9968	0.7367	0.6578	0.1460
65	b61G3681	0.9790	0.8762	0.4552	0.1279
66	d62G3698	0.9795	0.7977	0.5155	0.2782
67	d63G3719	0.9907	0.7431	0.6455	0.1477
68	d63G3724	0.9931	0.7981	0.5758	0.1568
69	d63G3721	0.9883	0.3292	0.9316	0.0804
70	d64G3694	0.9897	0.8115	0.1444	0.5570
71	d64G3700	0.9583	0.7078	0.5824	0.3436
72	d64G3704	0.9982	0.9575	0.2147	0.1877
73	d66G3702	0.9841	0.5781	0.6282	0.5048
74	b72G3688	0.9988	0.8507	0.5128	0.1106
75	c72G3889	0.9904	0.6428	0.7580	0.0515
76	d74G3703	0.9909	0.6019	0.7274	0.3157
77	d74G3705	0.9988	0.9277	0.3339	0.1630
78	d74G3710	0.9998	0.8663	0.4712	0.1649
79	d74G3715	0.9994	0.8371	0.5236	0.1182
80	d75G3712	0.9982	0.8860	0.4383	0.1448
81	d76G3736	0.9980	0.8750	0.4552	0.1586
82	b82G3677	0.9751	0.8317	0.4921	0.2031
83	b82G3681	0.9953	0.7818	0.6070	0.1045
84	b82G3684	0.9984	0.7968	0.5929	0.1096
85	d83G3668	0.9926	0.7664	0.6332	0.0661
86	d83G3670	0.9791	0.8267	0.5408	0.0566
87	d84G3731	0.9831	0.9155	0.3469	0.1569
88	d84G3732	0.9922	0.8385	0.5167	0.1487
89	d94G3690	0.9981	0.8519	0.5111	0.1059
90	d94G3700	0.9730	0.8438	0.5046	0.0801
91	b10H3632	0.9983	0.9011	0.3449	0.2596
92	b10H3633	0.9880	0.9470	0.1485	0.2629
93	b10H3635	0.9981	0.8653	0.4624	0.1893
94	b10H3641	0.9929	0.8196	0.5300	0.2007
95	b10H3653	0.9657	0.7523	0.6230	0.1079
96	b10H3658	0.8995	0.7980	0.3163	0.4032
97	b10H3671	0.9083	0.0936	0.8386	0.1430
98	b10H3673	0.9926	0.2128	0.9608	0.1553
99	b10H3674	0.8426	0.0069	0.7288	0.3580
100	d20H3646	0.9739	0.4336	0.8858	0.0315
101	d20H3647	0.9908	0.5083	0.8428	0.1435
102	d20H3651	0.6327	0.7512	0.0390	0.2585
103	b31H3579	0.9976	0.9127	0.3579	0.1912
104	b31H3580	0.9997	0.8537	0.4650	0.2337
105	a63H3628	0.9911	0.7801	0.6129	0.0799
106	b03J3687	0.9894	0.7480	0.6516	0.0730
107	d08J3726	0.9968	0.3618	0.9159	0.1580
108	d10J3743	0.9531	0.1432	0.9483	0.1825
109	d17J3755	0.9780	0.3566	0.8407	0.3795
110	b28J3735	0.9692	0.8236	0.5132	0.1657
111	b28J3737	0.9933	0.8139	0.5610	0.1133
112	b28J3757	0.9881	0.9067	0.3802	0.1463
113	d29J3742	0.9906	0.9316	0.3287	0.1213
114	d39J3735	0.8348	0.4379	0.7332	0.3248
115	d39J3740	0.9719	0.7760	0.6003	0.0968
116	d49J3733	0.9973	0.9386	0.3200	0.1183
117	d15A3714	0.9921	0.7118	0.6753	0.1718

GRAIN SIZE PLOTS

1 2 3 4 5 6 7

beaches.

The discontinuous Halfway Formation would appear to have been deposited in a barrier environment where the sand bodies were deposited perpendicular to the paleoslope.The grain size analysis clearly show that most of the Halfway samples analysed were deposited as dune sands and most of the remainder as beach sands indicating the composite types of environments found in barrier islands.

Paleomagnetic studies were carried out on oriented samples to document any change in the magnetic polarity conditions during the time of deposition of these sand bodies,and the results showed that at Milligan d-94-G negative paleoinclination values occur above positive values indicating as at Weasel d-13-B that the reversed polarity situation was a later event recorded by the sedimentary sequence. In general the paleoinclination data from Wildmint, Willow, Milligan,and Beatton show an irregular geographic distribution of positive and negative values. Because barriers are a complex of beach, berm, dune, tidal flat, tidal channel, tidal delta and washover fan deposits the sand bodies forming barriers should show an irregular internal distribution of sands from a number of environments and ages.The cored stratigraphic sequence at any location would show an upward progression from older to younger

sands. However, the cored stratigraphic sequence at adjacent locations could be older, the same age or younger depending on such factors as the relationship of the cut and fill of tidal channels or washover fans throughout the barrier, or progradation of the barrier basinward and the overlapping relationship of beach and tidal flat sediments over a submerging barrier. The upward change from positive to negative paleoinclination in several wells at Weasel and Milligan combined with positive paleoinclination values recorded in the main sand body at Weasel and an irregular distribution of positive and negative paleoinclination values recorded in the main part of the upper sand bodies in the Wildmint to Beatton trend provides fairly conclusive evidence on the age relationship of the sand bodies. The upper sand body at Weasel is older than the upper sand bodies of the Wildmint to Beatton trend. The discontinuous Halfway Formation sand bodies would appear to have been deposited as prograding barrier islands by the Triassic sea as it transgressed to the northeast.

The lower sand of the discontinuous Halfway Formation was fine grained and did not show cross-bedding, coquina and granule zones based on the short cored interval at Willow b-10-H. These lower sands of the discontinuous Halfway Formation probably resulted from the action of tidal inlets

that eroded down into the shelf sediments of the Doig Formation below the base of the upper barrier sand and then later were filled with sand either when the tidal inlet migrated laterally or during the marine transgression that submerged these barriers.

The lack of clay sediments on the landward side of the barrier trend would tend to indicate that rivers did not flow into lagoons formed by these barriers. In addition, Mothersill (1967) pointed out the occurrence of gypsum on the landward side of the Peejay and Current sand bodies to the south of the area study which suggests a restricted lagoonal environment under arid conditions. This would tend to substantiate a distal source for the sediment of the discontinuous sand bodies of the area of study possibly from Pennsylvanian clastic strata from the north and northeast as suggested by Torrie (1973).

CONCLUSIONS

The discontinuous Halfway Formation consists of isolated sand bodies up to 8.3 miles (13.3 km) in length, and 3.3 miles (5.3 km) in width in the area of study. The discontinuous Halfway Formation predominantly consists of an upper sand although in a few locations a lower sand occurs below the upper sand.

The upper sand forms the substantial sand bodies at Weasel, Wildmint, Willow, Milligan, and Beatton. These upper sands form an en echelon arrangement parallel or nearly parallel to the strike of the present day structural contours and were probably deposited perpendicular to the paleoslope of the Western Canadian Sedimentary Basin. The basal contact of the upper sand with the underlying Doig Formation is quite sharp, and in some cases erosional, and the upper contact with the overlying Charlie Lake Formation is gradational and interfingering. This stratigraphic relationship would indicate that the Halfway and Charlie Lake Formations form a transgressive onlapping relationship that overstepped the Doig Formation during a transgressive phase of the Triassic sea. Utilization of the paleoinclination data as a relative time indicator substantiates that the Weasel sand body was older than the sand bodies of the Wildmint to Beatton trend.

The high angle of dip of some of the foresets of the cross-bedded sections of the Halfway sand is indicative of aeolian deposition. Graphs of mean size versus standard deviation,after Friedman (1961),simple skewness measure versus simple sorting measure,after Friedman (1979),skewness versus mean size, after Friedman (1979), Moiola and Weiser (1968), and Greenwood (1969) show clearly that most of the upper sands of the discontinuous Halfway sand bodies would appear to have been deposited as dunes,and the remaining samples deposited as beach sands.

The application of the four discriminant functions,after Sahu (1964), and linear discriminant functions,after Sevon (1966) also indicate that the sand bodies of the Halfway Formation probably were deposited under aeolian or shallow marine environments.

The upper sands of the discontinuous Halfway Formation would appear to have been deposited perpendicular to the paleoslope in a barrier environments.Based on the high angle of dip of some of the foreset beds, and on the examination of graph plots of grain size parameters,discriminant functions,linear discriminant functions and factor analysis most of these upper sands would appear to have been deposited under aeolian conditions with beach conditions forming a substantially secondary method of deposition.

Therefore the upper sands would appear to have been deposited in a complex environment comprising dune and beach sands such as would be present on barrier islands. These granule zones that occur in the upper part of the Halfway Formation may have been deposited in the high energy conditions associated with the deposition of washover fans.

The lower sands of the discontinuous Halfway Formation that are present in southern Willow and Wildmint occur stratigraphically below the upper barrier islands sand, and probably are the result of sand that filled these tidal inlets during lateral migration of the inlets or submergence of the barrier islands during the marine transgression to the northeast.

The predominance of such stable minerals as quartz, chert, lithic grains, tourmaline, zircon, leucoxene and the moderate rounding, and the sphericity of the grains would indicate that the upper sands were derived from a distal source of clastic sediments.

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APPENDIX A
COMPLIATION OF WELL LOG DATA

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-2-A	2351	3570	3606	3615	-1219	-1255	-1264	7	6
d-4-A	2338	3570	3610	3618	-1232	-1272	-1280	8	8
d-5-A	2377	3628	3672	3677	-1251	-1295	-1300	5	5
d-6-A	2403	3646	3689 3724	3698 3766	-1243	-1286 -1321	-1295 -1363	51	43
d-7-A	2364	3607	3672	3721	-1243	-1308	-1357	49	35
d-13-A	2322	3522	3566 3576	3576 3630	-1200	-1244 -1254	-1254 -1308	64	48
d-14-A	2331	3546	3592	3594	-1215	-1261	-1263	2	2
d-15-A	2415	3646	3708	3722	-1231	-1293	-1307	14	14
d-16-A	2418	3661	3718 3733	3728 3757	-1243	-1300 -1315	-1310 -1339	34	28
b-21-A	2343	3565	3617	3622	-1222	-1274	-1279	5	5
b-22-A	2330	3522	3560	3585	-1192	-1230	-1255	25	17
b-23-A	2348	3548	3595	3616	-1200	-1247	-1268	21	21
b-24-A	2399	3620	3662	3668	-1221	-1263	-1269	6	6
d-24-A	2365	3550	3610 3648	3629 3672	-1185	-1245 -1283	-1264 -1307	41	39

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL)			Thickness of Halfway	Net Thickness
					A Marker	Top H.W.	Base H.W.		
d-25-A	2421	3640	3701	3713	-1219	-1280	-1292	12	12
d-26-A	2423	3653	3693	3721	-1230	-1270	-1298	28	18
b-34-A	2392	3577	3628	3660	-1185	-1236	-1268	32	32
d-34-A	2342	3522	3577	3608	-1180	-1235	-1266	34	34
b-35-A	2431	3659	3702	3706	-1228	-1271	-1275	4	4
d-35-A	2413	3616	3657	3672	-1203	-1244	-1259	15	15
d-37-A	2425	3648	3708	3718	-1223	-1287	-1293	10	10
d-44-A	2310	3498	3543	3566	-1188	-1233	-1256	23	23
b-45-A	2436	3642	3692	3700	-1206	-1256	-1264	8	8
d-45-A	2400	3593	3638	3665	-1193	-1238	-1265	27	27
d-47-A	2436	3654	3705	3718	-1218	-1269	-1282	13	11
d-50-A	2365	3543	3588	3618	-1178	-1223	-1253	30	30
b-54-A	2377	3565	3608	3629	-1188	-1231	-1252	21	21
b-55-A	2425	3624	3665	3700	-1199	-1240	-1275	35	35

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-55-A	2391	3588	3633	3658	-1197	-1242	-1267	25	25
b-56-A	2445	3660	3700	3725	-1215	-1255	-1280	25	25
c-56-A									
d-56-A	2448	3638	3680	3716	-1190	-1232	-1268	36	36
d-57-A	2438	3623	3697	3700	-1185	-1259	-1262	3	3
c-60-A	2366	3558	3600	3609	-1192	-1234	-1243	9	9
b-65-A	2420	3598	3673	3684	-1178	-1253	-1264	11	
b-66-A	24.50	3638	3680	3716	-1188	-1230	-1266	36	36
c-66-A	2470	3636	3678	3716	-1166	-1208	-1246	38	38
d-66-A	2438	3628	3670	3704	-1190	-1232	-1266	34	34
d-67-A	2450	3632	3688	3708	-1182	-1238	-1258	20	8
b-68-A	2408	3597	3642	3653	-1189	-1234	-1245	11	9
b-75-A	2419	3521	3620	3647	-1102	-1241	-1228	7	7
b-76-A	2450	3636	3670	3717	-1186	-1220	-1267	47	47

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-78-A	2333	3580	3634	3647	-1247	1301	-1314	13	13
b-86-A	2446	3609	3652	3684	-1163	-1206	-1238	32	32
d-96-A	2434	3583	3638	3642	-1149	-1204	-1208	4	4
b-46-A	2438	3659	3700	3724	-1221	-1262	-1286	24	24
d-46-A	2442	3660	3702	3732	-1218	1260	-1290	32	32
d-2-B	2354	3635	3694	3720	-1281	-1340	-1366	24	18
d-3-B	2378	3687	3758	3767	-1309	-1380	-1389	9	9
b-3-B	2383	3716	3790	3795	-1333	-1407	-1412	5	5
d-4-B	2415	3718	3775	3818	-1303	-1360	-1403	43	31
d-5-B	2442	3756	3830	3848	-1314	-1388	-1406	18	14
d-9-B	2479	3843	3905	3922	-1364	-1426	-1443	17	15
b-13-B	2395	3704	3774	3782	-1309	-1379	-1387	8	8
d-13-B	2381	3650	3723	3732	-1269	-1342	-1351	9	9
b-14-B	2429		3790	3822		-1361	-1393	32	32

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-14-B	2417.1	3720	3790	3808	-1303	-1373	-1391	18	18
d-15-B	2451	3759	3838	3850	-1308	-1387	-1397	12	12
b-23-B	2394	3675	3746	3756	-1281	-1381	-1352	10	10
a-24-B	2427	3717	3786	3816	-1290	-1359	-1389	30	28
d-24-B	2411	3698	3768	3782	-1287	-1357	-1371	14	13
d-25-B	2443	3760	3836	3842	-1317	-1393	-1399	6	6
d-26-B	2483	3789	3860	3876	-1306	-1377	-1393	17	17
d-27-B	2506	3829	3890	3908	-1323	-1384	-1402	18	12
d-33-B	2369	3610	3654	3662	-1291	-1285	-1293	8	6
d-34-B	2393	3672	3744	3758	-1279	-1351	-1365	14	14
b-34-B	2422	3717	3785	3796	-1295	-1363	-1374	11	11
b-35-B	2461	3758	3844	3851	-1297	-1383	-1390	7	7
d-35-B	2435	3744	3700	3820	-1309	-1266	-1385	19	19
b-36-B	2489	3797	3846	3889	-1308	-1357	-1400	43	43

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-36-B	2477	3775	3828	3868	-1298	-1351	-1391	40	30
b-44-B	2418	3700	3743	3785	-1282	-1325	-1367	12	12
d-45-B	2443	3706	3756	3760	-1263	-1313 -1325	-1317 -1365	52	44
a-46-B	2480	3765	3824	3855	-1205	-1344	-1375	31	31
d-46-B	2473	3768	3840	3852	-1295	-1367	-1379	12	11
d-47-B	2492	3794	3868	3880	-1302	-1376	-1388	12	12
d-56-B	2450	3741	3792	3808	-1291	-1342	-1358	16	14
d-57-B	2486	3768	3832	3862	-1282	-1346	-1376	30	21
d-58-B	2509	3810	3868	3890	-1301	-1359	-1381	18	12
d-62-B									
d-67-B	2478	3760	3811	3833	-1282	-1333	-1355	22	22
d-68-B	2506	3797	3857	3880	-1291	-1352	-1374	22	14
b-70-B	2460	3778	3844	3866	-1318	-1384	-1406	22	21

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL)			Thickness of Halfway	Net Thickness
					A Marker	Top H.W.	Base H.W.		
d-71-B	2386	3545	3592	3604	-1159	-1206	-1218	12	9
d-77-B	2472	3730	3780	3810	-1258	-1308	-1338	30	30
d-78-B	2508	3792	3836	3863	-1284	-1328	-1355	27	27
d-80-B	2499	3764	3836	3840	-1265	-1337	-1341	4	4
d-95-B	2441	3654	3696	3702	-1213	-1255	-1261	6	6
d-71-C	2459	3734	3808	3817	-1275	-1349	-1358	9	9
d-72-C	2428	3705	3772	3790	-1277	-1344	-1362	12	12
d-73-C	2411	3712	3772	3794	-1301	-1361	-1383	22	14
d-76-C									
b-81-C	2438	3710	3768	3788	-1272	-1330	-1350	20	12
c-81-C									
d-81-C									
d-82-C	2430	3715	3780	3797	-1285	-1350	-1367	23	23
d-95-C	2410	3714	3798	3818	-1304	-1388	-1408	20	20

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL)			Thickness of Halfway	Net Thickness
					A Marker	Top H.W.	Base H.W.		
d-98-C									
d-61-C	2449	3700	3818	3840	-1251	-1369	-1391	22	19
d-61-D	2358	3776	3850	3870	-1410	-1492	-1512	20	20
d-89-D	2293	3690	3762	3770	-1397	-1469	-1477	8	8
d-11-E	2388	3738	3806	3834	-1350	-1418	-1440	28	28
d-2-F	2441	3706	3759	3787	-1265	-1318	-1346	28	28
d-12-F	2451	3692	3753	3780	-1241	-1302	-1329	27	27
a-27-F	2432	3733	3804	3830	-1301	-1372	-1398	26	24
d-32-F	2473	3707	3764	3781	-1234	-1291	-1308	17	11
d-34-F	2451	3692	3764	3783	-1241	-1313	-1332	19	19
d-67-F	2413	3670	3740	3748	-1257	-1327	-1335	8	8
c-71-F	2551	3730	3796	3840	-1179	-1245	-1289	44	44
d-88-F	2446	3746	3819	3826	-1300	-1373	-1380	7	7
b-2-G	2434	3632	3674	3680	-1198	-1240	-1246	6	6

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-11-G	2470	3687	3698	3706	-1167	-1228	-1236	8	8
c-23-G	2498	3625	3704	3710	-1127	-1206	-1212	6	
d-26-G	2463	3654	3704	3720	-1191	-1241	-1257	14	10
d-28-G	2461	3703	3743	3757	-1242	-1282	-1296	14	14
b-30-G	2491	3740	3801	3806	-1249	-1310	-1315	5	5
b-31-G	2499	3654	3705 3715	3707 3717	1155	-1206 1216	-1208 -1218	12	4
a-32-G									
c-32-G	2498	3625	3704	3710	-1127	-1206	-1212	6	6
d-32-G	2501	3046	3689	3718	-1145	-1188	-1217	21	21
d-33-G	2493	3643	3689	3694	-1150	-1196	-1201	5	5
c-36-G	2470	3636	3670	3677	-1166	-1200	-1207	7	4
b-41-G	2509	3632	3672	3690	-1123	-1163	-1181	18	9
d-41-G	2489	3624	3673	3678	-1135	-1184	-1189	6	6
b-42-G	2508	3645	3683	3719	-1137	-1175	-1211	36	36

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-42-G	2509	3632	3676	3712	-1123	-1167	-1203	36	36
a-43-G	2499	3649	3690	3702	-1150	-1191	-1203	12	12
d-43-G	2508	3635	3678	3710	-1127	-1170	-1202	32	32
d-44-G	2508	3654	3697	3724	-1146	-1189	-1216	27	27
c-50-G	2509	3690	3762	3778	-1181	-1253	-1269	16	14
b-51-G	2511	3610	3669	3681	-1099	-1158	-1170	12	9
a-52-G	2522		3680	3715		1058	1193	35	35
b-52-G	2524	3639	3680	3717	-1115	-1156	-1193	37	37
c-52-G	2534	3646	3690	3723	-1112	-1156	-1189	33	33
d-52-G	2520	3630	3676	3704	-1110	-1156	-1184	28	28
b-53-a	2516	3654	3696	3726	-1138	-1180	-1210	30	30
d-53-G	2528	3654	3695	3726	-1126	-1167	-1198	31	31
b-54-G	2515	3672	3715	3732	-1157	-1200	-1217	17	17
d-54-G	2521	3664	3706	3734	-1143	-1185	-1213	28	28

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-56-G	2503	3665	3716	3719	-1162	-1213	-1216	3	3
b-61-G	2495	3628	3666	3680	-1133	-1171	-1185	14	7
b-62-G	2535	3637	3689	3718	-1102	-1154	-1183	29	29
d-62-G	2526	3621	3690	3701	-1095	-1164	-1175	11	11
b-63-G	2533	3680	3731	3735	-1147	-1198	-1202	4	4
c-63-G	2540	3682	3724	3728	-1142	-1184	-1188	4	4
d-63-G	2549	3644	3712	3726	-1095	-1163	-1177	14	14
b-64-G	2531	3654	3708	3732	-1123	-1177	-1201	24	11
d-64-G	2534	3655	3695	3722	1121	-1161	-1188	27	27
b-65-G	2522	3657	3700	3730	-1135	-1178	-1208	30	30
d-65-G	2534	3666	3712	3730	-1132	-1178	-1196	18	18
d-66-G	2524	3658	3702	3714	-1134	-1178	-1191	12	4
d-67-G	2516	3658	3692	3710	-1142	-1176	-1194	18	6
b-72-G	2538	3630	3680	3705	-1092	-1142	-1167	25	25

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL)			Thickness of Halfway	Net Thickness
					A Marker	Top H.W.	Base H.W.		
c-72-G	2546	3634	3676	3702	-1088	-1130	-1156	26	26
b-73-G	2547	3642	3697	3720	-1095	-1150	-1173	23	23
d-73-G	2548	3655	3678	3698	-1107	-1130	-1150	18	12
a-74-G	2547	3652	3695	3722	-1105	-1148	-1175	27	27
d-74-G	2549	3650	3700	3718	-1101	-1151	-1169	18	18
b-75-G	2538	3657	3703	3731	-1119	-1165	-1193	28	28
d-75-G	2548	3662	3701	3725	-1114	-1153	-1177	24	24
d-76-G	2539	3666	3730	3740	-1127	-1191	-1201	10	10
b-82-G	2552	3626	3672	3698	-1074	-1120	-1146	26	26
b-83-G	2564	3660	3712	3732	-1096	-1148	-1168	20	20
d-83-G	2551	3622	3667	3692	-1071	-1116	-1141	25	25
a-84-G	2563	3672	3720	3733	-1109	-1157	-1170	13	13
d-84-G	2574	3670	3724	3737	-1096	-1150	-1163	13	13
b-85-G	2550	3667	3712	3733	-1117	-1162	-1183	21	21

Zone 94-H $_2$

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-85-G	2568	3648	3726	3740	-1080	-1158	-1172	14	4
b-86-G	2545	3687	3739	3747	-1142	-1194	-1202	8	8
d-93-G	2560	3627	3670	3700	-1067	-1110	-1140	30	30
d-94-G	2555	3622	3690	3709	-1067	-1135	-1154	19	19
d-95-G	2588	3695	3749	3752	-1107	-1161	-1164	3	3
d-96-G	2580	3693	3740	3750	-1113	-1160	-1170	10	7
d-97-G	2562	3700	3750	3753	-1138	-1188	-1191	3	3
d-98-G	2560	3703	3740	3757	-1143	-1180	-1197	17	17
d-99-G	2565	3628	3731	3744	-1063	-1166	-1179	13	13
d-9-H	2446	3582	3629	3648	-1163	-1183	-1202	19	11
b-10-H	2433	3589	3632 3670	3656 3705	-1156	-1199 -1237	-1223 -1272		
d-12-H	2446	3530	3572	3598	-1084	-1126	-1152	26	26
c-16-H	2441	3568	3612	3620	-1127	-1171	-1179	8	8
d-20-H	2464	3604	3644	3656	-1140	-1180	-1192	12	12

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL)			Thickness of Halfway	Net Thickness
					A Marker	Top H.W.	Base H.W.		
d-29-H	2485	3614	3662	3665	-1129	-1177	-1180	3	3
b-31-H	2463	3537	3579	3583	-1074	-1116	-1120	4	4
d-36-H	2479	3578	3614	3627	-1099	-1135	-1148	13	11
d-37-H	2474	3580	3612	3625	-1106	-1138	-1151	13	13
d-38-H	2479	3607	3644	3655	-1128	-1165	-1176	11	11
b-44-H	2512	3599	3642	3645	-1087	-1130	-1133	3	3
d-47-H	2484	3552	3600	3622	-1068	-1116	-1138	22	20
d-55-H	2553	3614	3659	3661	-1061	-1106	-1108	2	2
b-56-H	2496	3582	3624	3628	-1086	-1128	-1132	4	4
a-60-H	2501	3627	3674	3677	-1126	-1173	-1176	3	3
a-63-H	2540	3583	3627	3634	-1043	-1087	-1094	7	7
d-69-H	2506	3602	3656	3660	-1096	-1150	-1154	4	4
d-74-H	2585	3620	3667	3673	-1035	-1082	-1088	10	10
d-75-H	2581	3598	3648	3652	-1017	-1067	-1071	4	4

Zone 94-H -2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-83-H	2472	3567	3613	3628	-1095	-1141	-1156	15	15
d-93-H	2587	3550	3608	3626	- 963	-1021	-1039	18	18
d-99-H	2552	3578	3605	3630	-1026	-1053	-1078	25	25
d-39-I	2645	3623	3685	3701	- 978	-1040	-1056	16	16
d-44-I	2671	3588	3642	3656	- 917	- 971	- 985	14	14
d-48-I	2674	3658	3702	3705	- 984	-1028	-1031	3	3
d-59-I	2685	3652	3698	3703	- 967	-1013	-1018	5	5
c-76-I	2721	3642	3852	3855	-1021	-1131	-1134	3	3
a-81-I	2723	3553	3595	3624	- 830	- 872	901	29	29
d-77-I	2710	3637	3684	3692	- 927	- 974	- 982	8	8
d-87-I	2740	3652	3694	3700	- 912	954	960	6	6
b-3-J	2571	3637	3681	3715	-1066	-1110	-1144	-34	34
d-3-J	2573	3643	3668	3686	-1070	-1095	-1113	18	18
d-4-J	2589	3678	3729	3732	-1089	-1140	-1143	3	3

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
b-7-J	2574	3707	3759	3766	-1133	-1185	-1192		
d-8-J	2579	3682	3726	3729	-1103	-1147	-1150	3	3
d-9-J	2573	3685	3728	3745	=1112	-1155	-1172	17	17
d-10-J	2572	3674	3716	3748	-1102	-1144	-1176	32	28
d-17-J	2594	3694	3730	3743	-1100	-1136	-1149	13	12
d-18-J	2588	3676	3742	3748	-1088	-1154	-1160	6	6
d-19-J	2584	3666	3719	3752	-1082	-1135	-1168	33	30
d-24-J	2623	3659	3722	3730	-1036	-1099	-1107	8	
d-24-J	2623	3659	3722	3730	-1036	-1099	-1107	8	8
b-28-J	2591	3660	3728	3759	-1069	-1137	-1168	31	31
d-28-J	2597	3696	3744	3750	-1099	-1147	-1153	6	6
d-29-J	2588	3668	3725	3757	-1080	-1137	-1169	32	32
b-38-J	2594		3730	3754		-1136	-1160	24	24

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
b-39-J	2581		3739	3757		-1158	-1176	18	18
d-39-J	2580	3680	3732	3742	-1100	-1152	-1162	10	10
d-40-J	2577	3664	3729	3741	-1087	-1151	-1164	13	13
b-43-J	2631	3644	3694	3708	-1013	-1063	-1077	14	14
b-46-J	2593	3644	3694	3700	-1051	-1101	-1107	6	6
b-48-J	2599	3688	3737	3746	-1089	-1138	-1147	9	9
d-48-J	2612	3695	3742	3745	-1083	-1130	-1133	3	3
b-49-J	2585	3640	3710	3738	-1055	-1125	-1153	28	28
d-49-J	2594	3663	3718	3744	-1069	-1124	-1150	26	26
b-50-J	2577	3659	3702	3712	-1082	-1125	-1135	10	10
d-50-J	2578	3650	3694	3707	-1072	-1116	-1129	13	13
d-54-J	2647		3702	3723		-1055	-1076	21	21
b-58-J	2615	3680	3734	3740	-1065	-1119	-1125	6	6
b-59-J	2591	3647	3694	3705	-1056	-1103	1114	11	11

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-60-J	2592	3643	3685	3702	-1051	-1093	1110	17	17
d-71-J	2693	3660	3707	3710	- 967	-1014	-1017	3	3
d-95-J	2682	3668	3722	3725	- 986	-1040	-1043	3	3
d-1-K	2561	3677	3724	3774	-1116	-1163	-1213	50	46
d-3-K	2504	3640	3703	3717	-1136	-1199	-1213	14	9
d-11-K	2558	3669	3711	3763	-1111	-1153	-1205	52	30
a-12-K	2529	3657	3710	3720	-1128	-1181	-1191	10	10
d-21-K	2542	3644	3690	3700	-1102	-1148	-1158	10	9
d-39-K	2468	3657	3716	3750	-1189	-1248	-1282	34	34
d-41-K	2568	3649	3692	3700	-1081	-1124	-1132	8	8
d-42-K	2546	3666	3709	3721	-1120	-1163	-1175	12	9
d-48-K	2507	3674	3744	3772	-1167	-1237	-1265	28	28
b-51-K	2557	3632	3672 3686	3682 3698	-1075	-1115 -1129	-1125 -1141	26	22

Zone 94-H-2

Well	Elevation	A Marker	Top of H.W.	Base of H.W.	Depth in feet (BSL) A Marker	Top H.W.	Base H.W.	Thickness of Halfway	Net Thickness
d-55-K	2532	3638	3694	3702	-1106	-1162	-1170	8	8
d-57-K	2557	3706	3776	3794	-1149	-1219	-1237	18	18
d-62-K	2584	3610	3658	3673	-1026	-1074	1089	15	11
d-63-K	2576	3631	3676	3680	-1055	-1100	-1104	4	4
d-86-K	2608	3718	3762	3782	-1110	-1154	-1174	13	9
b-93-K	2632	3696	3765	3780	-1064	-1133	-1148	15	15
d-50-L	2513	3878	3936	3948	-1365	-1423	-1435	12	12
d-21-L	2498	3747	3816	3824	-1249	-1318	-1328	8	8

APPENDIX B
Compilation of Thin Section Data

Abbreviations

R	Roundness
S	Sphericity
Pri. Carb.	Primary Carbonate
Liths	Lithic grains
Leuc	Leucoxene
Micr	Microline
Musc	Muscovite
Plag	Plagioclase
Py	Pyrite
Tour	Tourmaline
Zirc	Zircon

Zone:94-E-2

Well	Depth	Quartz %	Quartz R		Pri. Carb.	Liths	Chert	Leuc	Micr	Musc	Plag	Py	Tour	Zirc
d-5-A	3675	75	.3	.5	20	*	*						*	*
d-15-A	3710	80	.5	.3	15	*	*					*	*	
	3719	85	.3	.7	12	*	*					*		*
b-22-A	3785	73	.2	.5	20	*	*						*	*
d-26-A	3717	70	.5	.7	18	*	*						*	*
d-29-A	3623	71	.3	.5	20	*							*	*
	3680	65	.3	.5	30	*							*	
d-34-A	3601	35	.3	.7	25	*	*						*	
	3609	65	.5	.7	29	*	*							*
	3609	40	.3	.5	50	*	*						*	*
b-35-A	3707	65	.3	.5	20	*	*						*	
d-37-A	3707	45	.3	.5	50	*	*							*
d-44-A	3544	55	.2	.7	35		*							*
d-55-A	3639	74	.5	.7	17	*	*							
	3646	75	.3	.7	15	*			*					
	3659	80	.2	.5	15	*			*					
b-65-A	3664	35	.3	.7	60	*								
	3675	73	.5	.7	25	*							*	*
c-66-A	3712	85	.5	.7	10	*							*	*
	3717	75	.3	.5	20	*								
d-96-A	3642	45	.3	.5	60	*	*							
	3644	74	.5	.7	80	*	*							

Zone:94-H-2

Well	Depth	Quartz %	Quartz R	Quartz S	Pri. Carb.	Liths	Chert	Leuc Micr	Musc	Plag	Py	Tour	Zirc
d a-5-B	3840	45	.5	.7	60				*				
	3852	50	.3	.5	45	*							
						*							
	3853	35	.3	.7	65	*							
d-9-B	3917	30	.5	.5	63		*				*		
	3921	35	.3	.7	63		*				*	*	
d-13-B	3757	64	.5	.7	25		*				*		
	3775	72	.3	.5	20		*				*		
b-14-B	3820	60	.5	.5	25	*	*					*	
d-15-B	3839	74	.3	.7	20	*	*				*		
	3848	60	.5	.5	35	*	*				*		
d-25-B	3833	67	.5	.7	25	*					*		
	3834	75	.3	.5	20	*					*	*	*
	3836	74	.5	.7	18	*					*	*	*
d-47-B	3870		.3	.5	55	*					*		
d-13-C	3870	45	.5	.7	50				*				
d-73-C	3771	40	.3	.7	55				*				
b-81-C	3786	65	.5	.5	25	*	*					*	*
	3790	64	.3	.7	30	*	*					*	*
d-95-C	3794	74	.5	.7	20	*							
c-32-G	3707	72	.3	.7	18								

Well	Depth	Quartz %	R	S	Pri. Carb.	Liths	Chert	Leuc	Micr	Musc	Plag	Py	Tour	Zirc
c-32-G	3711	65	.5	.7	30	*						*	*	*
b-42-G	3686	75	.3	.7	20							*	*	*
	3688	70	.5	.5	25							*	*	*
	3693	78	.3	.7	16									
b-51-G	3688.2	45	.5	.5	50									
	3688.5	50	.3	.7	45	*	*					*	*	*
	3691	71	.5	.7	20	*	*					*	*	*
d-53-G	3685	35	.3	.5	63	*						*	*	
	3699.6	72	.5	.3	19	*						*	*	
b-61-G	3681.4	53	.5	.7	42	*					*	*		
	3688.5	23	.3	.6	72	*	*						*	*
d-63-G	3723	65	.5	.7	30	*	*						*	*
d-64-G	3694.1	61	.3	.5	29	*				*	*			
	3699.4	74	.5	.7	24	*	*						*	
	3719.9	73	.3	.5	22	*	*					*	*	*
d-65-G	3694	53	.5	.3	45	*					*			
	3706.3	34	.3	.5	63	*					*			
	3728.8	63	.5	.7	25	*	*					*	*	*
d-66-G	3712.4	56	.5	.7	41	*	*					*	*	*
b-72-G	3696	64	.5	.7	31	*	*						*	
	3699.4	69	.5	.9	33	*	*						*	*
d-74-G	3703	74	.3	.7	23	*	*				*	*	*	
	3707	76	.5	.5	20	*					*	*	*	

Zone:94-H-2

Well	Depth	Quartz %	R	S	Pri.	Carb.	Liths	Chert	Leuc	Micr	Musc	Plag	Py	Tour	Zirc
d-75-G	3705	65	.5	.7	32		*						*		
d-76-G	3735	72	.5	.5	22		*	*						*	*
d-83-G	3635	71	.3	.7	20		*							*	*
d-84-G	3727	45	.3	.5	53		*								
	3731.1	73	.5	.7	22		*						*	*	
b-86-G	3741	62	.3	.7	31		*						*	*	
d-94-G	3679	61	.5	.5	33		*					*	•		
	3693	74	.5	.7	22		*						*	*	
b-10-H	3552	71	.3	.5	23		*	*				*	*	*	
	3647	74	.5	.7	20		*	*				*		*	
	3657	62	.3	.5	33		*	*				*	*	*	*
	3672	73	.5	.7	22		*	*					*	*	*
d-20-H	3648	64	.3	.5	33									*	
d-8-J	3723	62	.5	.7	34		*			*	*	*	*		
	3724	73	.3	.5	21		*				*	*			
	3729	72	.5	.7	20		*							*	
d-9-J	3720	45	.3	.5	54		*			*	*	*			
b-28-J	3735	74	.5	.7	22		*						*		
	3757	61	.3	.5	33		*						*		
d-29-J	3752	71	.5	.3	22			*						*	
	3753	74	.4	.7	19			*					*	*	
d-49-J	3722	62	.5	.5	33			*					*		
	3728	74	.3	.7	21			*					*		

APPENDIX C

Compilation of Heavy Mineral Analysis

Abbreviations

Apat	Apatite
Epid	Epidote
Gar	Garnet
Ilm	Ilmenite
Leuc	Leucoxene
Py	Pyrite
Tour	Tourmaline
Zirc	Zircon

Zone:94-H-2

Well		Sieve size (phi)	The Common Heavy Minerals						
			Apat	Epid	Gar	Ilm	Leuc	Py	Tour	Zirc
b-22-A	3577	4.00				*		*	*	*
d-26-A	3694.4	,,				*			*	*
d-34-A	35 80	,,				*	*	*	*	*
	3587	,,				*	*	*	*	*
	3601	,,				*	*		*	*
d-44-A	3544	,,				*	*	*	*	*
	3547	,,				*	*	*	*	*
b-55-A	3694	,,				*	*	*	*	*
d-55-A	3636	,,				*	*	*	*	*
	3651	,,						*	*	*
c-66-A	3680	,,				*	*		*	*
d-66-A	3671	,,				*	*		*	*
	3688	,,				*	*	*	*	*
d-a-5-B	3845	,,							*	*
b-14-B	3813	,,				*			*	*
	3819.5	,,				*	*		*	*
d-15-B	3836	,,				*	*	*	*	*
	3839	,,				*	*	*	*	*

Zone:94-H-2

Well	Depth	Sieve size (phi)	The Common Heavy Minerals							
			Apat	Epid	Gar	Ilm	Leuc	Py	Tour	Zirc
d-25-B	3315	4.00				*	*	*	*	*
	38 31	,,				*	*	*	*	*
	3834	,,				*	*	*	*	*
d-47-B	3856	,,				*	*	*	*	*
	38 60	,,				*	*		*	*
	3878	,,				*	*	*	*	*
c-32-G	3704	,,					*	*	*	*
	3711	,,					*	*	*	*
b-42-G	3702	,,				*		*	*	*
b-52-G	3686	,,				*	*	*	*	*
d-53-G	3699	,,				*	*	*	*	*
b-61-G	3681	,,						*	*	*
d-63-G	3724	,,				*	*	*	*	*
	3725	,,				*	*	*	*	*
d-64-G	3704	,,						*	*	
d-66-G	3702	,,					*	*	*	*
b-72-G	3688	,,						*	*	*
d-74-G	3705	,,				*	*	*	*	*
	37 15	,,				*	*	*	*	*

Zone:94-H-2

Well	Depth	Sieve size (phi)	The Common Heavy Minerals							
			Apat	Epid	Gar	Ilm	Leuc	Py	Tour	Zirc
d-76-G	3736	4.00						*	*	*
d-83-G	3670	,,				*	*	*	*	*
d-84-G	3731	,,						*	*	*
d-94-G	3690	,,				*	*	*	*	*.
	3700	,,				*	*	*	*	*
b-10-H	3622	,,				*	*	*	*	*
	3658	,,				*	*	*	*	*
d- 8-J	3726	,,				*	*	*	*	*
d-10-J	3743	,,				*	*	*	*	*
b-28-J	3735	,,				*	*	*		*
	3757.5	,,				*	*	*	*	*
d-29-J	3742	,,				*	*	*	*	*
	3752.7	,,				*	*	*	*	*
d-49-J	3733	,,				*	*	*	*	*

APPENDIX D

Compilation of the X-Ray Diffraction Data

APPENDIX D

Formation	Well	Depth	The Major Common Minerals
Charlie Lake	d-5-A	3669	Quartz,calcite,and dolomite
	d-15-A	3696	Quartz,calcite,and dolomite
	d-26-A	3699.4	Quartz and dolomite
	d-66-A	3669.2	Quartz,dolomite and plagioclase
	C-32-G	37Ø2	Quartz,dolomite,and plagioclase
	b-42-G	3683	Quartz,calcite,dolomite and plagiocla
	d-63-G	37Ø8	Quartz,dolomite and plagioclase
	d-64-G	3692.7	Quartz and dolomite
	d-4-J	372Ø	Quartz,and dolomite
	d-4-J	3729	Dolomite,quartz and plagioclase
	d-8-J	3764	Quartz,dolomite and calcite
	d-49-J	3721	Dolomite,quartz and plagioclase
	b-28-J	3729.	Quartz,dolomite,calcite and plagioclase
Halfway	d-34-A	3576.7	Quartz and dolomite
	b-57-A	3679	Quartz,calcite and dolomite
	d-9-J	3723	Quartz and dolomite
Doig	d-5-A	3674	Quartz,dolomite and plagioclase
	d-37-A	3715.5	Quartz,calcite,dolomite, and plagioclase
	d-15-B	849.2	Calcite,quartz,and dolomite
	b-51-G	3692	Dolomite,quartz,and calcite

	d-64-G	3722	Quartz, dolomite and plagioclase
	b-72-G	3707	Quartz, calcite, and dolomite
	d-29-J	3754	Quartz, dolomite and plagioclase

APPENDIX E

1-Compilation of Data

Abbreviations

A	Moment measures after Friedman (1961)
B	Moment measures after Friedman (1979)
C	Graphic parameters,after Folk and Ward (1957)
Mz	Mean size
Sd	Standard deviation
SK	Skewness
K	Kurtosis
Md	Median

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
1	d-5-B	3846 (-1405)	4.60	2.50	2.91	5.82	2.1	7.10	1.05	1.28
2	b-14-B	3813 (-1384)	3.80	2.70	3.10	6.20	1.10	6.50	0.55	0.30
3	b-14-B	3814 (-1384)	4.95	2.80	3.18	6.36	2.15	7.75	1.07	1.39
4	b-14-B	3819 (-1390.1)	4.50	2.60	3.05	6.10	1.90	7.10	0.95	1.00
5	d-15-B	3836 (-1385)	4.62	2.37	2.78	5.56	2.25	6.99	1.12	1.43
6	d-15-B	3839 (-1388)	5.00	2.80	3.22	6.44	2.20	7.80	1.1	1.36
7	d-15-B	3846 (-1395)	4.00	2.90	3.23	6.46	1.10	6.90	0.55	0.44
8	d-25-B	3815 (-1372)	5.10	2.43	3.28	6.56	2.67	7.53	1.33	0.97
9	d-25-B	3831 (-1388)	5.00	2.23	3.05	6.10	2.77	7.23	1.38	1.13
10	d-25-B	3833 (-1390)	4.95	2.35	3.07	6.14	2.60	7.30	1.30	1.16
11	d-25-B	3836 (-1393)	5.02	2.03	2.95	5.90	2.99	7.05	1.49	1.15
12	d-25-B	3834 (-1391)	4.45	1.95	2.80	5.60	2.50	6.40	1.25	0.80
13	d-47-B	3856 (-1364)	5.32	2.80	3.55	7.10	2.52	8.12	1.26	1.02
14	d-47-B	3860 (-1368)	5.70	2.50	3.55	7.10	3.20	8.20	1.6	1.1
15	d-47-B	3870 (-1378)	4.85	2.35	2.95	5.90	2.50	7.20	1.25	1.3
16	d-47-B	3878 (-1386)	4.80	2.08	2.75	5.50	2.72	6.82	1.36	1.38
17	d-15-A	3708 (-1293)	4.50	2.98	3.45	6.9	1.52	7.48	0.78	0.58
18	b-22-A	3577 (-1247)	4.06	3.23	3.55	7.10	0.83	7.29	0.41	0.19
19	d-26-A	3694 (-1271)	3.95	2.90	3.35	6.70	1.05	6.85	0.52	0.15
20	b-34-A	3639 (-1250)	4.00	2.28	2.95	5.90	1.72	6.28	0.86	0.38

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
21	d-34-A	3576 (-1234)	4.20	2.18	2.68	5.36	2.02	6.38	1.01	1.02
22	d-34-A	3580 (-1238)	4.70	2.20	2.86	5.72	2.5	6.90	1.25	1.18
23	d-34-A	3585 (-1243)	3.65	2.40	2.95	5.90	1.25	6.05	0.62	0.15
24	d-34-A	3587 (-1245)	4.25	2.30	2.77	5.54	1.95	6.55	0.97	1.01
25	d-34-A	3592 (-1250)	4.35	2.43	2.93	5.86	1.92	6.78	0.96	0.92
26	d-34-A	3593 (-1251)	4.00	2.60	3.12	6.24	1.4	6.6	0.70	0.36
27	d-34-A	3601 (-1259)	3.85	2.50	3.85	5.90	1.35	6.35	0.67	0.45
28	d-44-A	3544 (-1234)	4.15	2.25	2.95	5.90	1.9	6.4	0.95	0.50
29	d-44-A	3547 (-1237)	3.58	2.42	2.95	5.90	1.16	6.00	0.58	0.10
30	b-46-A	3706 (-1266)	4.50	2.70	3.13	6.26	1.8	7.20	0.90	0.94
31	d-40-A	3716 (-1270)	3.85	2.40	3.02	6.04	1.45	6.25	0.72	0.21
32	b-46-A	3711 (-1274)	4.20	2.10	2.95	5.90	2.64	6.36	1.02	0.46
33										
34	b-55-A	3694 (-1269)								
35	d-55-A	3635 (-1246)	5.60	3.03	3.40	6.80	2.57	8.03	1.28	1.83
36	d-55-A	3636 (-1244)	3.80	2.36	2.88	5.76	1.44	6.16	0.72	0.40
37	d-55-A	3646 (-1254)	3.75	2.35	2.98	5.96	0.77	6.10	0.38	0.14
38	d-55-A	3651 (-1259)	3.80	2.52	2.95	5.90	1.28	6.32	0.64	0.42
39	d-57-A	3670								
40	c-66-A	3680 (-1210)	5.47	2.90	3.47	6.94	2.57	8.37	1.28	1.43

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
41	d-66-A	3688 (-1250)	3.75	2.43	3.04	6.08	1.32	6.18	0.66	0.10
42	d-66-A	3671 (-1233)	4.40	2.50	2.95	5.90	1.9	6.90	0.95	1.00
43	b-2-G	3676 (-1143)	3.80	2.25	2.85	5.70	1.55	6.05	0.77	0.35
44	b-31-G	3699 (-1198)	5.25	2.85	3.75	7.50	2.40	8.10	1.20	0.60
45	c-32-G	3704 (-1206)	5.08	2.35	3.50	7.00	2.73	7.43	1.36	0.43
46	c-32-G	3706 (-1208)	5.26	2.25	3.05	6.10	3.01	7.51	1.50	1.41
47	c-32-G	3707 (-1209)	5.05	2.43	3.75	7.5	2.62	7.48	1.31	-0.02
48	c-32-G	3711 (-1213)	4.81	2.35	3.20	6.40	2.46	7.16	1.23	0.76
49	c-32-G	3711 (-1213)	4.97	2.30	3.05	6.10	2.67	7.27	1.33	1.17
50	b-42-G	3694 (-1189)	4.00	2.15	3.02	6.04	1.85	6.15	0.92	0.11
51	b-42-G	3699 (-1194)	3.92	2.23	3.10	6.20	1.69	6.15	0.84	-0.05
52	b-42-G	3702 (-1198)	3.77	2.50	3.00	6.00	1.52	6.02	0.76	0.02
53	b-42-G	3703 (-1199)	3.55	2.12	2.85	5.70	1.43	5.67	0.71	-0.03
54	d-43-G	3685 (-1177)	3.75	2.00	2.90	5.80	1.75	5.75	0.87	-0.05
55	d-43-G	3695 (-1187)	3.50	2.20	2.97	5.94	1.30	5.70	0.65	-0.24
56	d-43-G	3705 (-1197)	3.72	2.50	3.13	6.26	1.22	6.22	0.61	-0.04
57	d-44-G	3705 (-1202)	3.73	2.50	3.08	6.16	1.23	6.23	0.61	0.07
58	c-50-G	3763 (-1255)	5.50	2.23	3.22	6.44	3.27	7.73	1.63	1.29
59	b-52-G	3686 (-1164)	3.50	2.15	2.75	5.50	1.35	5.65	0.67	0.15
60	d-53-G	3699 (-1171)	3.25	2.24	2.63	5.26	1.01	5.49	0.50	0.23
61	d-54-G	3708 (-1192)	3.60	1.95	3.00	6.00	1.65	5.55	0.82	-0.45

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
62	d-54-G	3716 (-1200)	3.60	2.45	3.01	6.02	1.15	6.00	0.57	-0.02
63	d-54-G	3720 (-1204)	3.82	2.25	2.98	5.96	1.57	6.07	0.78	0.11
64	d-54-G	3730 (-1212)	3.75	2.30	3.00	6.00	1.45	6.05	0.72	0.05
65	b-61-G	3681 (-1186)	3.55	2.20	2.84	5.68	1.35	5.75	0.67	0.07
66	d-62-G	3698 (-1169)	4.05	2.17	2.90	5.8	1.88	6.22	0.94	0.42
67	d-63-G	3619 (-1176)	3.75	2.43	3.07	6.14	1.32	6.18	0.66	0.04
68	d-63-G	3624 (-1181)	3.90	2.37	3.00	6.00	1.53	6.27	0.76	0.27
69	d-63-G	3625 (-1182)	4.10	2.90	3.30	6.60	1.20	7.00	0.60	0.40
70	d-64-G	3694 (-1161)	5.05	2.20	3.10	6.20	2.85	7.25	1.42	1.05
71	d-64-G	3700 (-1167)	4.20	2.00	3.06	6.12	2.20	6.20	1.10	0.08
72	d-64-G	3704 (-1170)	4.00	2.48	2.85	5.70	1.72	6.28	0.86	0.58
73	d-66-G	3702 (-1178)	5.16	2.55	3.35	6.70	2.61	7.71	1.30	1.01
74	b-72-G	3688 (-1150)	3.60	2.35	2.97	5.94	1.25	5.95	0.62	0.01
75	c-72-G	3889 (-1143)	3.65	2.50	3.13	6.26	1.15	6.15	0.57	-0.11
76	d-74-G	3703 (-1154)	4.90	2.15	3.15	6.30	2.75	7.05	1.37	0.75
77	d-74-G	3705 (-1156)	4.50	2.48	2.90	5.80	2.25	6.75	1.12	0.95
78	d-74-G	3710 (-1161)	4.00	2.42	2.95	5.90	1.58	6.42	0.79	0.52
79	d-74-G	3715 (-1166)	3.85	2.43	3.00	6.00	1.42	6.28	0.71	0.28
80	d-75-G	3712 (-1164)	3.75	2.24	2.95	5.90	1.51	5.99	0.75	0.09
81	d-76-G	3736 (-1197)	4.00	2.35	2.97	5.94	1.65	6.35	0.82	0.41

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
82	b-82-G	3677 (-1127)	3.73	2.18	2.95	5.90	1.55	5.91	0.77	0.01
83	b-82-G	3681 (-1131)	3.70	2.25	3.03	6.06	1.45	5.95	0.72	-0.11
84	b-82-G	3684 (-1134)	3.65	2.35	3.02	6.04	1.30	6.00	0.65	-0.04
85	b-83-G	3668 (-1117)	3.55	2.41	3.05	6.10	1.14	5.96	0.57	-0.14
86	d-83-G	3670 (-1119)	3.60	2.53	3.01	6.02	1.07	6.13	0.53	0.11
87	d-84-G	3731 (-1157)	3.50	2.05	2.60	5.20	1.45	5.55	0.72	0.35
88	d-84-G	3732 (-1154)	3.73	2.35	2.98	5.96	1.38	6.08	0.69	0.12
89	d-94-G	3690 (-1135)	3.60	2.36	2.99	5.98	1.24	5.96	0.62	-0.02
90	d-94-G	3700 (-1145)	3.60	2.55	3.03	6.06	1.05	6.15	0.52	0.09
91	b-10-H	3632 (-1199)	4.60	2.35	2.92	5.84	2.25	6.95	1.12	1.11
92	b-10-H	3633 (-1200)	4.15	2.26	2.75	5.5	1.89	6.41	0.94	0.91
93	b-10-H	3635 (-1202)	4.00	2.13	2.97	5.94	1.87	6.13	0.93	0.19
94	b-10-H	3641 (-1208)	4.40	2.04	3.00	6.00	2.36	6.44	1.18	0.44
95	b-10-H	3653 (-1220)	3.60	2.17	3.00	6.00	1.43	5.77	0.71	-0.23
96	b-10-H	3658 (-1225)	4.55	1.90	2.83	5.66	2.65	6.45	1.32	0.79
97	b-10-H	3671 (-1238)	5.50	3.07	3.52	7.04	2.43	8.57	1.21	1.53
98	b-10-H	3672 (-1239)	4.50	3.05	3.30	6.60	1.45	7.55	0.72	0.95
99	b-10-H	3674 (-1241)	6.00	3.20	3.52	7.04	2.8	9.20	1.4	2.16
100	d-20-H	3646 (-1182)	3.90	2.77	3.22	6.44	1.13	6.67	0.56	0.23
101	d-20-H	3047 (-1183)	4.55	2.77	3.20	6.40	1.78	7.32	0.89	0.92
102	d-20-H	3651 (-1187)	3.55	1.80	2.42	4.84	1.75	5.35	0.87	0.51

ZONE: 94-H-2

Sample Number	Location	Depth in feet (BSL)	95ϕ	5ϕ	50ϕ	2x50ϕ	95ϕ -5ϕ	95ϕ+5ϕ	Simple sorting measure	Simple skewness measure
103	b-31-H	3579	3.80	2.20	2.90	5.80	1.6	6.00	0.80	0.20
104	b-31-H	3580	4.35	2.30	2.98	5.96	2.05	6.65	1.02	0.69
105	a-63-H	3628	3.60	2.45	3.03	6.06	1.15	6.05	0.57	-0.01
106	b-3-J	3687 (-1117)	3.65	2.02	3.05	6.10	1.63	7.69	0.81	1.59
107	d-8-J	3726 (-1147)	4.00	2.87	3.32	6.64	1.13	6.87	0.56	0.23
108	d-10-J	3743 (-1171)	3.90	3.25	3.45	6.90	0.66	7.15	0.33	0.25
109	d-17-J	3755 (-1158)	5.75	2.78	3.33	6.66	2.97	8.53	1.48	1.87
110	b-28-J	3735 (-1144)	4.35	2.55	3.04	6.08	1.80	6.90	0.90	0.82
111	b-28-J	3737 (-1146)	3.85	2.45	2.90	5.80	1.40	6.30	0.70	0.50
112	b-28-J	3757 (-1166)	3.74	2.43	2.91	5.82	1.31	6.17	0.65	0.35
113	d-29-J	3742 (-1152)	3.93	2.42	2.90	5.80	1.51	6.35	0.75	0.55
114	d-39-J	3735 (-1157)	3.40	2.17	2.93	5.86	1.23	6.33	0.61	0.47
115	d-39-J	3740 (-1161)	3.50	2.12	3.00	6.00	1.38	5.62	0.69	-0.38
116	d-49-J	3733 (-1139)	3.43	2.20	2.87	5.74	1.23	5.63	0.61	-0.11
117	d-15-A	3714 (-1299)	4.55	2.45	3.15	6.30	1.4	7.00	0.7	0.70

APPENDIX E1

Compilation of Grain size analysis

1-Compilation of Data

Abbreviations

A Moment measures (The fraction smaller than 4.00 phi was treated as 4.25 phi),after Friedman (1961)

B Moment measures (The fraction smaller than 4.00 phi was treated as 6.00 phi),after Friedman (1967,1979)

C Graphic parameters,after Folk,and Ward (1957)

Mz Mean size

Sd Standard deviation

SK Skewness

K Kurtosis

APPENDIX E1

			A				B				C			
	Sample	Loc.	Mz	Sd	SK	K	Mz	Sd	SK	k	Mz	Sd	SK	k
1	d05B	3845	3.02	0.47	1.18	4.13	3.15	0.87	2.51	8.62	3.09	0.47	0.72	1.91
2	b14B	3813	3.06	0.34	0.63	4.47	3.09	0.51	3.49	20.82	3.34	0.56	0.58	1.83
3	b14B	3814	3.31	0.48	0.67	2.77	3.56	1.04	1.70	4.44	3.14	0.33	0.23	0.95
4	b14B	3819	3.10	0.43	0.92	4.11	3.21	0.79	2.64	9.81	3.08	0.43	0.34	1.94
5	d15B	3836	2.95	0.56	0.98	3.40	3.11	1.00	2.13	6.63	2.92	0.59	0.50	1.48
6	d15B	3839	3.39	0.50	0.26	2.07	3.67	1.09	1.37	3.49	3.38	0.60	0.53	1.45
7	d15B	3846	3.27	0.33	0.88	4.94	3.35	0.64	3.19	13.74	3.25	0.28	0.26	1.66
8	d25B	3815	3.50	0.68	-0.62	2.07	3.97	1.37	0.45	1.68	3.52	0.85	0.38	0.95
9	d25B	3831	3.14	0.66	0.30	2.29	3.44	1.23	1.28	3.32	3.26	0.83	0.39	1.30
10	d25B	3833	3.23	0.64	0.29	2.15	3.58	1.28	1.14	2.78	3.34	0.81	0.46	1.07
11	d25B	3836	3.09	0.63	0.34	2.44	3.34	1.16	1.45	4.02	3.09	0.78	0.35	1.53
12	d25B	3834	2.84	0.66	0.51	2.80	3.00	1.06	1.81	5.89	2.85	0.71	0.21	1.16
13	d47B	3856	3.59	0.56	-0.11	1.62	4.19	1.34	0.50	1.44	3.75	0.82	0.37	0.79
14	d47B	3860	3.49	0.65	-0.14	1.72	4.10	1.42	0.46	1.45	3.78	1.05	0.32	0.81
15	d47B	3870	3.07	0.65	0.57	2.26	3.35	1.21	1.44	3.69	3.15	0.77	0.44	1.06
16	d47B	3878	2.79	0.57	0.88	3.51	2.90	0.90	2.34	8.61	2.77	0.66	0.28	1.59
17	d15A	3708	3.49	0.38	0.08	3.11	3.66	0.81	2.05	6.54	3.47	0.44	0.29	2.16
18	b22A	3577	3.56	0.29	0.24	2.43	3.66	0.61	2.87	11.53	3.56	0.23	0.67	1.13
19	d26A	3694	3.36	0.34	0.34	3.28	3.43	0.60	2.94	13.48	2.38	0.31	0.31	1.16
20	b34A	3639	3.01	0.52	0.36	3.00	3.10	0.79	2.20	8.99				
21	d34A	3576	2.77	0.50	1.17	4.75	2.86	0.82	2.77	11.13	2.73	0.51	0.35	1.79
22	d34A	3580	2.91	0.52	0.90	3.95	3.03	0.88	2.43	8.81	2.90	0.59	0.30	2.07
23	d34A	3585	2.98	0.39	0.72	4.09	3.02	0.57	3.12	17.04	2.96	0.35	0.09	1.28
24	d34A	3587	2.87	0.48	1.00	4.55	2.96	0.79	2.75	11.13	2.83	0.48	0.38	1.58
25	d34A	3592	3.00	0.45	0.96	4.35	3.09	0.77	2.77	11.05	2.96	0.46	0.31	1.62
26	d34A	3593	3.16	0.40	0.49	3.93	3.25	0.70	2.75	11.71	3.14	0.36	0.17	1.50
27	d34A	3601	3.00	0.41	0.85	4.42	3.07	0.67	3.02	13.91	2.96	0.36	0.20	1.38
29	d44A	3547	2.96	0.42	0.62	4.28	3.02	0.66	2.93	14.26	2.96	0.36	0.06	0.88
30	d46A	3711	3.23	0.42	0.70	3.62	3.11	0.65	2.39	11.91	2.94	0.60	0.22	1.07
31	d46A	3716	3.06	0.46	0.24	3.19	3.11	0.65	2.39	11.91	3.06	0.43	0.09	1.09
32	b46A	3711	3.03	0.58	0.18	2.55	3.14	0.90	1.85	6.90				
33	d47A	3704	3.46	0.50	-0.13	2.75	3.75	1.07	1.30	3.46				
34	b55A	3694	2.93	0.35	0.28	4.01	2.95	0.45	3.07	22.74	2.95	0.32	0.07	1.04
35	d55A	3635	3.49	0.38	0.68	2.78	3.73	0.94	1.80	4.72	3.49	0.58	0.60	2.68
36	d55A	3636	2.90	0.43	0.84	4.51	2.96	0.67	3.02	14.55	2.91	0.38	0.21	1.40
37	d55A	3646	2.99	0.44	0.36	3.65	3.05	0.67	2.67	12.94	2.94	0.37	-0.03	1.23

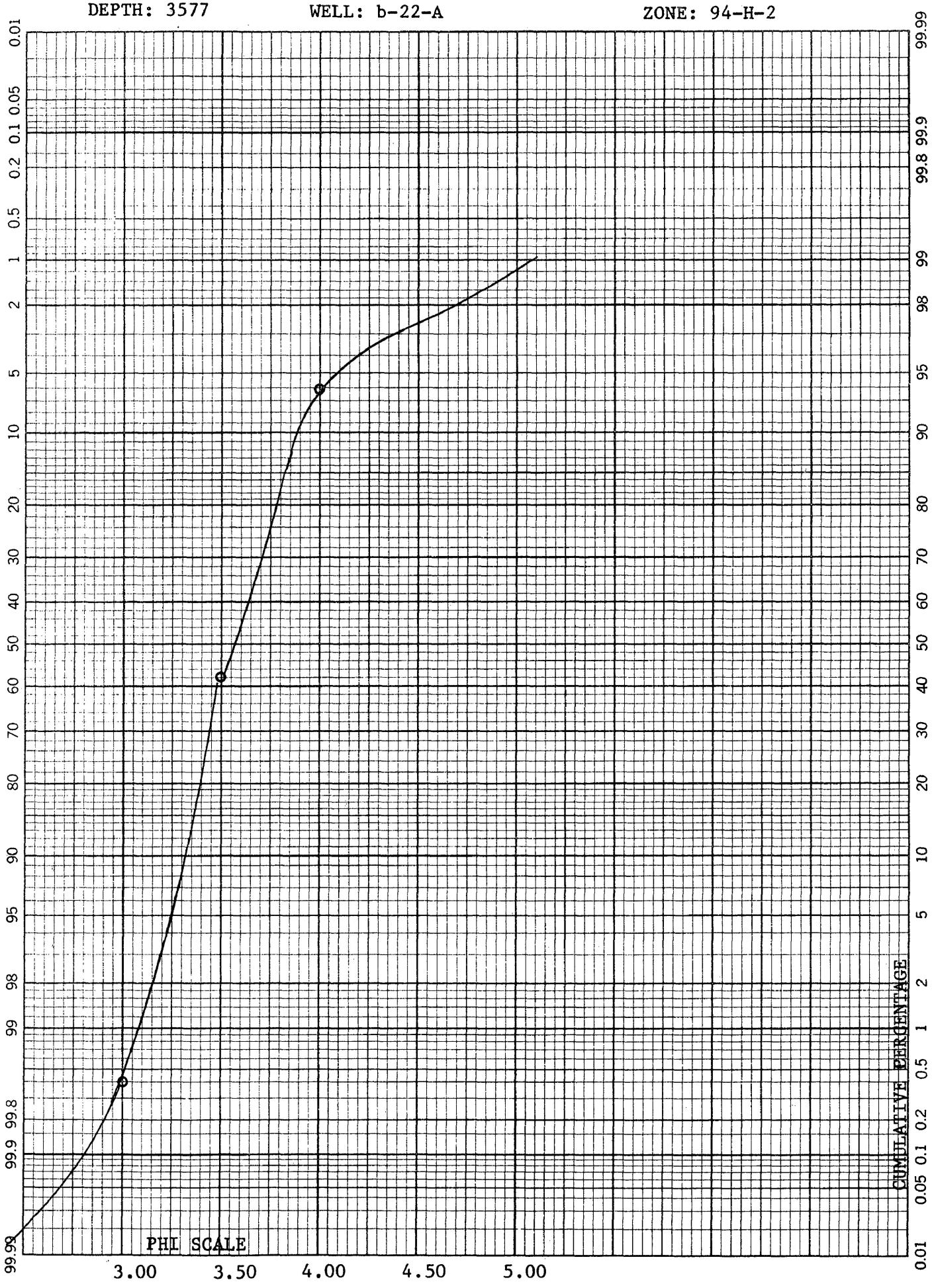
38	d55A	3651	2.98	0.39	1.09	4.92	3.04	0.65	3.26	15.39	2.97	0.34	0.22	1.38
39	d57A	3676	3.75	0.45	-0.46	2.38	4.40	1.24	0.41	1.37				
40	c66A	3680	3.52	0.44	0.09	2.61	3.83	1.04	1.39	3.47	3.57	0.65	0.42	1.72
41	d66A	3688	3.03	0.40	0.16	3.53	3.06	0.54	2.69	16.40	3.04	0.40	0.04	0.98
42	d66A	3671	3.03	0.47	0.79	3.68	3.14	0.80	2.54	9.66	3.01	0.45	0.41	1.76
43	b02Q	3672	2.93	0.43	0.93	4.26	2.99	0.67	2.99	13.98	2.87	0.43	0.13	1.28
44	b31Q	3699	3.74	0.51	-0.57	2.44	4.50	1.33	0.15	1.20	3.93	0.78	0.27	0.60
45	c32Q	3704	3.43	0.74	-0.27	1.60	4.02	1.51	0.36	1.39	3.51	0.86	0.10	0.84
46	c32Q	3706	3.23	0.77	0.15	1.51	3.75	1.51	0.66	1.71	3.36	1.02	0.44	0.72
47	c32Q	3707	3.58	0.69	-0.61	2.19	4.31	1.48	0.11	1.30	3.72	0.81	-0.02	0.81
48	c32Q	3711	3.25	0.61	0.10	2.46	3.53	1.16	1.30	3.53	3.28	0.71	0.24	1.17
49	c32Q	3712	3.14	0.60	0.18	2.95	3.37	1.10	1.52	4.43	3.20	0.73	0.39	1.49
50	b42Q	3694	3.00	0.53	0.17	3.24	3.09	0.82	2.12	8.71	2.95	0.51	-0.08	1.36
51	b42Q	3699	3.09	0.55	-0.09	2.68	3.17	0.78	1.79	8.07	3.10	0.51	-0.04	0.96
52	b42Q	3702	2.96	0.44	0.14	2.99	2.99	0.57	2.30	13.79	2.90	0.46	-0.01	0.95
53	b42Q	3703	2.85	0.49	0.36	3.08	2.89	0.66	2.40	12.54	2.80	0.45	-0.13	0.92
54	d43Q	3685	2.85	0.54	0.20	2.98	2.91	0.75	2.13	10.13	2.81	0.51	-0.15	1.01
55	d43Q	3695	2.93	0.44	0.12	3.47	2.97	0.60	2.54	14.68	2.89	0.37	-0.33	1.10
56	d4 Q	3705	3.14	0.40	-0.16	4.39	3.19	0.61	2.61	14.07	3.10	0.33	-0.10	1.32
57	d44Q	3705	3.06	0.50	-0.38	2.35	3.08	0.59	1.11	8.69	3.09	0.38	0.05	1.02
58	c50Q	3702	3.25	0.56	-0.07	2.85	3.46	1.03	1.52	4.69	3.29	0.99	0.24	2.02
59	b42Q	3686	2.76	0.44	0.71	4.48	2.79	0.60	2.93	16.75	2.74	0.39	0.04	1.12
60	d53Q	3699	3.16	0.36	0.46	3.75	3.19	0.46	2.73	17.55	2.64	0.27	0.15	1.11
61	d54Q	3708	2.98	0.45	-0.14	3.77	3.02	0.61	2.23	13.30	2.95	0.44	-0.19	1.21
62	d54Q	3716	3.07	0.39	0.13	3.87	3.11	0.57	2.86	16.17	3.00	0.30	-0.04	1.47
63	d54Q	3720	2.99	0.50	0.25	2.91	3.04	0.69	2.17	10.64				
64	d54Q	3730	3.05	0.46	-0.03	3.10	3.09	0.61	2.10	12.08	2.99	0.44	0.05	1.02
65	b61Q	3681	2.92	0.48	0.18	2.86	2.97	0.66	2.33	12.24	2.88	0.45	0.08	0.83
66	d62Q	3698	3.01	0.56	0.24	2.72	3.12	0.86	1.98	7.73	2.96	0.56	0.20	1.10
67	d63Q	3719	3.09	0.42	0.07	3.04	3.11	0.54	2.15	13.36	3.09	0.40	0.03	0.99
68	d63Q	3724	3.00	0.47	0.24	3.21	3.06	0.69	2.40	11.48	2.99	0.42	0.07	1.18
69	d63Q	3724	3.34	0.33	0.78	4.66	3.43	0.65	3.05	12.62	3.34	0.31	0.28	1.63
70	d64Q	3694	3.08	0.72	0.49	2.01	3.45	1.37	1.12	2.64	3.22	0.85	0.31	1.08
71	d64Q	3700	3.06	0.61	-0.09	2.55	3.18	0.91	1.59	6.32	3.06	0.63	0.03	1.08
72	d64Q	3704	2.86	0.45	0.87	4.55	2.92	0.71	2.94	13.51	2.84	0.44	0.15	1.49
73	d66Q	3702	3.36	0.59	-0.15	2.08	3.74	1.24	1.06	2.57	3.52	0.79	0.35	0.82
74	b72Q	3688	2.92	0.44	-0.18	3.64	2.94	0.52	1.72	13.56	2.95	0.33	-0.02	1.19
75	c72Q	3889	3.11	0.38	0.05	4.02	3.14	0.54	2.87	17.00	3.10	0.32	-0.11	1.38
76	d74Q	3703	3.23	0.55	0.19	2.57	3.45	1.04	1.60	4.66	3.29	0.68	0.22	1.92
77	d74Q	3705	2.89	0.46	0.70	4.38	2.97	0.74	2.80	12.34	2.95	0.59	0.29	1.84

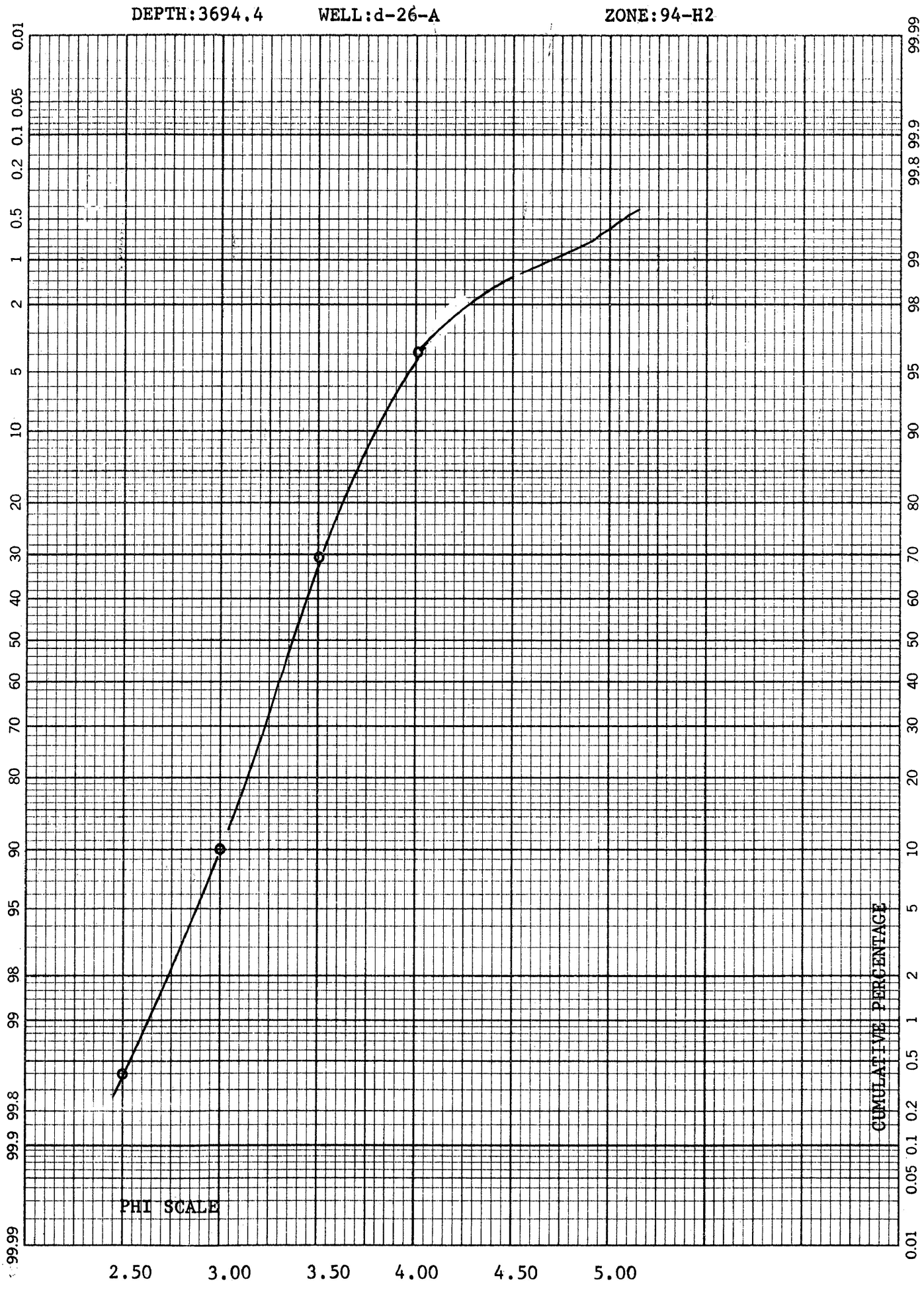
78	d74Q	3710	2.98	0.46	0.53	3.60	3.05	0.71	2.64	11.85	2.97	0.42	0.21	1.34
79	d74Q	3712	2.93	0.46	0.11	3.88	3.07	0.69	2.64	12.33	2.91	0.41	-0.03	1.28
80	d74Q	3715	3.00	0.45	0.42	3.61	2.97	0.64	2.39	13.25	2.99	0.39	0.07	1.29
81	d76Q	3736	2.97	0.46	0.48	3.90	3.05	0.72	2.62	11.72				
82	b82Q	3677	2.99	0.49	-0.17	2.72	3.01	0.58	1.32	9.63	2.95	0.47	0.01	0.97
83	b82Q	3681	3.02	0.42	0.36	3.76	3.08	0.64	2.78	13.79	2.99	0.37	-0.12	1.57
84	b82Q	3684	3.02	0.42	0.31	3.59	3.07	0.61	2.75	14.57	2.99	0.38	0.05	1.08
85	d83Q	3668	3.04	0.37	0.25	3.98	3.07	0.53	3.02	18.15	3.02	0.30	-0.14	1.48
86	d83Q	3670	3.00	0.34	0.56	4.84	3.04	0.52	3.56	21.40	3.00	0.31	0.03	1.09
87	d84Q	3731	2.81	0.47	-0.01	3.12	2.83	0.55	1.59	11.81	2.70	0.43	0.35	0.95
88	d84Q	3732	3.01	0.43	0.20	3.19	3.04	0.56	2.32	13.97	2.98	0.41	0.09	1.04
89	d94Q	3690	2.97	0.41	0.19	3.70	3.00	0.54	2.62	16.48	2.97	0.36	-0.04	1.03
90	d94Q	3700	3.10	0.35	0.58	4.12	3.04	0.47	3.30	21.67	3.02	0.29	0.01	1.19
91	b10H	3632	2.99	0.53	0.78	3.35	3.14	0.93	2.21	7.40	3.31	0.33	0.62	0.57
92	b10H	3633	2.82	0.53	0.75	3.88	2.92	0.84	2.44	9.74	2.79	0.50	0.30	1.35
93	b10H	3635	2.98	0.48	0.59	3.43	3.07	0.77	2.51	10.32	2.93	0.49	-0.03	1.61
94	b10H	3641	2.98	0.55	0.16	3.35	3.09	0.88	2.02	7.83	2.93	0.59	-0.01	1.94
95	b10H	3653	2.97	0.46	0.05	3.17	3.01	0.64	2.35	12.82	2.90	0.42	-0.29	1.37
96	b10H	3658	2.88	0.70	0.35	2.58	3.07	1.13	1.58	4.92	2.97	0.75	0.19	1.20
97	b10H	3671	3.57	0.39	-0.19	3.41	3.80	0.89	1.71	4.87	3.56	0.49	0.43	2.98
98	b10H	3673	3.43	0.32	0.63	4.86	3.54	0.67	2.83	10.89	3.48	0.45	0.61	1.00
99	b10H	3674	3.65	0.38	-0.35	3.55	3.95	0.96	1.42	3.65	3.67	0.60	0.60	3.30
100	d20H	3646	3.24	0.34	0.32	5.25	3.31	0.61	3.11	14.74	3.23	0.27	0.09	1.91
101	d20H	3647	3.29	0.41	0.72	3.44	3.43	0.82	2.37	7.94	3.26	0.44	0.40	1.69
102	d20H	3651	2.52	0.56	0.77	3.46	2.56	0.70	2.35	12.05	2.50	0.53	0.24	0.94
103	b31H	3579	2.94	0.46	0.68	3.62	3.00	0.71	2.71	12.25	2.90	0.44	0.07	1.26
104	b31H	3580	3.02	0.51	0.61	3.20	3.15	0.87	2.25	8.05	2.98	0.54	0.15	1.64
105	a63H	3628	3.04	0.39	0.43	4.15	3.09	0.59	3.06	16.22	3.01	0.32	-0.03	1.41
106	b03J	3687	3.06	0.38	0.14	4.42	3.10	0.55	2.88	16.98	3.04	0.31	0.07	1.35
107	d08J	3726	3.35	0.36	0.36	3.33	3.43	0.64	2.80	12.08	3.35	0.33	0.18	0.67
108	d10J	3743	3.46	0.27	0.68	2.48	3.50	0.44	3.80	21.76	3.48	0.20	0.31	1.08
109	d17J	3755	3.47	0.49	0.24	2.34	3.83	1.15	1.18	2.78	3.52	0.73	0.55	1.75
110	b28J	3735	3.09	0.45	0.93	3.88	3.22	0.83	2.52	8.94	3.04	0.44	0.24	1.56
111	b28J	3737	3.03	0.41	0.51	3.90	3.09	0.63	2.92	14.48	2.96	0.39	0.30	0.80
112	b28J	3757	2.95	0.42	0.70	4.08	3.01	0.62	3.01	15.25	2.95	0.38	0.21	1.16
113	d29J	3742	2.90	0.38	0.46	4.08	2.92	0.50	2.98	19.67	2.90	0.36	0.18	1.67
114	d39J	3735	2.87	0.46	0.56	3.64	2.93	0.69	2.77	13.24	2.82	0.40	-0.27	0.95
115	d39J	3740	2.95	0.45	-0.01	3.32	2.99	0.61	2.34	13.52	2.88	0.51	-0.38	1.29
116	d49J	3733	2.85	0.39	-0.15	3.41	2.86	0.43	1.22	12.75	2.86	0.36	-0.05	1.00
117	d15A	3714	3.14	0.47	0.54	3.41	3.27	0.85	2.29	8.04	3.11	0.56	0.19	1.76

APPENDIX E2

Compilation of Cumulative Curves

DEPTH: 3577 WELL: b-22-A ZONE: 94-H-2

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WELL:d-26-A
ZONE:94-H2
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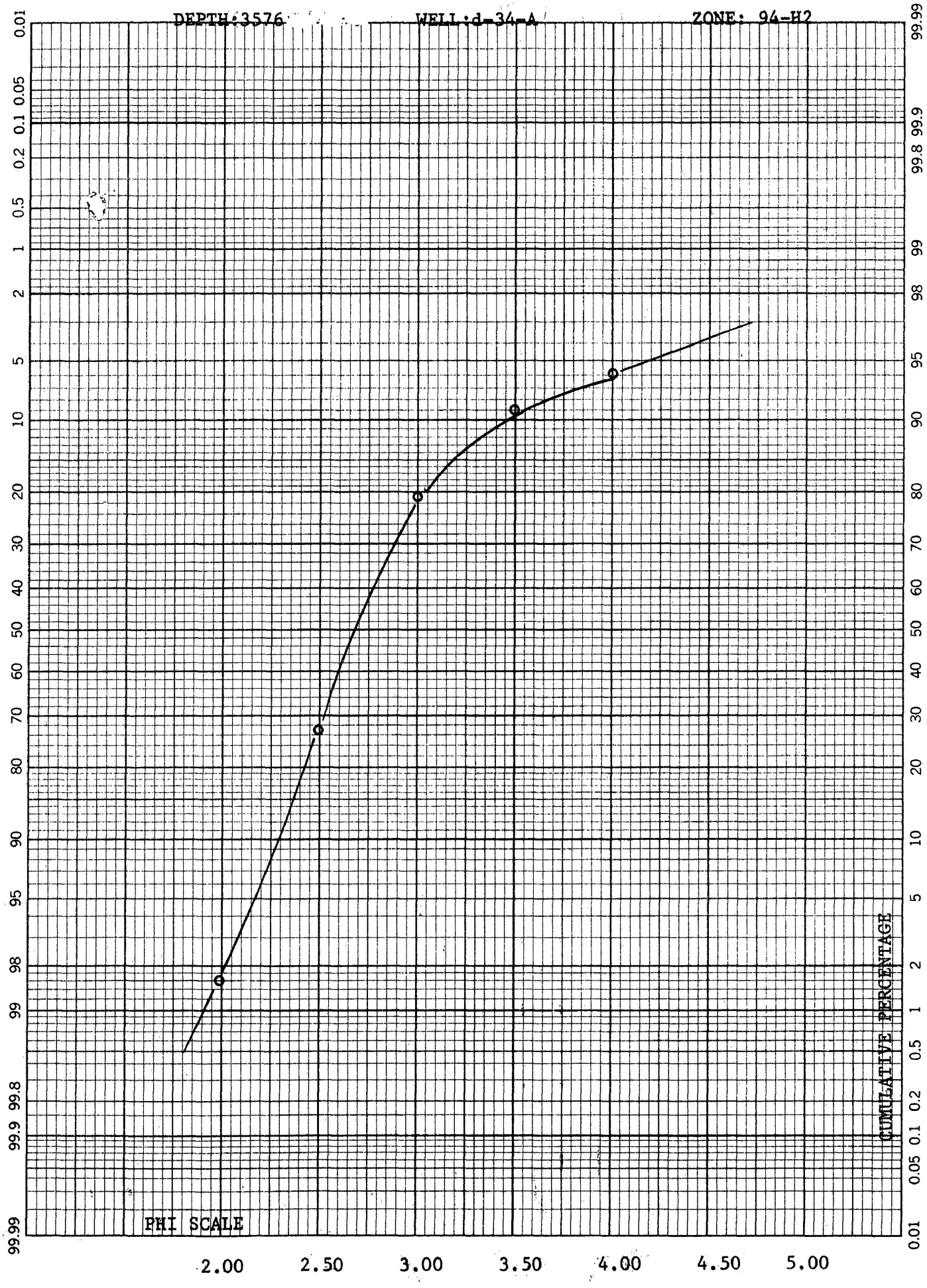
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.50 3.00 3.50 4.00 4.50 5.00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WELL:d-34-A
ZONE: 94-H2
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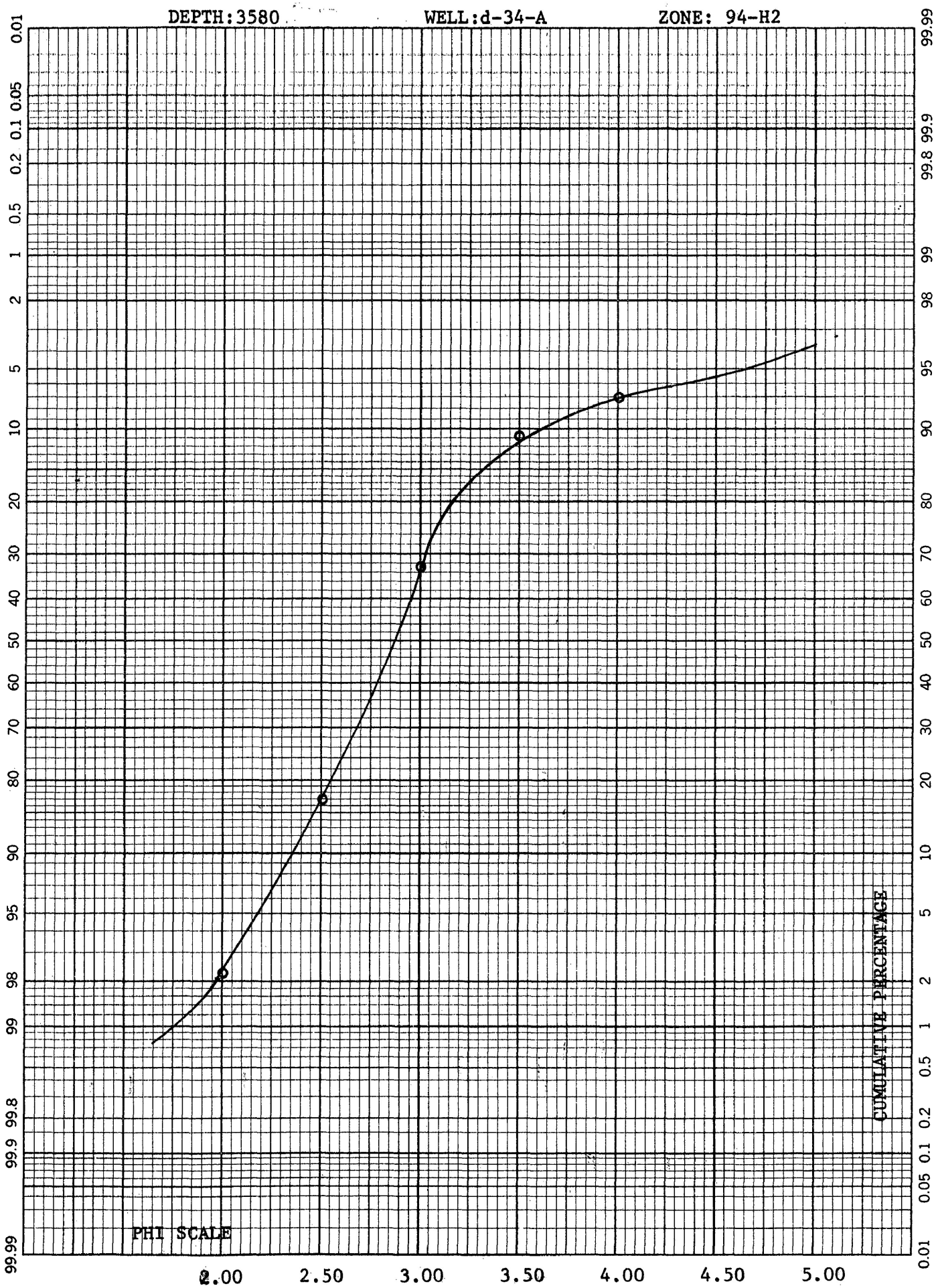
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00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WELL:d-34-A
ZONE: 94-H2
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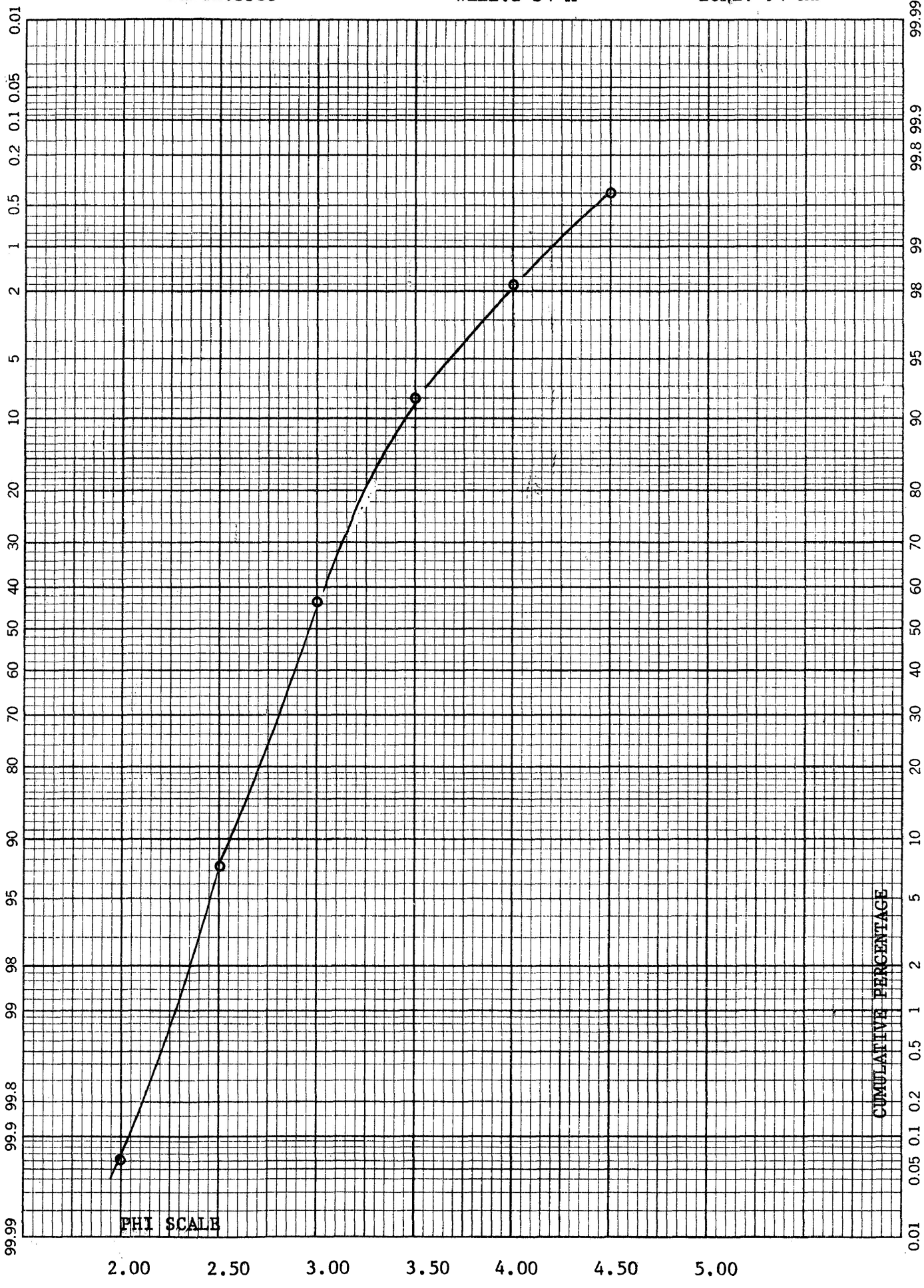
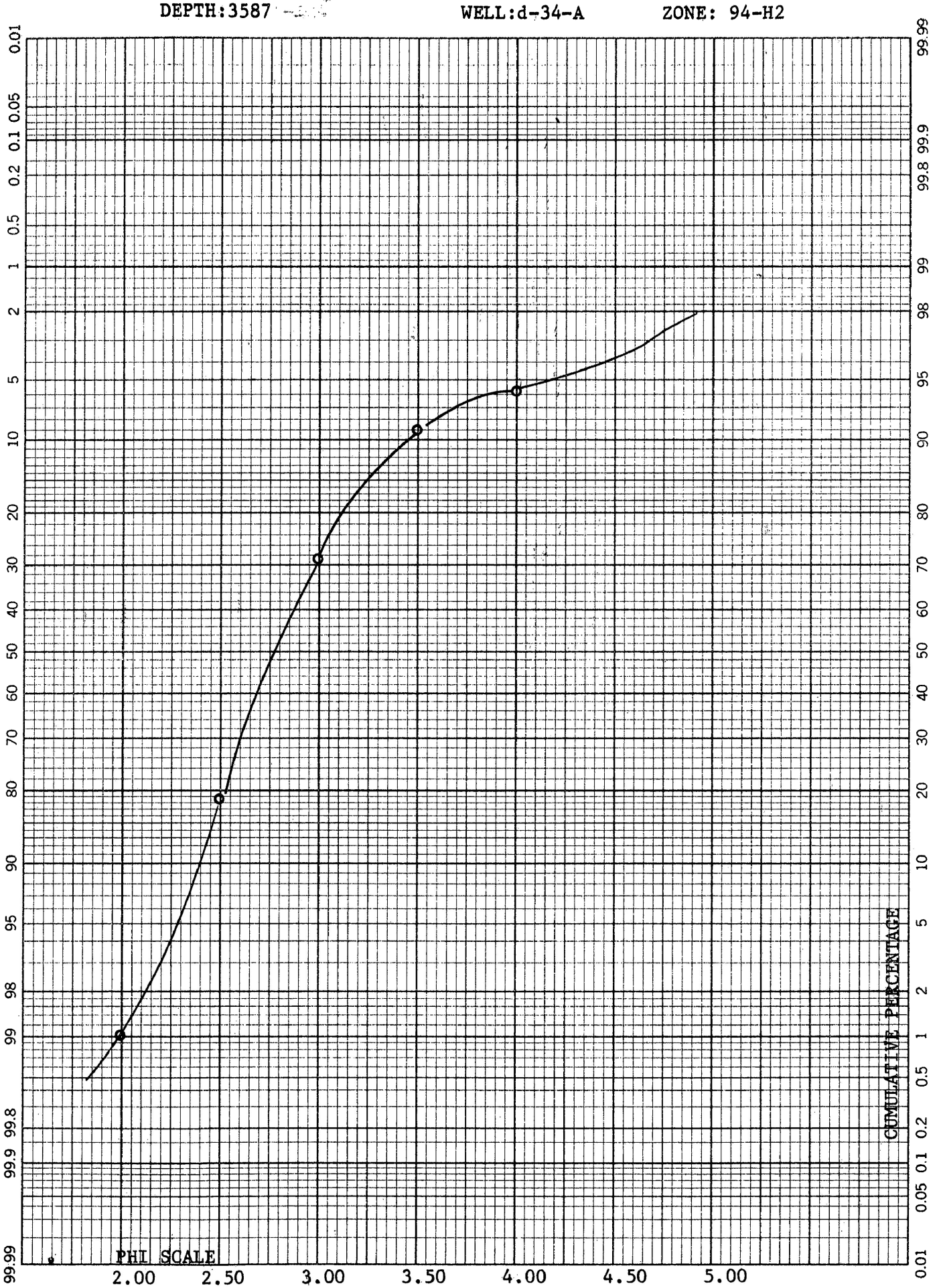
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

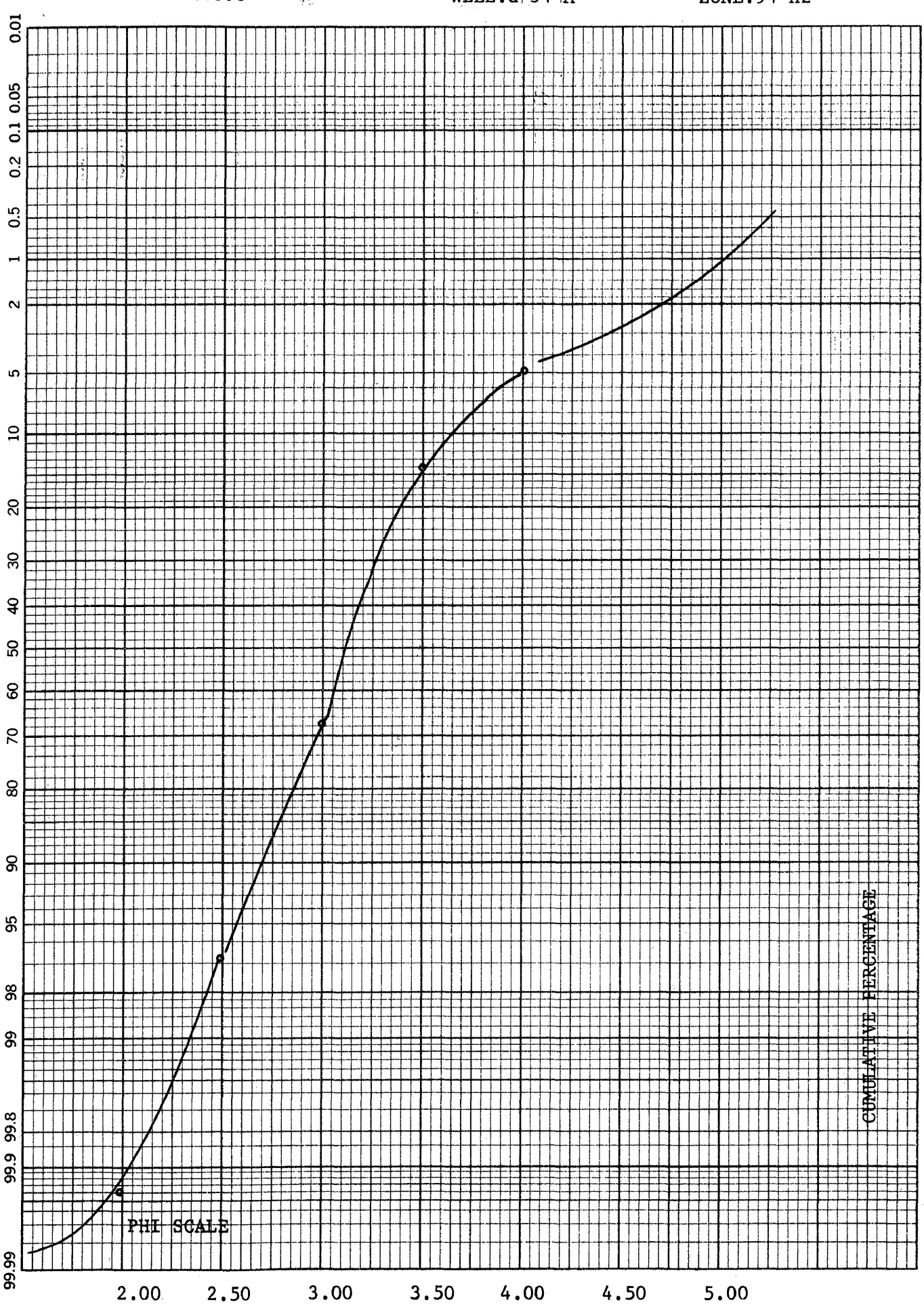
DEPTH:3585 WELL:d-34-A ZONE: 94-H2

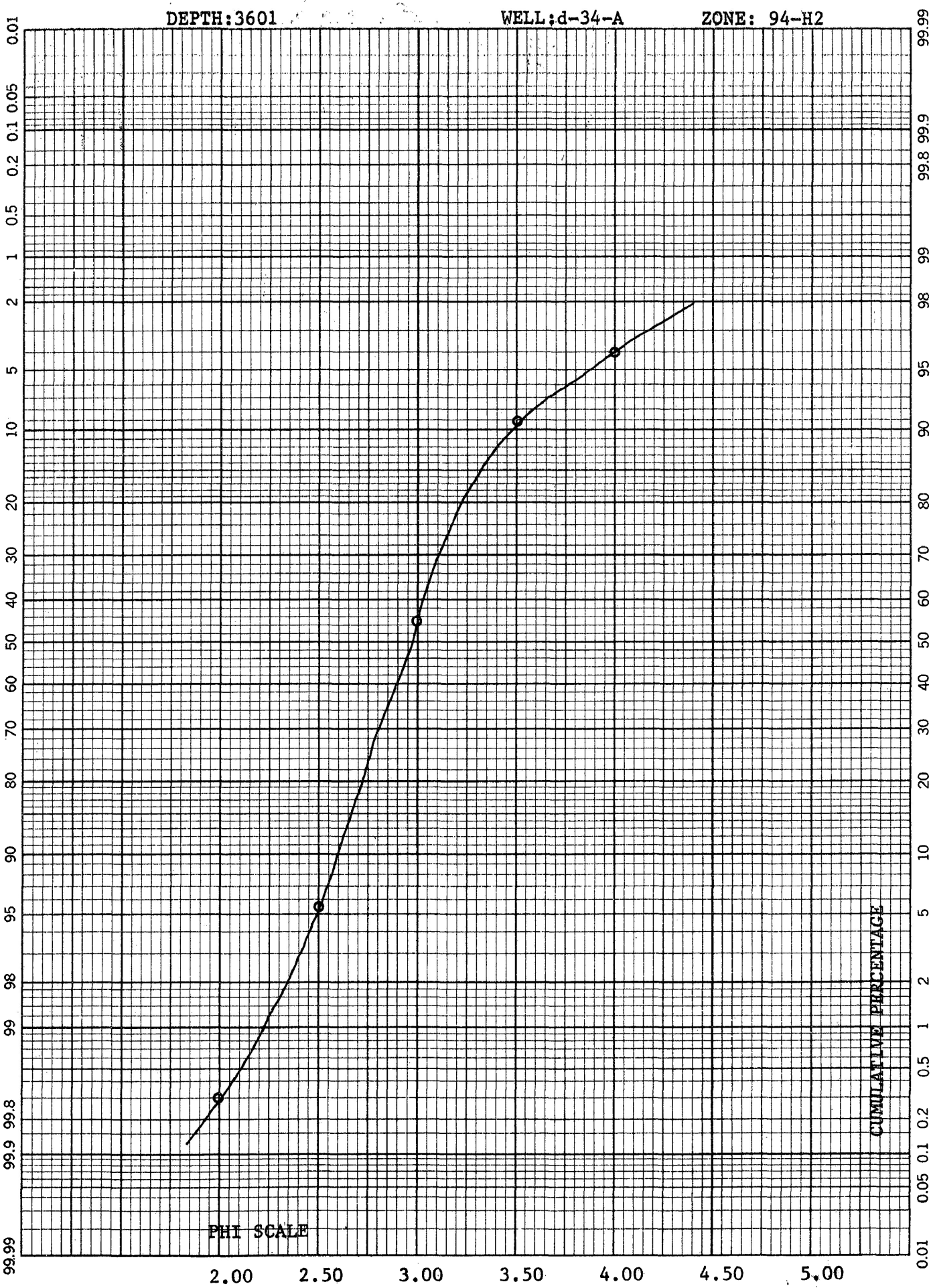


DEPTH:3587 WELL:d-34-A ZONE: 94-H2



DEPTH:3593 WELL:d-34-A ZONE:94-H2




DEPTH:3601
WELL:d-34-A
ZONE: 94-H2
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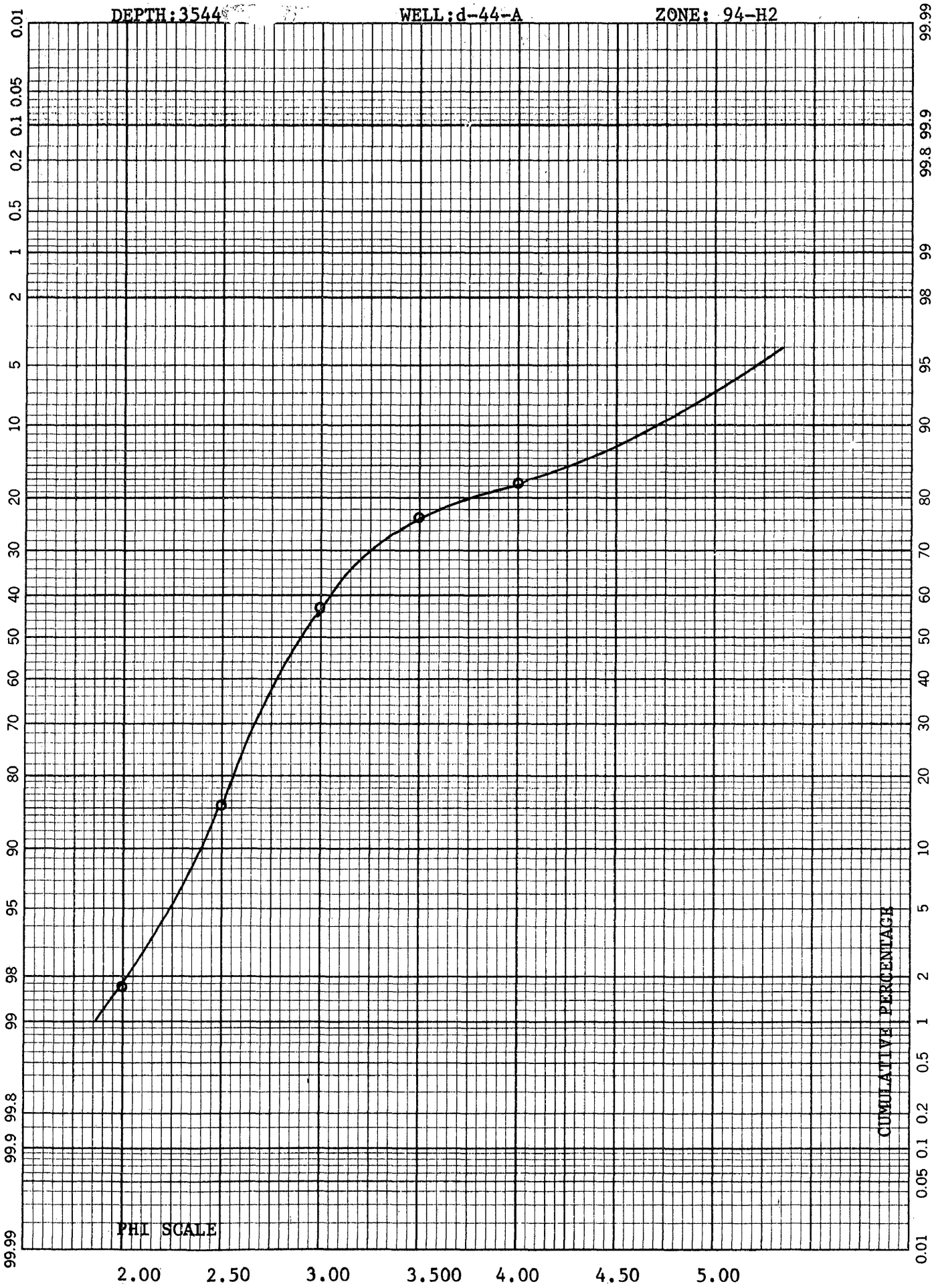
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00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WELL:d-44-A
ZONE: 94-H2
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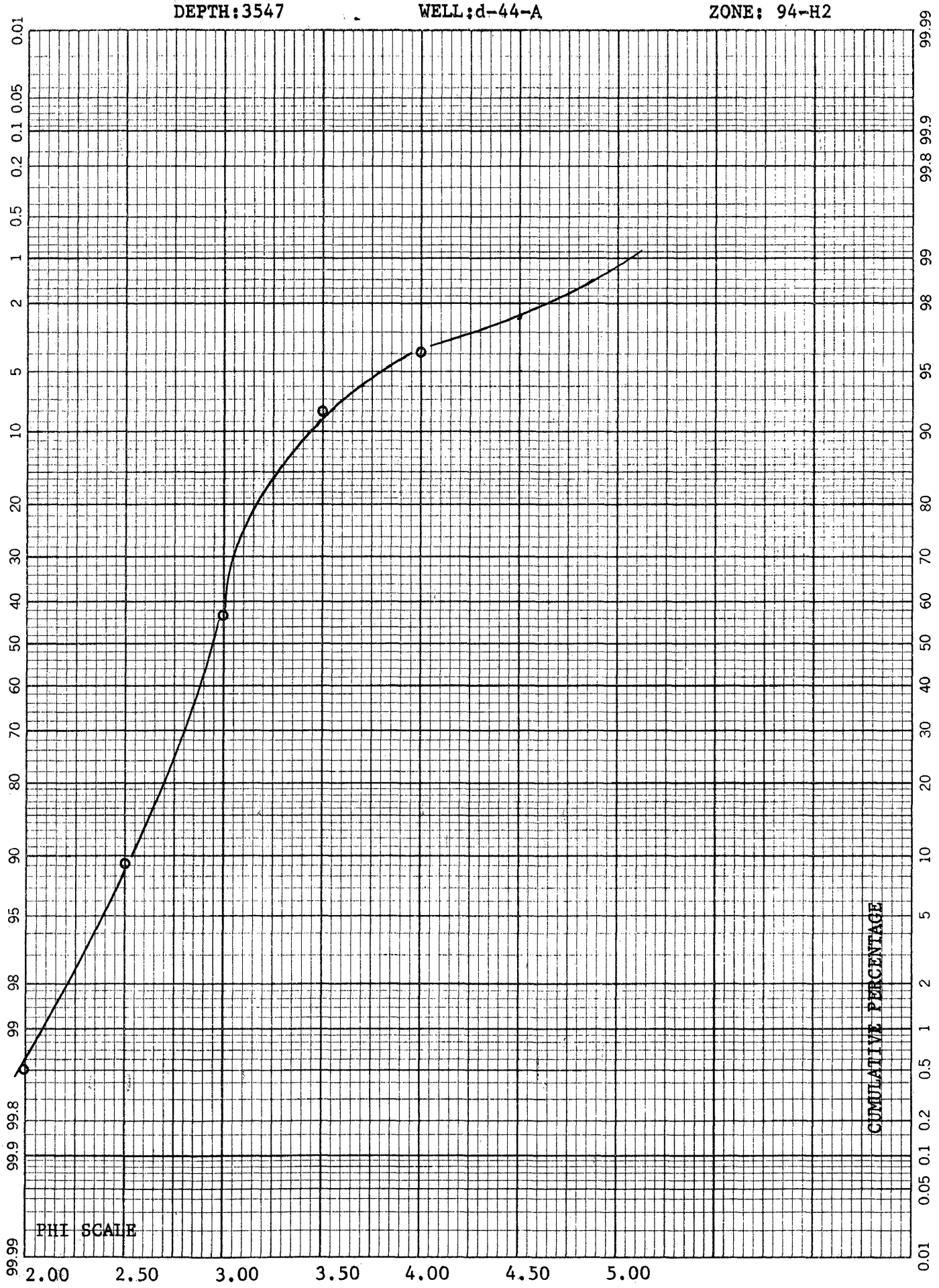
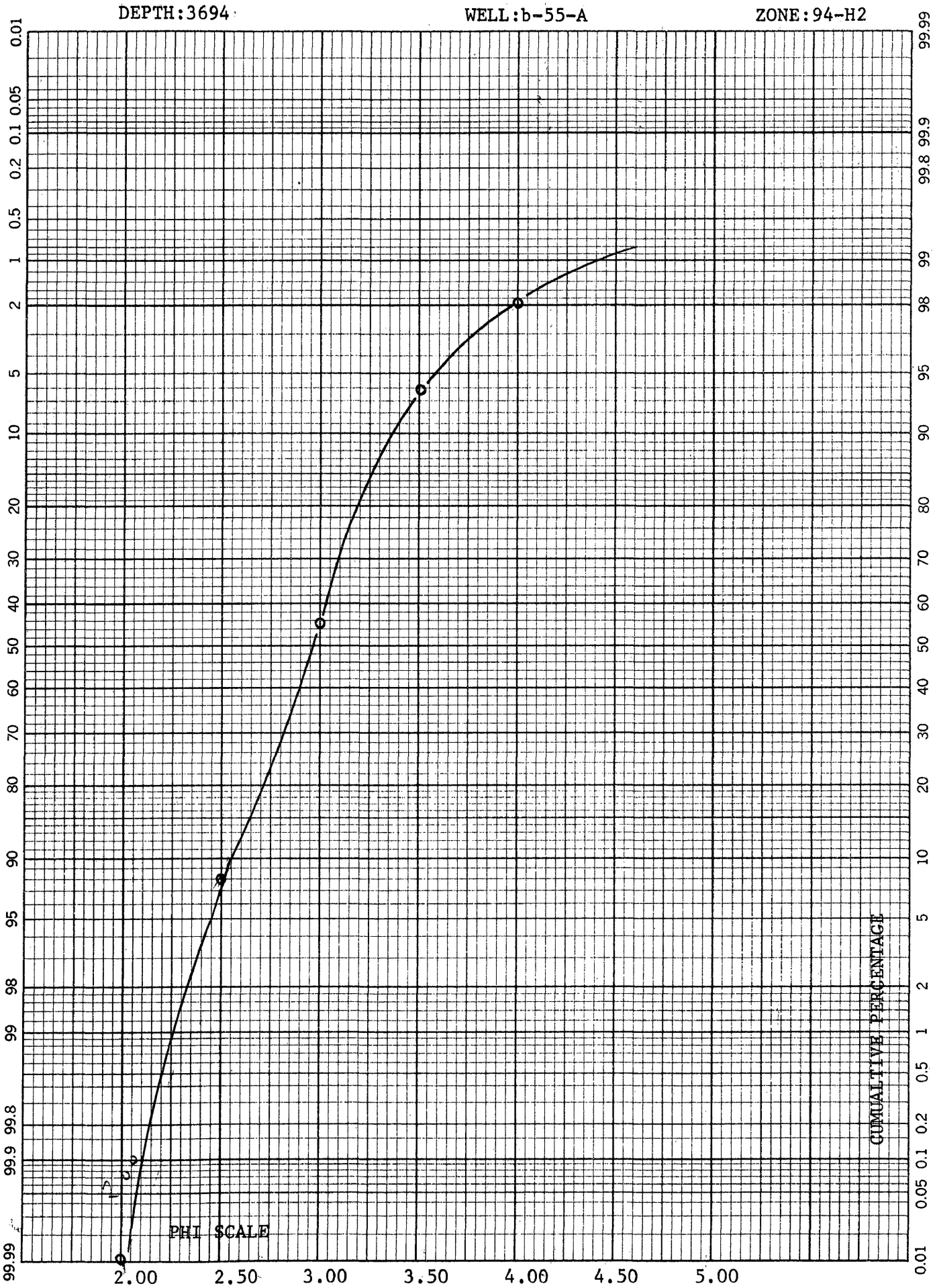
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.500 4.00 4.50 5.00

DEPTH:3547 WELL:d-44-A ZONE: 94-H2




DEPTH:3694
WELL:b-55-A
ZONE:94-H2
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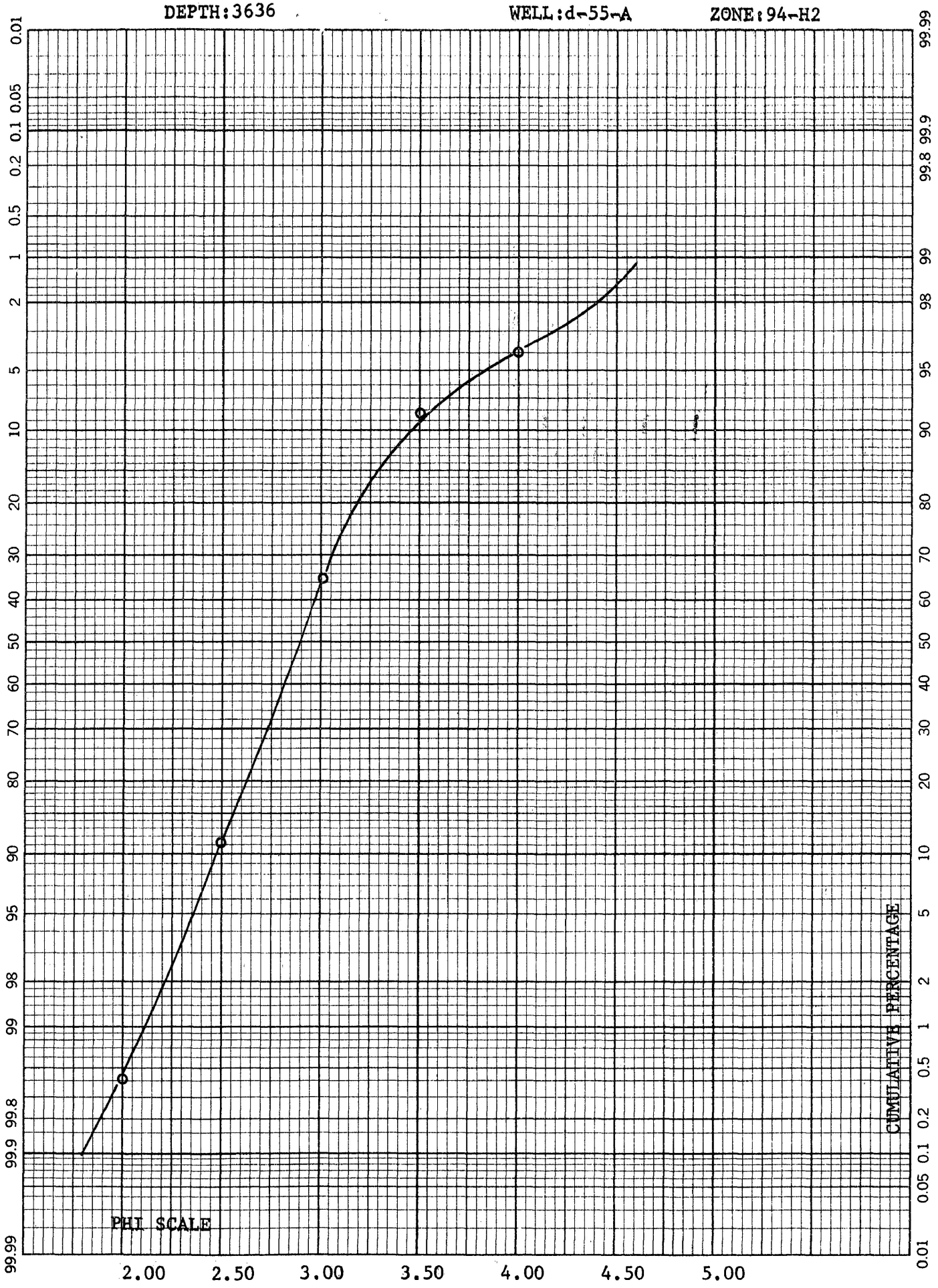
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00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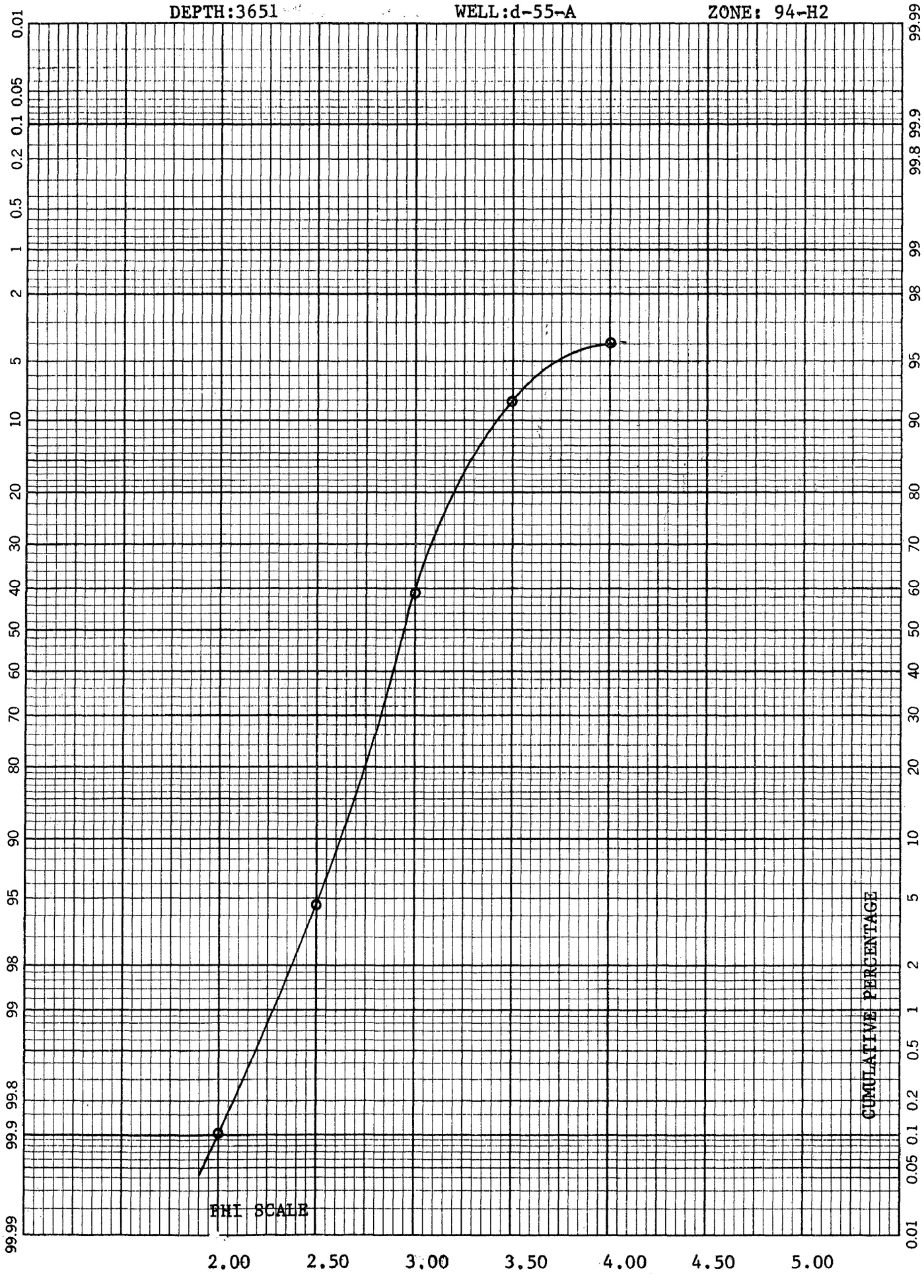
WELL:d-55-A
ZONE:94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00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ZONE: 94-H2
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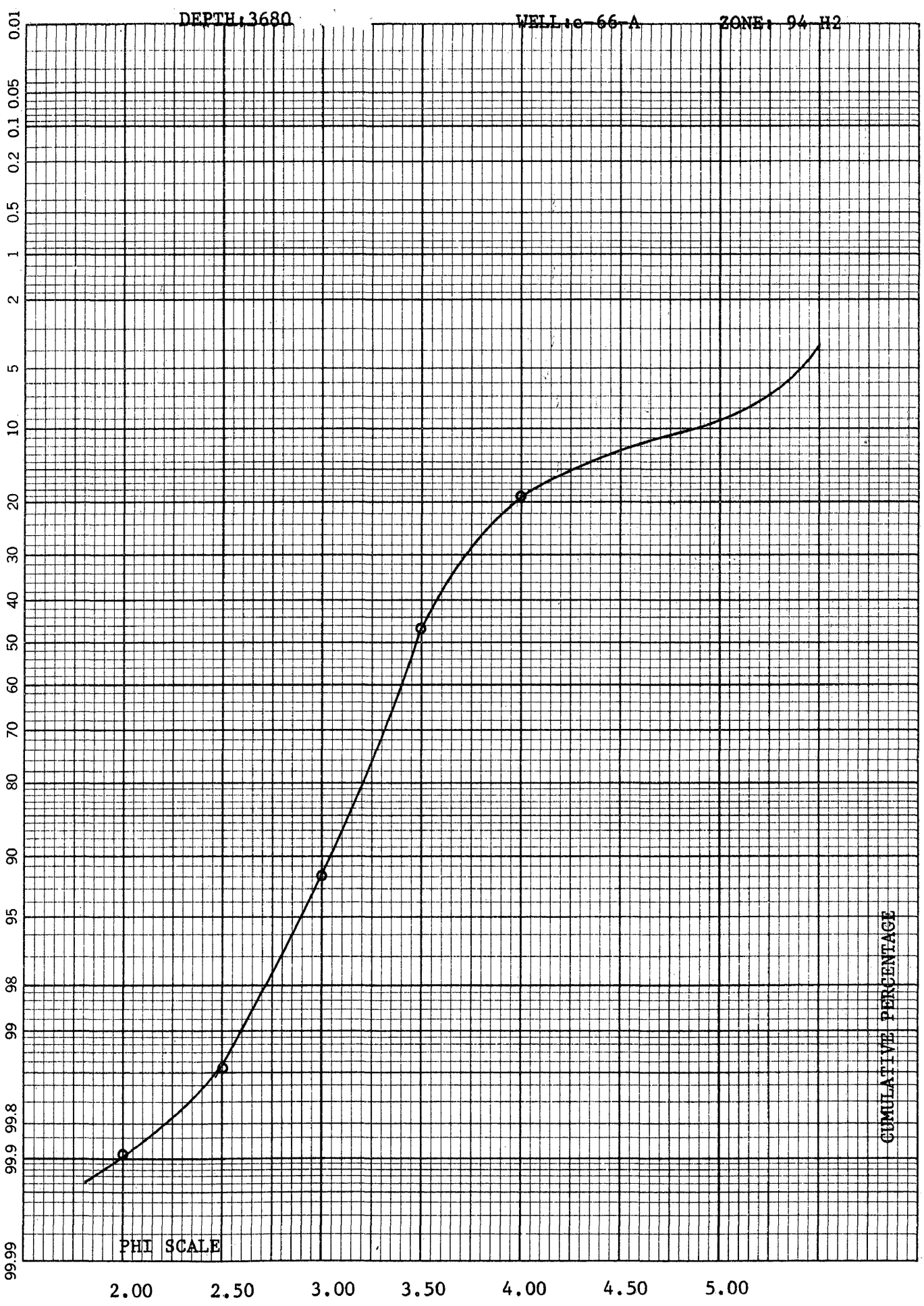
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00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WELL:e-66-A
ZONE: 94 H2
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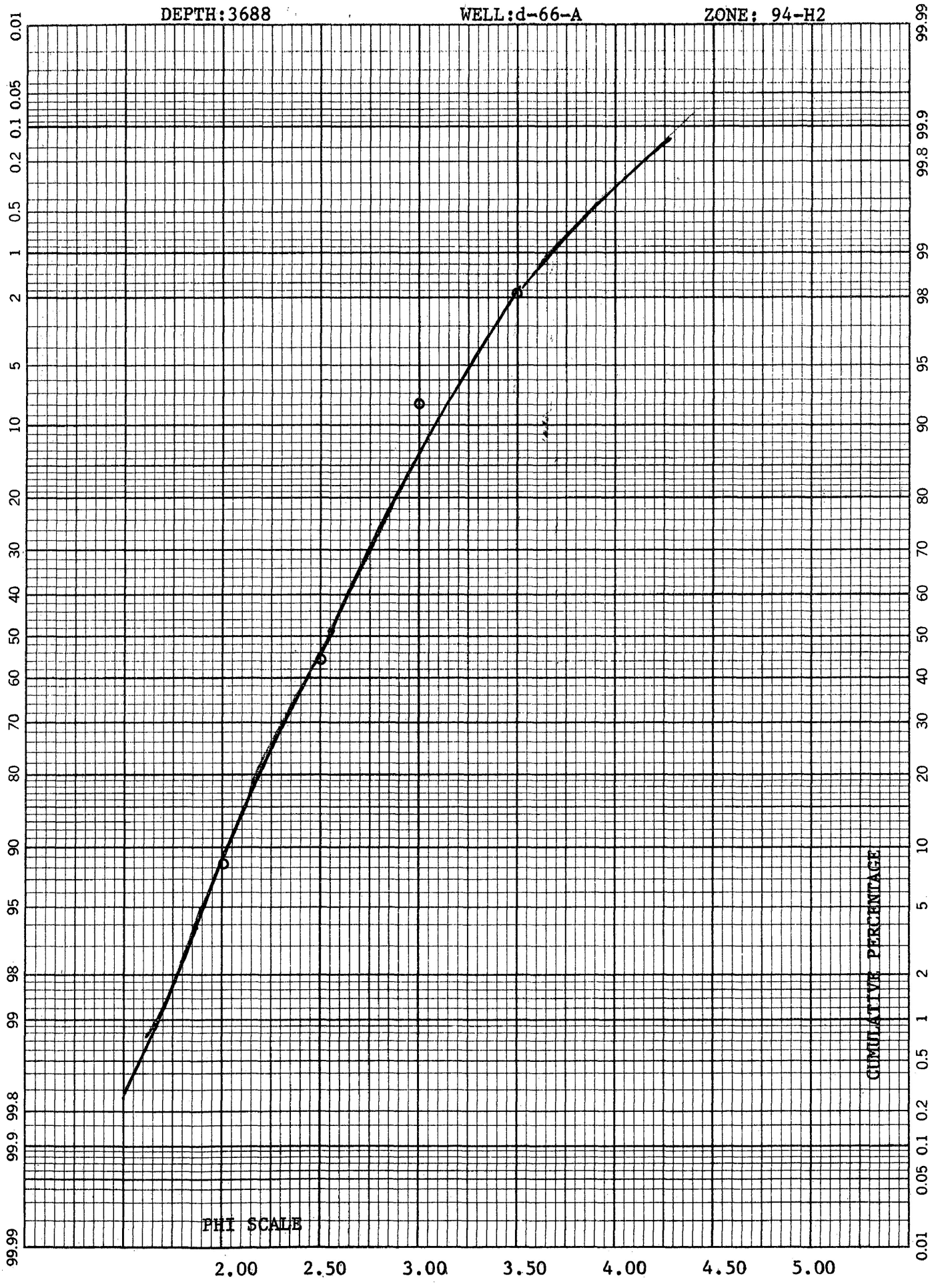
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00


DEPTH:3688
WELL:d-66-A
ZONE: 94-H2
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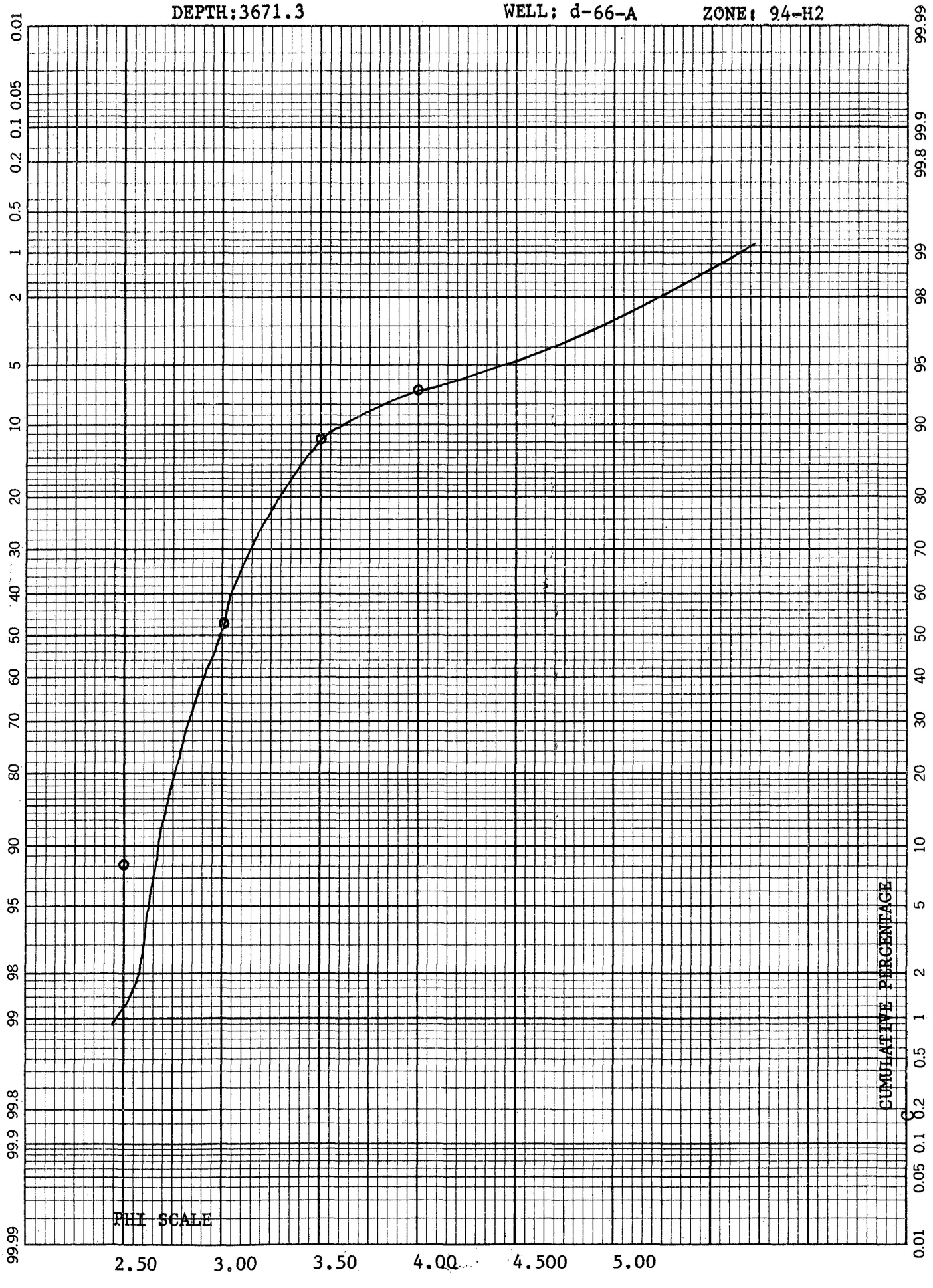
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00


DEPTH:3671.3
WELL: d-66-A
ZONE: 94-H2
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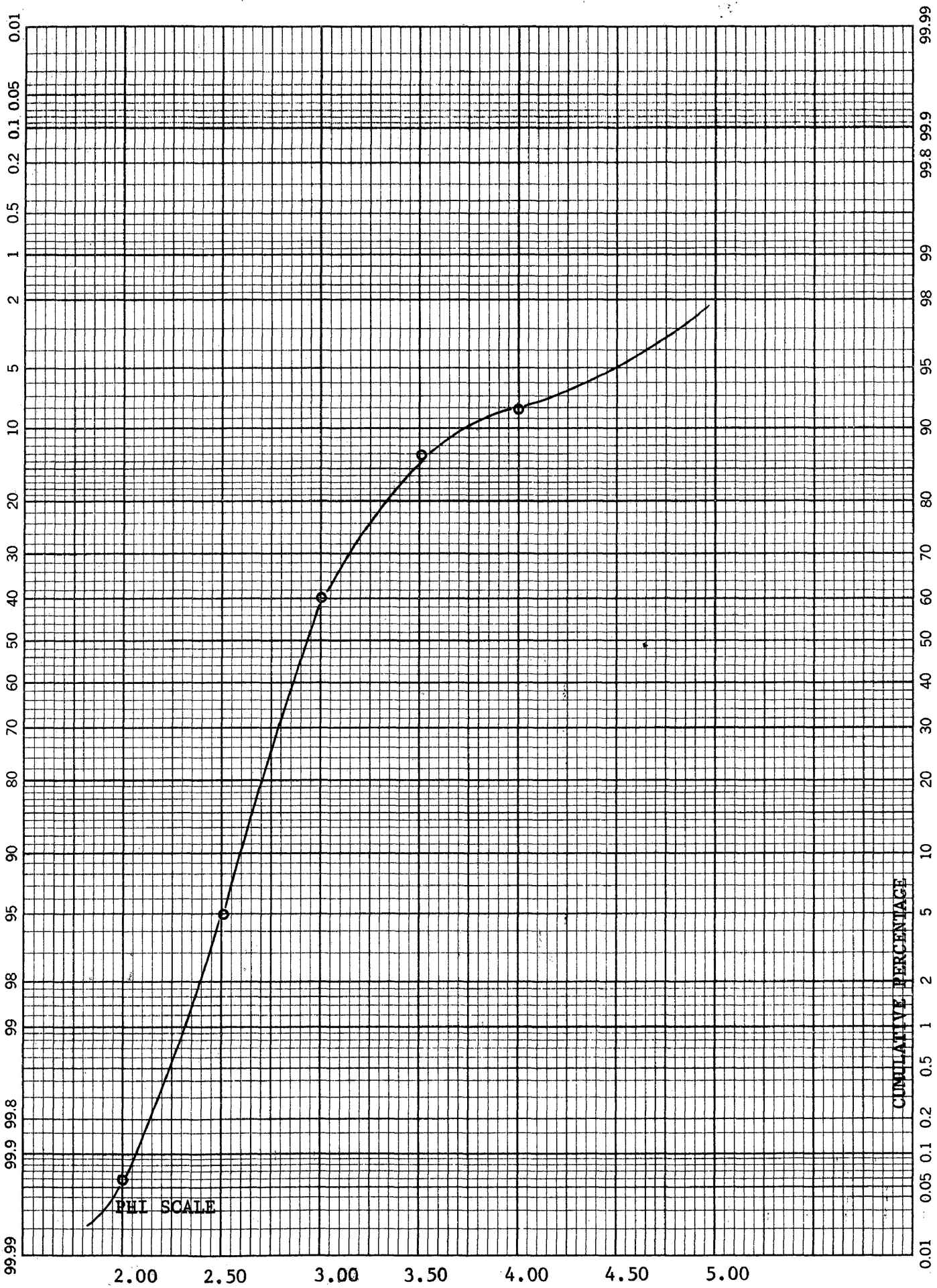
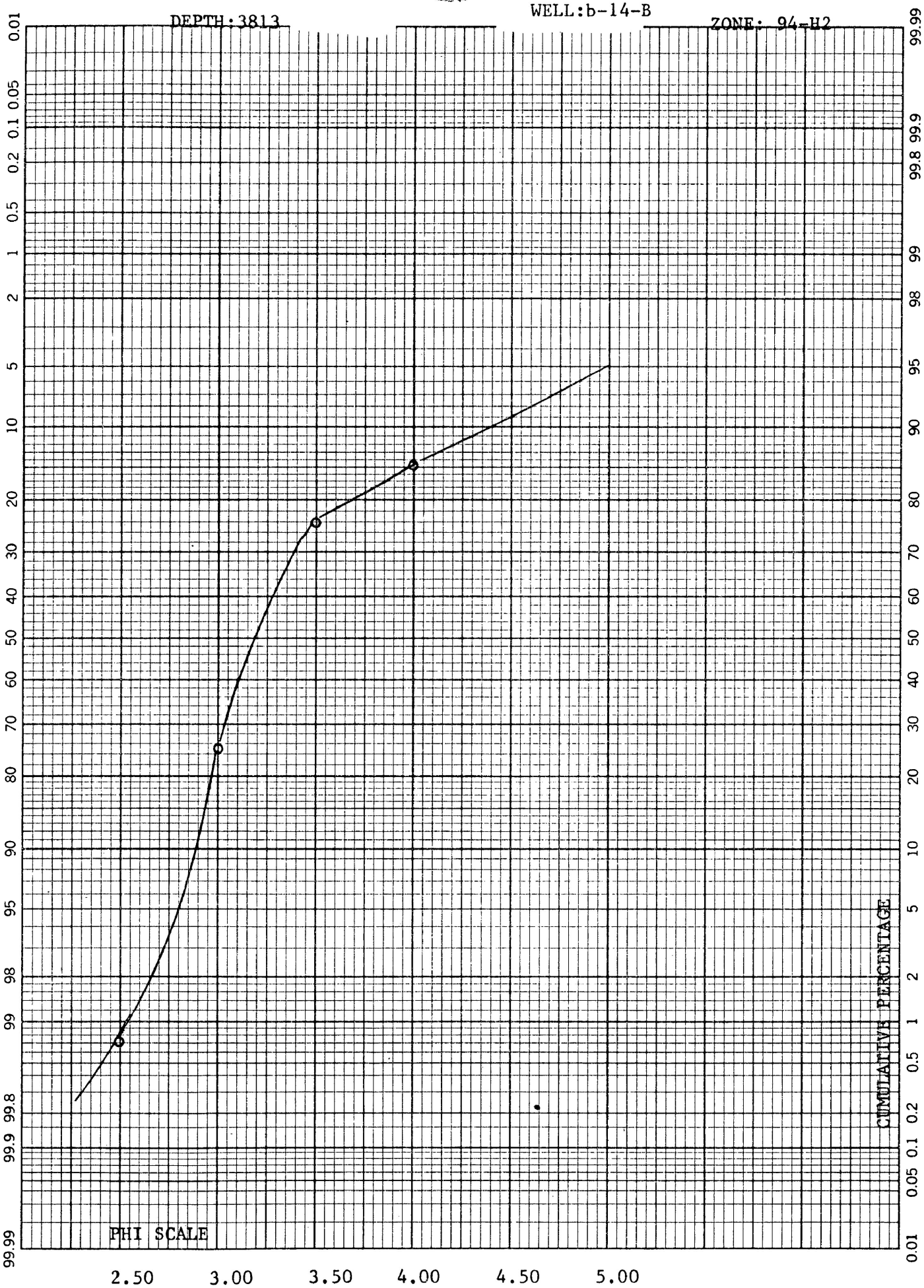
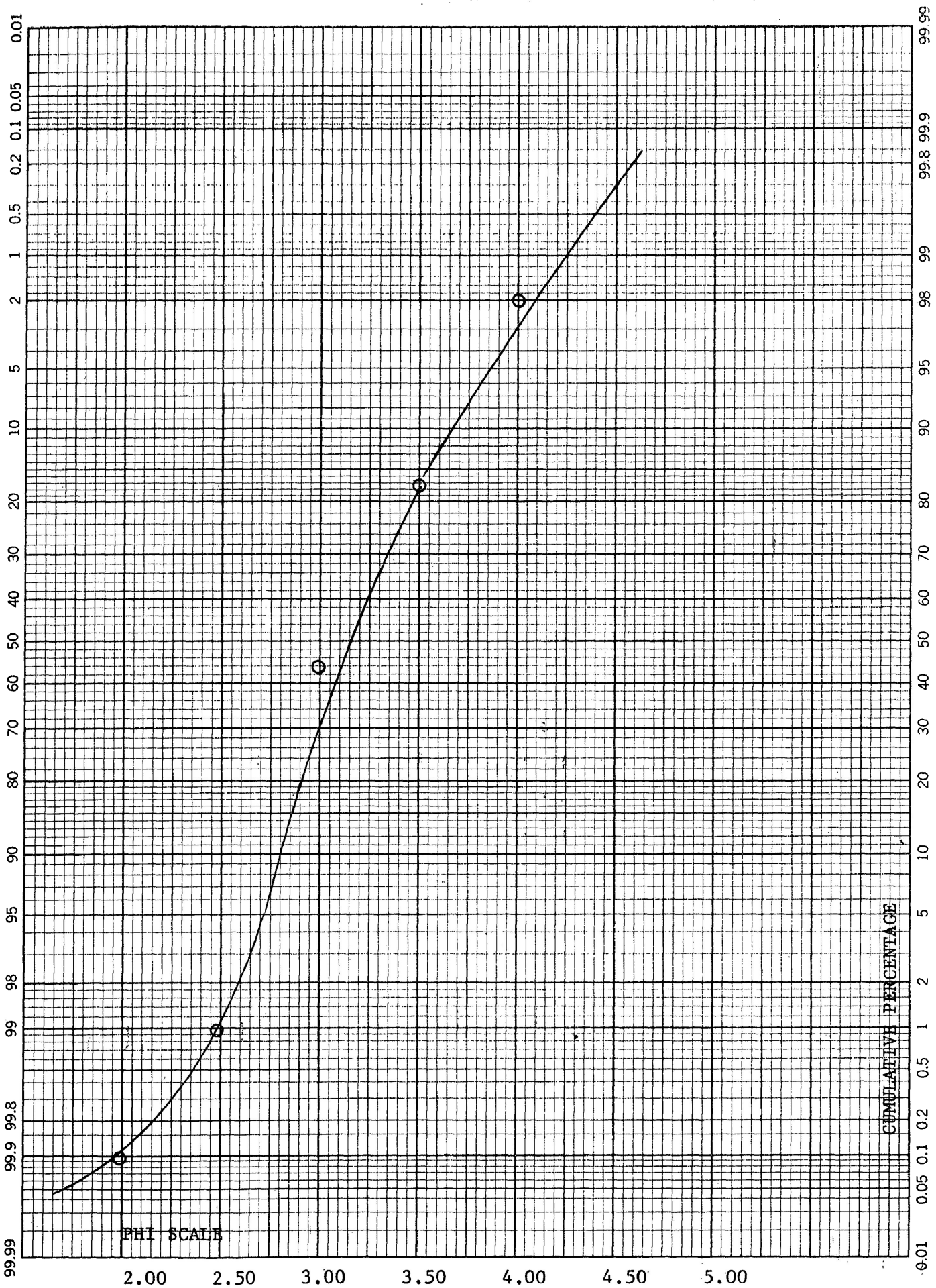
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.50
3.00
3.50
4.00
4.500
5.00

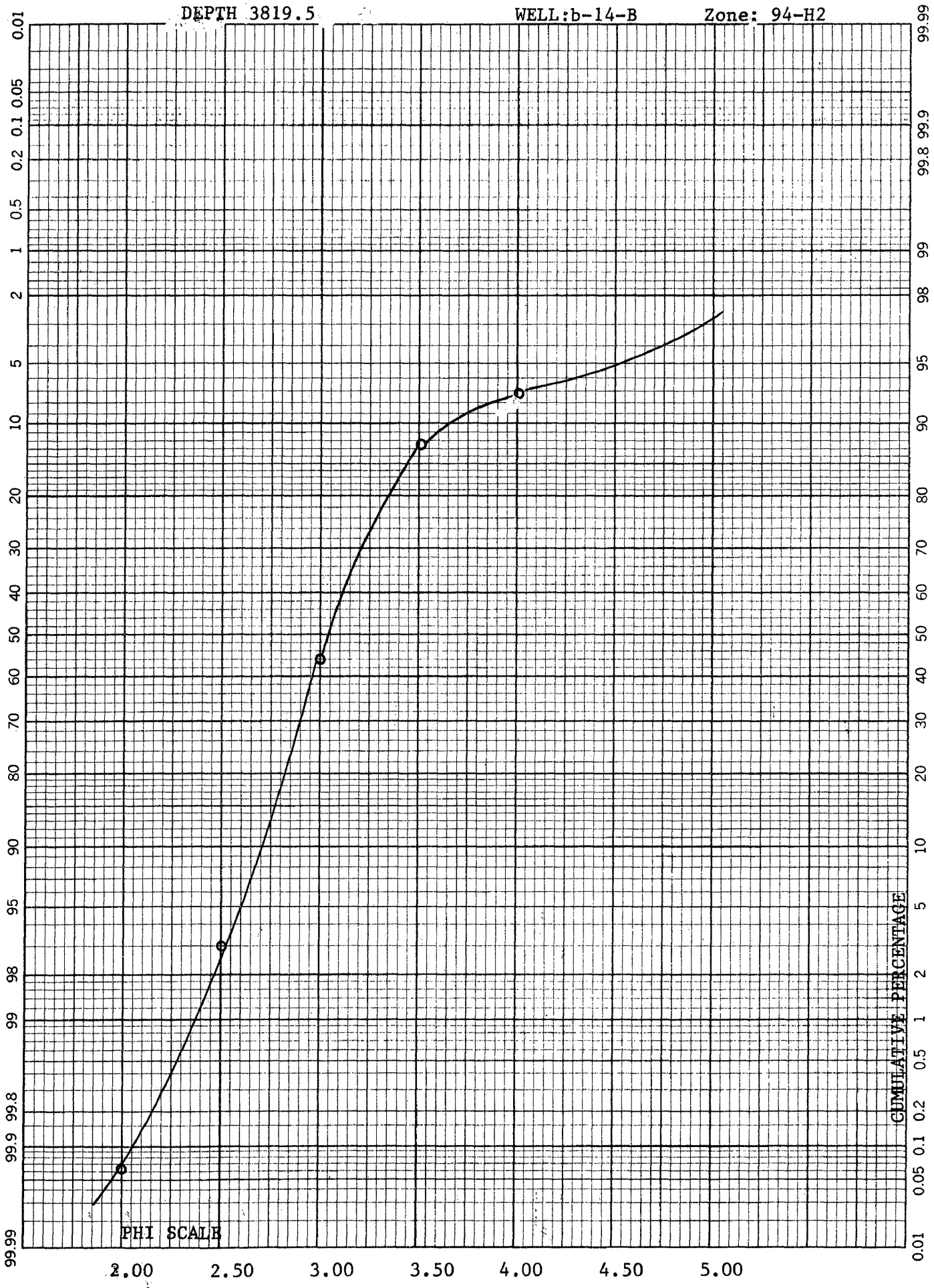
DEPTH:3845 WELL:d-a-5-B ZONE: 94-H2




DEPTH:3813
WELL:b-14-B
ZONE: 94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.50 3.00 3.50 4.00 4.50 5.00

DEPTH:3814 WELL:b-14-B ZONE:94-H2




DEPTH 3819.5
WELL:b-14-B
Zone: 94-H2
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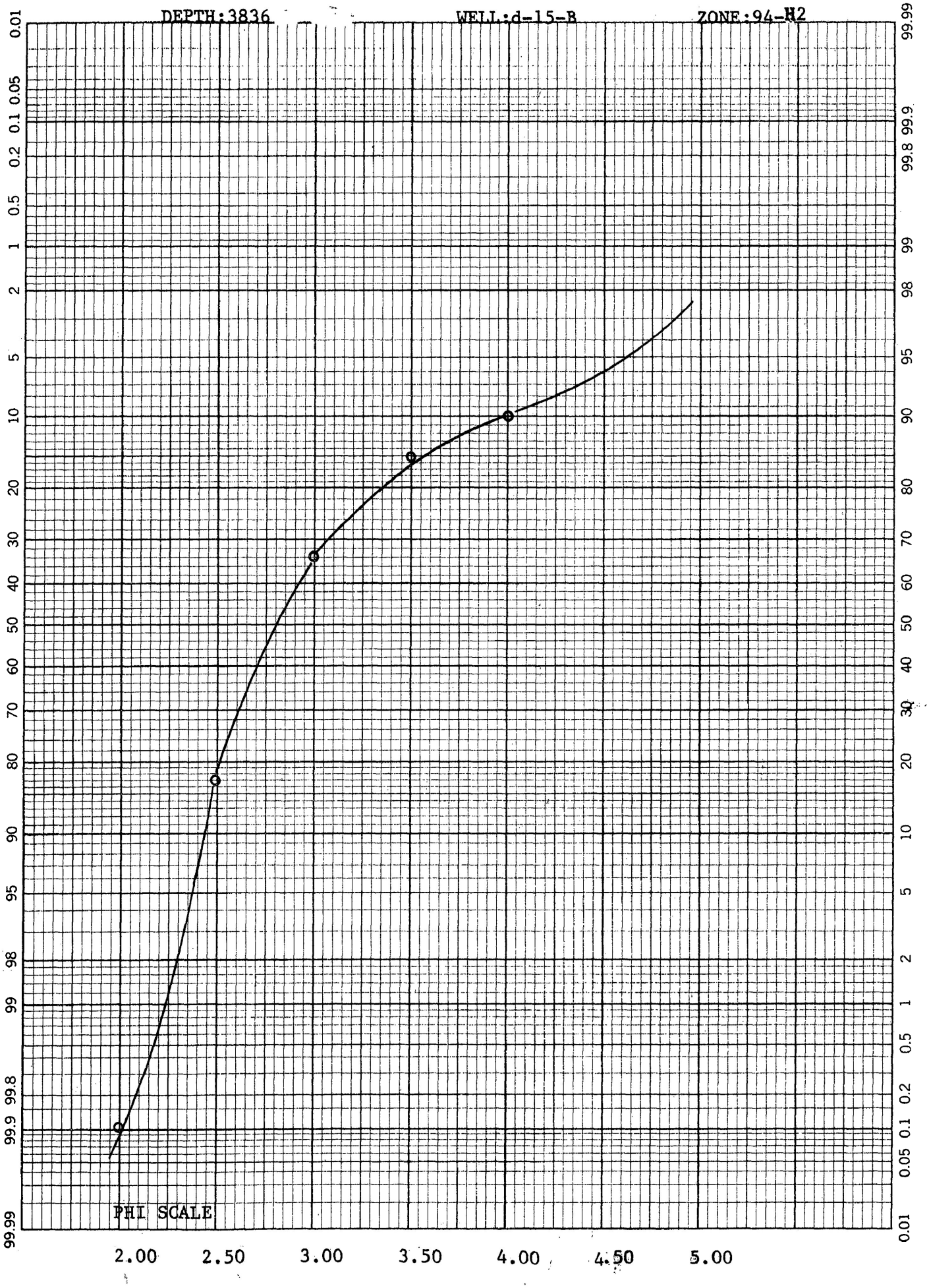
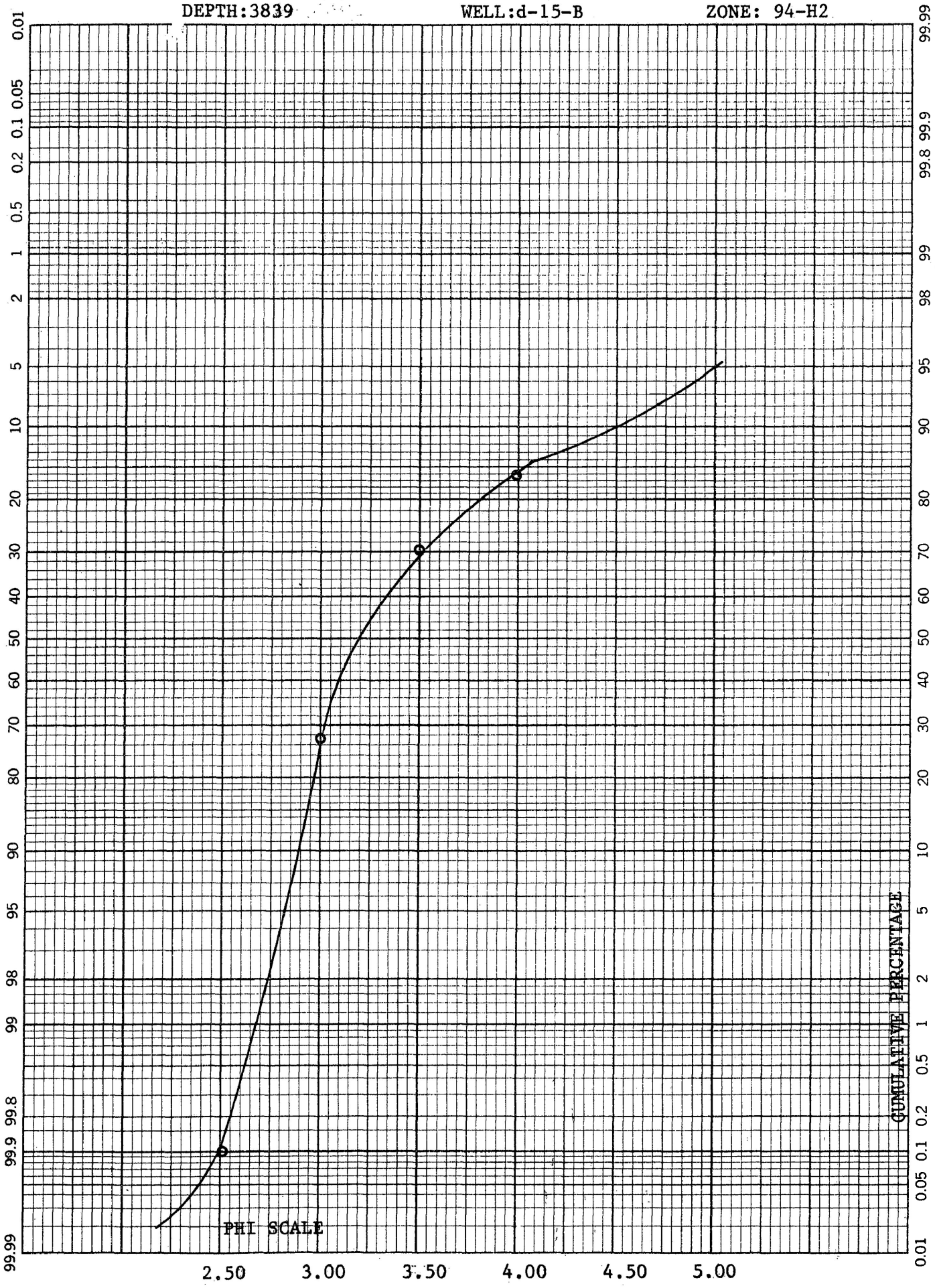
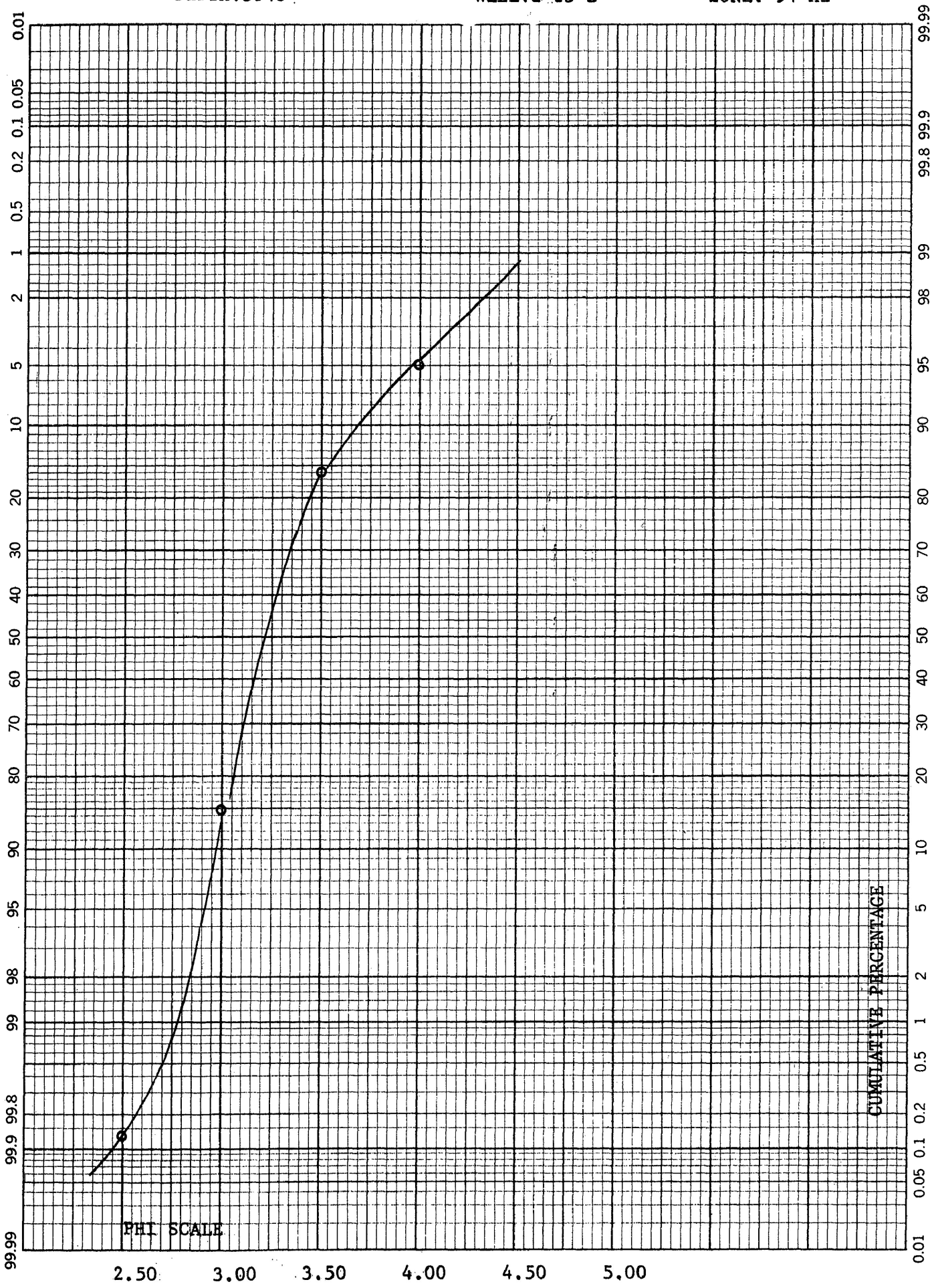
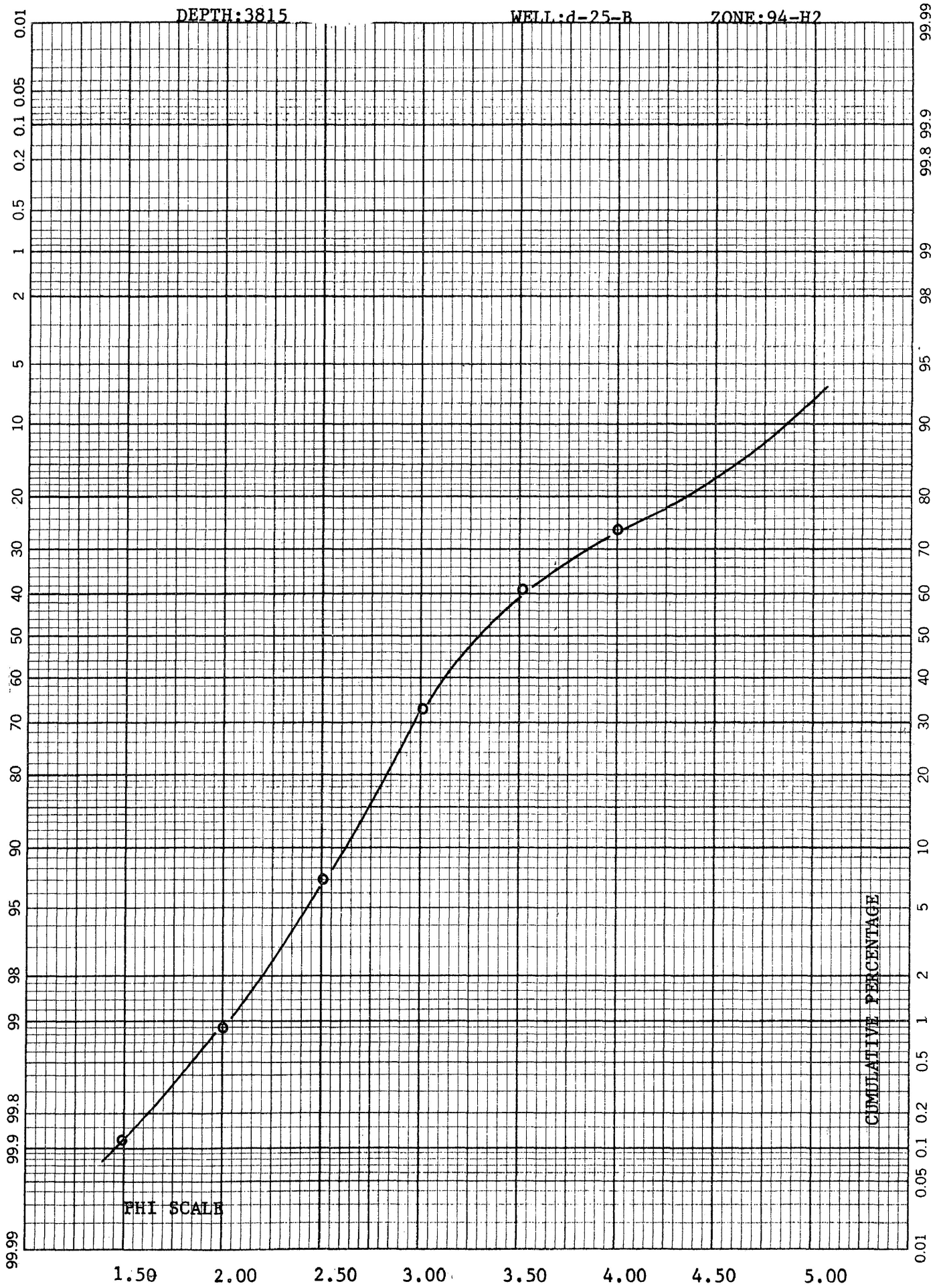
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

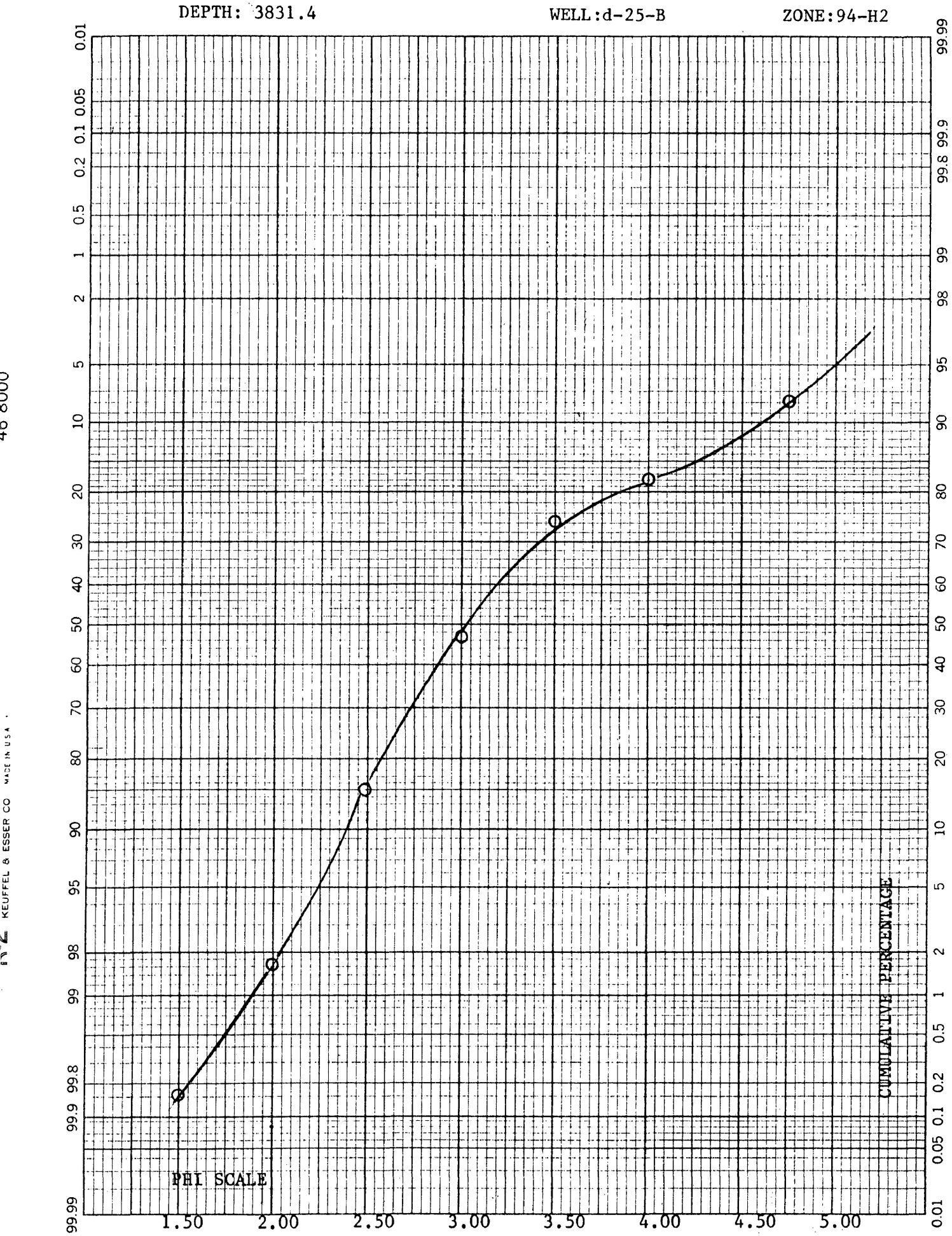

DEPTH:3836
WELL:d-15-B
ZONE:94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00


DEPTH:3839
WELL:d-15-B
ZONE: 94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.50 3.00 3.50 4.00 4.50 5.00

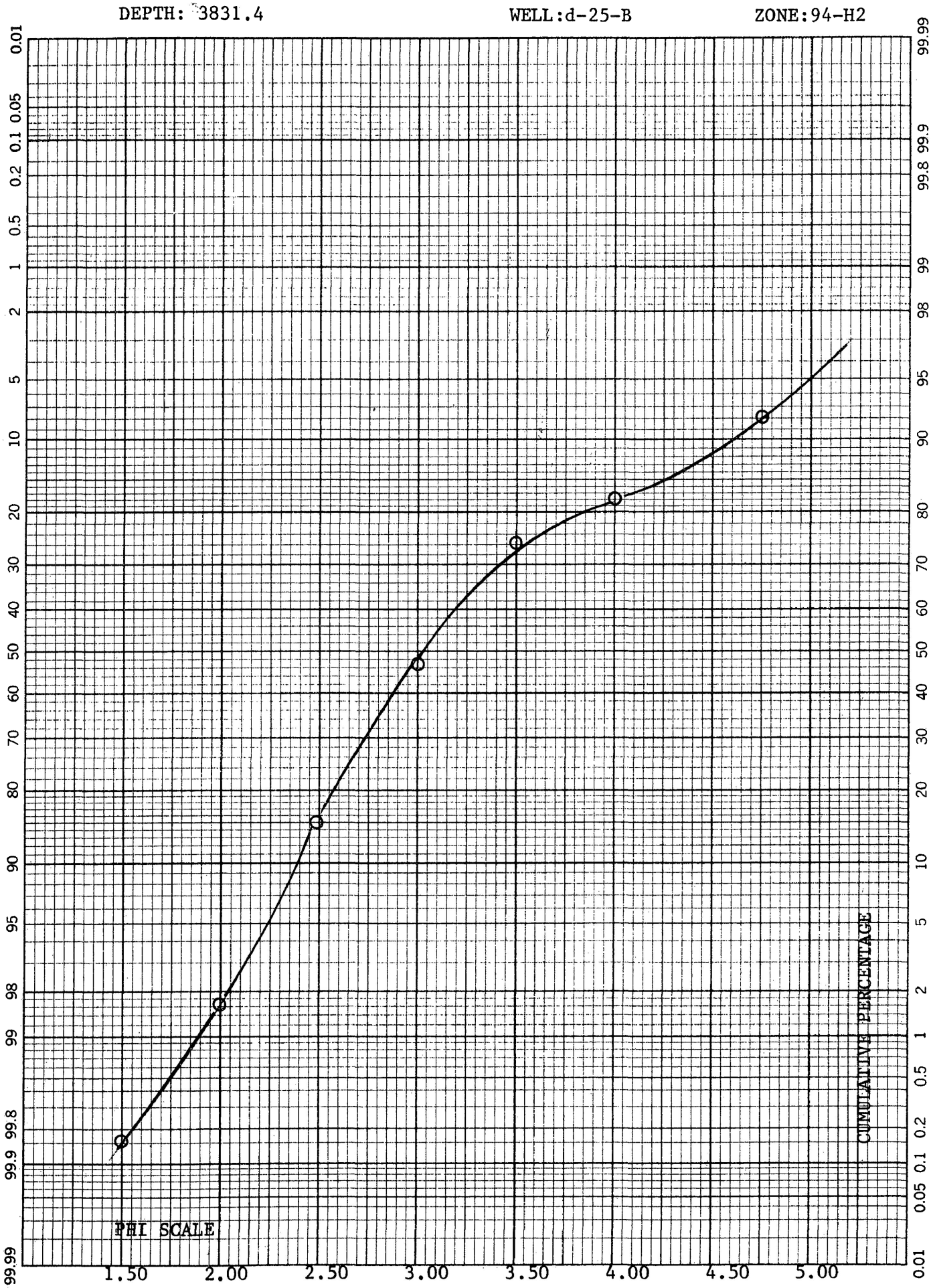
DEPTH:3846 WELL:d-15-B ZONE: 94-H2



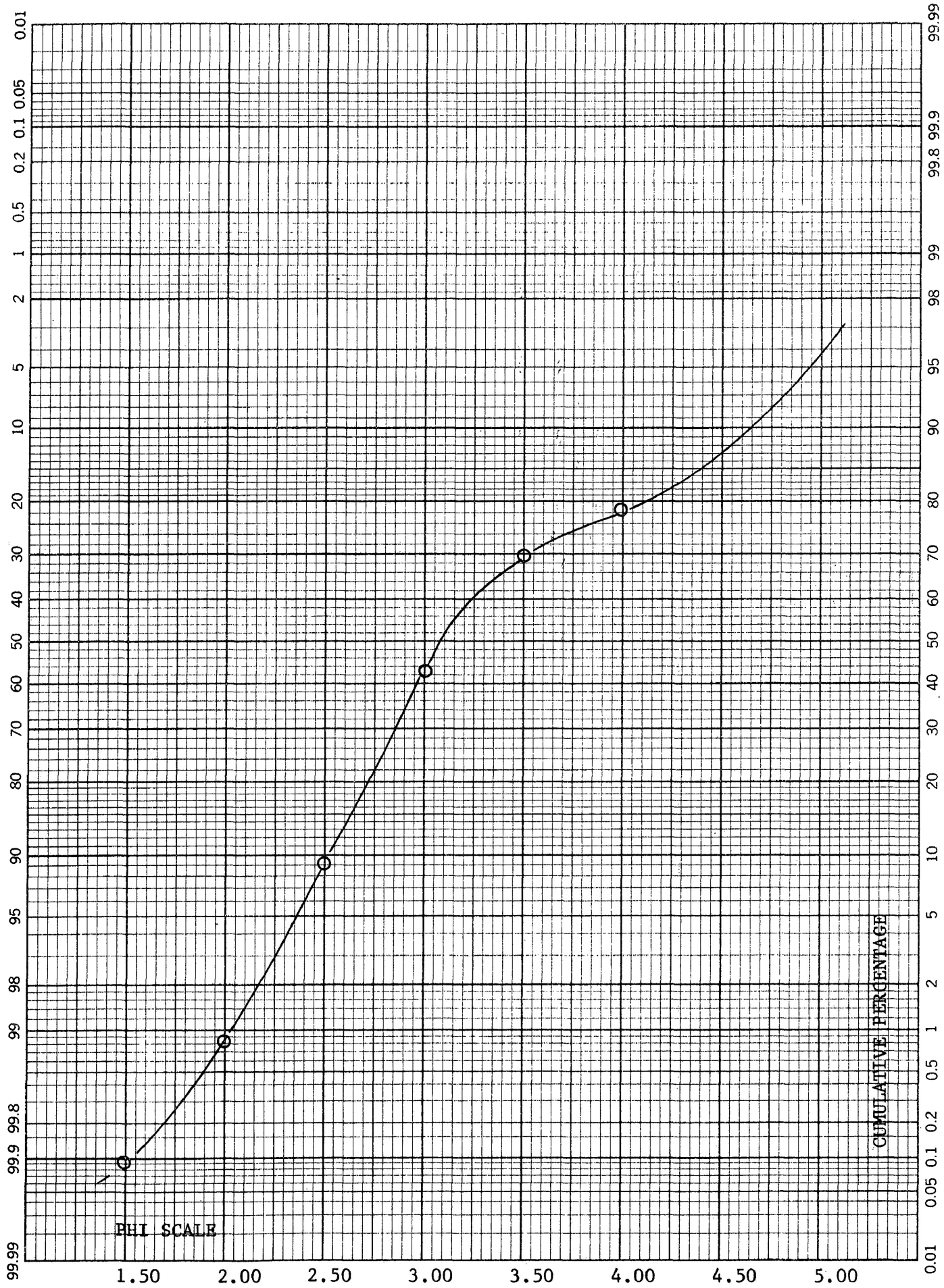

DEPTH:3815
WELL:d-25-B
ZONE:94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00


DEPTH: 3831.4
WELL:d-25-B
ZONE:94-H2
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
PHI SCALE
CUMULATIVE PERCENTAGE
46 8000
KEUFFEL & ESSER CO MADE IN U.S.A.

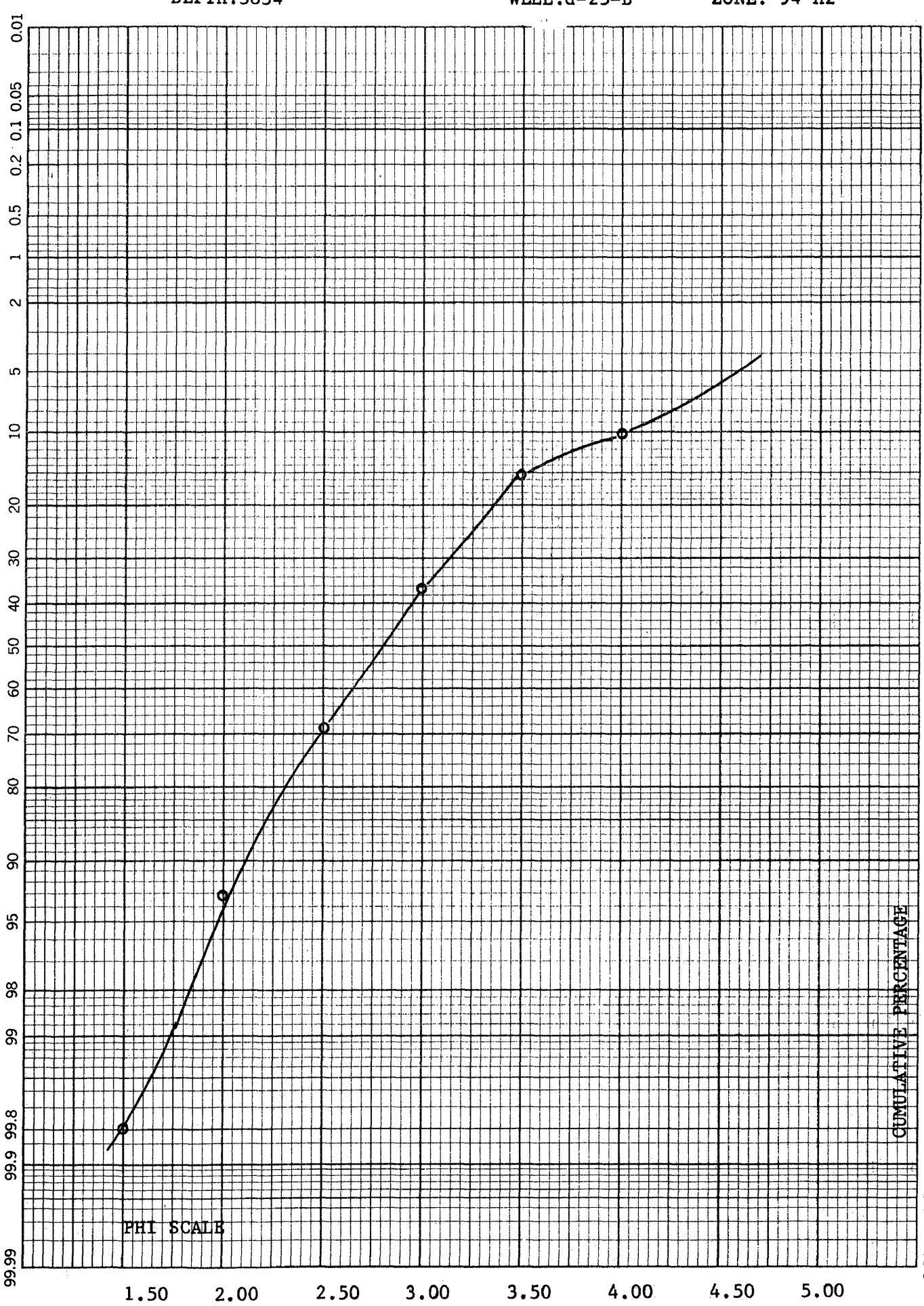
DEPTH: 3831.4 WELL:d-25-B ZONE:94-H2



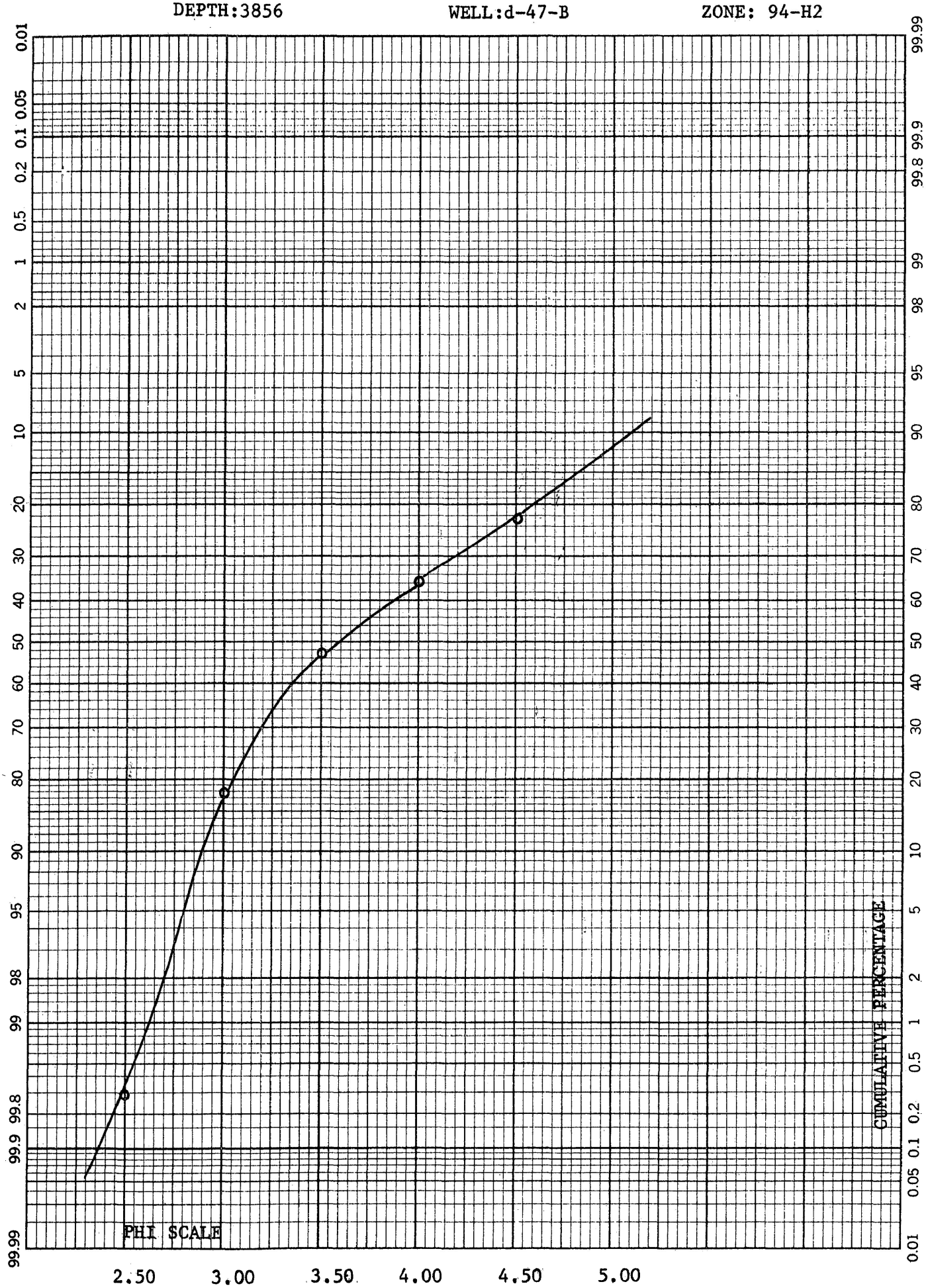
DEPTH:3833 WELL:d-25-B ZONE:94-H2



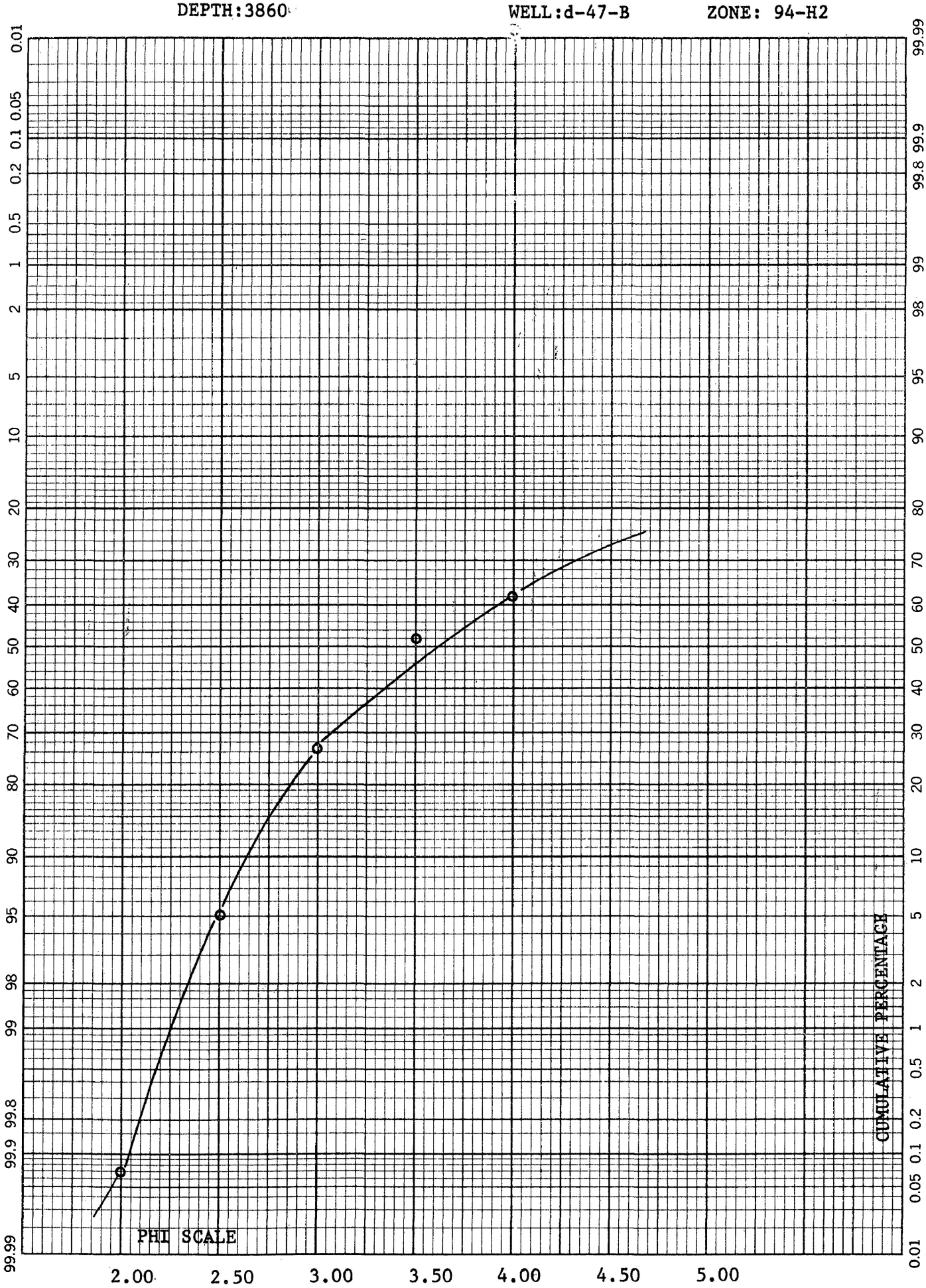
DEPTH:3834 WELL:d-25-B ZONE: 94-H2

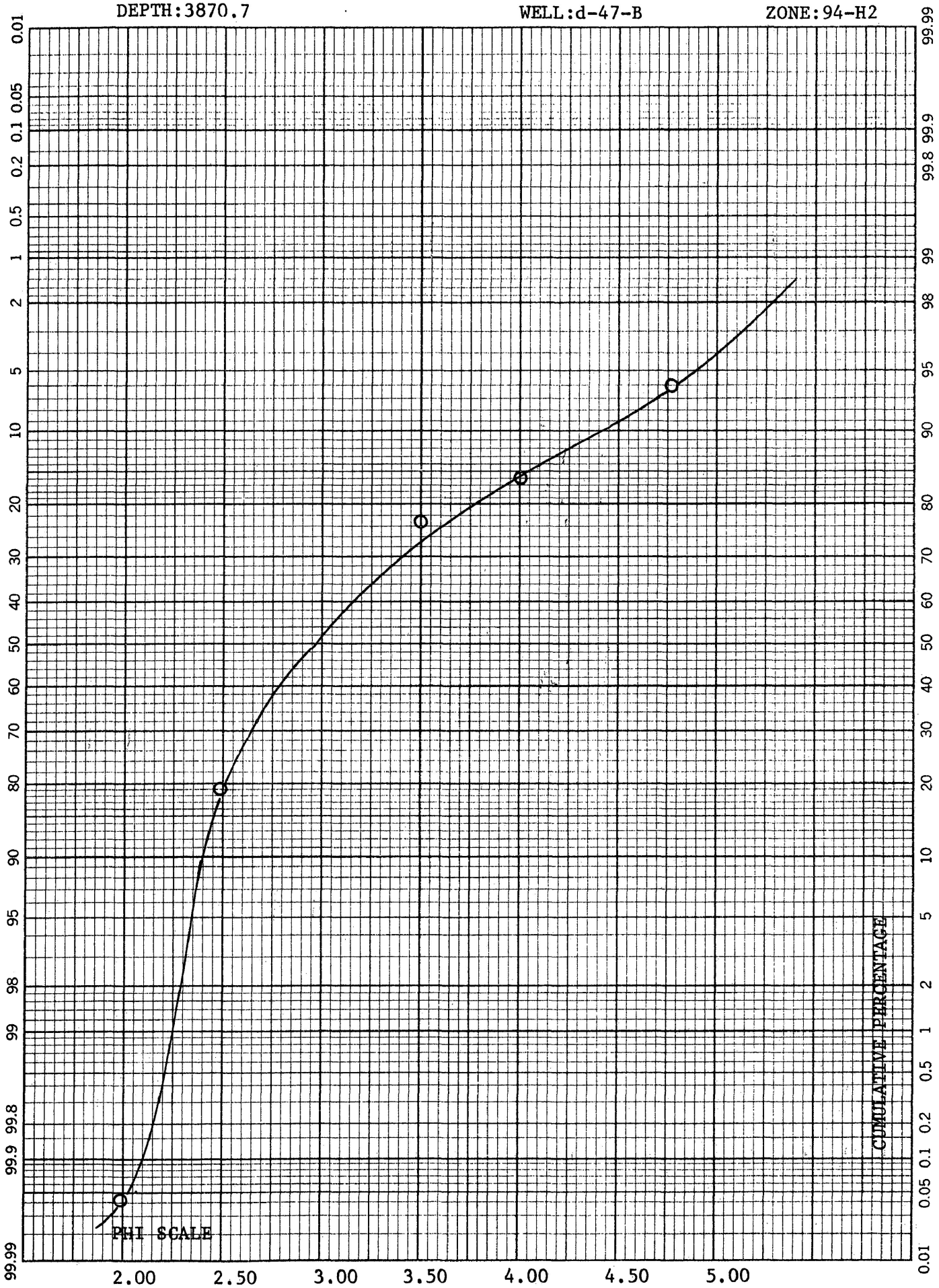


DEPTH:3856 WELL:d-47-B ZONE: 94-H2

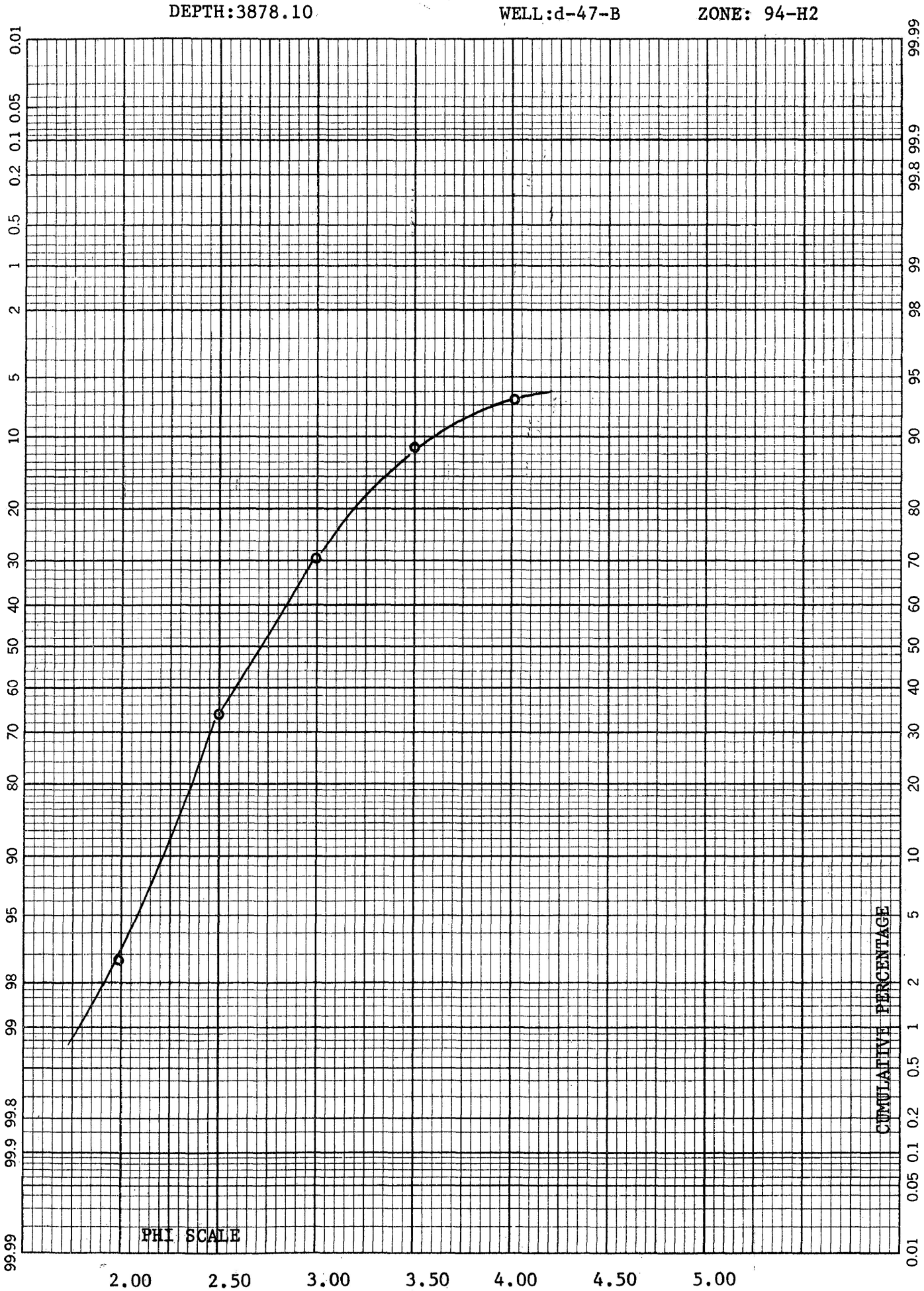


DEPTH:3860 WELL:d-47-B ZONE: 94-H2

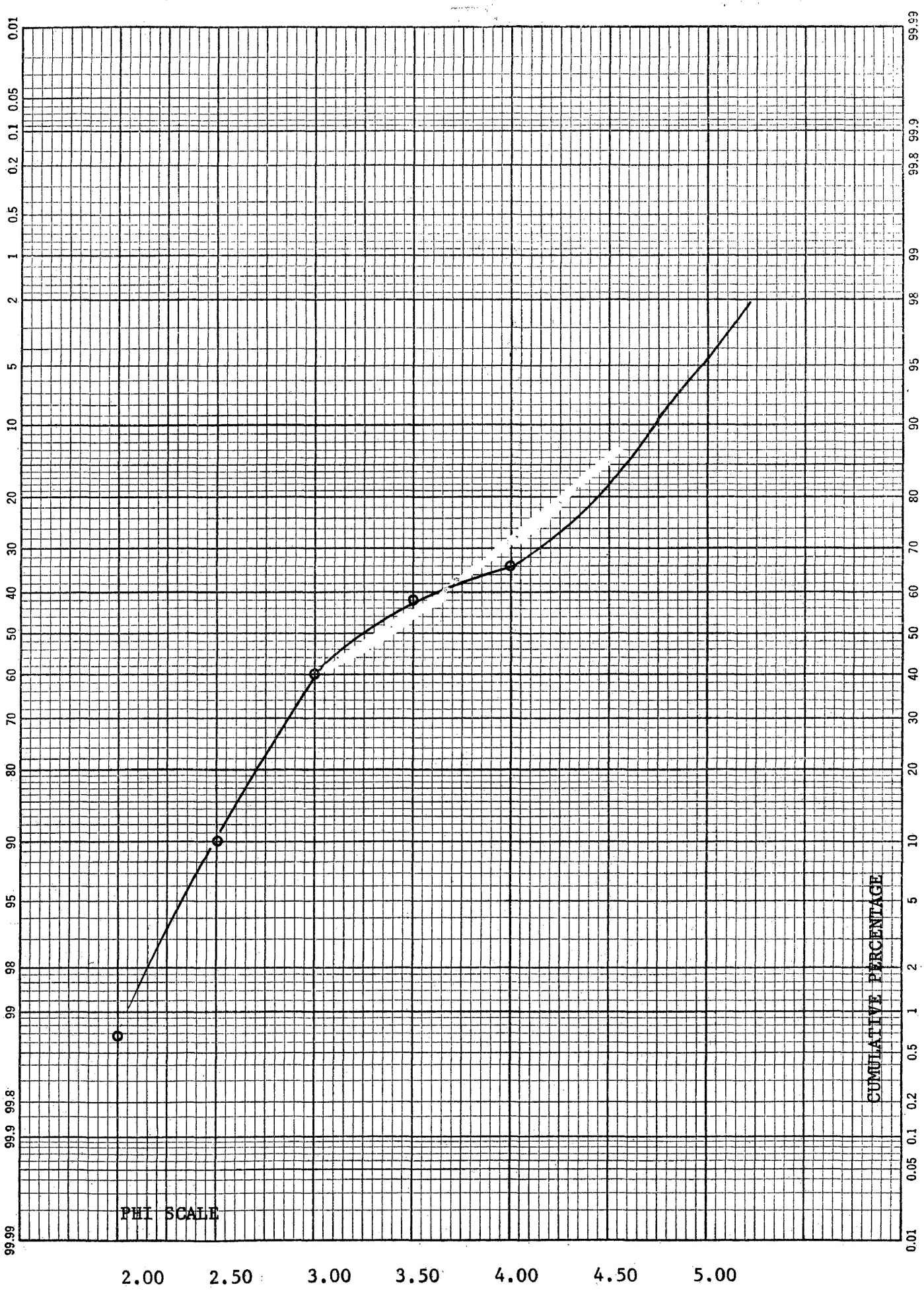


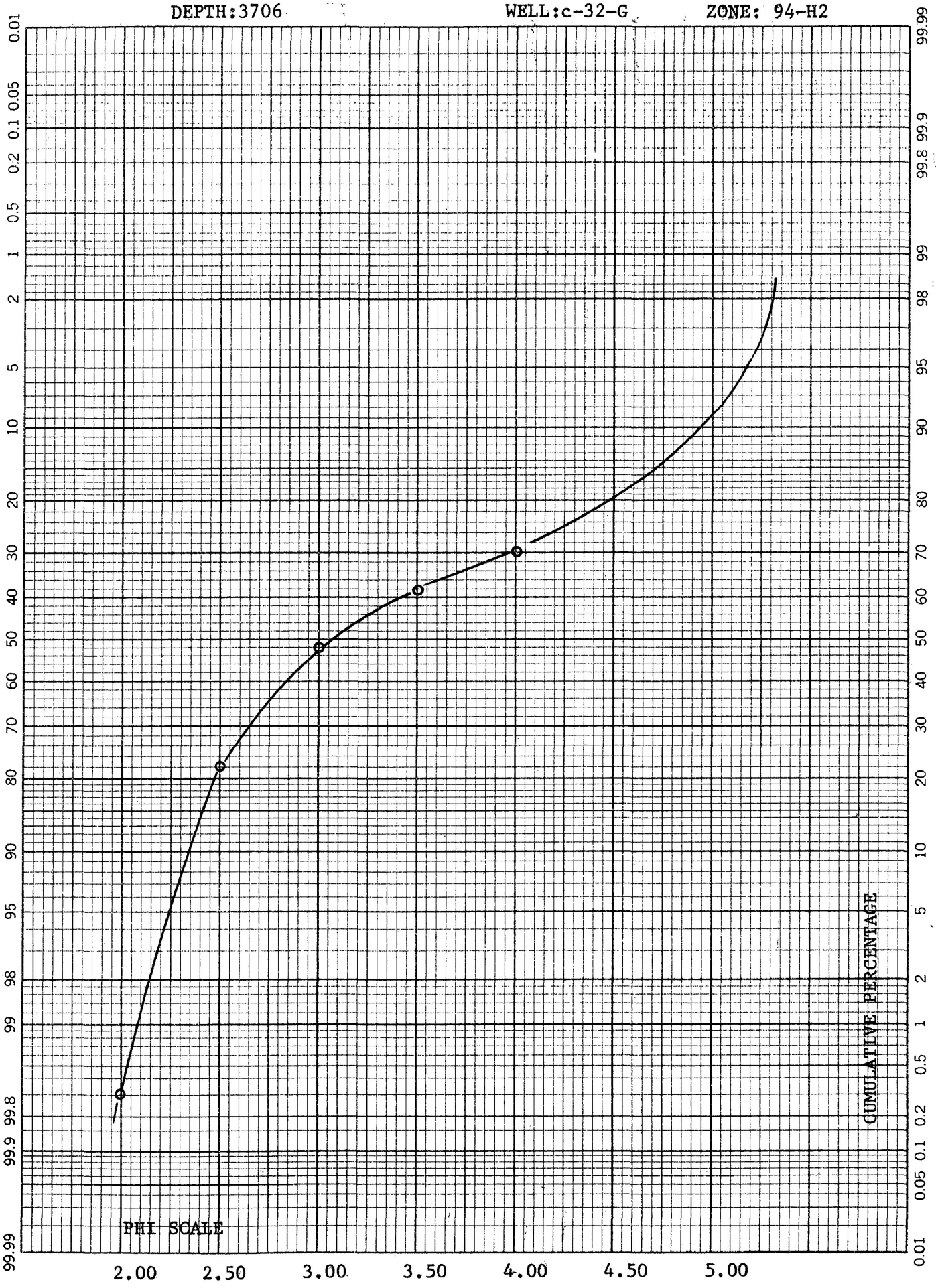

DEPTH:3870.7
WELL:d-47-B
ZONE:94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

DEPTH:3878.10 WELL:d-47-B ZONE: 94-H2



DEPTH:3704 WELL:c-32-G ZONR:94-H2




DEPTH:3706
WELL:c-32-G
ZONE: 94-H2
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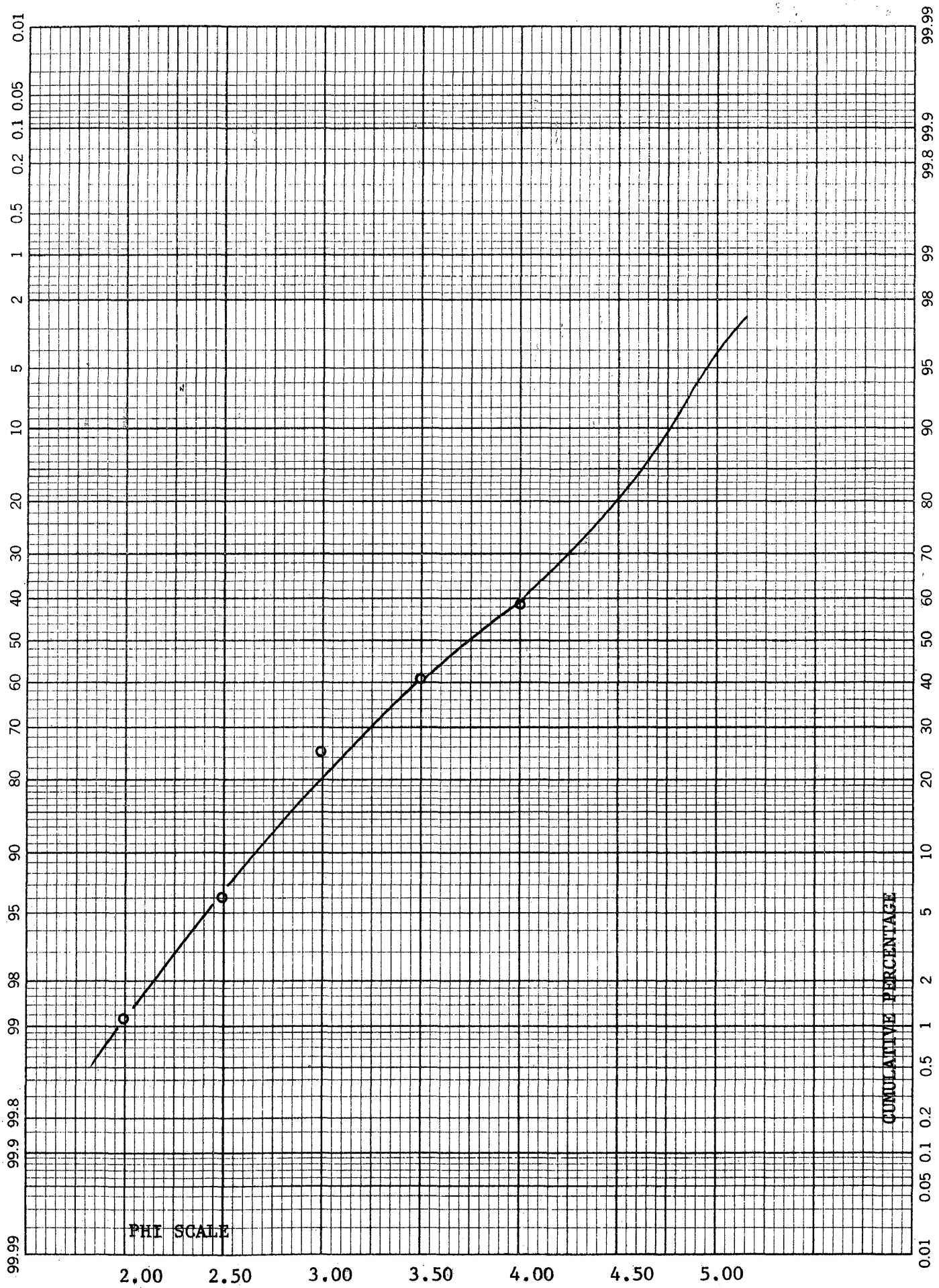
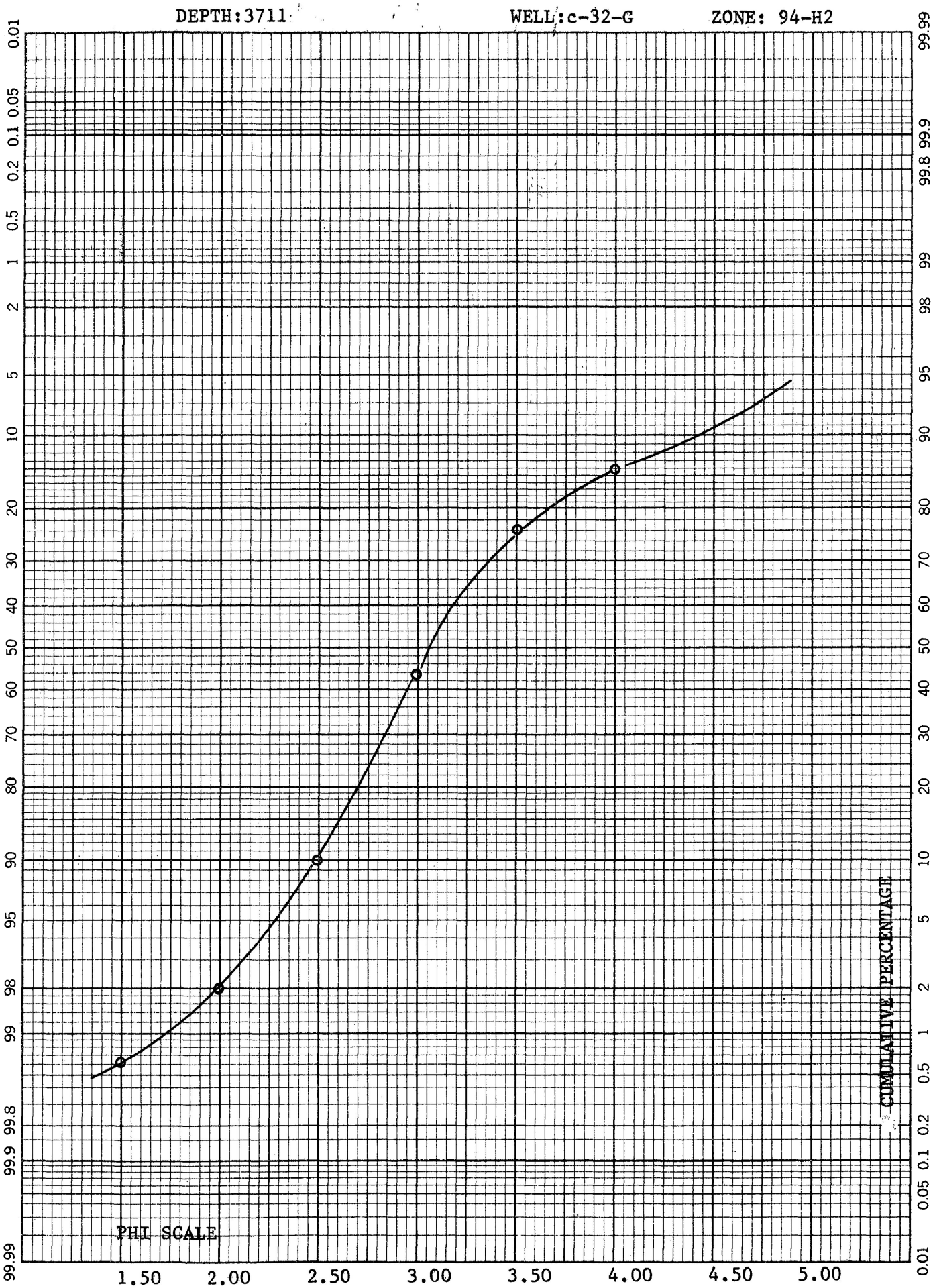
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

DEPTH:3707 WELL:c-32-G ZONE:94-H2




DEPTH:3711
WELL:c-32-G
ZONE: 94-H2
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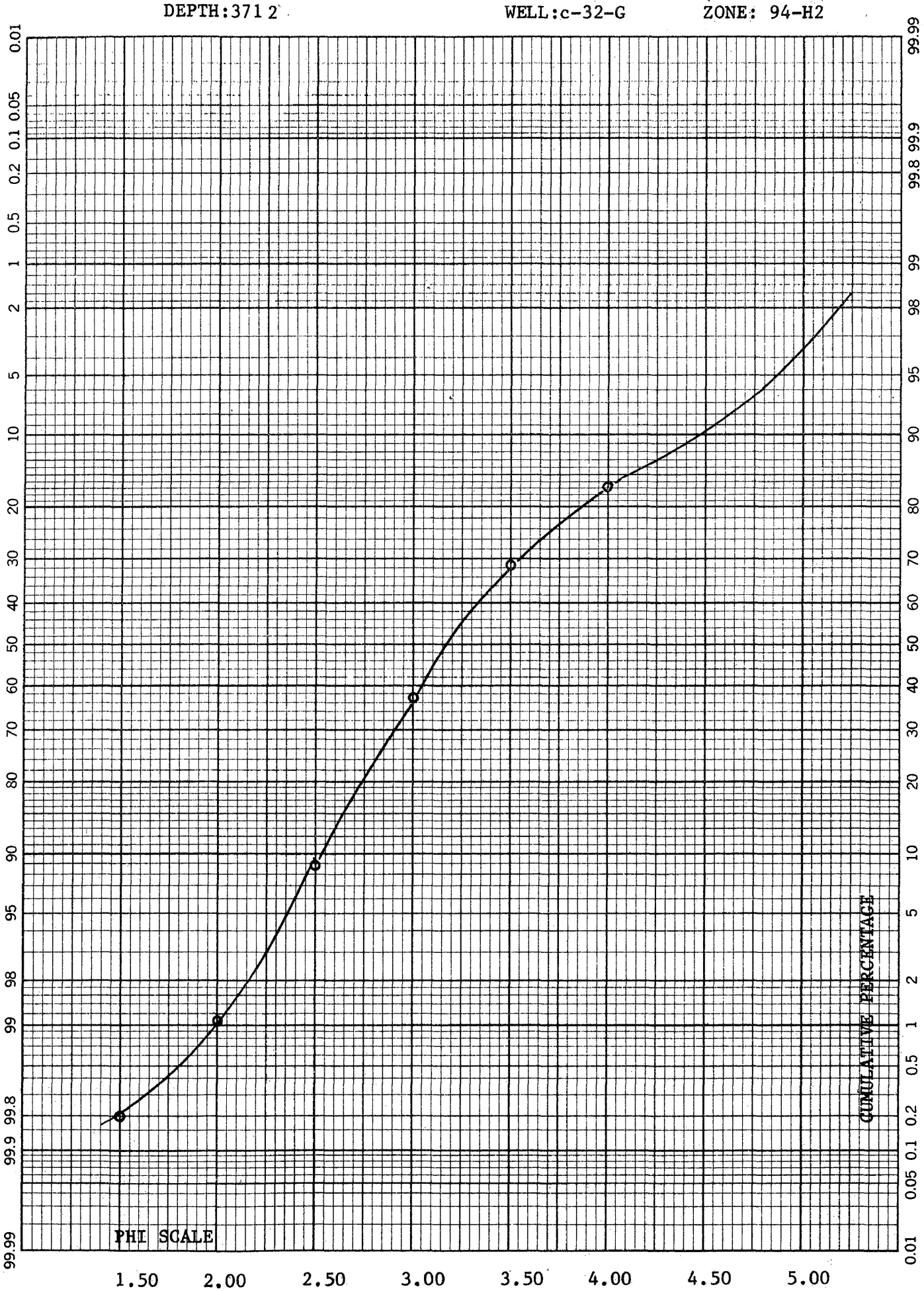
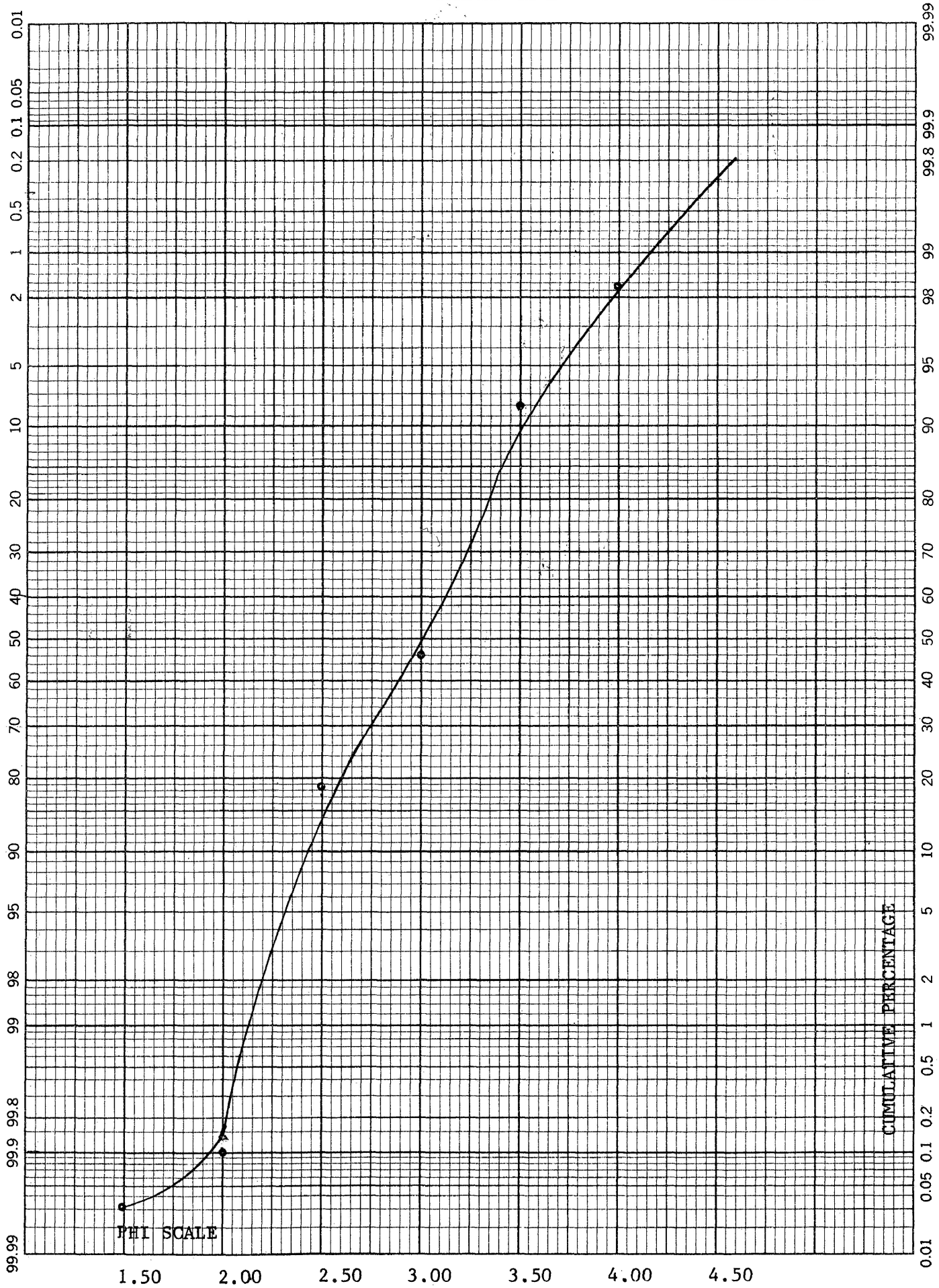
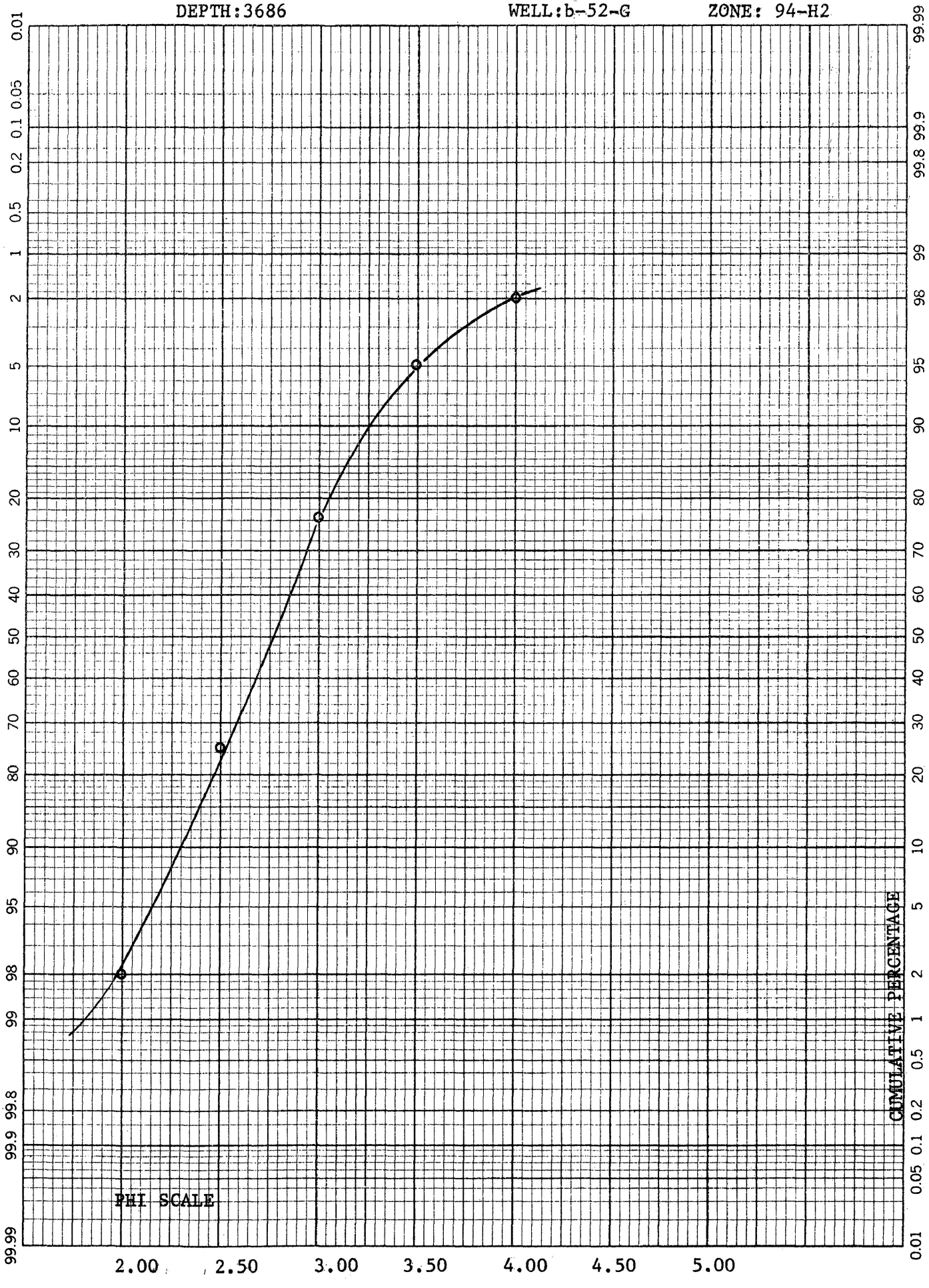
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00

DEPTH:3712 WELL:c-32-G ZONE: 94-H2



DEPTH:3702 WELL:b-42-G ZONE:94-H2




DEPTH:3686
WELL:b-52-G
ZONE: 94-H2
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
99.99
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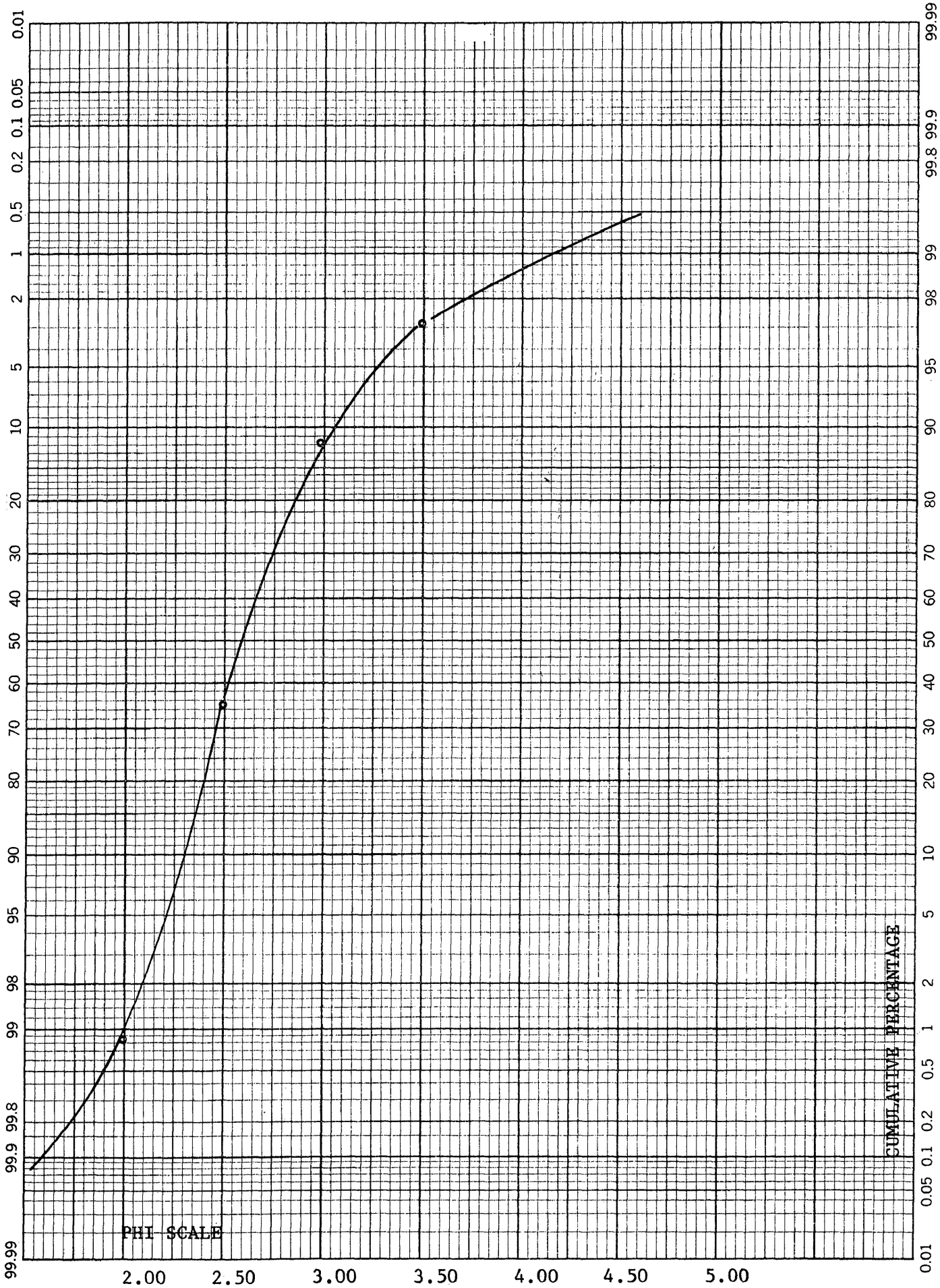
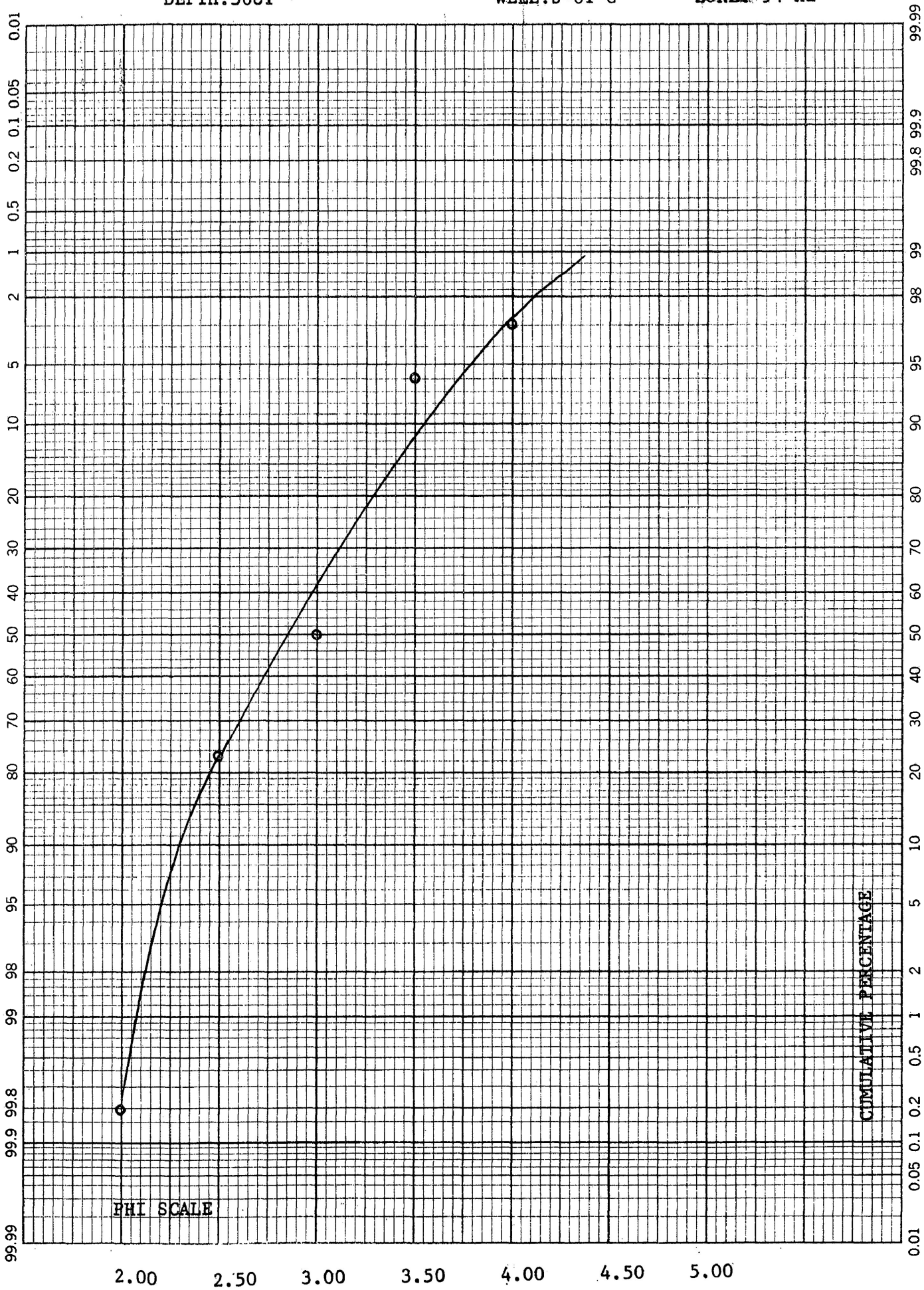
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00
2.50
3.00
3.50
4.00
4.50
5.00

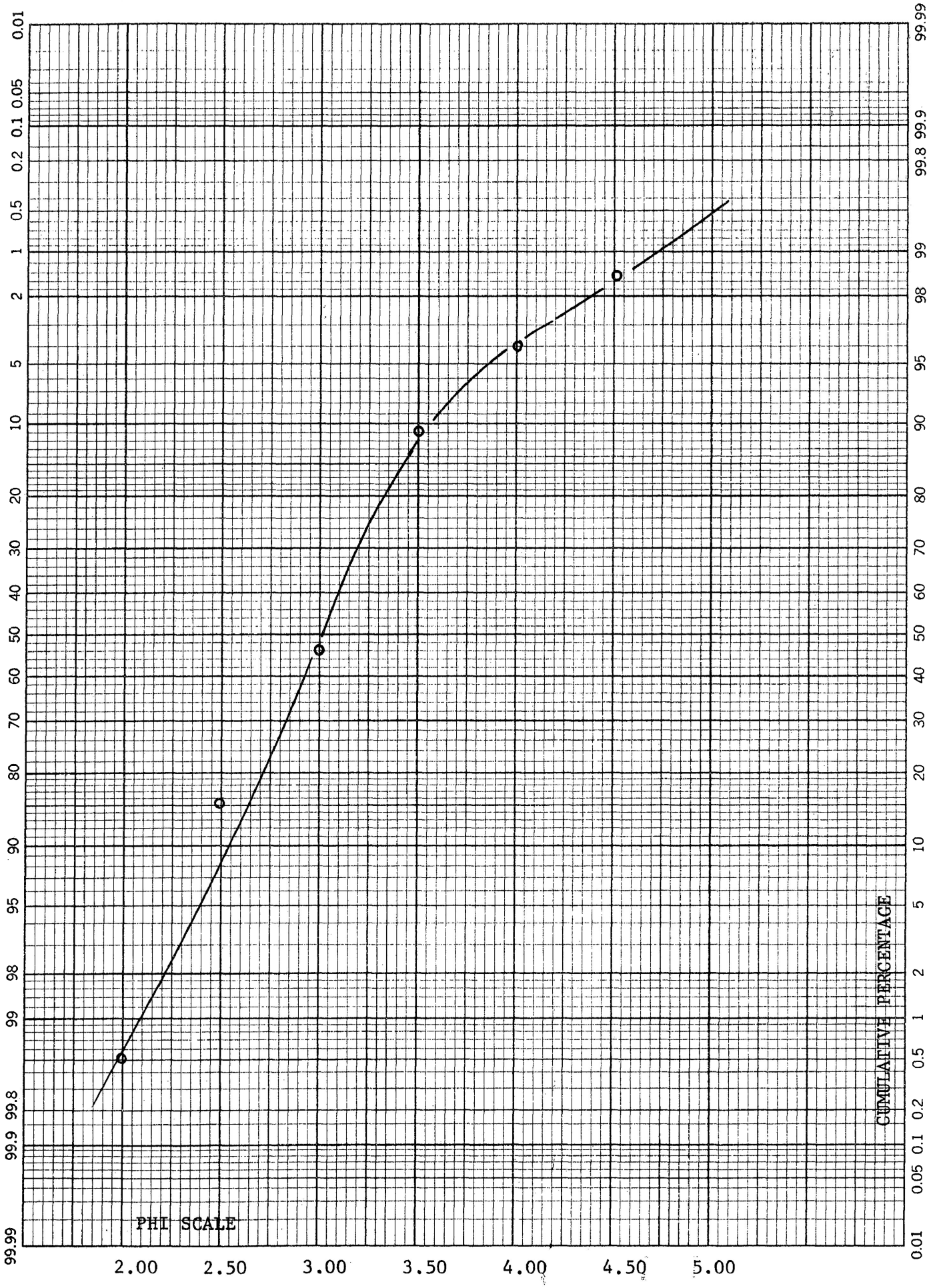
DEPTH:3699 WELL:d-53-G ZONE:94-H2

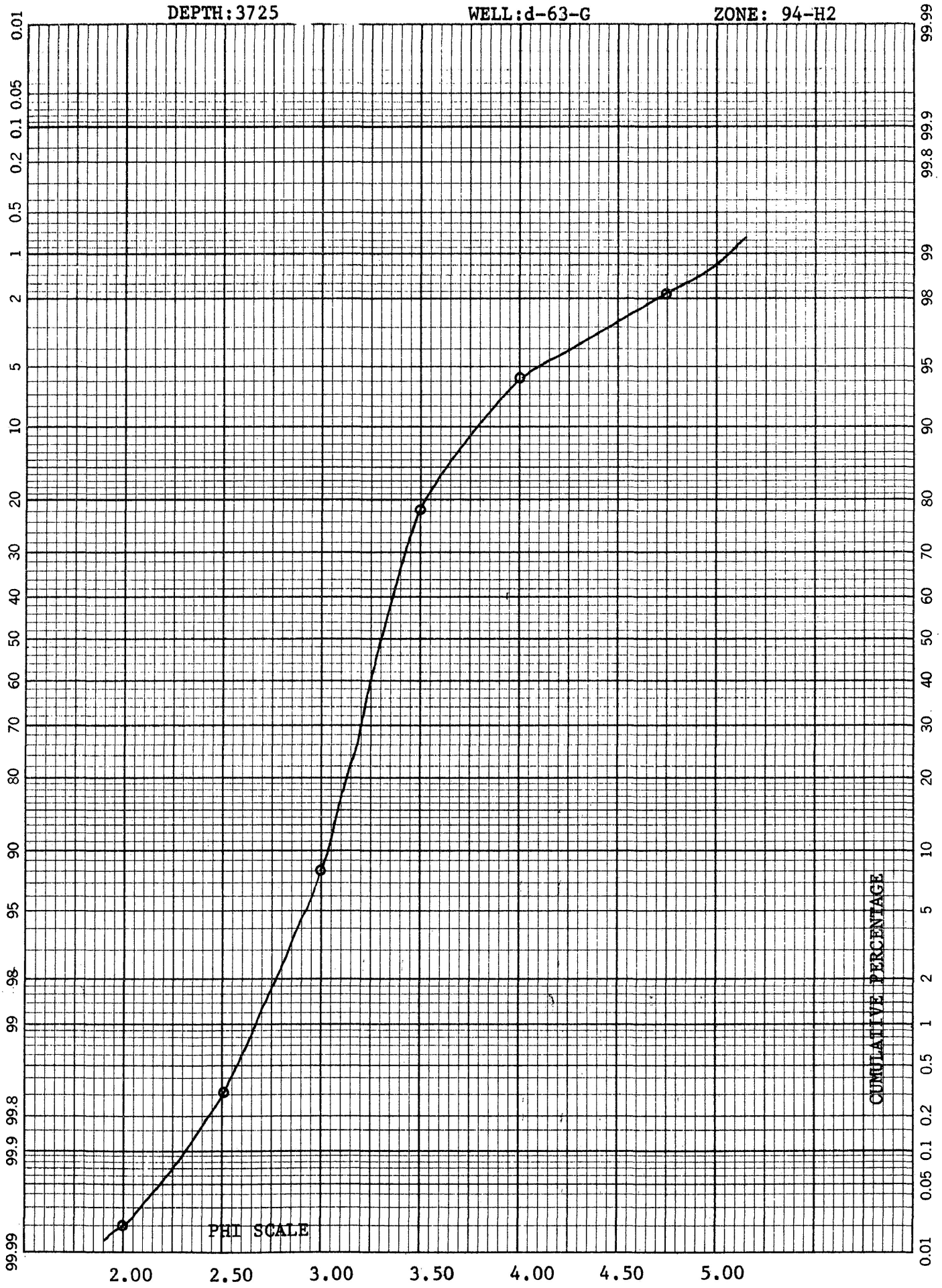


DEPTH:3681 WELL:b-61-G ZONE: 94-H2

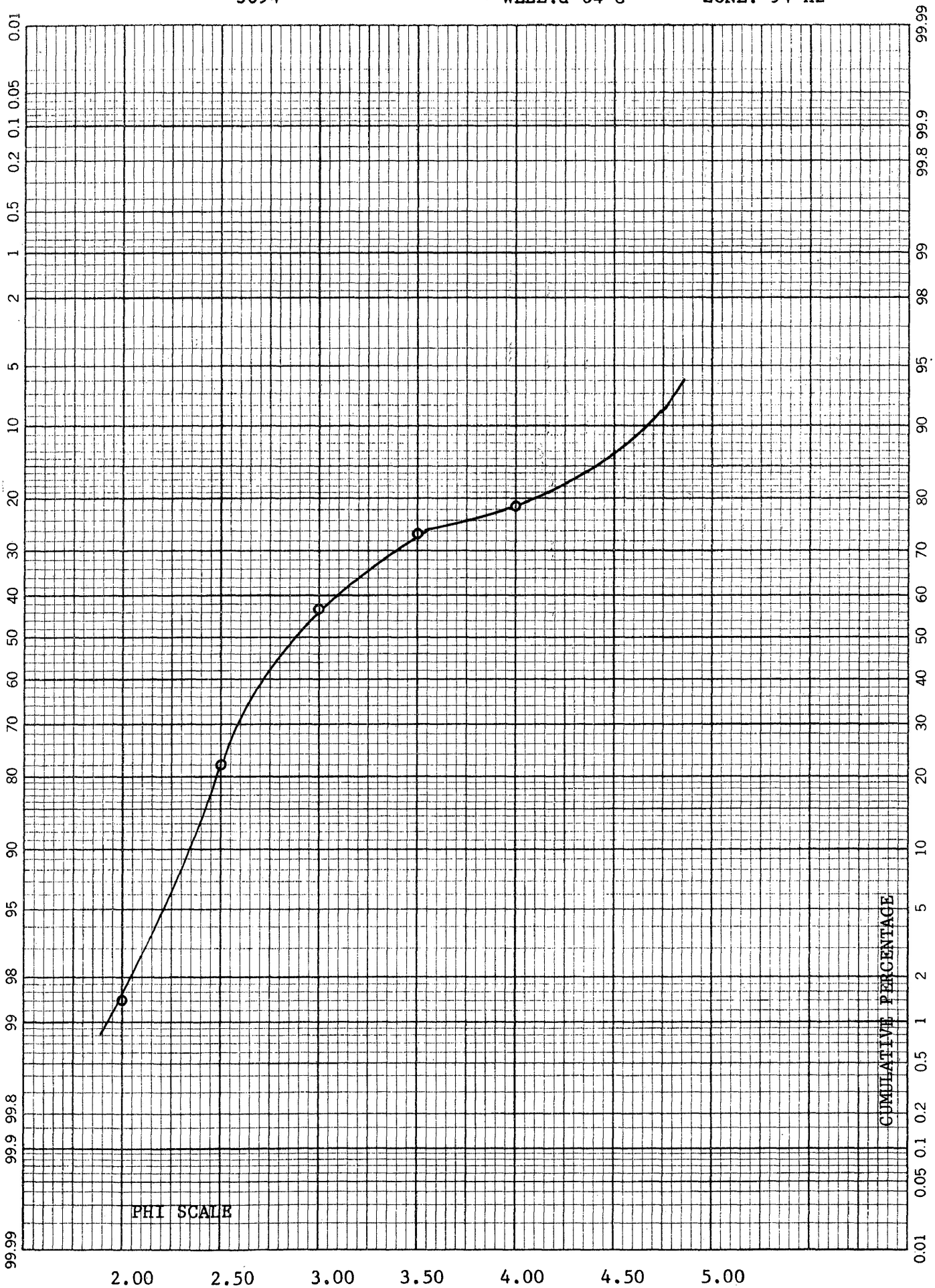


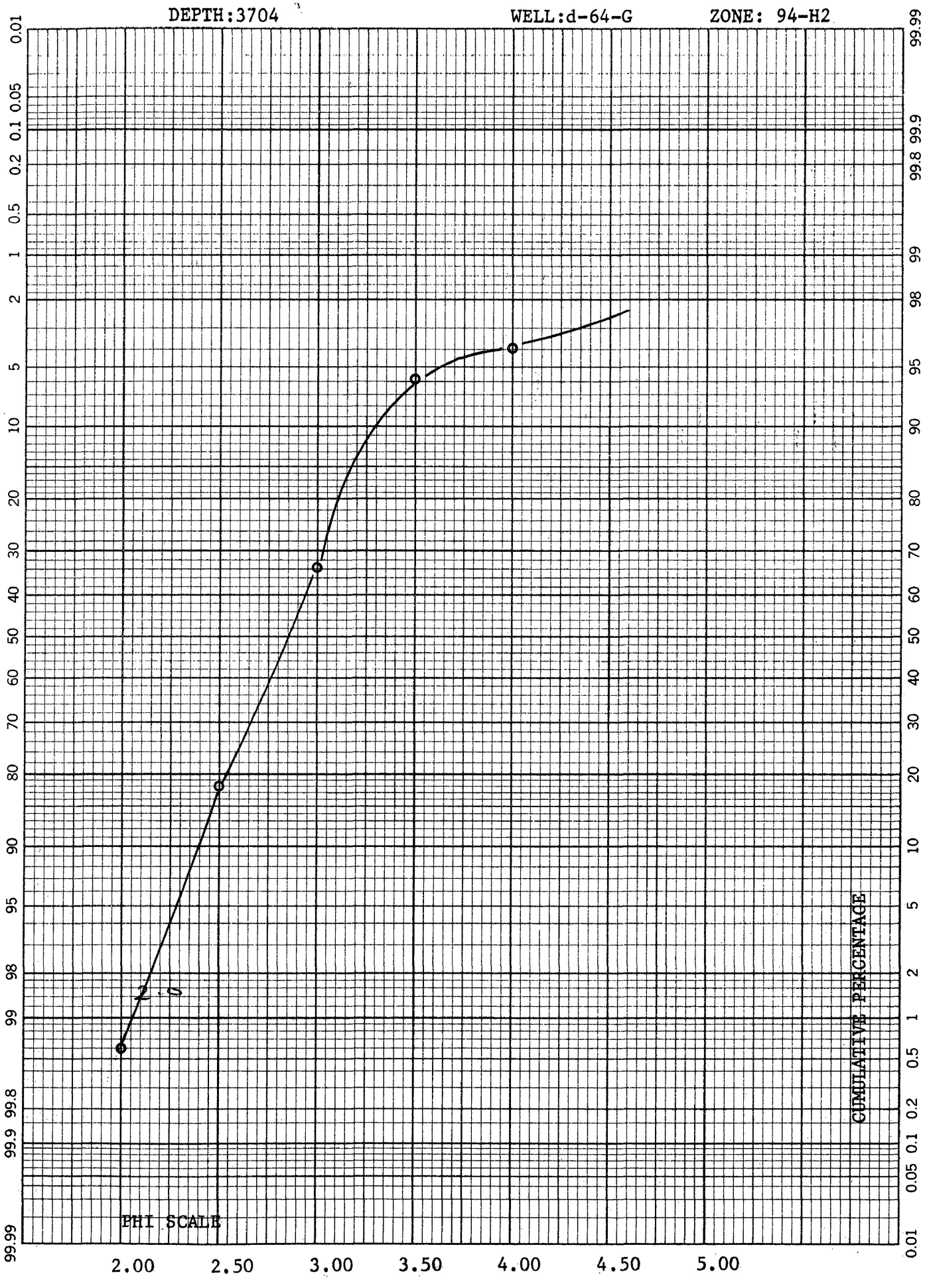
DEPTH:3724 WELL:d-63-G ZONE:94-H2




DEPTH:3725
WELL:d-63-G
ZONE: 94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

DEPTH 3694 WELL:d-64-G ZONE: 94-H2




DEPTH:3704
WELL:d-64-G
ZONE: 94-H2
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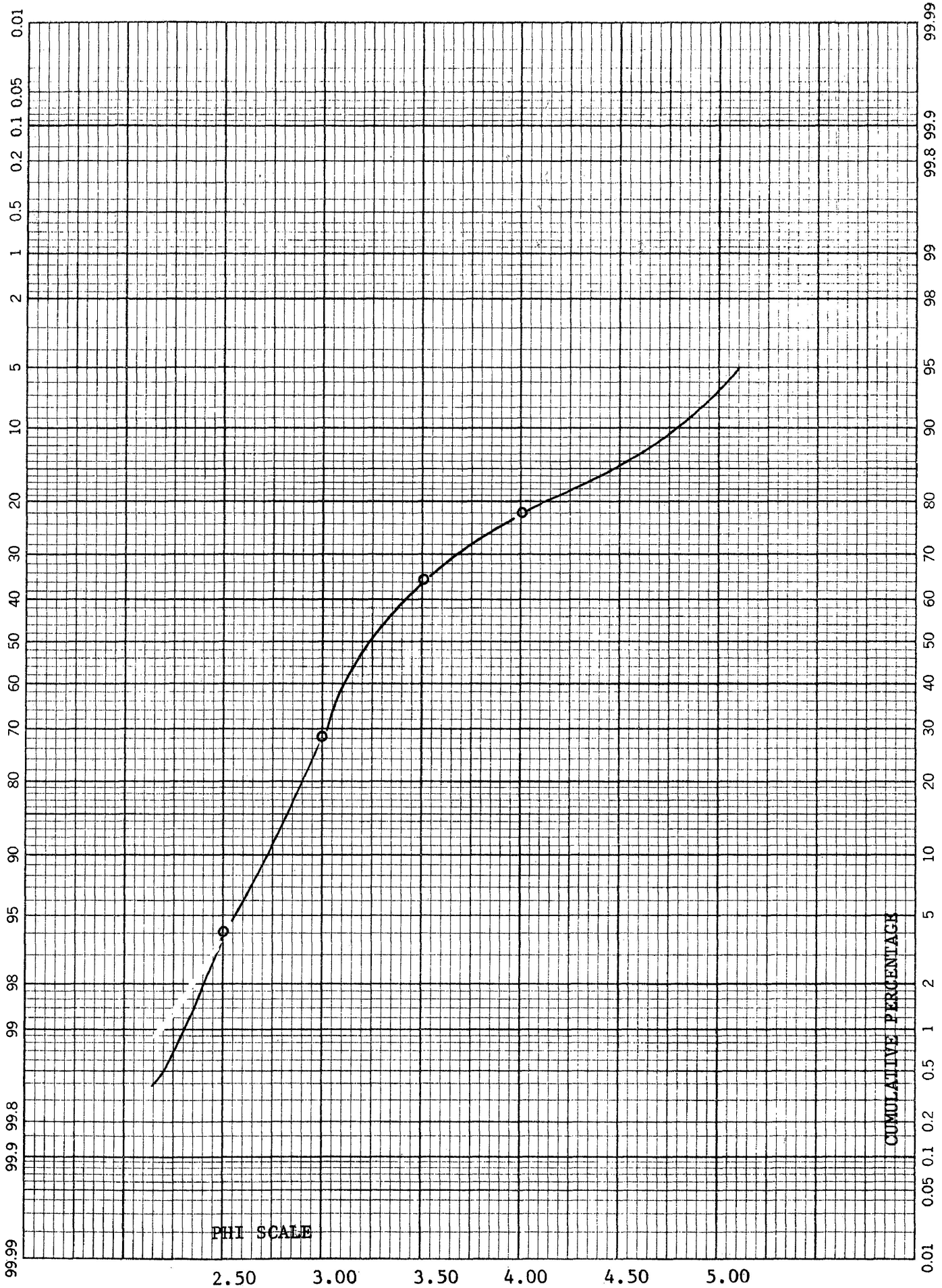
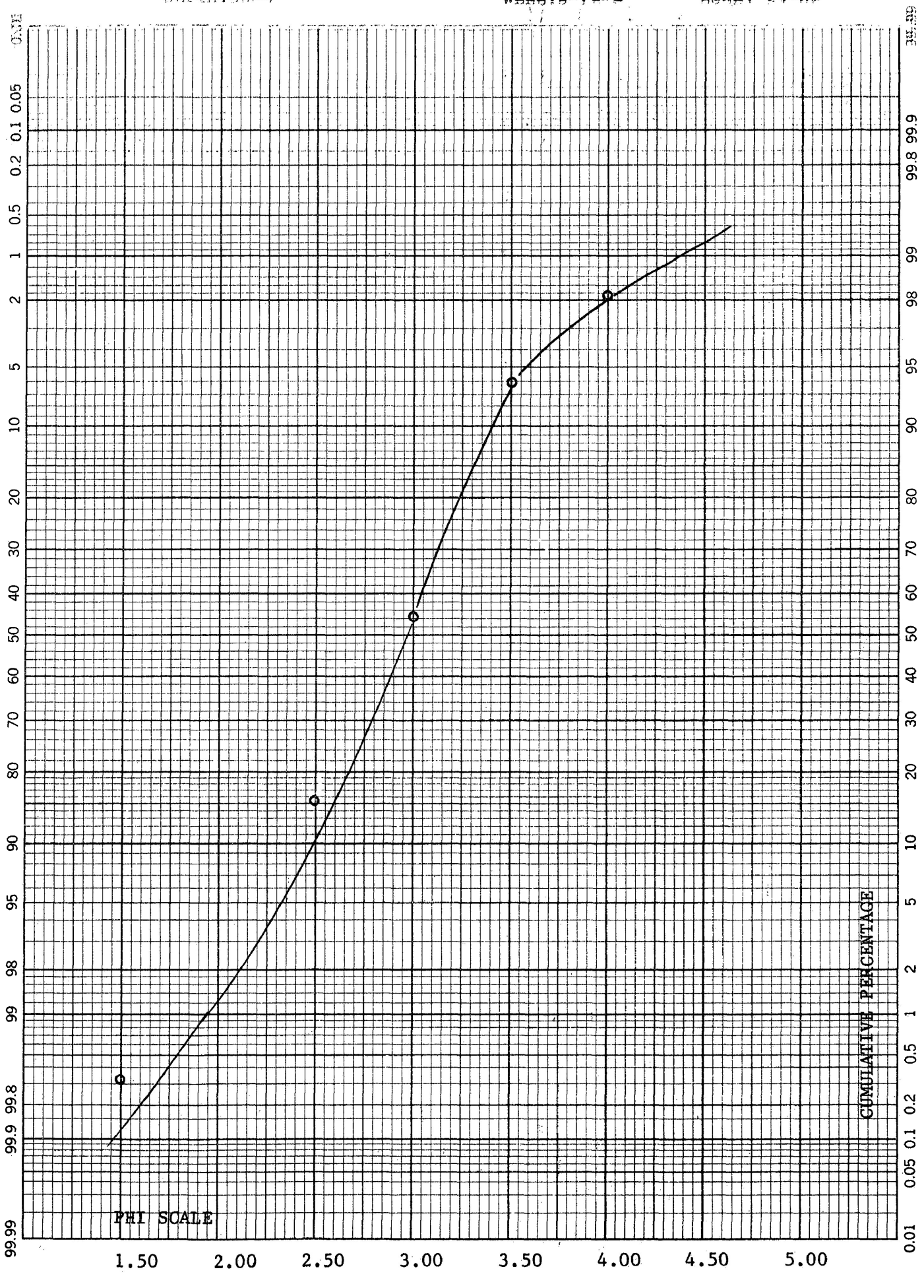
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.00 2.50 3.00 3.50 4.00 4.50 5.00

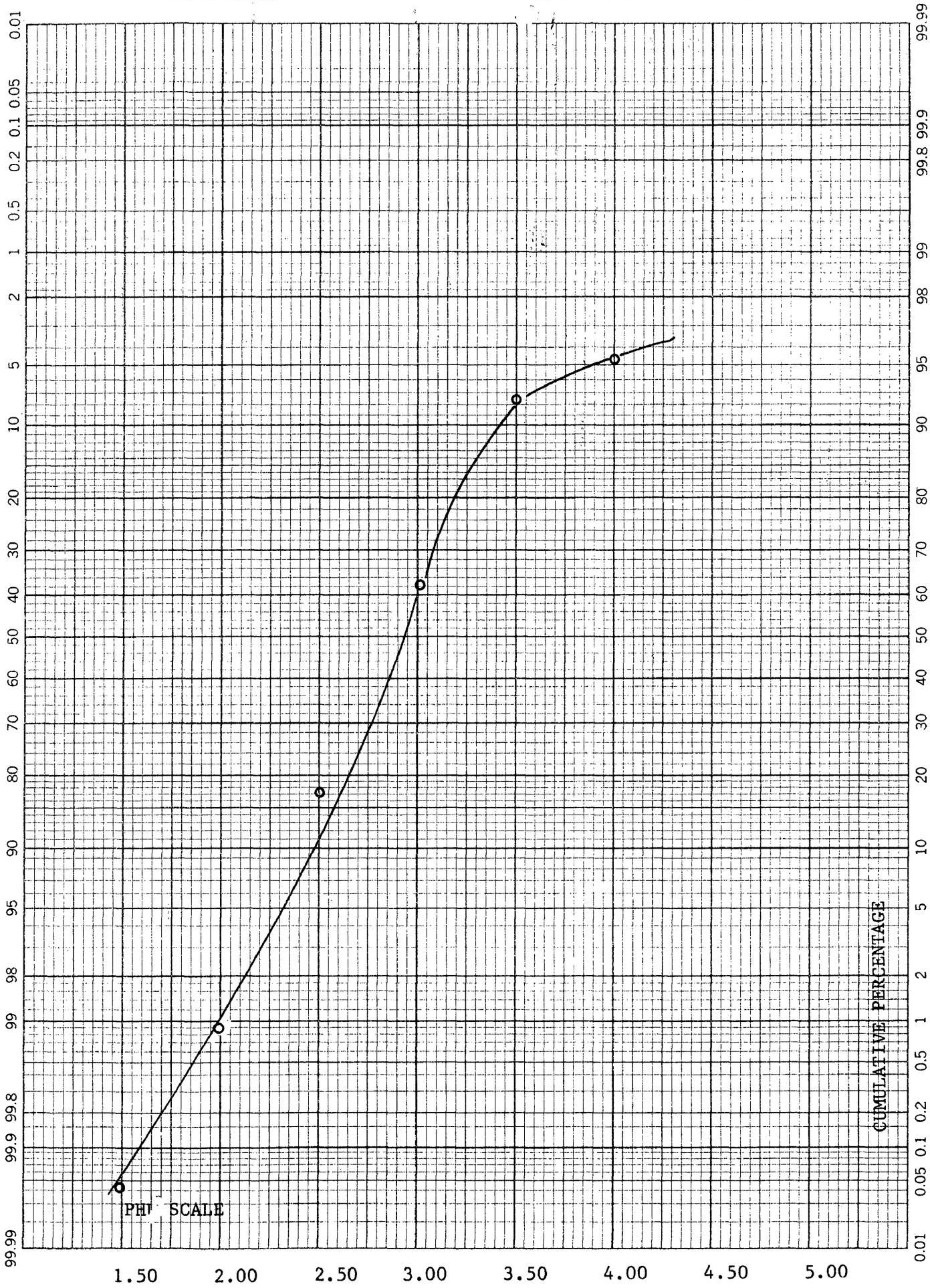
depth;3702 WELL:d-66-G ZONE: 94-H2



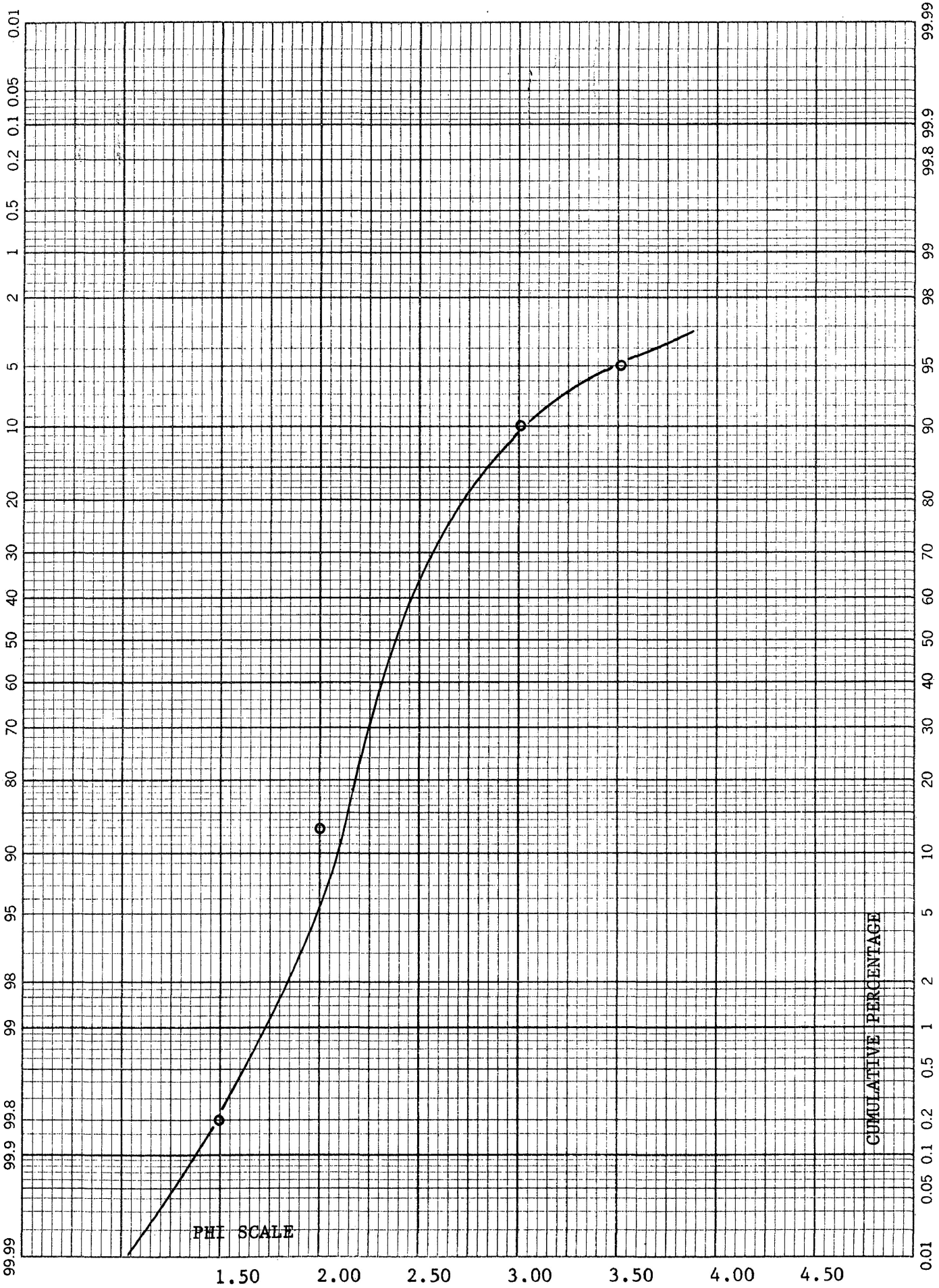
DEPTH:3688 WELL:b-72-G ZONE: 94-H2

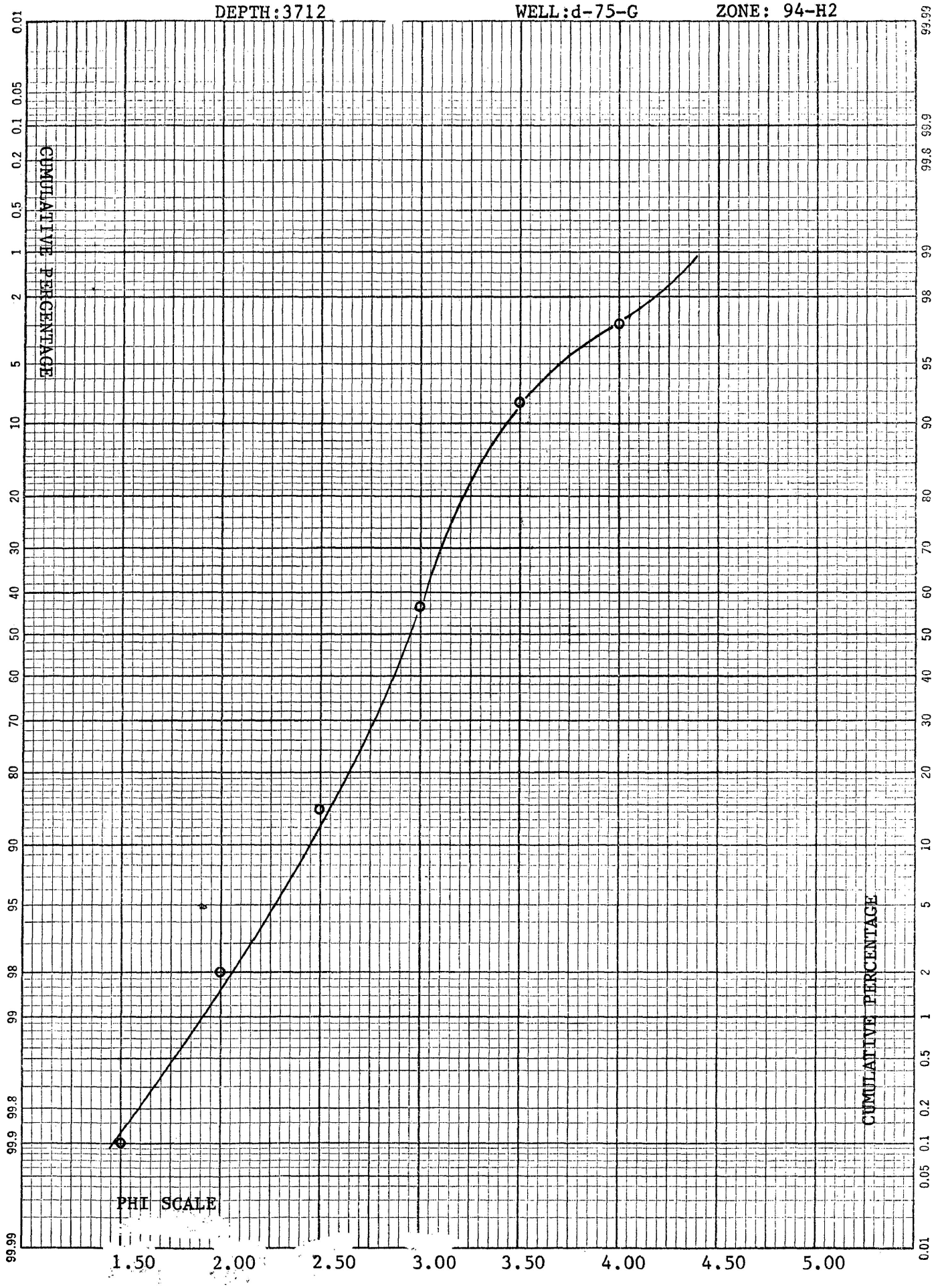


DEPTH:3705 WELL:d-74-G ZONE: 94-H2

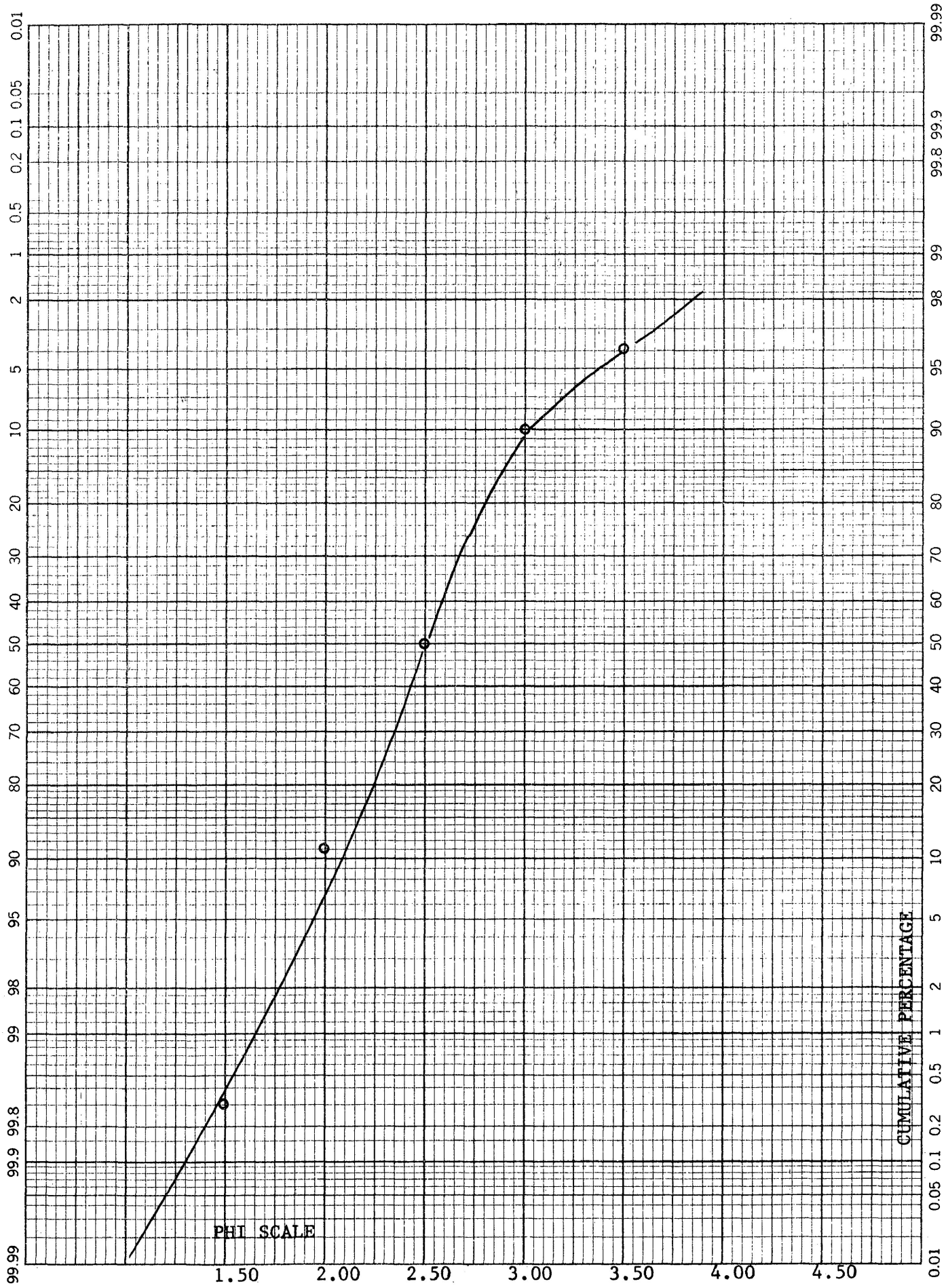


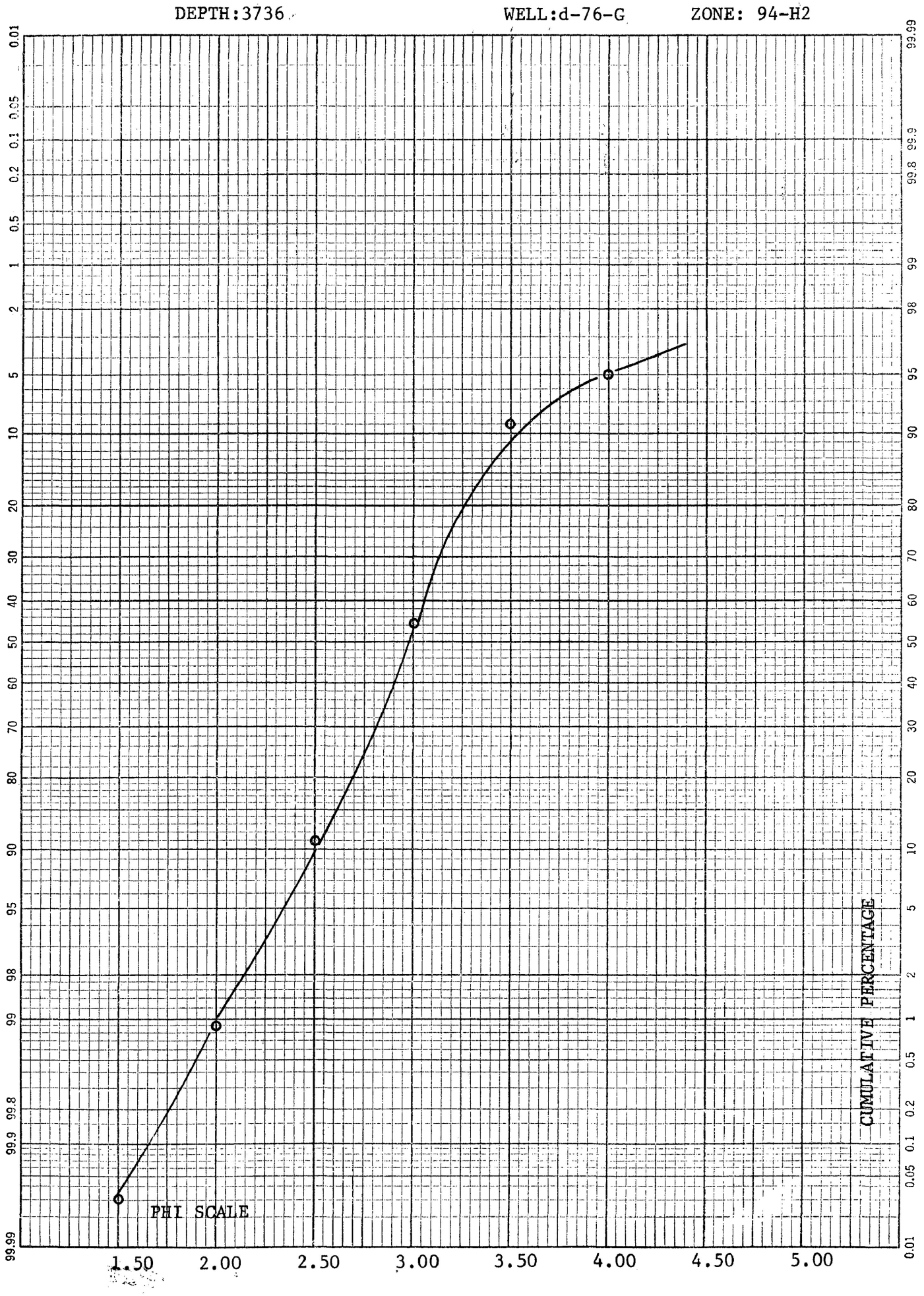
DEPTH:3710 208 WELL:d-74-G ZONE: 94-H2




DEPTH:3712
WELL:d-75-G
ZONE: 94-H2
CUMULATIVE PERCENTAGE
CUMULATIVE PERCENTAGE
PHI SCALE
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99

DEPTH:3715 210 WELL:d-74-G ZONE: 94-H2




DEPTH:3736
WELL:d-76-G
ZONE: 94-H2
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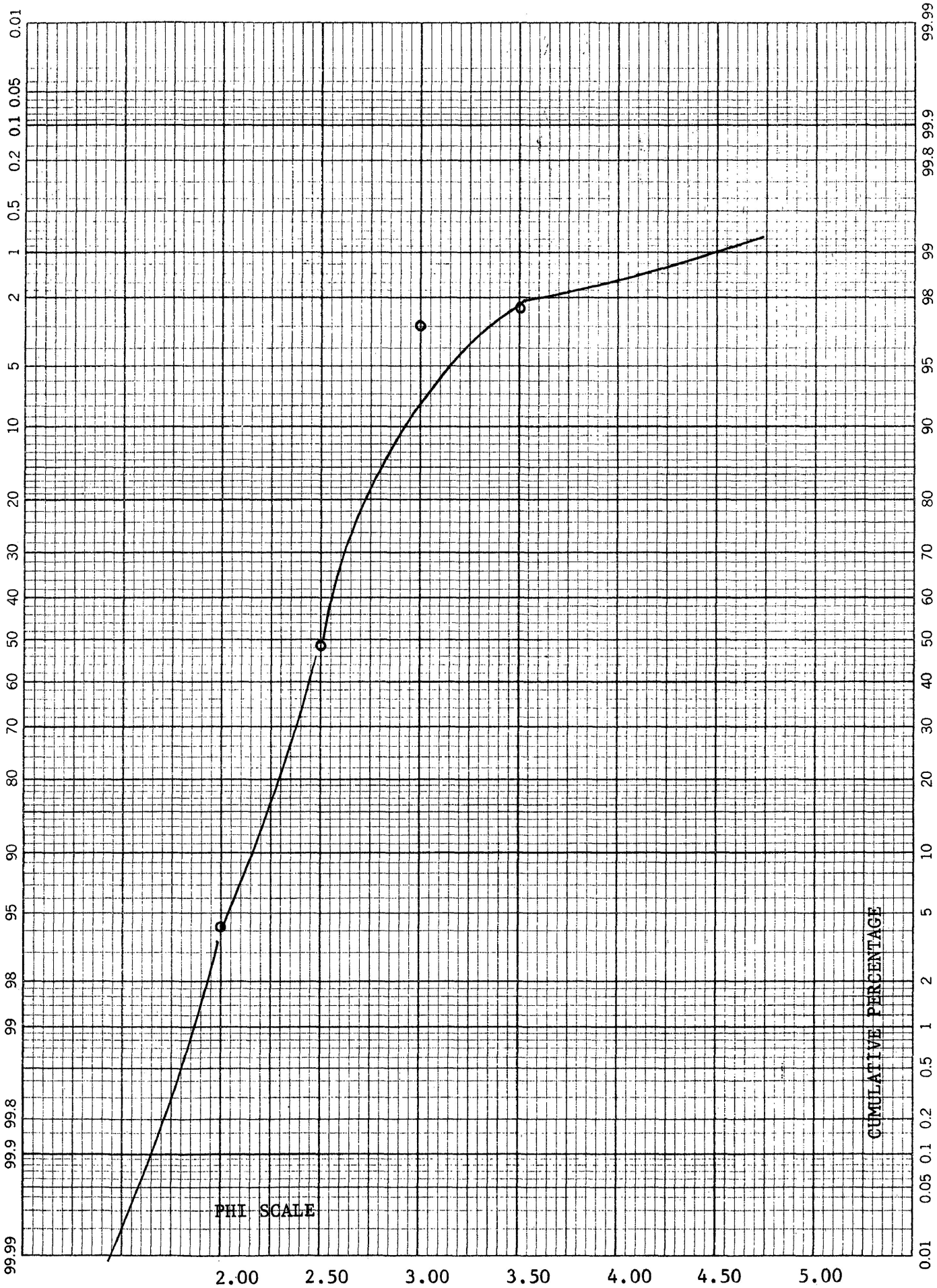
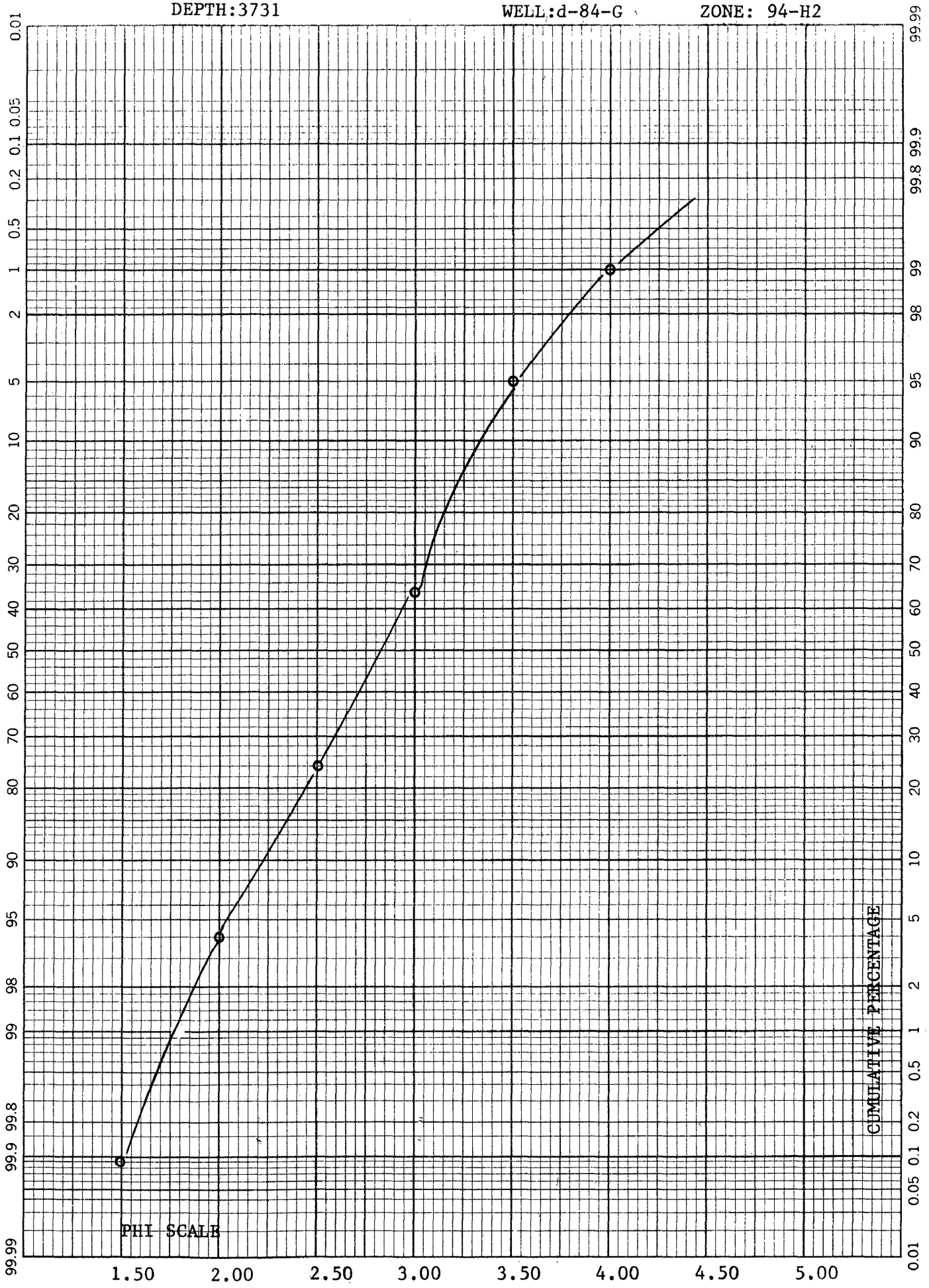
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
PHI SCALE
CUMULATIVE PERCENTAGE

DEPTH:3670 WELL:d-83-G ZONE: 94-H2




DEPTH:3731
WELL:d-84-G
ZONE: 94-H2
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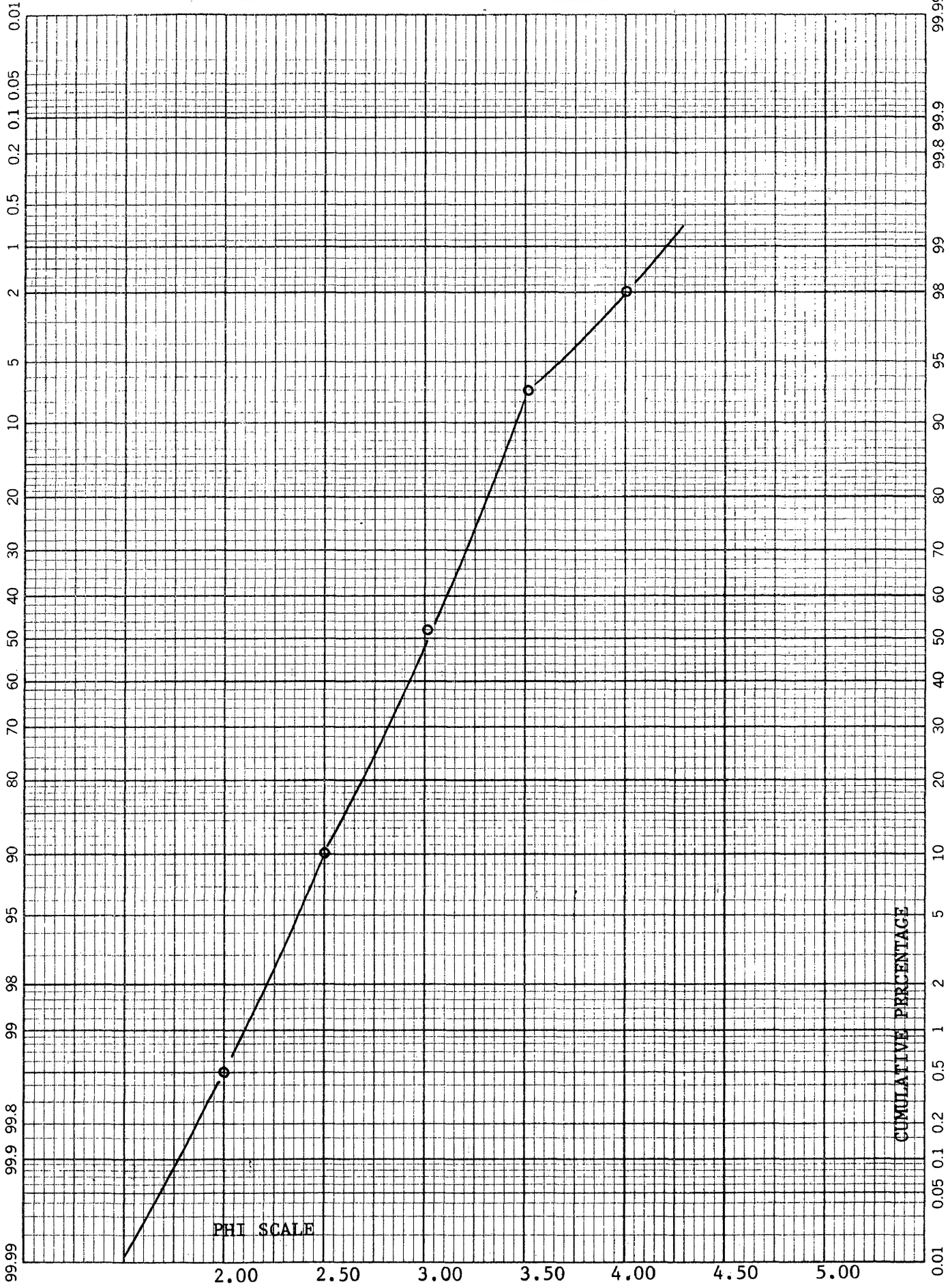
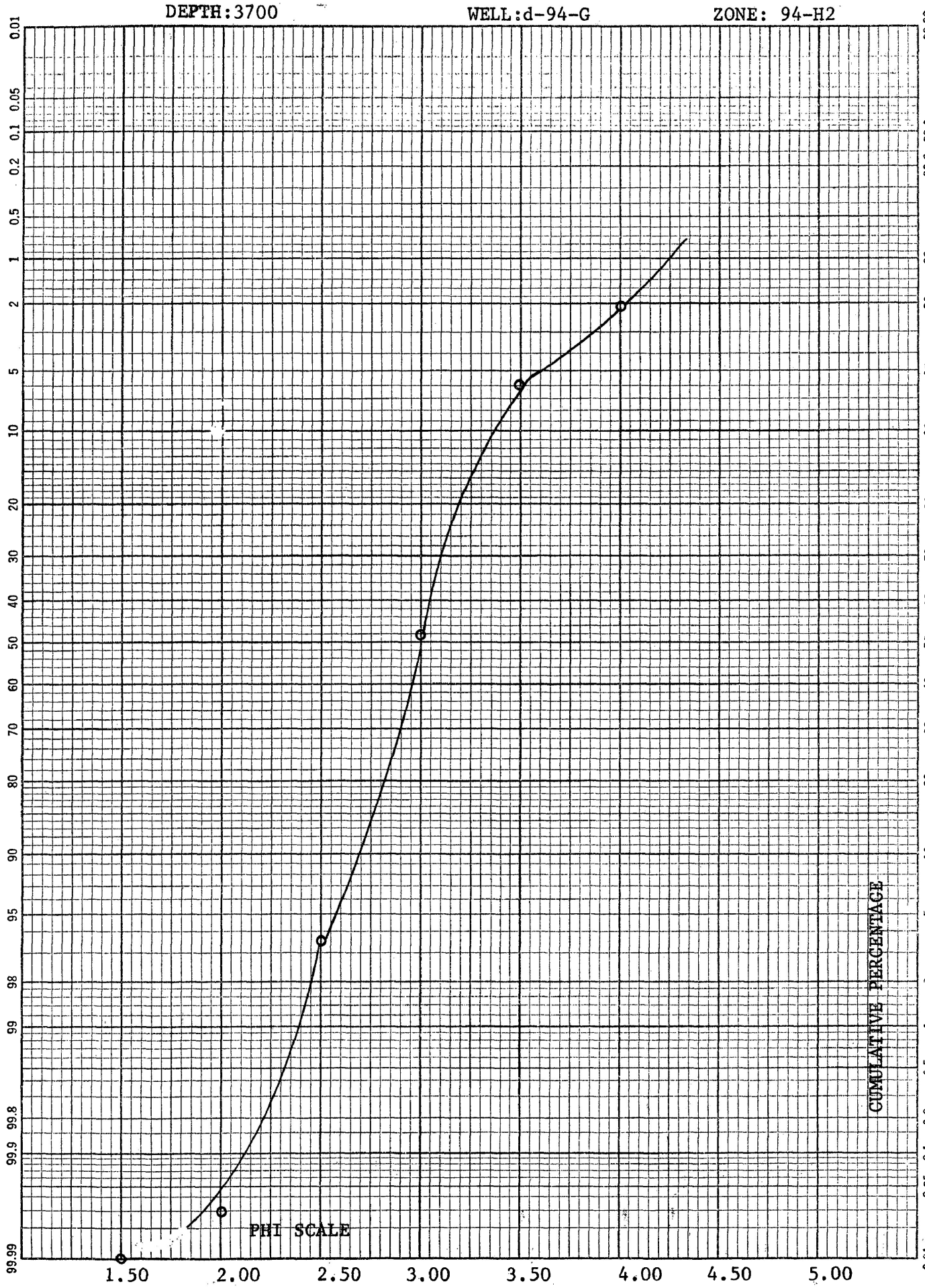
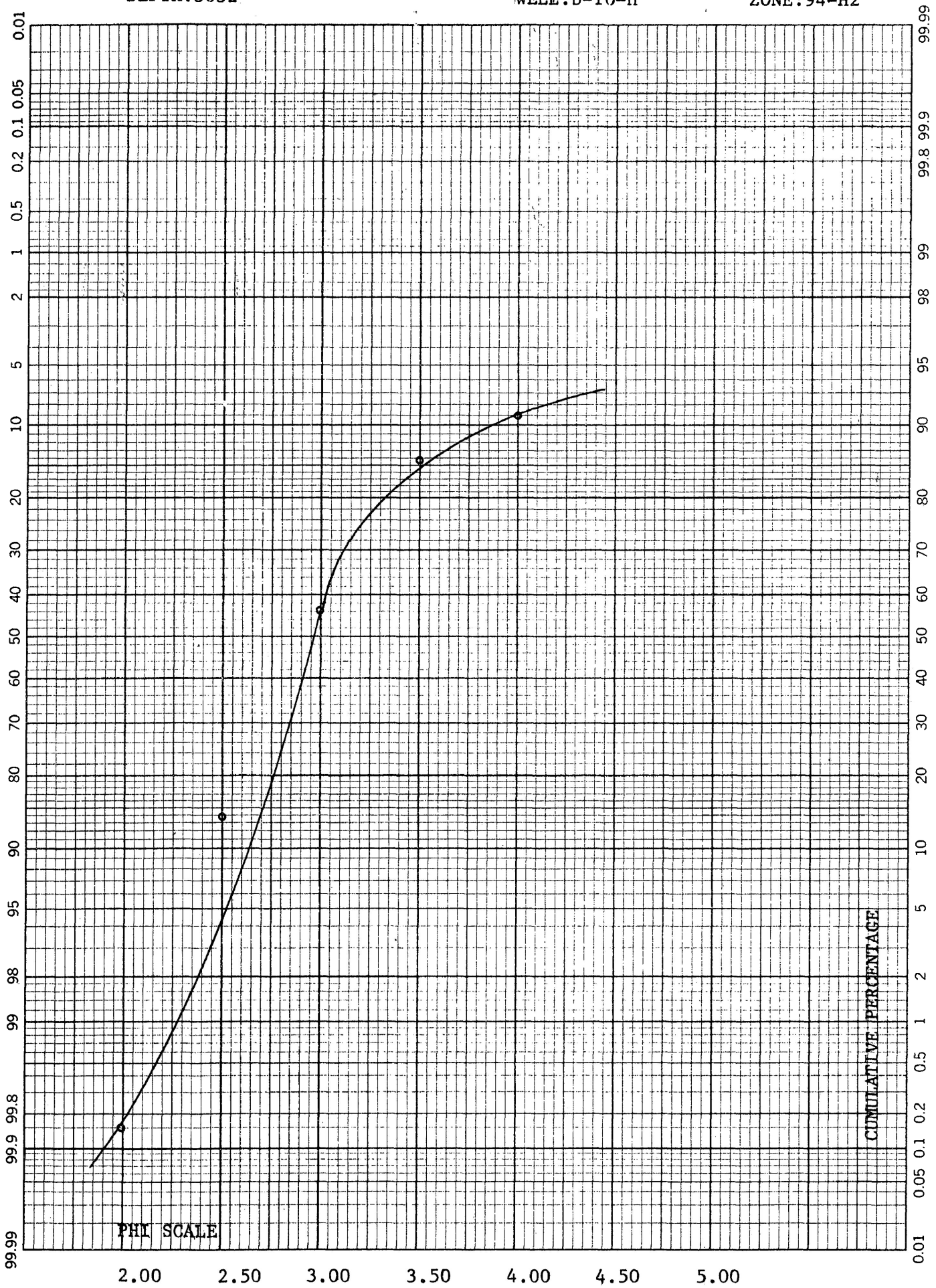
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00

DEPTH:3690 WELL:d-94-G ZONE: 94-H2

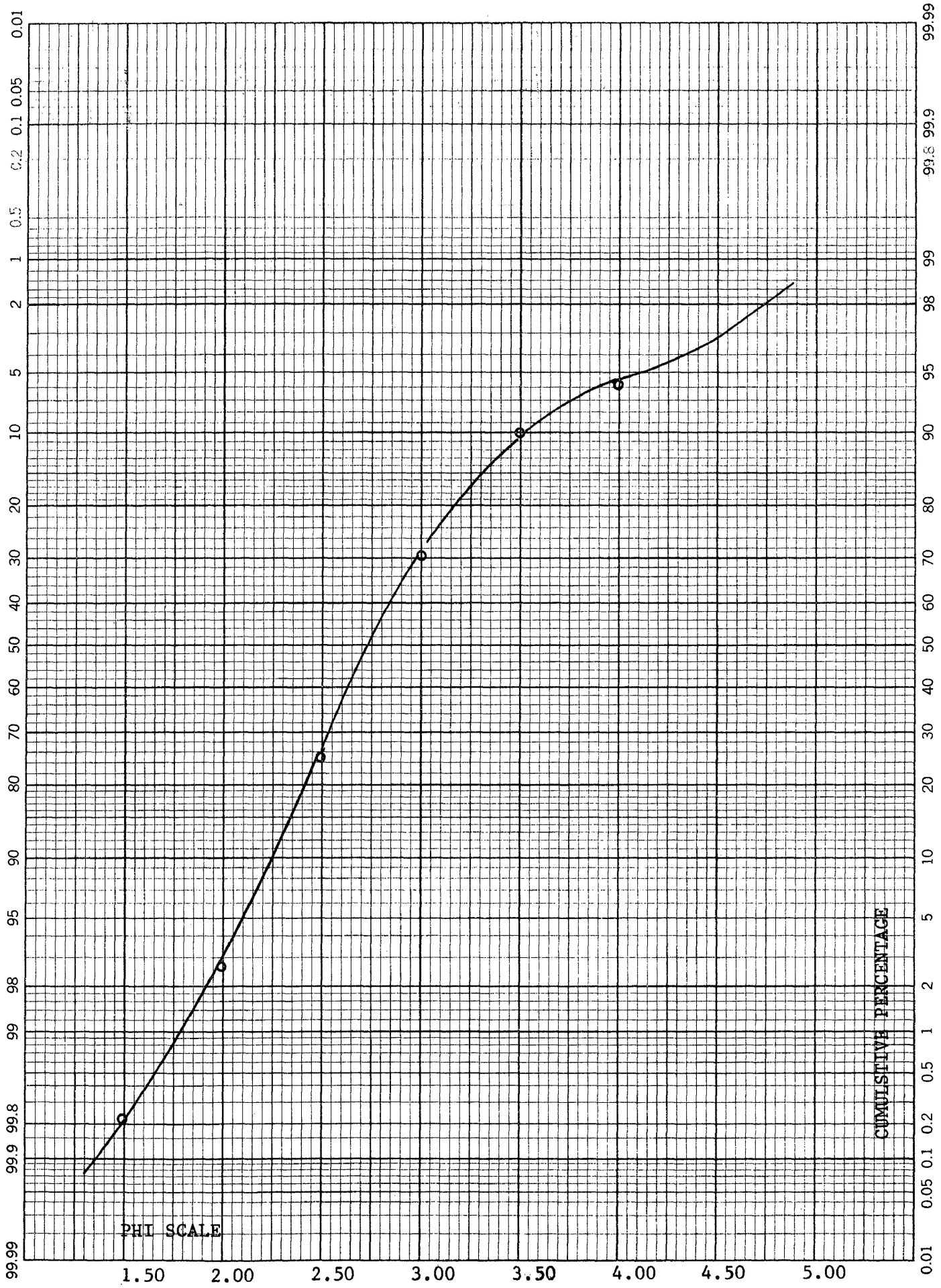



DEPTH:3700
WELL:d-94-G
ZONE: 94-H2
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
CUMULATIVE PERCENTAGE
PHI SCALE
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00

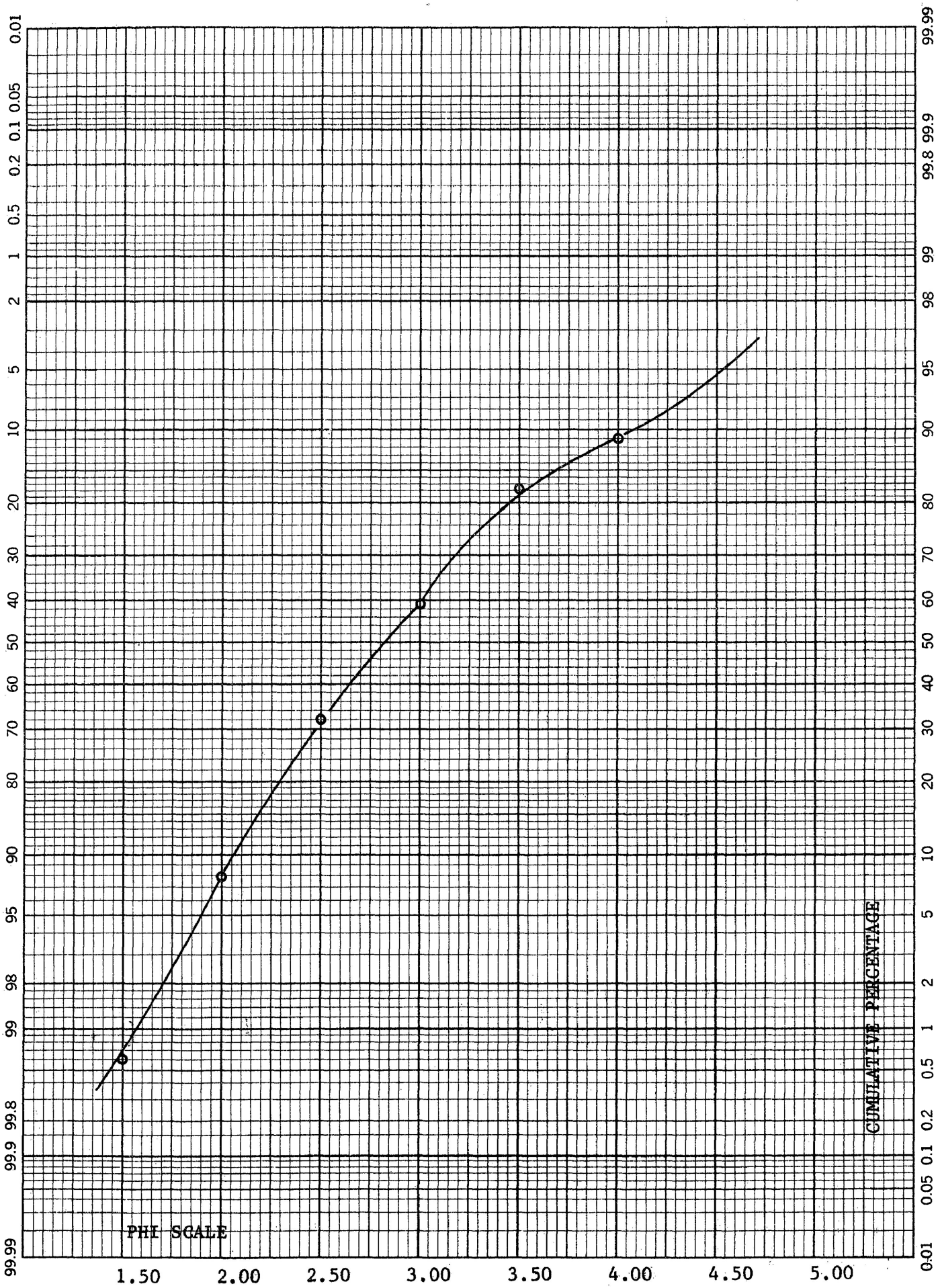
DEPTH:3632 WELL:b-10-H ZONE:94-H2



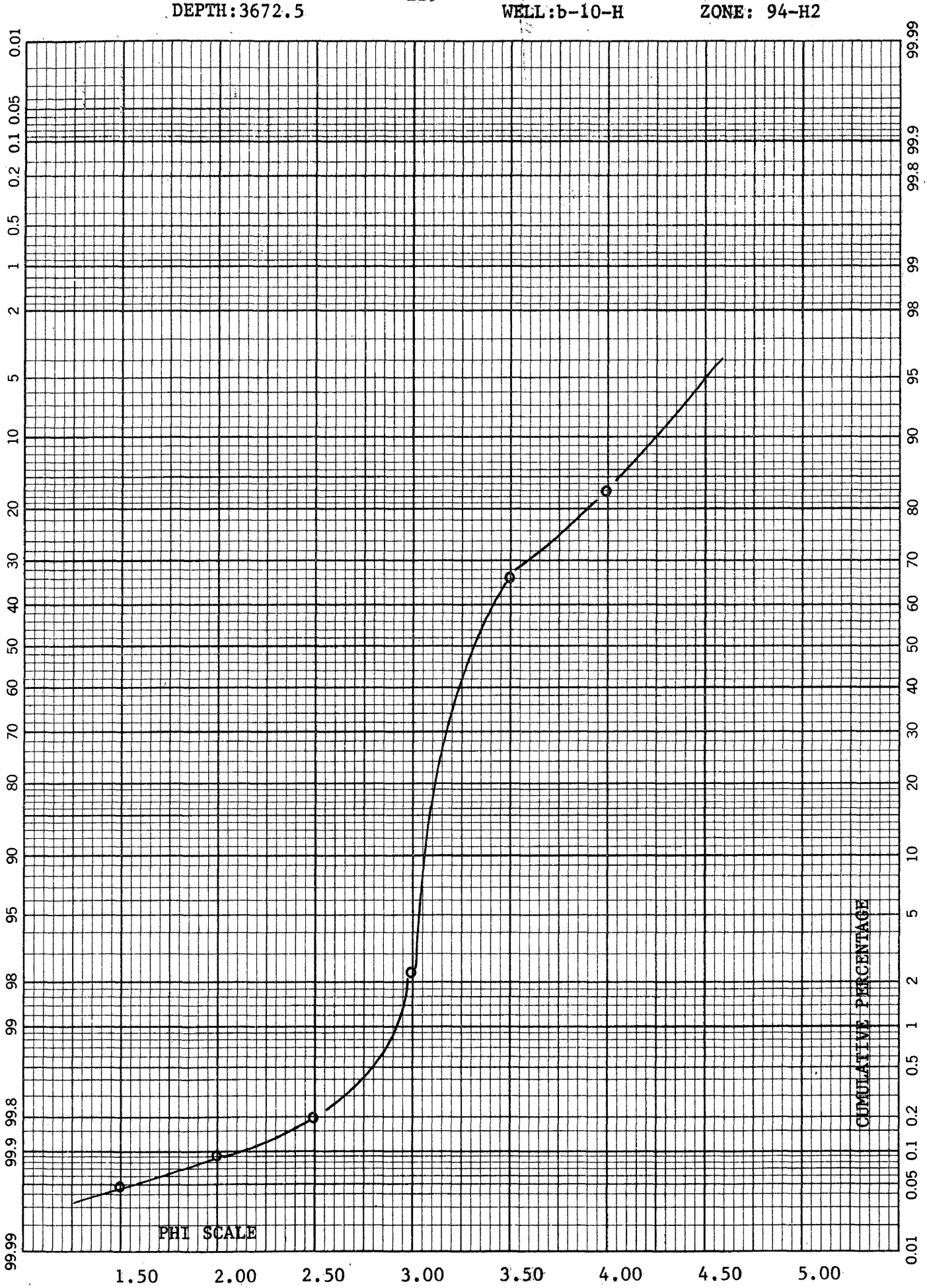
DEPTH:3633 WELL:b-10-H ZONE: 94-H2



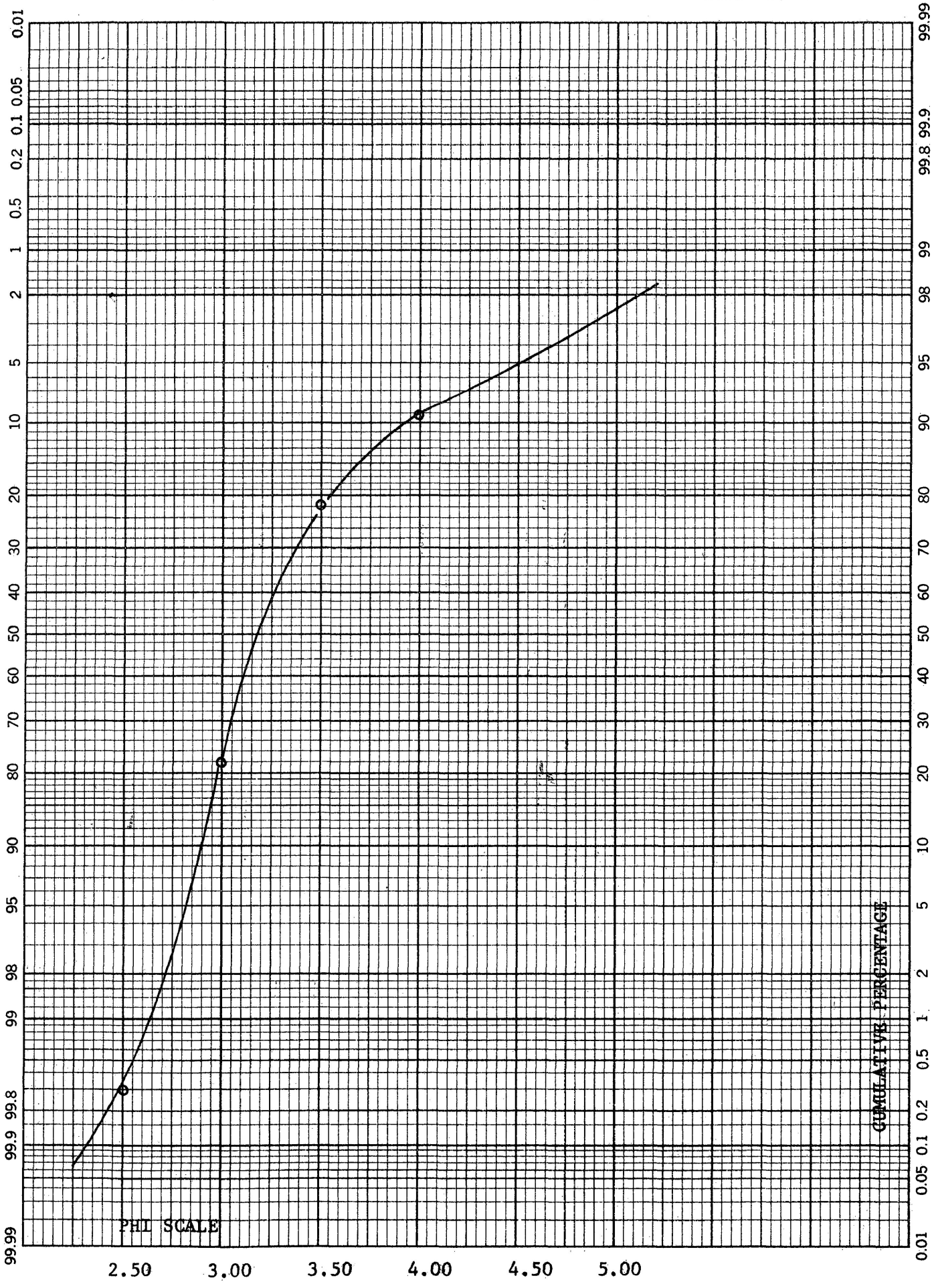
DEPTH:3658 WELL:b-10-H ZONE: 94-H2

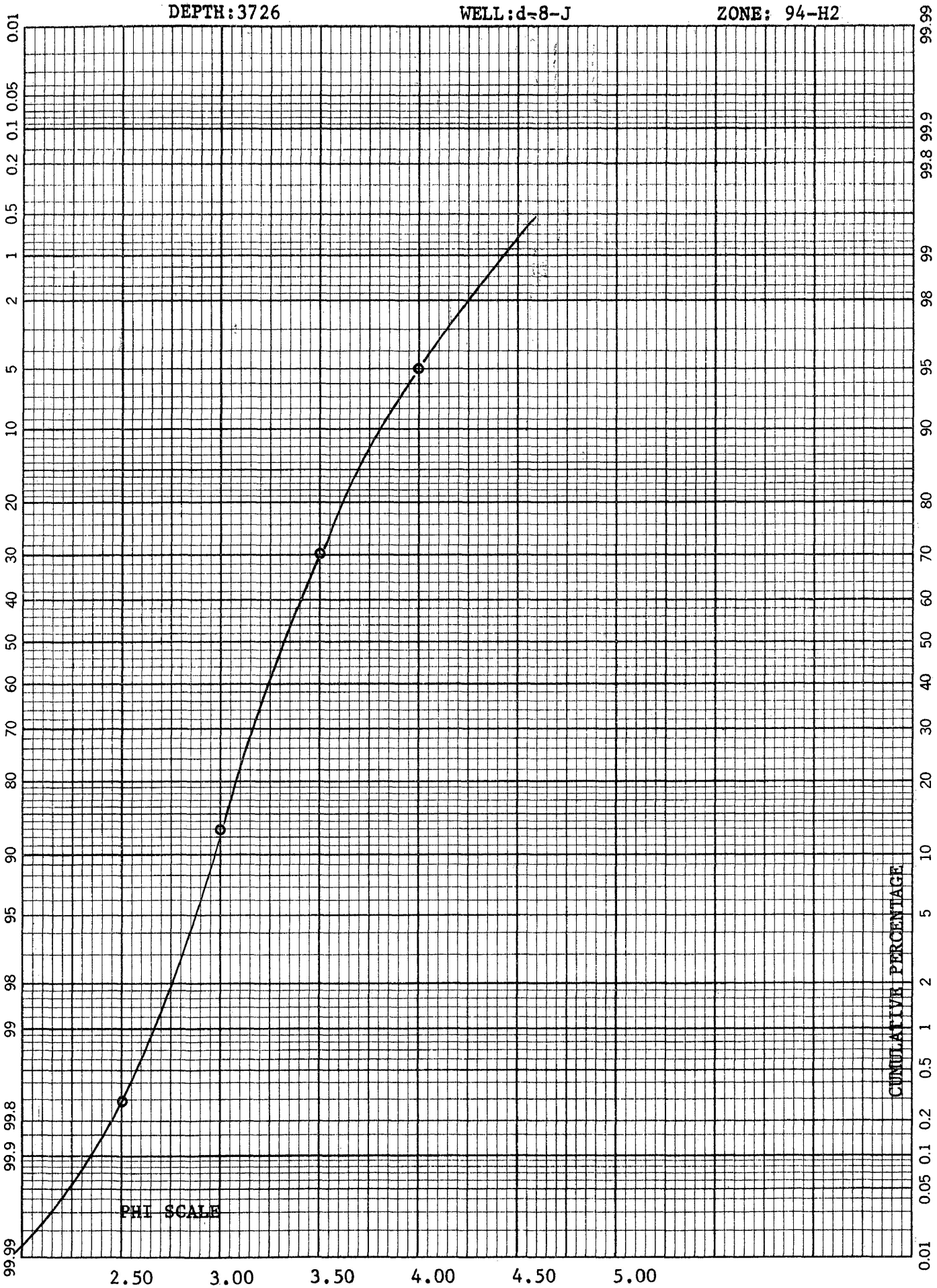


DEPTH:3672.5 WELL:b-10-H ZONE: 94-H2

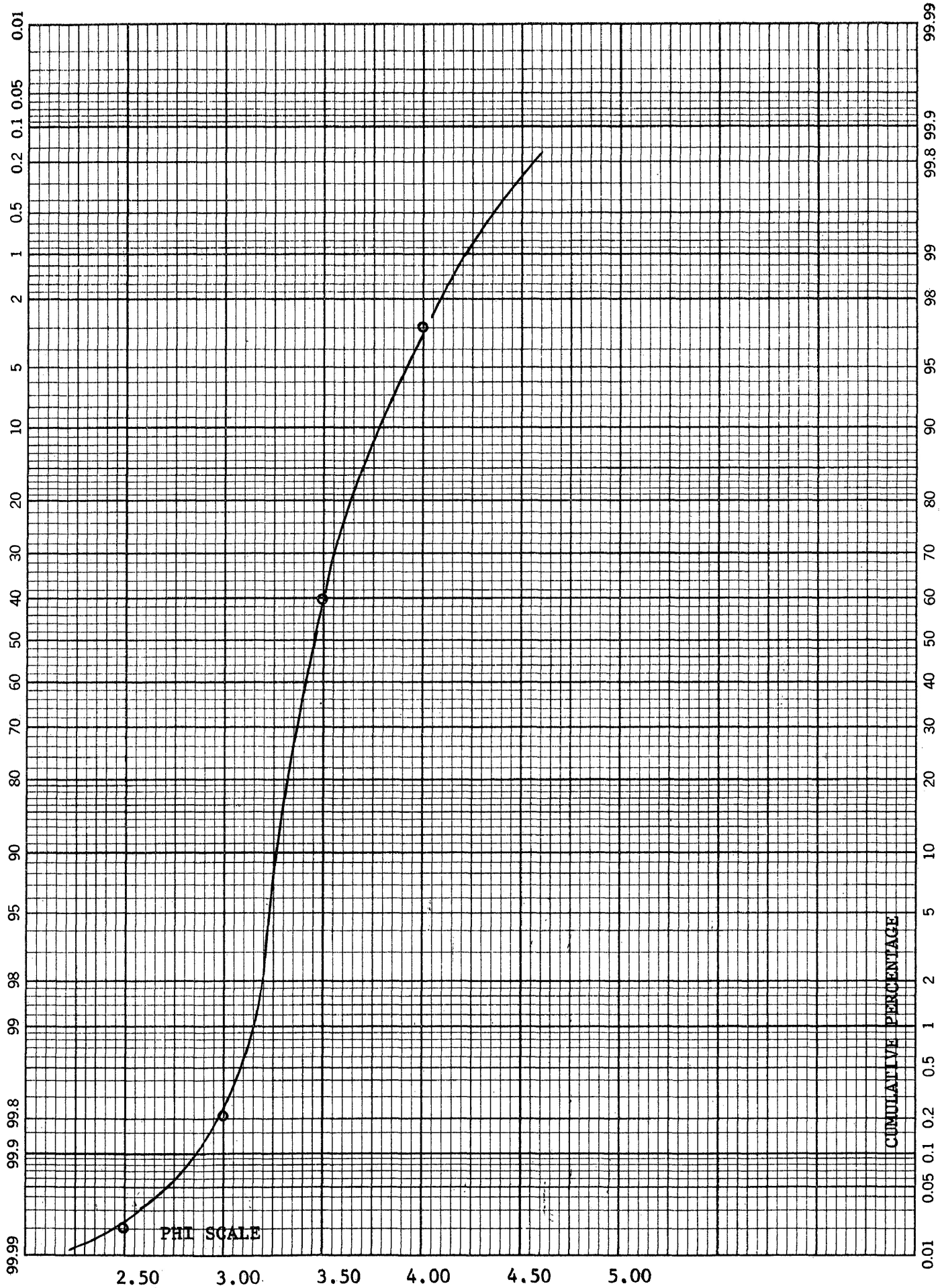


DEPTH:3647 WELL:d-20-H ZONE: 94-H2

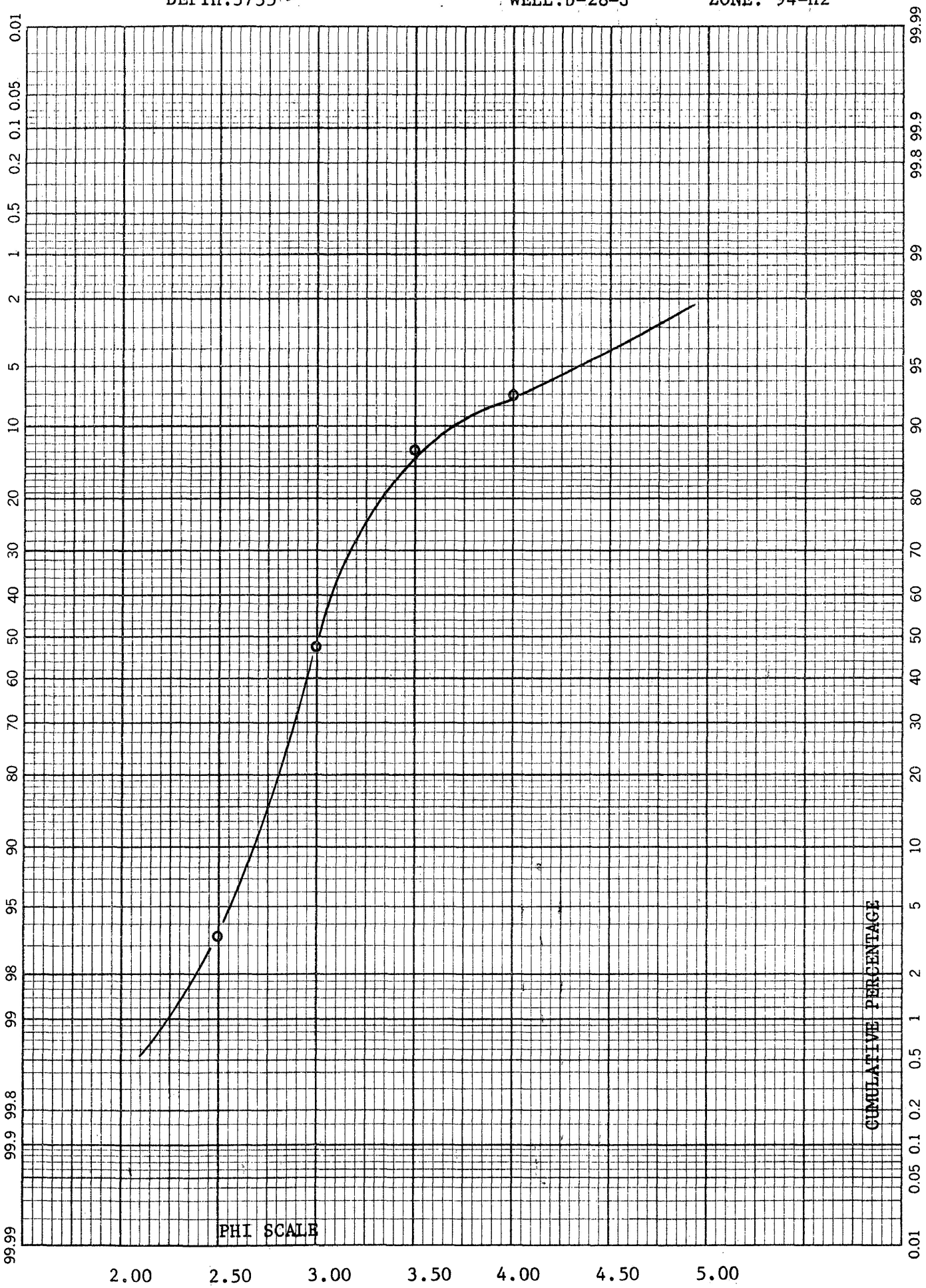



DEPTH:3726
WELL:d-8-J
ZONE: 94-H2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
CUMULATIVE PERCENTAGE
PHI SCALE
2.50
3.00
3.50
4.00
4.50
5.00

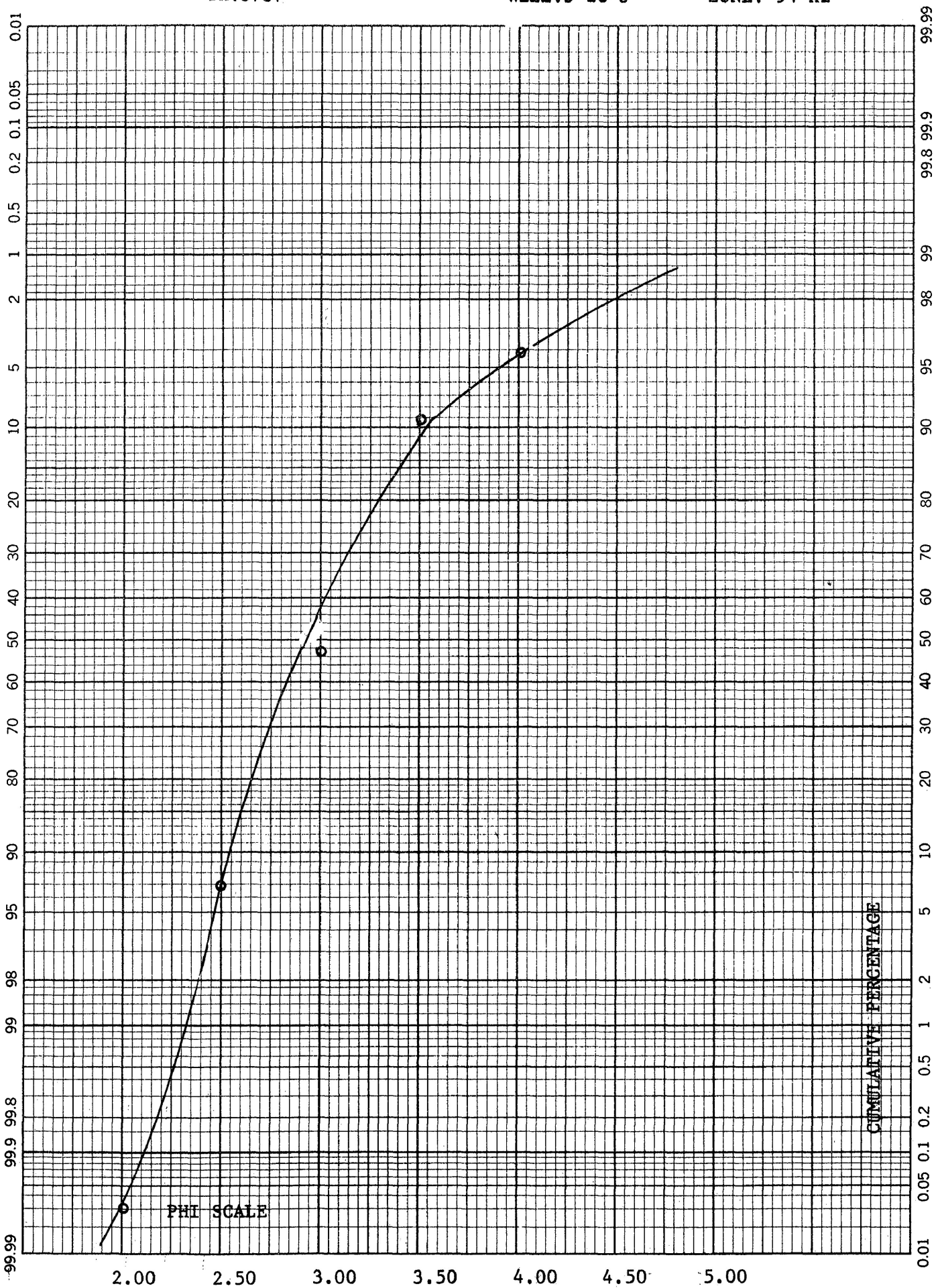
DEPTH:3743 WELL:d-10-J ZONE: 94-H2



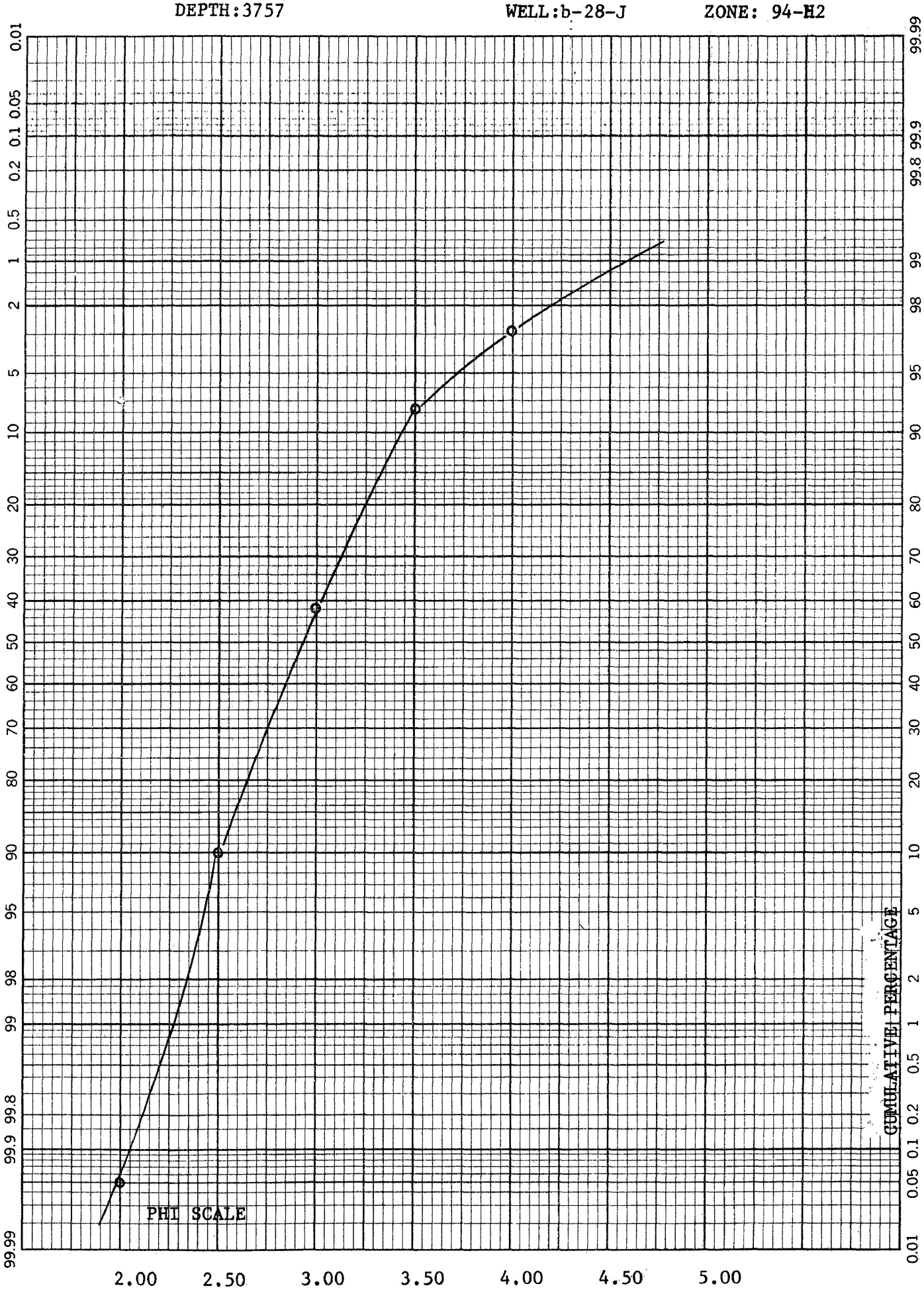
DEPTH:3735 WELL:b-28-J ZONE: 94-H2



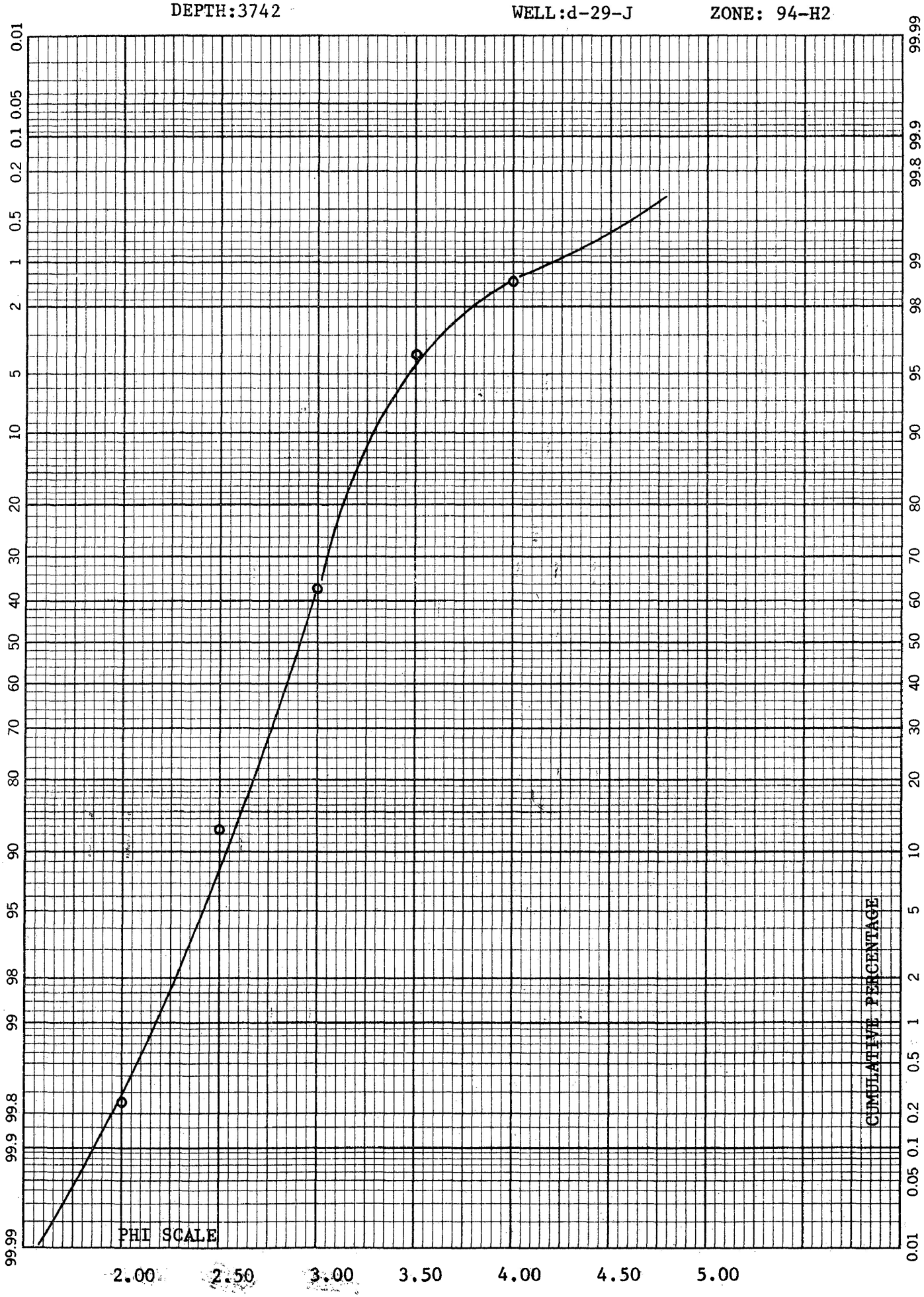
DEPTH:3737 WELL:b-28-J ZONE: 94-H2



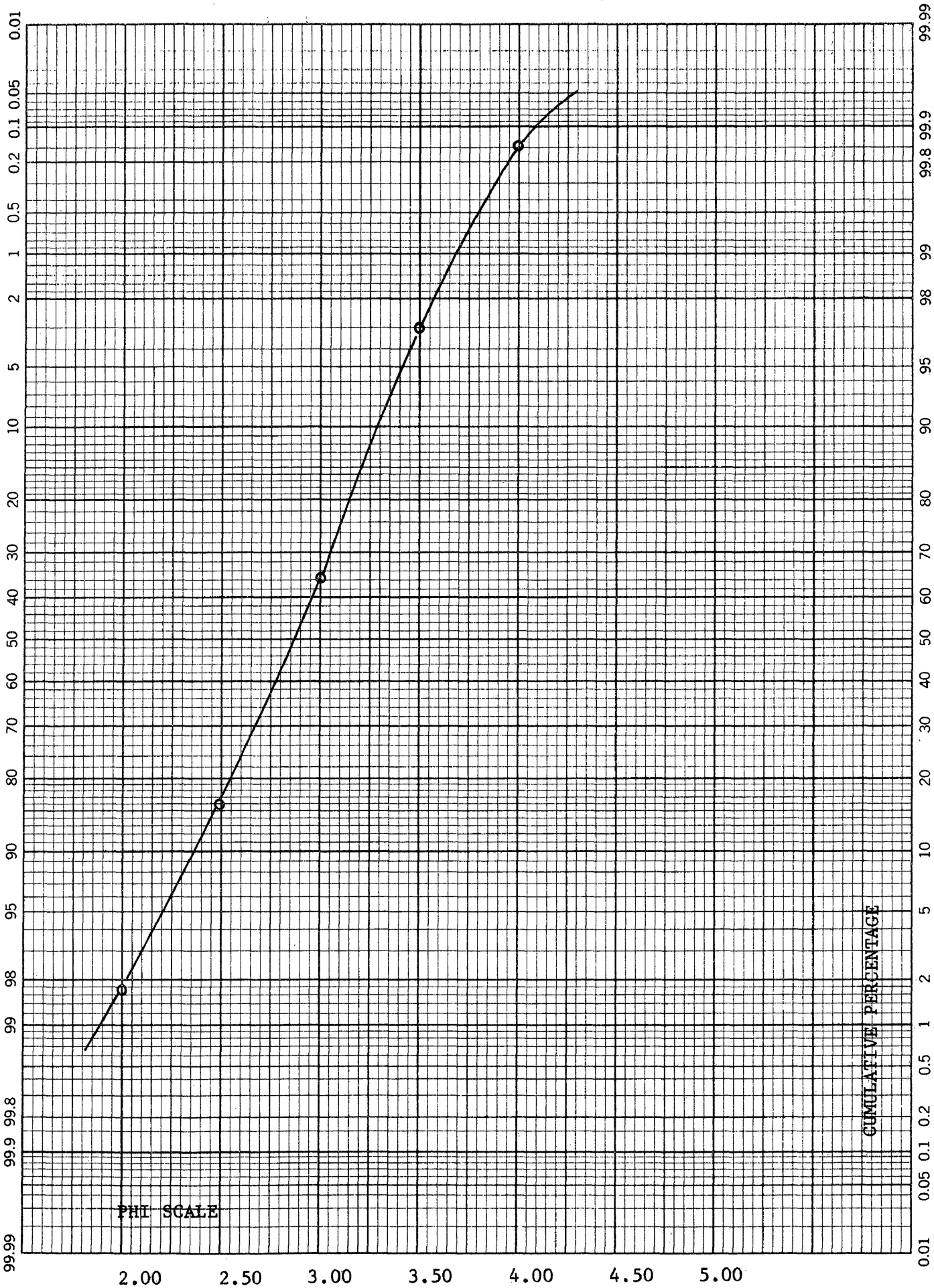
DEPTH:3757 WELL:b-28-J ZONE: 94-H2



DEPTH:3742 WELL:d-29-J ZONE: 94-H2



DEPTH:3733 WELL:d-49-J ZONE: 94-H2



APPENDIX F

Compilation of Q Mode Factor Analysis Data

1- Q Mode Factor Analysis Data

2- The Principal Component Factor Matrix

3- Varimax Factor Matrix for Six Factors Comprising the Halfway Samples

4- Varimax Factor Matrix for Three Factors Comprising the Halfway Samples

5- Normalized Varimax Factor Components

APPENDIX F1

Q MODE FACTOR ANALYSIS DATA

Sample Number	Well Location	Percentages in phi units						
		1.00	1.50	2.00	2.50	3.00	3.50	Less than 4.00
1	d05B 3845	00.00	00.06	05.19	55.22	27.38	04.60	07.53
2	b14B 3813	00.00	00.10	01.87	42.50	49.30	04.20	02.00
3	b14B 3814	00.00	00.00	00.77	24.40	51.10	09.22	14.40
4	b14B 3819	00.00	0006	03.10	41.30	44.40	04.52	06.50
5	d15B 3836	00.00	00.10	17.80	48.50	19.27	04.91	09.34
6	d15B 3839	00.00	00.00	00.09	26.90	44.50	12.50	15.88
7	d15B 3846	00.00	00.00	00.15	15.20	69.70	10.09	04.77
8	d25B 3815	00.12	00.86	06.06	26.10	27.92	13.41	25.40
9	d25B 3831	00.15	01.45	13.70	32.20	26.70	08.55	17.11
10	d25B 3833	00.09	00.80	08.54	34.00	26.70	09.35	20.30
11	d25B 3836	00.04	01.81	14.63	37.78	24.48	07.42	13.80
12	d25B 3834	00.22	06.99	25.40	31.56	21.54	05.18	09.04
13	d47B 3856	00.00	00.00	00.28	17.90	30.00	17.00	34.50
14	d47B 3860	00.00	00.07	05.15	22.00	26.35	11.60	34.70
15	d47B 3870	00.00	00.04	19.70	35.70	22.40	06.83	15.70
16	d47B 3878	00.00	02.75	31.98	36.70	18.40	03.92	06.20
17	d15A 3708	00.00	00.00	00.70	05.30	52.00	32.50	09.50
18	b22A 3577	00.00	00.00	00.01	00.40	42.50	51.50	05.51
19	d26A 3694	00.00	00.00	00.13	11.30	58.70	25.80	03.95
20	b34A 3639	00.00	01.30	12.70	40.00	30.00	11.00	05.00
21	d34A 3576	00.00	01.64	25.90	52.20	11.60	03.33	05.14
22	d34A 3580	00.00	01.25	15.32	50.70	21.80	04.07	06.71
23	d34A 3585	00.00	00.06	06.78	50.51	34.84	05.46	02.32
24	d34A 3587	00.00	01.03	16.22	53.90	20.50	03.00	05.18
25	d34A 3592	00.03	00.20	06.78	51.35	31.96	04.24	05.40
26	d34A 3593	00.01	00.04	03.01	29.40	54.00	08.60	04.81
27	d34A 3601	00.00	00.29	05.31	50.10	35.60	04.74	03.81
28	d44A 3544	00.00	01.36	14.15	41.29	19.34	06.50	17.34
29	d44A 3547	00.00	00.55	09.24	47.40	35.70	03.62	03.37
30	b46A 3706	00.00	01.60	18.40	33.00	29.00	11.50	06.50
31	d46A 3716	00.00	00.70	07.80	38.40	38.00	12.00	03.00
32	d46A 3711	00.00	00.00	01.50	26.40	55.00	09.00	08.00
33	d47A 3704	00.00	00.00	04.00	10.00	43.90	25.00	17.00
34	b55A 3694	00.00	00.01	08.42	47.40	38.17	04.91	01.03
35	d55A 3635	00.00	00.00	00.15	03.55	61.00	21.00	13.80
36	d55A 3636	00.00	00.40	13.40	52.08	27.71	02.92	03.39

37	d55A 3646	00.00	00.10	12.90	42.00	38.00	03.50	03.40
38	d55A 3651	00.00	00.09	04.68	54.70	33.28	03.60	03.60
39	d57A 3676	00.00	00.00	00.50	04.00	26.50	32.00	36.90
40	c66A 3680	00.00	00.14	00.37	08.34	44.87	28.84	17.43
41	d66A 3688	00.00	00.00	08.60	36.03	47.78	05.71	01.84
42	d66A 3671	00.00	00.00	08.54	44.60	35.03	05.81	06.00
43	b02G 3672	00.00	00.00	11.50	53.50	26.50	05.00	03.50
44	b31G 3699	00.00	00.00	01.70	04.00	31.30	20.00	43.00
45	c32G 3704	00.00	00.78	10.33	29.62	16.71	09.47	33.06
46	c32G 3705	00.00	00.38	21.84	25.80	14.42	08.00	29.53
47	c32G 3707	00.06	01.14	05.74	18.22	16.37	16.79	41.68
48	c32G 3711	00.20	00.94	07.68	28.20	32.10	14.64	16.10
49	c32G 3712	00.60	01.50	08.38	33.60	32.70	09.85	13.10
50	b42G 3694	00.00	02.50	14.50	31.00	40.50	06.00	05.50
51	b42G 3699	00.00	02.00	13.00	26.00	37.00	17.50	04.50
52	b42G 3702	00.03	00 90	16.40	28.80	46.30	05.56	01.79
53	b42G 3703	00.00	01 40	25 60	34 00	33.00	03.50	02.50
54	d43G 3685	00.00	04.50	23 50	31.00	33 50	04.00	03.50
55	d43G 3695	00.00	00.80	16.20	36.00	42.50	02.30	02.20
56	d43G 3705	00.00	00.07	04.80	27.50	57.00	07.00	03.00
57	d44G 3705	00.00	00.25	21 75	11.00	52.00	13.70	01.30
58	c50G 3702	00 00	01 60	06 90	21.50	41.00	17.00	12.00
59	b52G 3686	00.00	02 11	23.50	51.90	17.50	02.88	01.99
60	d53G 3699	00.06	00.70	33 30	54.00	09.00	01.39	01.25
61	d54G 3708	00.00	02.50	10.50	35.00	45.00	04.70	02.30
62	d54C 3716	00.00	00.00	06.50	38.50	48.50	04.10	02.40
63	d54G 3720	00.00	01.30	13.70	39.00	31.00	12.00	03.00
64	d54C 3730	00.00	00.85	11.15	31.00	44.00	10.80	02.20
65	b61G 3681	00.00	00.20	23.20	26.70	43.70	03.32	02.67
66	d62G 3698	00.00	01.80	17.20	31.00	33.00	11.00	06.00
67	d63G 3719	00.00	00.25	06.75	35.00	43.00	13.40	01.60
68	d63G 3724	00.00	00.54	14.60	33.30	41.20	06.66	03.49
69	d63G 3724	00.00	00.02	00.32	08.52	69.36	16.50	05.20
70	d64G 3694	00.00	01.46	20.70	35.20	16.00	05.31	21.10
71	d64G 3700	00.00	05.00	13.00	27.00	31.00	17.50	06.50
72	d64G 3704	00.00	00.66	17.90	50.20	25.40	01.70	03.86
73	d66C 3702	00.00	00.23	04.60	24.80	34.50	13.80	21.80
74	b72G 3688	00.34	01.22	13.90	38.60	40.00	04.70	01.04
75	c72G 3889	00.00	00.00	05.70	28.30	57.50	06.30	02.20
76	d74G 3703	00.00	00.00	10.00	22.00	43.00	12.50	12.50

77	d74G 3705	00.04	00.82	16.70	45.20	32.20	00.40	04.41
78	d74G 3710	00.00	00.26	12.90	40.60	37.00	05.00	04.03
79	d74G 3715	00.00	00.38	11.00	39.20	39.90	05.63	03.69
80	d75G 3712	00.14	02.41	12.00	42.70	35.40	04.71	02.54
81	d76G 3736	00.03	00.94	11.40	42.41	36.70	04.19	04.22
82	b82G 3677	00.00	02.00	15.00	37.00	33.50	13.00	01.20
83	b82G 3681	00.00	00.00	10.00	36.00	46.50	04.20	03.30
84	b82G 3684	00.00	00.00	10.00	37.00	45.00	05.30	02.70
85	d83G 3668	00.00	00.00	06.50	37.50	50.00	04.00	02.00
86	d83G 3670	00.00	00.00	04.70	45.10	47.10	00.93	02.09
87	d84G 3731	00.09	04.24	20.31	40.13	30.30	03.92	00.99
88	d84G 3732	00.00	00.45	09.55	41.00	38.00	09.30	01.70
89	d94G 3690	00.01	00.52	10.13	42.00	41.00	04.55	01.66
90	d94G 3700	00.01	00.01	03.55	47.70	42.80	04.36	01.40
91	b10H 3632	00.00	00.16	14.20	43.30	29.10	05.04	08.09
92	b10H 3633	00.20	02.67	22.81	45.25	19.80	03.85	05.37
93	b10H 3635	00.00	00.00	15.00	39.00	36.00	05.00	05.00
94	b10H 3641	00.00	04.50	12.00	34.50	37.50	05.00	06.50
95	b10H 3653	00.00	00.60	17.40	29.00	46.50	03.90	02.60
96	b10H 3658	00.69	07.44	24.70	26.60	22.90	06.91	10.60
97	b10H 3671	00.00	00.00	01.20	02.60	40.20	43.00	13.00
98	b10H 3673	00.05	00.07	00.07	02.22	64.50	26.80	06.16
99	b10H 3674	00.00	00.00	00.90	01.50	30.60	50.00	17.00
100	d20H 3646	00.00	00.00	02.30	14.70	70.00	09.00	04.00
101	d20H 3647	00.00	00.00	00.30	21.30	57.40	12.60	08.20
102	d20H 3651	00.00	15.50	40.50	25.00	13.90	03.10	02.00
103	b31H 3579	00.00	00.00	15.50	44.50	31.00	05.20	03.80
104	b31H 3580	00.00	00.10	13.40	38.50	34.50	06.50	07.00
105	a63H 3628	00.00	00.00	06.50	38.50	48.50	03.70	02.80
106	b03J 3687	00.00	00.80	03.70	37.50	50.00	05.80	02.20
107	d08J 3726	00.00	00.00	00.31	13.07	58.19	23.70	04.61
108	d10J 3743	00.00	00.00	00.02	00.19	59.20	38.20	02.20
109	d17J 3755	00.00	00.00	01.40	12.10	49.50	16.00	21.00
110	b28J 3735	00.00	00.00	03.48	43.69	40.17	04.77	07.04
111	b28J 3737	00.00	00.03	07.23	40.50	43.80	05.17	03.19
112	b28J 3757	00.00	00.05	10.20	48.60	33.80	04.34	02.90
113	d29J 3742	00.00	00.26	12.00	51.30	32.50	02.50	01.37
114	d39J 3735	00.00	00.00	00.00	24.00	36.00	36.50	03.50
115	d39J 3740	00.00	01.20	16.80	31.00	46.00	02.70	02.30
116	d49J 3733	00.00	01.89	14.78	48.96	31.50	02.43	00.41
117	d15A 3714	00.00	00.00	06.00	32.00	47.00	07.50	07.50

APPENDIX E2

PRINCIPAL COMPONENT FACTOR MATRIX

		VARIANCE	84.065	9.285	3.931	1.587	1.081	0.070
		COMM.	1	2	3	4	5	6
1	d05B 3845	1.0002	0.9218	-0.3031	0.0257	-0.2070	0.1220	0.0170
2	b14B 3813	1.0002	0.9682	0.0067	-0.1983	-0.1515	0.0018	0.0191
3	b14B 3814	1.0002	0.9370	0.2990	-0.0493	-0.1308	-0.1146	0.0125
4	b14B 3819	1.0002	0.9800	-0.0127	-0.1151	-0.1614	-0.0115	0.0156
5	d15B 3836	1.0002	0.9010	-0.3986	0.1528	-0.0168	0.0713	-0.0286
6	d15B 3839	1.0002	0.9512	0.2612	0.0355	-0.1562	-0.0356	0.0166
7	d15B 3846	1.0002	0.8467	0.4440	-0.2546	-0.0269	-0.1435	0.0059
8	d25B 3815	1.0003	0.9089	0.1383	0.3688	-0.1303	-0.0449	0.0133
9	d25B 3831	1.0002	0.9653	-0.0811	0.2431	-0.0092	-0.0509	-0.0011
10	d25B 3833	1.0002	0.9518	-0.0500	0.2750	-0.1252	-0.0226	0.0081
11	d25B 3836	1.0002	0.9593	-0.2005	0.1989	-0.0124	0.0022	0.0061
12	d25B 3834	1.0003	0.9052	-0.2729	0.1772	0.2530	-0.0826	0.0639
13	d47B 3856	1.0004	0.7854	0.3470	0.4626	-0.2033	-0.0879	0.0126
14	d47B 3860	1.0004	0.8124	0.1917	0.4955	-0.1854	-0.1543	0.0001
15	d47B 3870	1.0002	0.9337	-0.2260	0.2615	0.0633	-0.0491	-0.0499
16	d47B 3878	1.0003	0.8511	-0.3765	0.1589	0.2978	-0.0542	-0.0424
17	d15A 3708	1.0002	0.7577	0.6360	-0.0060	0.0970	0.1100	-0.0055
18	b22A 3577	1.0001	0.5971	0.6802	0.0914	0.1992	0.3645	-0.0107
19	d26A 3694	1.0002	0.8215	0.5447	-0.1477	0.0566	0.0612	0.0006
20	b34A 3639	1.0001	0.9818	-0.1500	0.0276	0.0153	0.1128	0.0029
21	d34A 3576	1.0002	0.8097	-0.5485	0.1584	0.0959	0.0933	-0.0261
22	d34A 3580	1.0002	0.9117	-0.3903	0.0329	-0.0493	0.0860	0.0014
23	d34A 3585	1.0002	0.9594	-0.2116	-0.0840	-0.1322	0.1016	0.0084
24	d34A 3587	1.0002	0.8905	-0.4368	0.0657	-0.0491	0.0979	-0.0032
25	d34A 3592	1.0002	0.9514	-0.2471	-0.0314	-0.1595	0.0854	0.0120
26	d34A 3593	1.0002	0.9554	0.2133	-0.1832	-0.0727	-0.0537	0.0071
27	d34A 3601	1.0002	0.9609	-0.1745	-0.0781	-0.1599	0.0838	0.0168
28	d44A 3544	1.0002	0.9131	-0.2832	0.2849	-0.0704	0.0141	0.0025
29	d44A 3547	1.0002	0.9703	-0.2007	-0.0822	-0.0985	0.0428	0.0073
30	b46A 3706	1.0002	0.9781	-0.1077	0.0822	0.1500	0.0473	-0.0191
31	d46A 3716	1.0001	0.9907	-0.0202	-0.0725	-0.0337	0.1086	0.0073
32	d46A 3711	1.0002	0.9418	0.2726	-0.1530	-0.0925	-0.0823	0.0099
33	d47A 3704	1.0002	0.8280	0.5416	0.1344	0.0519	0.0190	-0.0118
34	b55A 3694	1.0002	0.9716	-0.1686	-0.1230	-0.0907	0.0653	0.0005

35	d55A 3635	1.0002	0.7702	0.6258	-0.0676	0.0258	-0.1009	-0.0013
36	d55A 3636	1.0002	0.9333	-0.3435	-0.0161	-0.0698	0.0771	-0.0056
37	d55A 3646	1.0001	0.9842	-0.1482	-0.0929	-0.0227	-0.0143	-0.0156
38	d55A 3651	1.0002	0.9396	-0.2566	-0.0682	-0.1889	0.1037	0.0179
39	d57A 3676	1.0006	0.5837	0.5739	0.5708	-0.0496	0.0471	-0.0018
40	c66A 3680	1.0002	0.7867	0.5976	0.1370	0.0224	0.0702	0.0017
41	d66A 3688	1.0002	0.9819	0.0376	-0.1801	-0.0307	-0.0335	-0.0071
42	d66A 3671	1.0001	0.9807	-0.1551	-0.0361	-0.1032	0.0475	-0.0013
43	b02G 3672	1.0001	0.9271	-0.3410	-0.0005	-0.0949	0.1235	-0.0055
44	b31G 3679	1.0005	0.6132	0.5258	0.5459	-0.1216	-0.1880	-0.0017
45	c32G 3704	1.0005	0.7999	-0.0623	0.5690	-0.1505	-0.1019	-0.0004
46	c32G 3705	1.0005	0.7763	-0.1405	0.5807	0.0819	-0.1751	-0.0589
47	c32G 3707	1.0007	0.6538	0.1978	0.7055	-0.1627	-0.0983	0.0152
48	c32G 3711	1.0002	0.9723	0.1203	0.1927	-0.0464	0.0303	0.0078
49	c32G 3712	1.0000	0.9913	-0.0031	0.1085	-0.0716	0.0055	0.0207
50	b42G 3674	1.0001	0.9911	0.0102	-0.0741	0.0724	-0.0823	0.0131
51	b42G 3679	1.0001	0.9740	0.1434	-0.0021	0.1492	0.0929	0.0028
52	b42G 3702	1.0002	0.9714	0.0623	-0.1610	0.1217	-0.1063	-0.0234
53	b42G 3703	1.0002	0.9492	-0.1915	-0.0369	0.2251	-0.0923	-0.0449
54	d43G 3685	1.0002	0.9572	-0.1396	-0.0324	0.2265	-0.1090	0.0176
55	d43G 3695	1.0001	0.9810	-0.0737	-0.1408	0.0602	-0.0922	-0.0187
56	d43G 3705	1.0002	0.9428	0.2265	-0.2246	-0.0359	-0.0906	0.0010
57	d44G 3705	1.0003	0.8583	0.3331	-0.1511	0.3259	-0.1393	-0.0644
58	c50G 3702	1.0002	0.9526	0.2976	0.0555	0.0257	0.0085	0.0167
59	b52G 3686	1.0002	0.8583	-0.4945	0.0659	0.0811	0.0888	-0.0111
60	d53G 3699	1.0003	0.7536	-0.6102	0.1278	0.1844	0.0778	-0.0604
61	d54G 3708	1.0002	0.9850	0.0078	-0.1616	0.0005	-0.0537	0.0279
62	d54G 3716	1.0002	0.9785	0.0184	-0.1859	-0.0798	-0.0379	0.0016
63	d54G 3720	1.0001	0.9818	-0.1323	-0.0014	0.0540	0.1255	-0.0026
64	d54G 3730	1.0001	0.9862	0.0888	-0.1276	0.0571	0.0095	-0.0064
65	b61G 3681	1.0002	0.9505	0.0110	-0.1240	0.2168	-0.1747	-0.0602
66	d62G 3698	1.0001	0.9884	-0.0381	0.0316	0.1426	0.0138	-0.0116
67	d63G 3719	1.0001	0.9848	0.0755	-0.1232	-0.0158	0.0958	0.0003
68	d63G 3724	1.0001	0.9913	-0.0106	-0.1010	0.0672	-0.0459	-0.0213
69	d63G 3724	1.0002	0.8037	0.5411	-0.2226	0.0262	-0.1060	0.0010
70	d64G 3694	1.0003	0.8630	-0.2913	0.4001	0.0447	-0.0893	-0.0250
71	d64G 3700	1.0001	0.9720	0.0789	0.0852	0.1495	0.1229	0.0664
72	d64G 3704	1.0002	0.9224	-0.3837	0.0122	-0.0063	0.0409	-0.0171
73	d66G 3702	1.0002	0.9373	0.2187	0.2404	-0.1180	-0.0465	0.0044
74	b72G 3688	1.0001	0.9855	-0.0990	-0.1333	0.0322	-0.0161	-0.0029
75	c72G 3889	1.0002	0.9442	0.2087	-0.2353	-0.0269	-0.0951	-0.0023

76	d74G 3703	1.0001	0.9627	0.2517	0.0296	0.0398	-0.0940	-0.0234
77	d74G 3705	1.0001	0.9594	-0.2768	-0.0416	-0.0044	-0.0343	-0.0134
78	d74G 3710	1.0001	0.9885	-0.1323	-0.0716	-0.0116	-0.0015	-0.0145
79	d74G 3715	1.0001	0.9919	-0.0749	-0.0996	-0.0257	-0.0040	-0.0069
80	d75G 3712	1.0001	0.9804	-0.1730	-0.0836	-0.0227	0.0271	0.0268
81	d76G 3736	1.0001	0.9848	-0.1510	-0.0740	-0.0457	0.0042	0.0038
82	b82G 3677	1.0001	0.9828	-0.0888	-0.0371	0.1036	0.1193	0.0036
83	b82G 3681	1.0001	0.9849	0.0135	-0.1582	-0.0264	-0.0633	-0.0112
84	b82G 3684	1.0001	0.9877	-0.0040	-0.1508	-0.0238	-0.0331	-0.0111
85	d83G 3668	1.0002	0.9752	0.0389	-0.2001	-0.0724	-0.0481	0.0010
86	d83G 3670	1.0002	0.9685	-0.0712	-0.1899	-0.1423	-0.0266	0.0113
87	d84G 3731	1.0002	0.9555	-0.2601	-0.0497	0.1274	-0.0016	0.0293
88	d84G 3732	1.0001	0.9879	-0.0825	-0.0967	-0.0280	0.0846	-0.0009
89	d94G 3690	1.0001	0.9843	-0.1018	-0.1373	-0.0449	0.0088	0.0002
90	d94G 3700	1.0002	0.9677	-0.1060	-0.1592	-0.1547	0.0547	0.0157
91	b10H 3632	1.0001	0.9694	-0.2366	0.0504	-0.0325	0.0203	-0.0190
92	b10H 3633	1.0002	0.8963	-0.4170	0.1035	0.1030	0.0391	-0.0037
93	b10H 3635	1.0001	0.9890	-0.1346	-0.0457	0.0219	-0.0221	-0.0277
94	b10H 3641	1.0001	0.9939	-0.0524	-0.0488	0.0088	-0.0572	0.0622
95	b10H 3653	1.0001	0.9692	0.0461	-0.1558	0.1209	-0.1375	-0.0311
96	b10H 3658	1.0001	0.9092	-0.1736	0.2068	0.2890	-0.1097	0.0757
97	b10H 3671	1.0002	0.6576	0.6669	0.1762	0.1481	0.2644	-0.0111
98	b10H 3673	1.0003	0.7461	0.6441	-0.1456	0.0870	-0.0085	-0.0029
99	b10H 3674	1.0002	0.5574	0.6522	0.3264	0.1570	0.3644	-0.0118
100	d20H 3646	1.0002	0.8468	0.4325	-0.2643	-0.0008	-0.1621	-0.0001
101	d20H 3647	1.0002	0.9108	0.3718	-0.1518	-0.0671	-0.0696	0.0097
102	d20H 3651	1.0006	0.6797	-0.3842	0.1519	0.5704	-0.1343	0.1564
103	b31H 3579	1.0001	0.9683	-0.2444	-0.0198	0.0055	0.0425	-0.0256
104	b31H 3580	1.0001	0.9928	-0.1185	-0.0028	-0.0032	-0.0031	-0.0212
105	a63H 3628	1.0002	0.9785	0.0167	-0.1829	-0.0836	-0.0454	0.0017
106	b03J 3687	1.0002	0.9728	0.0655	-0.1967	-0.1004	-0.0161	0.0217
107	d08J 3726	1.0002	0.8412	0.5173	-0.1473	0.0390	0.0430	0.0016
108	d10J 3743	1.0003	0.6913	0.6808	-0.1084	0.1559	0.1509	-0.0078
109	d17J 3755	1.0002	0.8495	0.4989	0.0859	-0.0636	-0.1345	0.0021
110	b28J 3735	1.0002	0.9786	-0.0735	-0.0778	-0.1743	0.0190	0.0152
111	b28J 3737	1.0002	0.9860	-0.0363	-0.1409	-0.0827	-0.0013	0.0008
112	b28J 3757	1.0001	0.9645	-0.2306	-0.0682	-0.0874	0.0663	-0.0035
113	d29J 3742	1.0002	0.9488	-0.2897	-0.0803	-0.0743	0.0632	-0.0039
114	d39J 3735	1.0000	0.8392	0.3571	0.0550	0.0440	0.4040	0.0063
115	d39J 3740	1.0001	0.9723	0.0123	-0.1627	0.0986	-0.1349	-0.0172
116	d49J 3733	1.0002	0.9486	-0.3013	-0.0815	-0.0168	0.0496	0.0119
117	d15A 3714	1.0001	0.9830	0.1216	-0.1052	-0.0702	-0.0556	-0.0008

APPENDIX F3

VARIMAX FACTOR MATRIX

		VARIANCE	54.736	31.661	10.172	1.986	1.345	0.119
		COMM.	1	2	3	4	5	6
1	d05B 3845	1.0002	0.9202	0.2508	0.2641	-0.1353	0.0248	0.0427
2	b14B 3813	1.0002	0.7878	0.5839	0.1272	-0.0991	-0.1064	0.0345
3	b14B 3814	1.0002	0.5547	0.7553	0.3109	-0.0451	-0.1514	0.0180
4	b14B 3819	1.0002	0.7959	0.5515	0.2078	-0.0895	-0.1021	0.0299
5	d15B 3836	1.0002	0.9287	0.1428	0.3267	0.0724	0.0628	-0.0368
6	d15B 3839	1.0002	0.5860	0.7090	0.3778	-0.0769	-0.0679	0.0301
7	d15B 3846	1.0002	0.4186	0.8828	0.1021	0.0097	-0.1876	0.0002
8	d25B 3815	1.0003	0.5771	0.4995	0.6460	0.0061	0.0076	0.0161
9	d25B 3831	1.0002	0.7635	0.4019	0.4913	0.1178	-0.0067	-0.0180
10	d25B 3833	1.0002	0.7384	0.4020	0.5415	0.0057	-0.0058	0.0103
11	d25B 3836	1.0002	0.8420	0.3174	0.4240	0.1007	0.0226	-0.0072
12	d25B 3834	1.0003	0.8244	0.2553	0.3345	0.3786	0.0138	0.0044
13	d47B 3856	1.0004	0.3418	0.5635	0.7497	-0.0568	-0.0159	0.0254
14	d47B 3860	1.0004	0.4431	0.4485	0.7731	-0.0020	-0.0727	0.0022
15	d47B 3870	1.0002	0.8195	0.2712	0.4624	0.1870	0.0142	-0.0785
16	d47B 3878	1.0003	0.8595	0.1370	0.2707	0.3955	0.0447	-0.1056
17	d15A 3708	1.0002	0.2202	0.9264	0.2563	0.0543	0.1577	-0.0090
18	b22A 3577	1.0001	0.0765	0.8546	0.2373	0.0633	0.4513	-0.0079
19	d26A 3694	1.0002	0.3412	0.9257	0.1508	0.0245	0.0587	-0.0008
20	b34A 3639	1.0001	0.8639	0.4192	0.2565	0.0608	0.0926	-0.0030
21	d34A 3576	1.0002	0.9431	-0.0184	0.2558	0.1743	0.1101	-0.0503
22	d34A 3580	1.0002	0.9450	0.1722	0.2720	0.0324	0.0486	-0.0004
23	d34A 3585	1.0002	0.9047	0.3786	0.1753	-0.0828	0.0065	0.0243
24	d34A 3587	1.0002	0.9597	0.1286	0.2428	0.0276	0.0531	-0.0042
25	d34A 3592	1.0002	0.9119	0.3299	0.2247	-0.0916	-0.0056	0.0294
26	d34A 3593	1.0002	0.6428	0.7399	0.1589	-0.0255	-0.1168	0.0097
27	d34A 3601	1.0002	0.8943	0.3891	0.1929	-0.1011	-0.0158	0.0354
28	d44A 3544	1.0002	0.8472	0.1994	0.4879	0.0594	0.0332	-0.0033
29	d44A 3547	1.0002	0.8987	0.3947	0.1846	-0.0326	-0.0364	0.0138
30	b46A 3706	1.0002	0.8147	0.4446	0.2926	0.2064	0.0897	-0.0491
31	d46A 3716	1.0001	0.8094	0.5498	0.1984	-0.0061	0.0567	0.0119
32	d46A 3711	1.0002	0.5904	0.7689	0.2003	-0.0346	-0.1376	0.0136
33	d47A 3704	1.0002	0.3043	0.8488	0.4162	0.0753	0.0891	-0.0199
34	b55A 3694	1.0002	0.8884	0.4325	0.1468	-0.0427	-0.0214	0.0088

35	d55A	3635	1.0002	0.2259	0.9356	0.2562	0.0517	-0.0736	-0.0106
36	d55A	3636	1.0002	0.9480	0.2465	0.2013	-0.0016	0.0124	-0.0031
37	d55A	3646	1.0001	0.8701	0.4514	0.1796	0.0468	-0.0650	-0.0236
38	d55A	3651	1.0002	0.9169	0.3241	0.1899	-0.1291	-0.0074	0.0414
39	d57A	3676	1.0006	0.0405	0.6120	0.7646	0.0217	0.1983	0.0032
40	c66A	3680	1.0002	0.2450	0.8673	0.4122	0.0271	0.1315	0.0028
41	d66A	3688	1.0002	0.7680	0.6191	0.1315	0.0196	-0.0956	-0.0116
42	d66A	3671	1.0001	0.8739	0.4232	0.2360	-0.0357	-0.0191	0.0062
43	b02G	3672	1.0001	0.9456	0.2393	0.2114	-0.0380	0.0516	0.0042
44	b31G	3699	1.0005	0.0744	0.5907	0.8015	0.0353	-0.0487	-0.0055
45	c32G	3704	1.0005	0.5785	0.2252	0.7831	0.0422	-0.0112	-0.0038
46	c32G	3705	1.0005	0.5864	0.1638	0.7375	0.2746	-0.0086	-0.1020
47	c32G	3707	1.0007	0.2909	0.3099	0.9042	0.0231	0.0400	0.0168
48	c32G	3711	1.0002	0.6661	0.5754	0.4699	0.0361	0.0561	0.0062
49	c32G	3712	1.0000	0.7651	0.5104	0.3916	0.0215	-0.0034	0.0199
50	b42G	3694	1.0001	0.7666	0.5806	0.2117	0.1517	-0.0853	-0.0125
51	b42G	3699	1.0001	0.6783	0.6625	0.2426	0.1621	0.1252	-0.0189
52	b42G	3702	1.0002	0.7276	0.6378	0.1283	0.1801	-0.1098	-0.0554
53	b42G	3703	1.0002	0.8407	0.4001	0.1731	0.3029	-0.0496	-0.0957
54	d43G	3685	1.0002	0.8134	0.4440	0.1891	0.3172	-0.0620	-0.0349
55	d43G	3695	1.0001	0.8177	0.5267	0.1413	0.1343	-0.1189	-0.0430
56	d43G	3705	1.0002	0.6252	0.7570	0.1181	0.0111	-0.1488	-0.0037
57	d44G	3705	1.0003	0.4629	0.7992	0.1043	0.3434	-0.0571	-0.1232
58	c50G	3702	1.0002	0.5585	0.7462	0.3530	0.0749	0.0344	0.0076
59	b52G	3696	1.0002	0.9620	0.0751	0.1974	0.1500	0.0807	-0.0321
60	d53G	3699	1.0003	0.9345	-0.0831	0.1868	0.2507	0.1127	-0.0981
61	d54G	3708	1.0002	0.7821	0.5944	0.1414	0.0658	-0.1030	0.0161
62	d54G	3716	1.0002	0.7796	0.6002	0.1342	-0.0219	-0.1173	0.0036
63	d54G	3720	1.0001	0.8569	0.4439	0.2218	0.0853	0.1098	-0.0118
64	d54G	3730	1.0001	0.7338	0.6537	0.1601	0.0900	-0.0136	-0.0203
65	b61G	3681	1.0002	0.7249	0.5823	0.1399	0.2913	-0.1367	-0.1119
66	d62G	3698	1.0001	0.7852	0.5180	0.2671	0.1996	0.0481	-0.0417
67	d63G	3719	1.0001	0.7526	0.6367	0.1626	-0.0022	0.0439	0.0035
68	d63G	3724	1.0001	0.7871	0.5717	0.1793	0.1269	-0.0605	-0.0427
69	d63G	3724	1.0002	0.3239	0.9304	0.1141	0.0394	-0.1226	-0.0080
70	d64G	3694	1.0003	0.7803	0.1412	0.5699	0.2084	0.0026	-0.0567
71	d64G	3700	1.0001	0.7061	0.5871	0.3062	0.1809	0.1690	0.0439
72	d64G	3704	1.0002	0.9527	0.2055	0.2105	0.0729	0.0032	-0.0274
73	d66G	3702	1.0002	0.5687	0.6144	0.5468	-0.0072	-0.0174	0.0082
74	b72G	3688	1.0001	0.8447	0.5058	0.1384	0.0897	-0.0576	-0.0179
75	c72G	3889	1.0002	0.6375	0.7474	0.1051	0.0201	-0.1539	-0.0087
76	d74G	3703	1.0001	0.5870	0.7232	0.3394	0.1118	-0.0546	-0.0418

77	d74Q 3705	1.0001	0.9173	0.3241	0.2004	0.0863	-0.0727	-0.0280
78	d74Q 3710	1.0001	0.8618	0.4615	0.1976	0.0551	-0.0437	-0.0232
79	d74G 3715	1.0001	0.8346	0.5149	0.1849	0.0360	-0.0540	-0.0127
80	d75G 3712	1.0001	0.8850	0.4277	0.1759	0.0431	-0.0273	0.0211
81	d76G 3736	1.0001	0.8726	0.4429	0.1982	0.0260	-0.0509	0.0000
82	b82G 3677	1.0001	0.8337	0.4919	0.1859	0.1250	0.1126	-0.0123
83	b82G 3681	1.0001	0.7784	0.5959	0.1531	0.0380	-0.1176	-0.0193
84	b82G 3684	1.0001	0.7931	0.5821	0.1522	0.0331	-0.0883	-0.0175
85	d83G 3668	1.0002	0.7653	0.6188	0.1235	-0.0159	-0.1266	0.0016
86	d83G 3670	1.0002	0.8299	0.5212	0.1270	-0.0754	-0.1322	0.0220
87	d84Q 3731	1.0002	0.9025	0.3469	0.1589	0.1999	-0.0052	-0.0020
88	d84G 3732	1.0001	0.8450	0.5064	0.1699	0.0065	0.0269	0.0005
89	d94Q 3690	1.0001	0.8522	0.4987	0.1467	0.0113	-0.0592	-0.0016
90	d94Q 3700	1.0002	0.8549	0.4847	0.1378	-0.1055	-0.0559	0.0336
91	b10H 3632	1.0001	0.8953	0.3342	0.2887	0.0533	-0.0056	-0.0260
92	b10H 3633	1.0002	0.9339	0.1477	0.2571	0.1900	0.0551	-0.0317
93	b10H 3635	1.0001	0.8562	0.4550	0.2171	0.0944	-0.0459	-0.0431
94	b10H 3641	1.0001	0.8082	0.5218	0.2361	0.1024	-0.0803	0.0458
95	b10H 3653	1.0001	0.7314	0.6222	0.1359	0.1902	-0.1381	-0.0656
96	b10H 3658	1.0001	0.7595	0.3294	0.3735	0.4184	0.0125	0.0098
97	b10H 3671	1.0002	0.1117	0.8499	0.3585	0.0676	0.3636	-0.0109
98	b10H 3673	1.0003	0.2139	0.9631	0.1512	0.0620	0.0116	-0.0121
99	b10H 3674	1.0002	0.0311	0.7431	0.4443	0.0596	0.4961	-0.0065
100	d20H 3646	1.0002	0.4236	0.8782	0.0892	0.0381	-0.1998	-0.0110
101	d20H 3647	1.0002	0.5069	0.8310	0.1987	-0.0251	-0.1115	0.0124
102	d20H 3651	1.0006	0.6975	0.0728	0.1706	0.6893	0.0490	0.0465
103	b31H 3579	1.0001	0.9095	0.3496	0.2113	0.0695	0.0085	-0.0353
104	b31H 3580	1.0001	0.8467	0.4562	0.2615	0.0719	-0.0245	-0.0321
105	a63H 3628	1.0002	0.7795	0.5977	0.1389	-0.0223	-0.1246	0.0036
106	b03J 3687	1.0002	0.7518	0.6356	0.1301	-0.0501	-0.1036	0.0291
107	d08J 3726	1.0002	0.3719	0.9137	0.1600	0.0180	0.0349	0.0007
108	d10J 3743	1.0003	0.1574	0.9574	0.1308	0.0707	0.1910	-0.0137
109	d17J 3755	1.0002	0.3427	0.8312	0.4254	0.0201	-0.1020	-0.0018
110	b28J 3735	1.0002	0.8298	0.4922	0.2300	-0.1012	-0.0724	0.0323
111	b28J 3737	1.0002	0.8157	0.5491	0.1634	-0.0252	-0.0767	0.0046
112	b28J 3757	1.0001	0.9120	0.3652	0.1847	-0.0281	-0.0094	0.0028
113	d29J 3742	1.0002	0.9358	0.3144	0.1587	-0.0136	-0.0148	-0.0003
114	d39J 3735	1.0000	0.4752	0.7343	0.2543	-0.0525	0.4083	0.0280
115	d39J 3740	1.0001	0.7563	0.5977	0.1302	0.1731	-0.1466	-0.0488
116	d49J 3733	1.0002	0.9385	0.3096	0.1454	0.0466	-0.0114	0.0058
117	d15A 3714	1.0001	0.7078	0.6619	0.2242	-0.0031	-0.1041	-0.0013

APPENDIX F4

VARIMAX FACTOR MATRIX

		VARIANCE	55.575	32.350	9.356
		COMM.	1	2	3
1	d05B 3845	0.9422	0.9066	0.2734	0.2133
2	b14B 3813	0.9769	0.7802	0.6037	0.0609
3	b14B 3814	0.9697	0.5617	0.7720	0.2414
4	b14B 3819	0.9737	0.7919	0.5718	0.1402
5	d15B 3836	0.9940	0.9341	0.1516	0.3139
6	d15B 3839	0.9742	0.5864	0.7267	0.3198
7	d15B 3846	0.9789	0.4256	0.8920	0.0455
8	d25B 3815	0.9811	0.5906	0.5136	0.6071
9	d25B 3831	0.9975	0.7821	0.4096	0.4670
10	d25B 3833	0.9840	0.7490	0.4173	0.4988
11	d25B 3836	1.0000	0.8547	0.3257	0.4043
12	d25B 3834	0.9253	0.8585	0.2451	0.3582
13	d47B 3856	0.9512	0.3563	0.5806	0.6980
14	d47B 3860	0.9422	0.4681	0.4655	0.7116
15	d47B 3870	0.9913	0.8430	0.2739	0.4534
16	d47B 3878	0.9069	0.8929	0.1236	0.3072
17	d15A 3708	0.9787	0.2114	0.9219	0.2901
18	b22A 3577	0.8275	0.0473	0.8389	0.3486
19	d26A 3694	0.9933	0.3327	0.9263	0.1569
20	b34A 3639	0.9871	0.8608	0.4257	0.2549

21	d34A	3576	0.9816	0.9525	-0.0179	0.2720
22	d34A	3580	0.9903	0.9452	0.1837	0.2513
23	d34A	3585	0.9723	0.8929	0.3966	0.1329
24	d34A	3587	0.9882	0.9585	0.1401	0.2231
25	d34A	3592	0.9673	0.9024	0.3497	0.1754
26	d34A	3593	0.9920	0.6431	0.7532	0.1049
27	d34A	3601	0.9673	0.8831	0.4091	0.1417
28	d44A	3544	0.9951	0.8589	0.2112	0.4613
29	d44A	3547	0.9886	0.8948	0.4106	0.1392
30	b46A	3706	0.9750	0.8261	0.4413	0.3127
31	d46A	3716	0.9871	0.8002	0.5599	0.1824
32	d46A	3711	0.9848	0.5930	0.7833	0.1396
33	d47A	3704	0.9970	0.3084	0.8483	0.4270
34	b55A	3694	0.9877	0.8809	0.4479	0.1057
35	d55A	3635	0.9894	0.2343	0.9382	0.2330
36	d55A	3636	0.9893	0.9449	0.2601	0.1700
37	d55A	3646	0.9992	0.8750	0.4623	0.1409
38	d55A	3651	0.9534	0.9029	0.3460	0.1358
39	d57A	3676	0.9959	0.0479	0.6138	0.7853
40	c66A	3680	0.9948	0.2416	0.8680	0.4277
41	d66A	3688	0.9980	0.7702	0.6304	0.0867
42	d66A	3671	0.9872	0.8702	0.4390	0.1931
43	b02G	3672	0.9758	0.9367	0.2543	0.1836
44	b31G	3699	0.9504	0.1031	0.5999	0.7615
45	c32G	3704	0.9675	0.6041	0.2400	0.7382
46	c32G	3705	0.9596	0.6318	0.1625	0.7308
47	c32G	3707	0.9643	0.3163	0.3223	0.8720
48	c32G	3711	0.9970	0.6710	0.5846	0.4528

49	c32G	3712	0.9944	0.7702	0.5228	0.3578
50	b42G	3694	0.9879	0.7823	0.5843	0.1858
51	b42G	3699	0.9692	0.6800	0.6583	0.2712
52	b42G	3702	0.9735	0.7449	0.6383	0.1061
53	b42G	3703	0.9390	0.8674	0.3933	0.1784
54	d43G	3685	0.9367	0.8417	0.4370	0.1929
55	d43G	3695	0.9877	0.8326	0.5321	0.1063
56	d43G	3705	0.9907	0.6298	0.7681	0.0642
57	d44G	3705	0.8705	0.4904	0.7831	0.1296
58	c50G	3702	0.9991	0.5632	0.7503	0.3451
59	b52G	3686	0.9856	0.9683	0.0774	0.2049
60	d53G	3699	0.9566	0.9492	-0.0888	0.2186
61	d54G	3708	0.9965	0.7887	0.6036	0.1004
62	d54G	3716	0.9924	0.7798	0.6151	0.0772
63	d54G	3720	0.9814	0.8533	0.4477	0.2300
64	d54G	3730	0.9968	0.7367	0.6578	0.1460
65	b61G	3681	0.9190	0.7554	0.5762	0.1279
66	d62G	3698	0.9795	0.7977	0.5155	0.2782
67	d63G	3719	0.9907	0.7431	0.6455	0.1477
68	d63G	3724	0.9931	0.7981	0.5758	0.1568
69	d63G	3724	0.9883	0.3292	0.9346	0.0804
70	d64G	3694	0.9897	0.8115	0.1444	0.5570
71	d64G	3700	0.9583	0.7078	0.5824	0.3436
72	d64G	3704	0.9982	0.9575	0.2147	0.1877
73	d66G	3702	0.9841	0.5784	0.6282	0.5048
74	b72G	3688	0.9988	0.8507	0.5128	0.1106
75	c72G	3889	0.9904	0.6428	0.7580	0.0515
76	d74G	3703	0.9909	0.6019	0.7274	0.3157

77	d74G	3705	0.9988	0.9277	0.3339	0.1630
78	d74G	3710	0.9998	0.8663	0.4712	0.1649
79	d74G	3715	0.9994	0.8374	0.5256	0.1482
80	d75G	3712	0.9982	0.8860	0.4383	0.1448
81	d76G	3736	0.9980	0.8750	0.4552	0.1586
82	b82G	3677	0.9751	0.8317	0.4921	0.2031
83	b82G	3681	0.9953	0.7848	0.6070	0.1045
84	b82G	3684	0.9984	0.7968	0.5929	0.1096
85	d83G	3668	0.9926	0.7664	0.6332	0.0661
86	d83G	3670	0.9791	0.8267	0.5408	0.0566
87	d84G	3731	0.9831	0.9155	0.3469	0.1569
88	d84G	3732	0.9922	0.8385	0.5167	0.1487
89	d94G	3690	0.9981	0.8519	0.5111	0.1059
90	d94G	3700	0.9730	0.8438	0.5046	0.0801
91	b10H	3632	0.9983	0.9011	0.3449	0.2596
92	b10H	3633	0.9880	0.9470	0.1485	0.2629
93	b10H	3635	0.9984	0.8653	0.4624	0.1893
94	b10H	3641	0.9929	0.8196	0.5300	0.2007
95	b10H	3653	0.9657	0.7523	0.6230	0.1079
96	b10H	3658	0.8995	0.7980	0.3163	0.4032
97	b10H	3671	0.9083	0.0936	0.8386	0.4430
98	b10H	3673	0.9926	0.2128	0.9608	0.1553
99	b10H	3674	0.8426	0.0069	0.7288	0.5580
100	d20H	3646	0.9739	0.4336	0.8858	0.0345
101	d20H	3647	0.9908	0.5083	0.8428	0.1485
102	d20H	3651	0.6327	0.7512	0.0390	0.2585
103	b31H	3579	0.9976	0.9127	0.3579	0.1912
104	b31H	3580	0.9997	0.8537	0.4650	0.2337

105	a63H	3628	0.9911	0.7804	0.6129	0.0799
106	b03J	3687	0.9894	0.7480	0.6516	0.0730
107	d08J	3726	0.9968	0.3648	0.9159	0.1580
108	d10J	3743	0.9531	0.1432	0.9483	0.1825
109	d17J	3755	0.9780	0.3566	0.8407	0.3795
110	b28J	3735	0.9692	0.8236	0.5132	0.1657
111	b28J	3737	0.9933	0.8139	0.5640	0.1133
112	b28J	3757	0.9881	0.9067	0.3802	0.1463
113	d29J	3742	0.9906	0.9316	0.3287	0.1213
114	d39J	3735	0.8348	0.4379	0.7332	0.3248
115	d39J	3740	0.9719	0.7760	0.6003	0.0968
116	d49J	3733	0.9973	0.9386	0.3200	0.1183
117	d15A	3714	0.9921	0.7118	0.6753	0.1718

APPENDIX 5

NORMALIZED VARIMAX FACTOR COMPONENTS

		COMM.	1	2	3
1	d05B 3845	0.9422	0.8724	0.0793	0.0483
2	b14B 3813	0.9769	0.6231	0.3731	0.0038
3	b14B 3814	0.9697	0.3254	0.6145	0.0601
4	b14B 3819	0.9737	0.6441	0.3357	0.0202
5	d15B 3836	0.9940	0.8777	0.0231	0.0992
6	d15B 3839	0.9742	0.3529	0.5421	0.1050
7	d15B 3846	0.9789	0.1850	0.8129	0.0021
8	d25B 3815	0.9811	0.3555	0.2688	0.3757
9	d25B 3831	0.9975	0.6132	0.1682	0.2186
10	d25B 3833	0.9840	0.5702	0.1770	0.2529
11	d25B 3836	1.0000	0.7304	0.1061	0.1635
12	d25B 3834	0.9253	0.7964	0.0649	0.1387
13	d47B 3856	0.9512	0.1335	0.3544	0.5122
14	d47B 3860	0.9422	0.2326	0.2300	0.5375
15	d47B 3870	0.9913	0.7169	0.0757	0.2074
16	d47B 3878	0.9069	0.8791	0.0168	0.1041
17	d15A 3708	0.9787	0.0457	0.8683	0.0860
18	b22A 3577	0.8275	0.0027	0.8504	0.1469
19	d26A 3694	0.9933	0.1114	0.8638	0.0248
20	b34A 3639	0.9871	0.7506	0.1836	0.0658
21	d34A 3576	0.9816	0.9243	-0.0003	0.0754
22	d34A 3580	0.9903	0.9021	0.0341	0.0638

23	d34A	3585	0.9723	0.8201	0.1618	0.0182
24	d34A	3587	0.9882	0.9298	0.0199	0.0504
25	d34A	3592	0.9673	0.8418	0.1264	0.0318
26	d34A	3593	0.9920	0.4169	0.5720	0.0111
27	d34A	3601	0.9673	0.8062	0.1730	0.0208
28	d44A	3544	0.9951	0.7414	0.0448	0.2138
29	d44A	3547	0.9886	0.8098	0.1706	0.0196
30	b46A	3706	0.9750	0.7000	0.1998	0.1003
31	d46A	3716	0.9871	0.6487	0.3176	0.0337
32	d46A	3711	0.9848	0.3571	0.6231	0.0198
33	d47A	3704	0.9970	0.0954	0.7217	0.1829
34	b55A	3694	0.9877	0.7856	0.2031	0.0113
35	d55A	3635	0.9894	0.0555	0.8897	0.0549
36	d55A	3636	0.9893	0.9024	0.0684	0.0292
37	d55A	3646	0.9992	0.7662	0.2139	0.0199
38	d55A	3651	0.9534	0.8551	0.1256	0.0193
39	d57A	3676	0.9959	0.0023	0.3784	0.6193
40	c66A	3680	0.9948	0.0587	0.7574	0.1839
41	d66A	3688	0.9980	0.5943	0.3981	0.0075
42	d66A	3671	0.9872	0.7670	0.1953	0.0378
43	b02G	3672	0.9758	0.8992	0.0663	0.0346
44	b31G	3699	0.9504	0.0112	0.3787	0.6101
45	c32G	3704	0.9675	0.3773	0.0595	0.5632
46	c32G	3705	0.9596	0.4159	0.0275	0.5565
47	c32G	3707	0.9643	0.1037	0.1077	0.7885
48	c32G	3711	0.9970	0.4516	0.3428	0.2056
49	c32G	3712	0.9944	0.5965	0.2748	0.1287
50	b42G	3694	0.9879	0.6194	0.3456	0.0349

51	b42G	3699	0.9692	0.4770	0.4471	0.0759
52	b42G	3702	0.9735	0.5699	0.4185	0.0116
53	b42G	3703	0.9390	0.8014	0.1647	0.0339
54	d43G	3685	0.9367	0.7564	0.2038	0.0397
55	d43G	3695	0.9877	0.7019	0.2866	0.0114
56	d43G	3705	0.9907	0.4003	0.5955	0.0042
57	d44G	3705	0.8705	0.2763	0.7044	0.0193
58	c50G	3702	0.9991	0.3175	0.5634	0.1192
59	b52G	3686	0.9856	0.9513	0.0061	0.0426
60	d53G	3699	0.9566	0.9418	-0.0082	0.0499
61	d54G	3708	0.9965	0.6242	0.3656	0.0101
62	d54G	3716	0.9924	0.6128	0.3812	0.0060
63	d54G	3720	0.9814	0.7419	0.2042	0.0539
64	d54G	3730	0.9968	0.5445	0.4342	0.0214
65	b61G	3681	0.9190	0.6209	0.3613	0.0178
66	d62G	3698	0.9795	0.6497	0.2713	0.0790
67	d63G	3719	0.9907	0.5574	0.4206	0.0220
68	d63G	3724	0.9931	0.6414	0.3339	0.0248
69	d63G	3724	0.9883	0.1097	0.8838	0.0065
70	d64G	3694	0.9897	0.6655	0.0211	0.3135
71	d64G	3700	0.9583	0.5228	0.3540	0.1232
72	d64G	3704	0.9982	0.9185	0.0462	0.0353
73	d66G	3702	0.9841	0.3400	0.4011	0.2590
74	b72G	3688	0.9988	0.7245	0.2632	0.0122
75	c72G	3889	0.9904	0.4172	0.5801	0.0027
76	d74G	3703	0.9909	0.3656	0.5339	0.1006
77	d74G	3705	0.9988	0.8618	0.1116	0.0266
78	d74G	3710	0.9998	0.7507	0.2221	0.0272

79	d74G	3715	0.9994	0.7016	0.2764	0.0220
80	d75G	3712	0.9982	0.7865	0.1925	0.0210
81	d76G	3736	0.9980	0.7672	0.2076	0.0252
82	b82G	3677	0.9751	0.7093	0.2484	0.0423
83	b82G	3681	0.9953	0.6188	0.3702	0.0110
84	b82G	3684	0.9984	0.6359	0.3521	0.0120
85	d83G	3668	0.9926	0.5917	0.4039	0.0044
86	d83G	3670	0.9791	0.6980	0.2987	0.0033
87	d84G	3731	0.9831	0.8525	0.1224	0.0251
88	d84G	3732	0.9922	0.7086	0.2691	0.0223
89	d94G	3690	0.9981	0.7271	0.2617	0.0112
90	d94G	3700	0.9730	0.7317	0.2617	0.0066
91	b10H	3632	0.9983	0.8133	0.1192	0.0675
92	b10H	3633	0.9880	0.9077	0.0223	0.0699
93	b10H	3635	0.9984	0.7499	0.2142	0.0359
94	b10H	3641	0.9929	0.6765	0.2829	0.0406
95	b10H	3653	0.9657	0.5861	0.4019	0.0121
96	b10H	3658	0.8995	0.7080	0.1112	0.1808
97	b10H	3671	0.9083	0.0096	0.7743	0.2161
98	b10H	3673	0.9926	0.0456	0.9301	0.0243
99	b10H	3674	0.8426	0.0001	0.6304	0.3695
100	d20H	3646	0.9739	0.1931	0.8057	0.0012
101	d20H	3647	0.9908	0.2608	0.7170	0.0222
102	d20H	3651	0.6327	0.8920	0.0024	0.1056
103	b31H	3579	0.9976	0.8349	0.1284	0.0366
104	b31H	3580	0.9997	0.7291	0.2163	0.0547
105	a63H	3628	0.9911	0.6145	0.3790	0.0064
106	b03J	3687	0.9894	0.5655	0.4292	0.0054

107	d08J	3726	0.9968	0.1335	0.8415	0.0250
108	d10J	3743	0.9531	0.0215	0.9435	0.0349
109	d17J	3755	0.9780	0.1300	0.7227	0.1473
110	b28J	3735	0.9692	0.6999	0.2717	0.0283
111	b28J	3737	0.9933	0.6668	0.3202	0.0129
112	b28J	3757	0.9881	0.8321	0.1463	0.0217
113	d29J	3742	0.9906	0.8761	0.1091	0.0149
114	d39J	3735	0.8348	0.2297	0.6439	0.1264
115	d39J	3740	0.9719	0.6196	0.3708	0.0096
116	d49J	3733	0.9973	0.8833	0.1027	0.0140
117	d15A	3714	0.9921	0.5106	0.4596	0.0297

APPENDIX G

Compilation of Discriminant Function Data

Abbreviations

Mz	Mean size
σ	Variance
Sk	Skewness
KG	Kurtosis
Y1	Discriminant function to differentiate between aeolian and beach environments
Y2	Discriminant function to differentiate between beach and shallow agitated marine environments
Y3	Discriminant function to differentiate between shallow marine and fluvial process
Y4	Discriminant function to differentiate between fluvial and turbidity current

APPENDIX G

Sample	Mz	σ	Sk	KG	Y1	Y2	Y3	Y4
d15A 3708	3.47	0.194	0.29	2.16	-5.54416	112.25893	-2.02129	15.88818
d15A 3714	3.11	0.314	0.19	1.76	-4.85294	105.29636	-2.70517	12.83813
b22A 3577	3.56	0.053	0.67	1.13	-10.38218	92.24374	-2.67209	13.05986
d26A 3694	2.38	0.096	0.31	1.16	-5.17011	70.64793	-1.62408	9.94368
d34A 3576	2.73	0.260	0.35	1.79	-3.93368	99.28490	-3.12633	13.79990
d34A 3580	2.90	0.348	0.30	2.07	-3.23903	112.00423	-3.59060	15.06790
d34A 3585	2.96	0.122	0.09	1.28	-6.31182	79.69857	-0.60765	9.51619
d34A 3587	2.83	0.230	0.38	1.58	-5.11663	95.55599	-2.99454	12.96255
d34A 3592	2.96	0.212	0.31	1.62	-5.38027	95.82828	-2.44832	12.79680
d34A 3593	3.14	0.130	0.17	1.50	-6.40908	88.50224	-0.99936	11.34903
d34A 3601	2.96	0.130	0.20	1.38	-6.20261	84.00732	-1.20328	10.78601
d44A 3544	3.10	0.504	0.41	1.20	-6.31251	111.27856	-5.48037	11.34809
d44A 3547	2.96	0.130	0.06	0.88	-7.46864	72.22018	-0.54233	7.19715
d46A 3716	3.06	0.185	0.09	1.09	-7.02928	81.84834	-1.13494	8.58273
d46A 3711	2.94	0.360	0.22	1.07	-6.28510	93.45944	-3.34019	9.26548
b55A 3694	2.95	0.102	0.07	1.04	-7.05624	73.41811	-0.34812	8.10409
d55A 3635	3.49	0.336	0.60	2.68	-4.11167	137.19069	-4.75839	20.74179
d55A 3636	2.91	0.144	0.21	1.40	-5.92788	84.74830	-1.39516	10.92311
d55A 3646	2.94	0.137	-0.03	1.23	-6.09362	77.23365	-0.15473	8.42927
d55A 3651	2.97	0.116	0.22	1.38	-6.33165	83.60607	-1.17565	10.92786
d66A 3680	3.57	0.422	0.42	1.72	-6.69364	123.07710	-4.65534	14.50672
d66A 3688	3.04	0.160	0.04	0.98	-7.28873	76.95829	-0.68315	7.64949
d66A 3671	3.01	0.202	0.41	1.76	-5.36416	100.41431	-2.83691	14.24707
d05B 3845	3.09	0.221	0.72	1.91	-5.75828	111.26447	-4.48495	17.18568
b14B 3813	3.34	0.314	0.58	1.83	-6.26369	117.25372	-4.54454	16.00013
b14B 3813	3.14	0.109	0.23	0.95	-8.32272	78.05112	-1.13813	8.84198
b14B 3819	3.08	0.185	0.34	1.94	-4.97333	102.41684	-2.31156	14.77901
d15B 3836	2.92	0.348	0.50	1.48	-5.56269	105.02119	-4.59197	13.30608
d15B 3839	3.38	0.360	0.53	1.45	-7.31599	112.99178	-4.71327	13.68115
d15B 3846	3.25	0.078	0.26	1.66	-6.67990	91.45013	-0.95214	12.88113
d25B 3815	3.52	0.723	0.38	0.95	-7.71905	127.03458	-7.13911	10.12598
d25B 3831	3.26	0.689	0.39	1.30	-5.84658	127.41444	-6.95098	11.85816
d25B 3833	3.34	0.656	0.46	1.07	-7.11496	123.52296	-6.99443	11.16981
d25B 3836	3.09	0.608	0.35	1.53	-4.73869	122.99548	-6.08743	12.68354
d25B 3834	2.85	0.504	0.21	1.16	-5.12953	103.00362	-4.57496	9.60957

d47B 3856	3.75	0.672	0.37	0.79	-9.20272	124.20108	-6.59340	9.37777
d47B 3860	3.78	1.102	0.32	0.81	-7.55163	152.39688	-10.10707	9.16866
d47B 3870	3.15	0.593	0.44	1.06	-6.66044	115.84882	-6.39758	10.84515
d47B 3879	2.77	0.436	0.28	1.59	-3.90414	106.47463	-4.31948	12.29896
b02G 3676	2.87	0.185	0.13	1.28	-5.84271	83.11430	-1.37569	9.72055
b31G 3699	3.93	0.608	0.27	0.60	-10.46591	117.48677	-5.50124	7.82881
c32G 3704	3.51	0.740	0.10	0.84	-7.38110	120.89621	-5.92697	7.65155
c32G 3706	3.36	1.040	0.44	0.72	-6.81201	142.24939	-10.27435	9.19715
c32G 3707	3.72	0.656	-0.02	0.81	-8.28385	115.96873	-4.54985	6.83642
c32G 3711	3.28	0.504	0.24	1.17	-6.69528	110.46284	-4.59864	10.17471
c32G 3711	3.20	0.533	0.39	1.49	-5.61834	119.74044	-5.59231	12.82048
b42G 3694	2.75	0.260	-0.08	1.36	-5.16469	86.98575	-0.98023	8.78792
b42G 3699	3.10	0.260	-0.04	0.96	-7.02847	82.65632	-1.15246	7.04835
b42G 3702	2.70	0.212	-0.01	0.95	-6.58767	76.69692	-0.93190	7.05309
b42G 3703	2.80	0.202	-0.13	0.92	-6.10869	71.80565	-0.29496	6.01430
d43G 3685	2.81	0.260	-0.15	1.01	-5.60942	77.05027	-0.69451	6.36321
d43G 3695	2.89	0.137	-0.33	1.10	-5.69695	68.61329	1.29271	5.68548
d43G 3705	3.10	0.109	-0.10	1.32	-6.34269	78.29623	0.48306	8.54979
d44G 3705	3.09	0.144	0.05	1.02	-7.42114	77.63714	-0.57923	7.96460
c50G 3703	3.29	0.980	0.24	2.02	-2.32253	157.62556	-8.72476	14.68072
d52G 3686	2.74	0.152	0.04	1.12	-5.81144	74.33377	-0.69275	8.17402
d53G 3699	2.64	0.073	0.15	1.11	-6.00729	69.37101	-0.56618	8.78949
d54G 3708	2.95	0.194	-0.19	1.21	-5.64944	77.84867	0.13336	7.25347
d54G 3716	3.00	0.090	-0.04	1.47	-5.71335	79.35106	0.33375	9.67548
d54G 3730	2.99	0.194	0.05	1.02	-6.88214	79.30470	-1.03876	7.89245
b61G 3681	2.88	0.202	0.08	0.83	-7.11049	75.19502	-1.30405	7.00944
d62G 3698	2.96	0.314	0.20	1.10	-6.39330	90.91659	-2.82869	9.30405
d63G 3719	3.09	0.160	0.03	0.99	-7.41527	77.74493	-0.61947	7.67117
d63G 3724	2.99	0.176	0.07	1.18	-6.48918	81.49732	-0.97823	8.87392
d63G 3724	3.34	0.096	0.28	1.63	-7.07051	93.82899	-1.18084	12.92193
d64G 3694	3.22	0.723	0.31	1.08	-6.09830	123.47662	-6.87588	10.12633
d64G 3700	3.06	0.397	0.03	1.08	-6.15108	94.50720	-2.69903	8.12587
d64G 3704	2.84	0.194	0.15	1.49	-5.09114	87.46441	-1.54821	10.94501
d66G 3702	3.52	0.624	0.35	0.82	-8.42575	117.62003	-6.13656	9.23596
b72G 3688	2.95	0.109	-0.02	1.19	-6.37826	74.99123	0.04255	8.29209
c72G 3889	3.10	0.102	-0.11	1.38	-6.15918	78.79830	0.59182	8.80003
d74G 3703	3.29	0.462	0.22	1.92	-4.50866	121.39539	-4.09646	14.01680
d74G 3705	2.95	0.348	0.29	1.84	-4.11281	108.34985	-3.53850	13.81933
d74G 3710	2.97	0.176	0.21	1.34	-6.21037	86.67994	-1.66127	10.64883
d74G 3715	2.99	0.152	0.07	1.29	-6.23664	81.93607	-0.76005	9.45612

d75G 3712	2.91	0.168	-0.03	1.28	-5.71539	79.73939	-0.43420	8.67226
b82G 3677	2.95	0.221	0.01	0.97	-6.71095	78.82291	-1.09601	7.32967
b82G 3681	2.99	0.137	-0.12	1.57	-5.02657	82.67815	0.31631	9.65896
b82G 3684	2.99	0.144	0.05	1.08	-6.87745	77.18206	-0.60486	8.21001
d83G 3668	3.02	0.090	-0.14	1.48	-5.54593	78.03846	0.82925	9.06962
d83G 3670	3.00	0.096	0.03	1.09	-7.01926	73.98775	-0.08053	8.13551
d84G 3731	2.70	0.185	0.35	0.95	-6.72032	78.33037	-2.51659	9.33239
d84G 3732	2.98	0.168	0.09	1.04	-6.96164	78.56694	-1.01299	8.26038
d94G 3690	2.97	0.130	-0.04	1.03	-6.82964	73.34164	-0.04293	7.32505
d94G 3700	3.02	0.084	0.01	1.19	-6.78217	75.00060	0.13298	8.54457
b10H 3632	3.31	0.109	0.62	0.57	-10.92242	80.74233	-3.01631	9.57897
b10H 3633	2.79	0.250	0.30	1.35	-5.45131	90.51320	-2.79728	11.17779
b10H 3635	2.93	0.240	-0.03	1.61	-4.49280	90.88993	-1.04334	10.43328
b10H 3641	2.93	0.348	-0.01	1.94	-3.10710	104.45507	-2.07142	12.31451
b10H 3653	2.90	0.176	-0.29	1.37	-4.82885	77.08578	0.76681	7.39101
b10H 3658	2.97	0.563	0.19	1.20	-5.17554	109.09748	-4.95255	9.77321
b10H 3671	3.56	0.240	0.43	2.98	-3.43088	134.43173	-3.04850	21.23563
b10H 3673	3.48	0.202	0.61	1.00	-9.82308	97.32956	-3.71814	11.91016
b10H 3674	3.67	0.360	0.60	3.30	-2.73633	153.03171	-4.88392	24.15314
d20H 3646	3.23	0.073	0.09	1.91	-5.49749	92.32353	-0.06576	13.04540
d20H 3647	3.26	0.194	0.40	1.69	-6.48648	102.26648	-2.64208	13.98963
d20H 3651	2.50	0.281	0.24	0.94	-5.45391	79.33093	-2.87686	8.39462
b31H 3579	2.90	0.194	0.07	1.26	-5.85524	82.69906	-1.15073	9.23241
b31H 3580	2.98	0.292	0.15	1.64	-4.76099	98.87103	-2.35957	11.83993
a63H 3628	3.01	0.102	-0.03	1.41	-5.91071	79.39320	0.17615	9.43246
b08J 3687	3.04	0.096	0.07	1.35	-6.43556	80.14928	-0.25232	9.80976
d08J 3726	3.35	0.109	0.18	0.67	-9.84012	75.25177	-0.84707	7.17493
d10J 3743	3.48	0.040	0.31	1.08	-9.35253	82.70004	-0.82276	10.31392
d17J 3755	3.52	0.533	0.55	1.75	-6.28310	132.45778	-6.27142	15.50462
b28J 3735	3.04	0.194	0.24	1.56	-5.77385	93.52003	-1.92818	12.06570
b28J 3737	2.96	0.152	0.30	0.80	-8.13281	76.56399	-1.91766	8.38946
b28J 3757	2.95	0.144	0.21	1.16	-6.81787	80.93340	-1.39532	9.68172
d29J 3742	2.90	0.130	0.18	1.67	-5.04404	88.07222	-1.10855	12.14295
d39J 3735	2.82	0.160	-0.27	0.95	-5.95325	67.34621	0.76955	5.24500
d39J 3740	2.88	0.260	-0.38	1.29	-4.50983	79.16258	0.46439	6.34727
d49J 3733	2.86	0.130	-0.05	1.00	-6.50971	70.88357	-0.02682	7.01958

APPENDIX H

Compilation of Linear Discriminant Function

Abbreviations

M	Mean Size
SD	Standard Deviation
SK	Skewness
KG	Kurtosis
R1	Linear discriminant function to distinguish between beach and dune
R2	Linear discriminant function to distinguish between beach and river
R3	Linear discriminant function to distinguish between dune and river

APPENDIX H

Sample	Loc.	M	SD	SK	KG	R1	R2	R3
d15A	3708	3.49	0.38	0.08	3.11	-0.20837	-0.00014	0.20209
d15A	3714	3.14	0.47	0.54	3.41	-0.18453	-0.00635	0.19175
b22A	3577	3.56	0.29	0.24	2.43	-0.21935	0.00035	0.19831
d26A	3694	3.36	0.34	0.34	3.28	-0.20197	0.00042	0.20391
b34A	3639	3.01	0.52	0.36	3.00	-0.17493	-0.00915	0.17364
d34A	3576	2.77	0.50	1.17	4.75	-0.15807	-0.00713	0.20510
d34A	3580	2.91	0.52	0.90	3.95	-0.16815	-0.00911	0.19255
d34A	3585	2.98	0.39	0.72	4.09	-0.17471	-0.00167	0.20319
d34A	3587	2.87	0.48	1.00	4.55	-0.16492	-0.00580	0.20520
d34A	3592	3.00	0.45	0.96	4.35	-0.17491	-0.00479	0.20845
d34A	3593	3.16	0.40	0.49	3.93	-0.18544	-0.00100	0.20566
d34A	3601	3.00	0.41	0.85	4.42	-0.17502	-0.00209	0.21072
d44A	3544	3.09	0.66	0.55	2.32	-0.18024	-0.01888	0.15913
d44A	3547	2.96	0.42	0.62	4.28	-0.17110	-0.00168	0.20345
b46A	3711	3.03	0.58	0.18	2.55	-0.17514	-0.01231	0.16117
d46A	3716	3.06	0.46	0.24	3.19	-0.17838	-0.00499	0.18141
d46A	3711	3.23	0.42	0.70	3.62	-0.19215	-0.00424	0.20398
d47A	3704	3.46	0.50	-0.13	2.75	-0.20300	-0.00547	0.18576
b55A	3694	2.93	0.35	0.28	4.01	-0.16990	0.00245	0.19706
d55A	3635	3.49	0.38	0.68	2.78	-0.21372	-0.00512	0.20161
d55A	3636	2.90	0.43	0.84	4.51	-0.16741	-0.00272	0.20675
d55A	3646	2.99	0.44	0.36	3.65	-0.17329	-0.00325	0.18919
d55A	3651	2.98	0.39	1.09	4.92	-0.17389	-0.00087	0.22274
d57A	3676	3.75	0.45	-0.46	2.38	-0.22287	-0.00217	0.19128
c66A	3680	3.52	0.44	0.09	2.61	-0.21071	-0.00466	0.19098
d66A	3688	3.03	0.40	0.16	3.53	-0.17621	-0.00064	0.18878
d66A	3671	3.03	0.47	0.79	3.68	-0.17785	-0.00707	0.19431
d05B	3845	3.02	0.47	1.18	4.13	-0.17802	-0.00783	0.20630
b14B	3813	3.06	0.34	0.63	4.47	-0.17931	0.00262	0.21579
b14B	3814	3.31	0.48	0.67	2.77	-0.19893	-0.00974	0.18805
b14B	3819	3.10	0.43	0.92	4.11	-0.18278	-0.00441	0.20905
d15B	3836	2.95	0.56	0.98	3.40	-0.17239	-0.01336	0.18261
d15B	3839	3.39	0.50	0.26	2.07	-0.20370	-0.01056	0.17329
d15B	3846	3.27	0.33	0.88	4.94	-0.19330	0.00358	0.23741
d25B	3815	3.50	0.68	-0.62	2.07	-0.19995	-0.01277	0.16078

d25B	3831	3.14	0.66	0.30	2.29	-0.18199	-0.01736	0.15841
d25B	3833	3.23	0.64	0.29	2.15	-0.18901	-0.01681	0.16077
d25B	3836	3.09	0.63	0.34	2.44	-0.17920	-0.01581	0.16088
d25B	3834	2.84	0.66	0.51	2.80	-0.16151	-0.01721	0.15645
d47B	3857	3.59	0.56	-0.11	1.62	-0.21454	-0.01226	0.16725
d47B	3860	3.49	0.65	-0.14	1.72	-0.20476	-0.01578	0.15978
d47B	3870	3.07	0.65	0.57	2.26	-0.17957	-0.01883	0.15775
d47B	3878	2.79	0.57	0.88	3.51	-0.16041	-0.01300	0.17589
b02Q	3672	2.93	0.43	0.93	4.26	-0.17100	-0.00417	0.20421
b31Q	3699	3.74	0.51	-0.57	2.44	-0.21953	-0.00390	0.18790
c32Q	3704	3.43	0.74	-0.27	1.60	-0.19784	-0.01945	0.14895
c32Q	3706	3.23	0.77	0.15	1.51	-0.18693	-0.02402	0.14062
c32Q	3707	3.58	0.69	-0.61	2.19	-0.20455	-0.01270	0.16636
c32Q	3711	3.25	0.61	0.10	2.46	-0.18867	-0.01312	0.16728
c32Q	3712	3.14	0.60	0.18	2.95	-0.18026	-0.01151	0.17291
b42Q	3694	3.00	0.53	0.17	3.24	-0.17175	-0.00752	0.17543
b42Q	3699	3.09	0.55	-0.09	2.68	-0.17763	-0.00873	0.16529
b42Q	3702	2.96	0.44	0.14	2.99	-0.17246	-0.00439	0.17299
b42Q	3703	2.85	0.49	0.36	3.08	-0.16487	-0.00778	0.16931
d43Q	3685	2.85	0.54	0.20	2.98	-0.16278	-0.00934	0.16333
d43Q	3695	2.93	0.44	0.12	3.47	-0.16842	-0.00252	0.18064
d47Q	3705	3.14	0.40	-0.16	4.39	-0.17791	0.00475	0.20723
d44Q	3703	3.06	0.50	-0.38	2.35	-0.17643	-0.00602	0.15724
c50Q	3702	3.25	0.56	-0.07	2.85	-0.18739	-0.00841	0.17561
b42Q	3686	2.76	0.44	0.71	4.48	-0.15710	-0.00267	0.19796
d53Q	3699	3.16	0.36	0.46	3.75	-0.18709	0.00026	0.20391
d54Q	3708	2.98	0.45	-0.14	3.77	-0.16850	-0.00013	0.18566
d54Q	3716	3.07	0.39	0.13	3.87	-0.17758	0.00132	0.19735
d54Q	3720	2.99	0.50	0.25	2.91	-0.17380	-0.00796	0.17092
d54Q	3730	3.05	0.46	-0.03	3.10	-0.17627	-0.00366	0.17659
b61Q	3681	2.92	0.48	0.18	2.86	-0.16946	-0.00694	0.16705
d62Q	3698	3.01	0.56	0.24	2.72	-0.17411	-0.01120	0.16510
d63Q	3719	3.09	0.42	0.07	3.04	-0.18096	-0.00270	0.18025
d63Q	3724	3.00	0.47	0.24	3.21	-0.17405	-0.00544	0.17854
d63Q	3724	3.34	0.33	0.78	4.66	-0.19838	0.00326	0.23428
d64Q	3694	3.08	0.72	0.49	2.01	-0.17871	-0.02231	0.14914
d64Q	3700	3.06	0.61	-0.09	2.55	-0.17446	-0.01189	0.15841
d64Q	3704	2.86	0.45	0.87	4.55	-0.16423	-0.00369	0.20497
d66Q	3702	3.36	0.59	-0.15	2.08	-0.19636	-0.01195	0.16361
b72Q	3688	2.92	0.44	-0.18	3.64	-0.16507	-0.00002	0.18051

c72Q	3889	3. 11	0 38	0. 05	4. 02	-0. 17938	0. 00288	0. 20179
d74Q	3703	3. 23	0. 55	0. 19	2. 57	-0. 18922	-0. 01068	0. 17235
d74Q	3705	2. 89	0. 46	0. 70	4. 38	-0. 16547	-0. 00366	0. 20093
d74Q	3710	2. 98	0. 46	0. 53	3. 60	-0. 17340	-0. 00538	0. 18843
d74Q	3712	2. 93	0. 46	0. 11	3. 68	-0. 16615	-0. 00179	0. 18741
d74Q	3715	3. 00	0. 45	0. 42	3. 61	-0. 17423	-0. 00419	0. 18897
d76Q	3736	2. 97	0. 46	0. 48	3. 90	-0. 17121	-0. 00396	0. 19325
b82Q	3677	2. 99	0. 49	-0. 17	2. 72	-0. 17202	-0..00561	0. 16367
b82Q	3681	3. 02	0. 42	0. 36	3. 76	-0. 17540	-0. 00191	0. 19369
b82Q	3684	3. 02	0. 42	0. 31	3. 59	-0. 17575	-0. 00224	0. 18993
d83Q	3668	3. 04	0. 37	0. 25	3. 98	-0. 17653	0. 00181	0. 20025
d83Q	3670	3. 00	0. 34	0. 56	4. 84	-0. 17339	0. 00435	0. 21945
d84Q	3731	2. 81	0 47	-0. 01	3. 12	-0. 16015	-0. 00451	0. 16563
d84Q	3732	3. 01	0. 43	0. 20	3. 19	-0. 17566	-0. 00351	0. 18022
d94Q	3690	2. 97	0. 41	0. 19	3. 70	-0. 17148	-0. 00072	0. 18907
d94Q	3700	3. 10	0. 35	0. 58	4. 12	-0. 17677	0. 00111	0. 20578
b10H	3632	2. 99	0. 53	0. 78	3. 35	-0. 17475	-0. 01093	0. 18304
b10H	3633	2. 82	0. 53	0. 75	3. 88	-0. 16118	-0. 00901	0. 18510
b10H	3635	2. 98	0. 48	0. 59	3. 43	-0. 17391	-0. 00727	0. 18476
b10H	3641	2. 98	0. 55	0. 16	3. 35	-0. 16935	-0. 00795	0. 17553
b10H	3653	2. 97	0. 46	0. 05	3. 17	-0. 17123	-0. 00402	0. 17503
b10H	3658	2. 88	0. 70	0. 35	2. 58	-0. 16282	-0. 01873	0. 15051
b10H	3671	3. 57	0. 39	-0. 19	3. 41	-0. 21037	0. 00235	0. 20840
b10H	3673	3. 43	0. 32	0. 63	4. 86	-0. 20281	0. 00552	0. 24130
b10H	3674	3. 65	0. 38	-0. 35	3. 55	-0. 21431	0. 00443	0. 21371
d20H	3646	3. 24	0. 34	0. 32	5. 25	-0. 18603	0..00775	0. 23602
d20H	3667	3. 29	0. 41	0. 72	3. 44	-0. 19726	-0. 00451	0. 20398
d20H	3651	2. 52	0. 56	0. 77	3. 46	-0. 14228	-0. 01248	0. 16193
b31H	3579	2. 94	0. 46	0. 68	3. 62	-0. 17168	-0. 00631	0. 18844
b31H	3580	3. 02	0. 51	0. 61	3. 20	-0. 17676	-0. 00951	0. 18088
a63H	3628	3. 04	0. 39	0. 43	4. 15	-0. 17650	0. 00045	0. 20427
b03J	3687	3. 06	0. 38	0. 14	4. 42	-0. 17508	0. 00374	0. 20805
d08J	3726	3. 35	0. 36	0. 36	3. 33	-0. 20067	-0. 00040	0. 20361
d10J	3743	3. 46	0. 27	0. 68	2. 48	-0. 21605	-0. 00149	0. 19997
d17J	3755	3. 47	0. 49	0. 24	2. 34	-0. 20806	-0. 00887	0. 18246
b28J	3735	3. 09	0. 45	0. 93	3. 88	-0. 18254	-0. 00623	0. 20328
b28J	3737	3. 03	0. 41	0. 51	3. 90	-0. 17680	-0. 00187	0. 19880
b28J	3757	2. 95	0. 42	0. 70	4. 08	-0. 17178	-0. 00294	0. 19993
d29J	3742	2. 90	0. 38	0. 46	4. 08	-0. 16799	0. 00023	0. 19728
d39J	3735	2. 87	0. 46	0. 56	3. 64	-0. 16616	-0. 00559	0. 18443
d39J	3740	2. 95	0. 45	-0. 01	3. 32	-0. 16919	-0..00267	0. 17691
d49J	3733	2. 85	0. 39	-0. 15	3. 41	-0. 16297	0. 00101	0. 17566

APPENDIX I

Compilation of Paleomagnetic Data

Zone 94-H -2

Sample	Location	Inclination
d-15-A	3718	53.9
	3718.8	15.4
d-26-A	3699	41.7
d-34-A	3601.11	49.4
	3609	-37.4
d-44-A	3557	53.9
d-55-A	3627.1	-32.8
	2636.1	-4.9
	3641.8	-8.9
	3646.6	11.5
	3648.7	-19.5
	3651.4	32.0
d-66-A	3688	-40.1
	3670.4	-20.9
	3671.5	16.0
	3675.1	17.4
	3680.9	-18.8
	3688	-40.1
	3705.2	-17.7
c-66-A	3717	-36.4
d-13-B	3762	-47.2
	3775	26.1

d-15-B	3834.6	15.9
	3886	15.9
	3839	52.3
	3839.4	20.6
	3846	58.00
	3848	8.7
b-10-H	3632.4	-6.9
	3656.10	-7.8
d-63-G	3691.8	-35.1
d-64-G	3719.6	-31.4
d-66-G	3711.4	64.5
b-72-G	3696.5	54.6
	3696.7	47.7
	3699	21.8
	3708	-15.8
d-76-G	3730.4	0.3
d-85-G	3733	58.8
b-86-G	3745	42.3
d-94-G	3679.3	-55.0
	3688	-66.4
	3702.3	-7.0
	3706	-34.1
	3706.8	28.1

d-8-J	3729.7	-12.8
d-10-J	3750	76.8
d-29-J	3745	60.0

APPENDIX J

Composite Well Logs of the Halfway Formation

APPENDIX J

Composite Well Logs

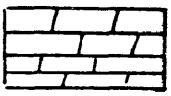
Abbreviations

Bls	Clastic dolomite
Cht	Chert
Epi	Epidote
Gar	Garnet
Glau	Glauconite
Ilm	Ilmenite
Lth	Lithic grains
Micr	Microline
Musc	Muscvite
Ool	Oolites,pellets
Plag	Plagioclase
Px	Pyroxene
Py	Pyrite
Tour	Tourmaline
Zirc	Zircon
Leuc	Leucoxene

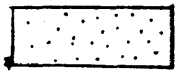
LEGEND



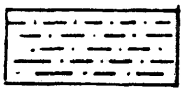
Sandy coquina



Dolomite



Sandstone



Siltstone



Conglomerate



Cored interval



Missing core



Thin section



Sieve analysis

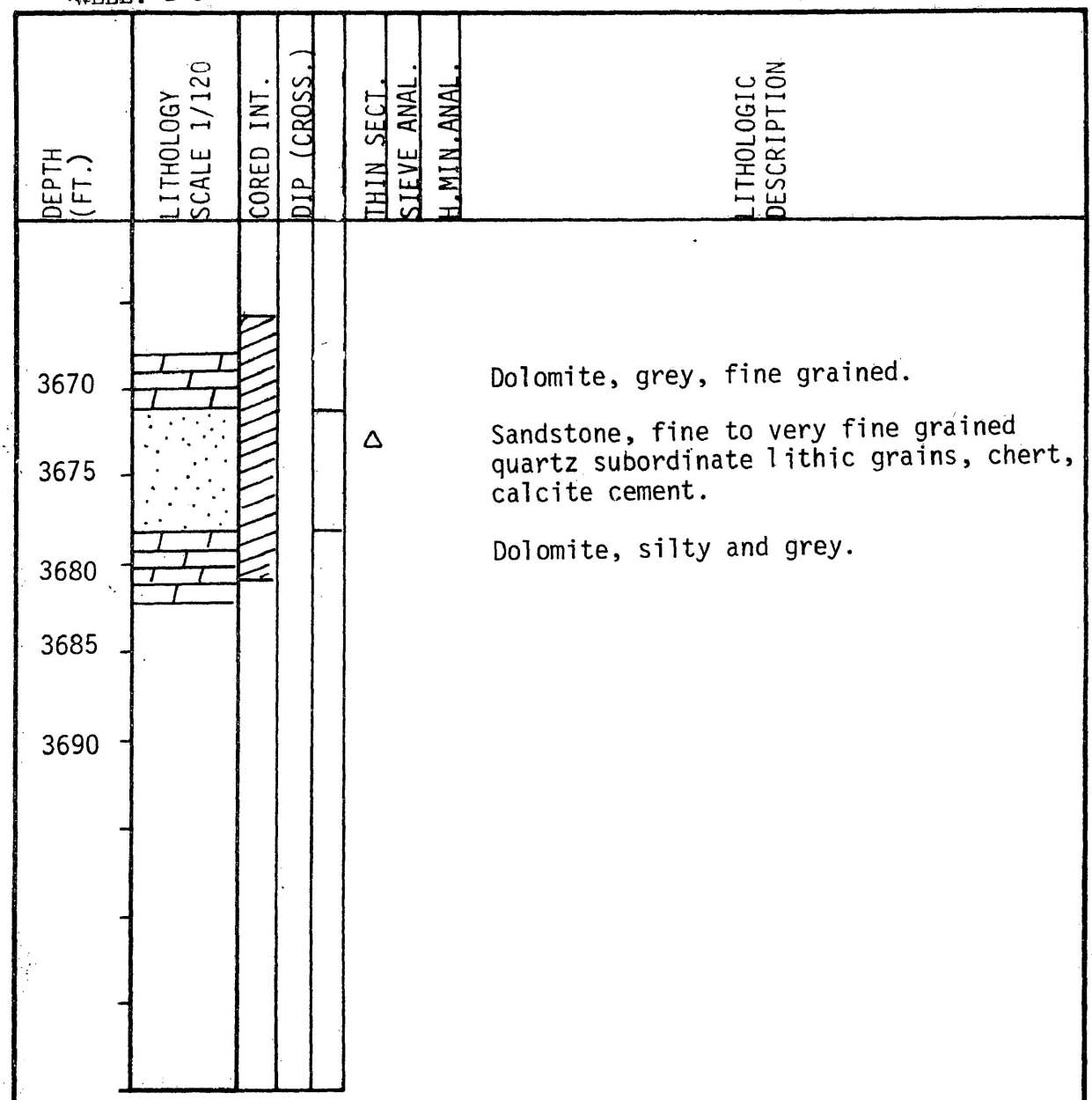


Heavy mineral analysis



WELL: d-5-A

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

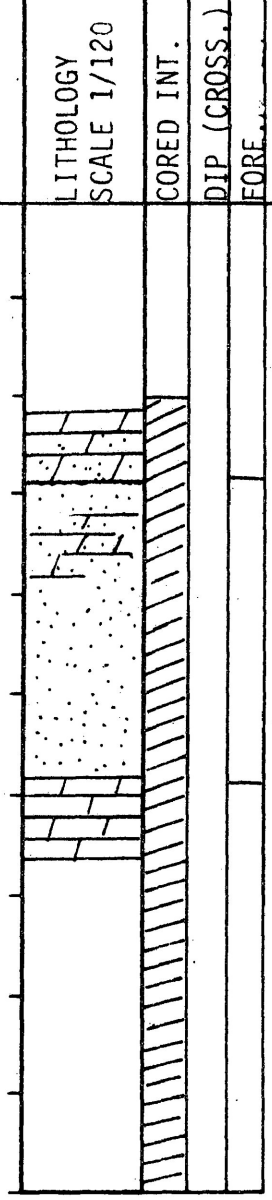
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3675	x	x		x					x		x	x
												•

WELL: d-15-A

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

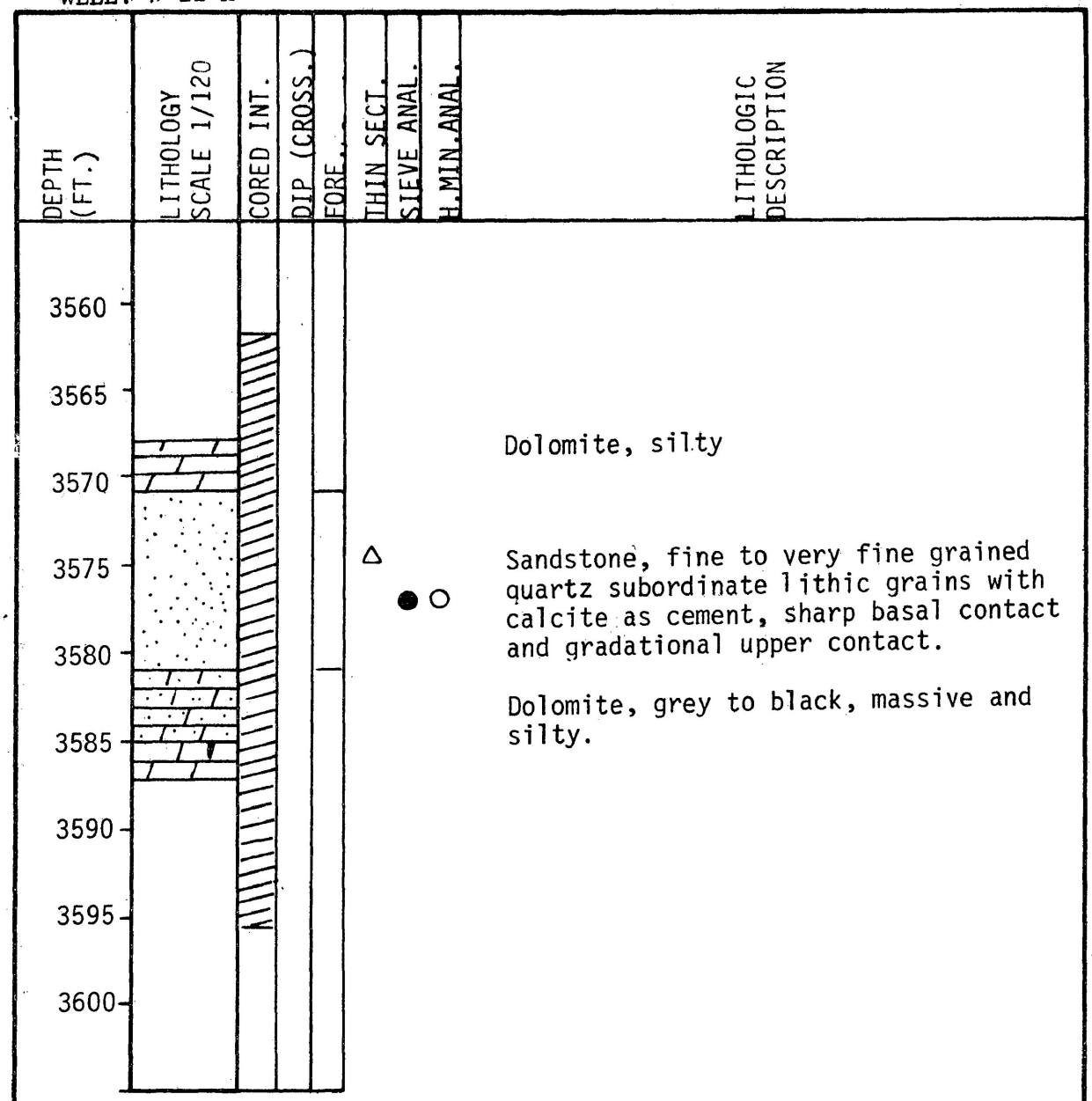
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3710.6	x	x		x					x		x	
3719	x	x		x					x			x
3720	x	x		x					x		x	
3711	x	x		x					x		x	

WELL: b-22-A

ZONE: 94-H2



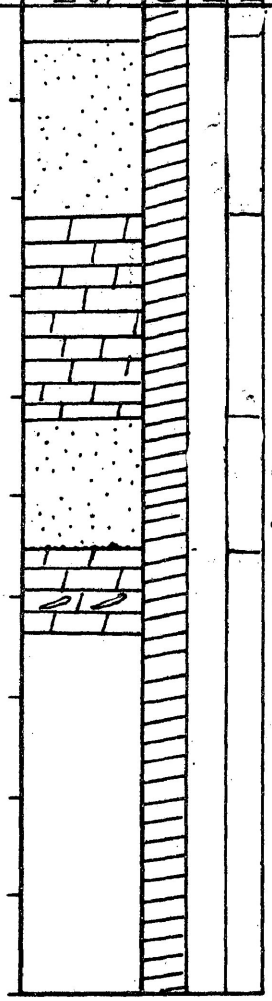
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3577							

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3577												

WELL: d-26-A ZONE: 94-H2



LITHOLOGIC DESCRIPTION

● ○ Sandstone, fine grained, coquina. Calcite cement.

Dolomite, massive, fine grained and silty.

Sandstone, fine to very fine grained, quartz subordinate lithic grains, chert and clastic dolomite. Sharp basal contact.

Dolomite, massive, coquina, fine grained and silty.

HEAVY MINERAL ANALYSIS

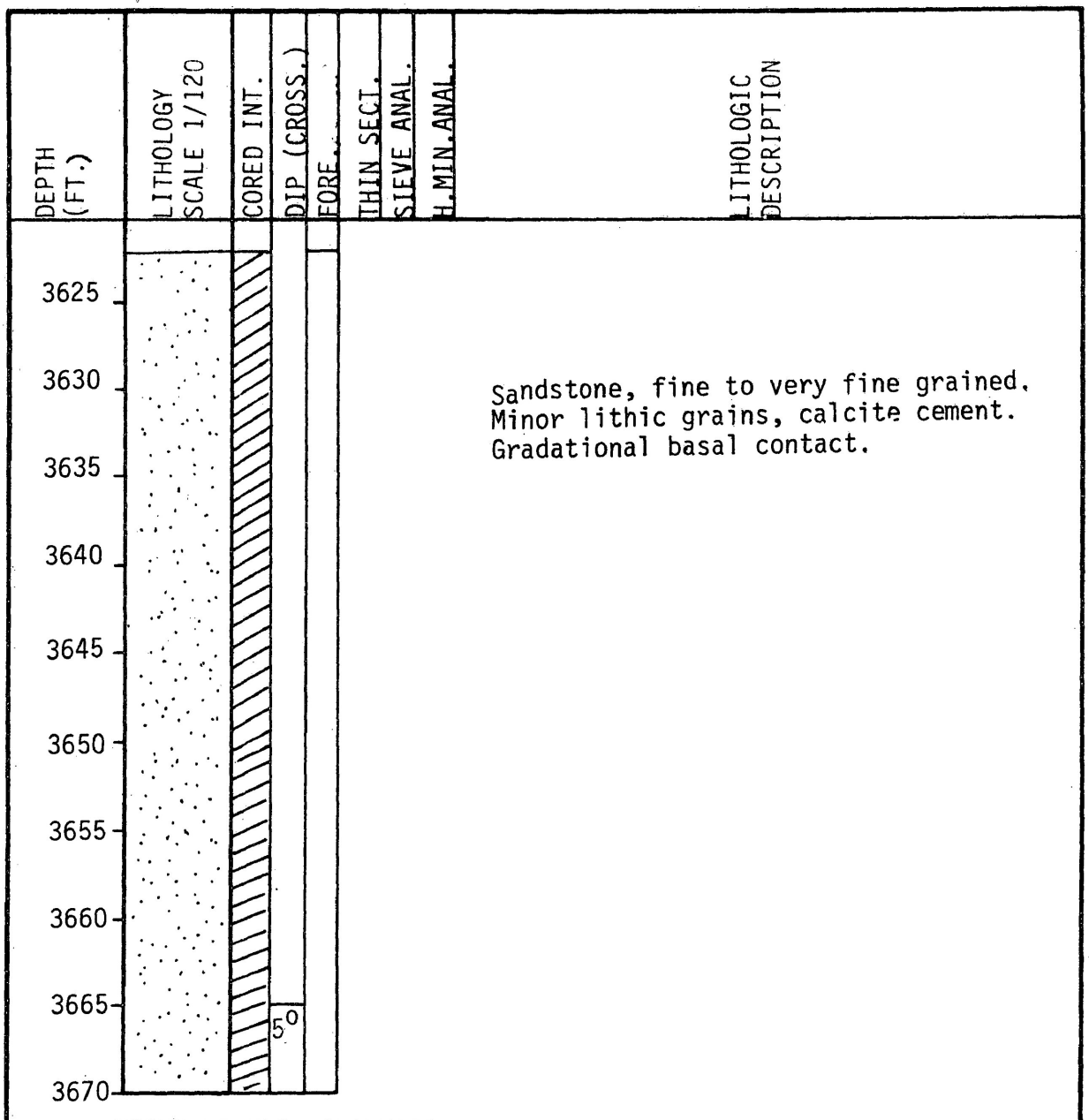
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3694			x			x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3717	x	x									x	
3701	x	x							x		x	x
3714	x										x	x
3721	x	x										

WELL: d-29-A

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

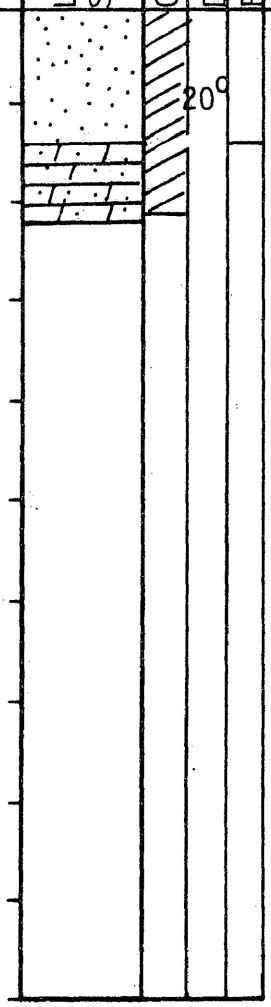
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3623	x			x							x	x

WELL: d-29-A

ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, interlaminated, very fine grained and silty.

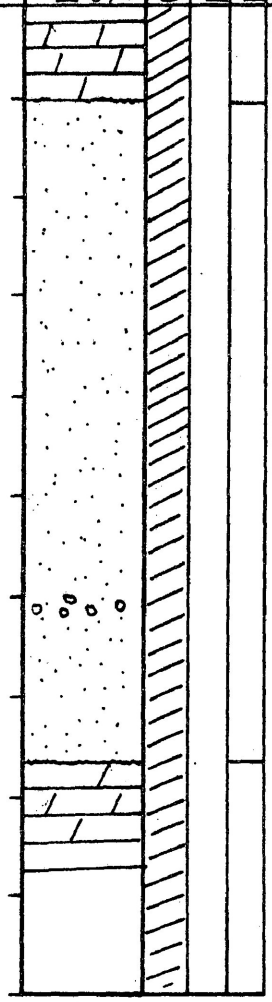
HEAVY MINERAL ANALYSIS

	Epid	Gar	Jim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
	x			x							x	
3680												

WELL: d-34-A ZONE: 94-H2



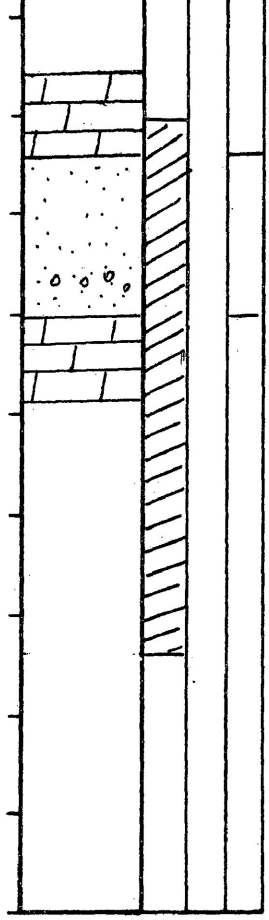
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3580			x	x	x	x	x
3587			x	x	x	x	x
3601			x	x		x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3601	x	x	.								x	
3608	x	x	x								x	x
3609	x	x									x	x

WELL: b-35-A ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, massive, very fine grained and silty.

Sandstone, fine to very fine grained quartz calcite cement, a granule zone of lithic grains, chert. Sharp basal contact.

Dolomite, grey to black, and silty.

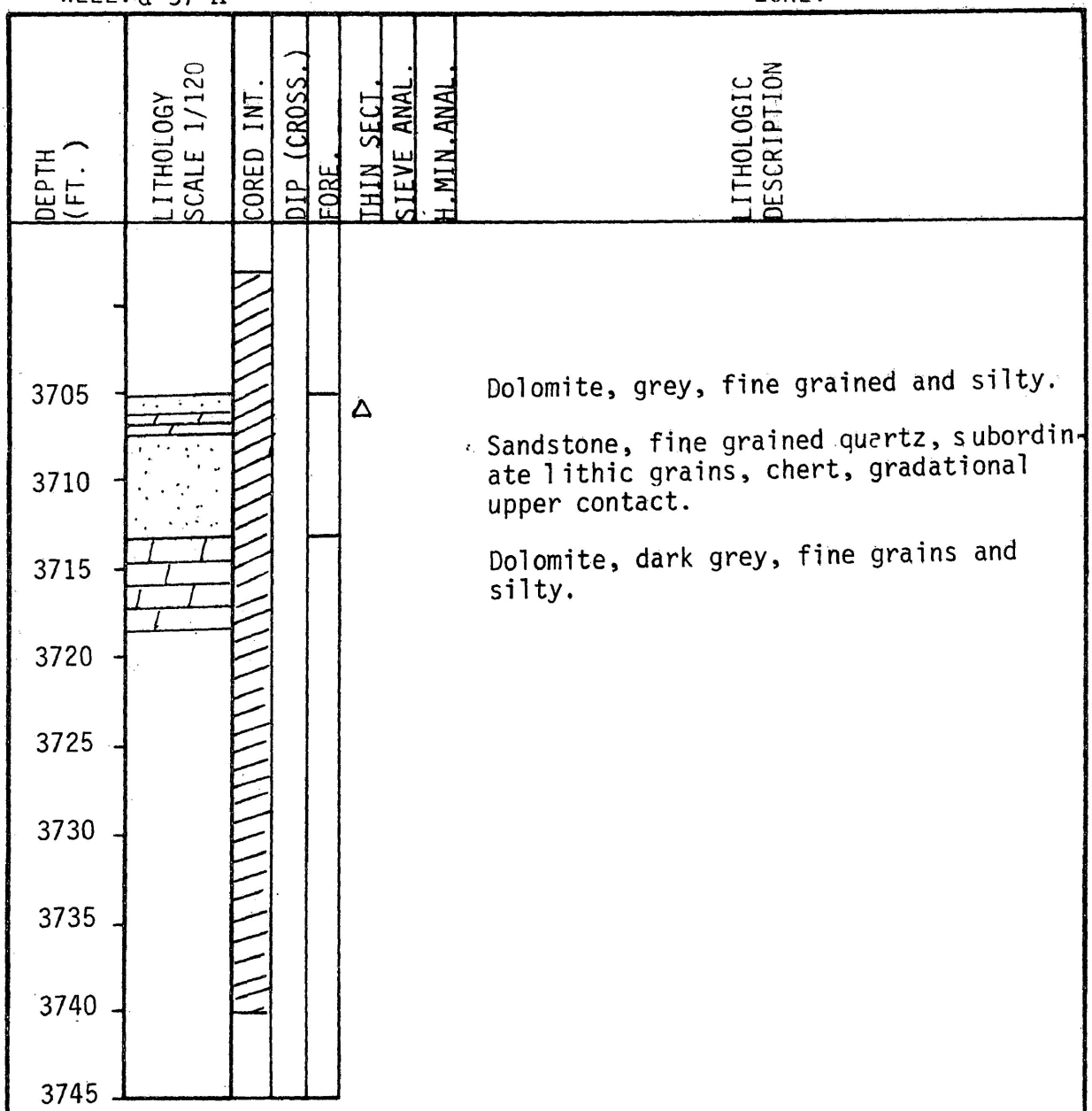
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3707	x	x							x		x	

WELL: d-37-A ZONE: 94-H2



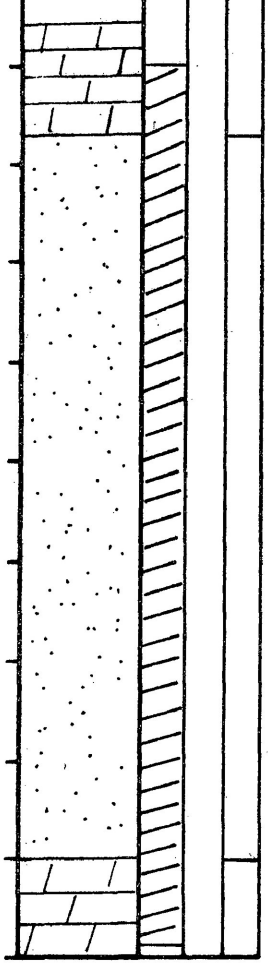
HEAVY MINERAL ANALYSIS

	Epid	Gar	Jim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3707	x	x						x				x

WELL: d-39-A ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, massive, fine grained and silty.

Sandstone, fine to very fine grained quartz thin bedded, calcite cement sharp basal contact.

Dolomite, massive, grey to black, and silty.

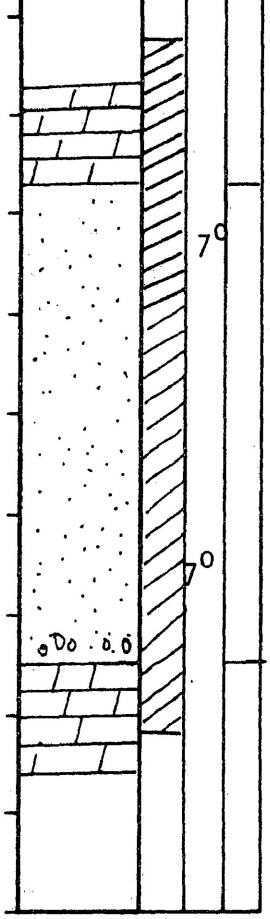
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: d-44-A ZONE: 94-H2



Dolomite, interlaminated, very fine grained and silty.

Sandstone, fine to very fine grained quartz subordinate lithic grains, chert, and clastic dolomite, gradational basal and upper contacts, a granule zone occurs above the basal contact.

Dolomite, interlaminated, and silty.

HEAVY MINERAL ANALYSIS

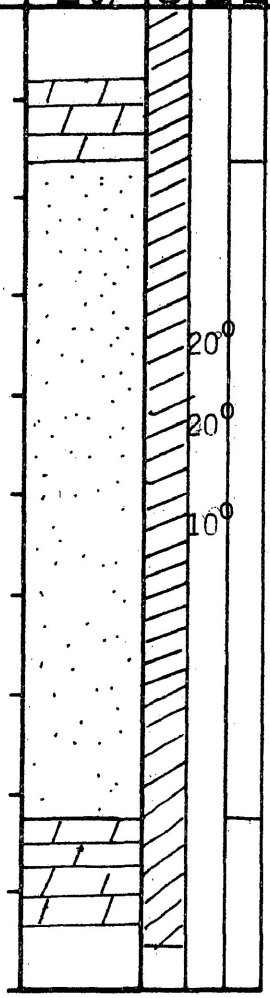
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3544			x	x	x	x	x
3547			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3544	x	x							x		x	x

WELL: b-55-A

ZONE: 94-H2



Dolomite, grey and very fine grained.

Sandstone, fine to very fine grained quartz subordinate lithic grains, and chert, calcite cement. Sharp basal and upper contacts.

● ○

Dolomite, grey and silty.

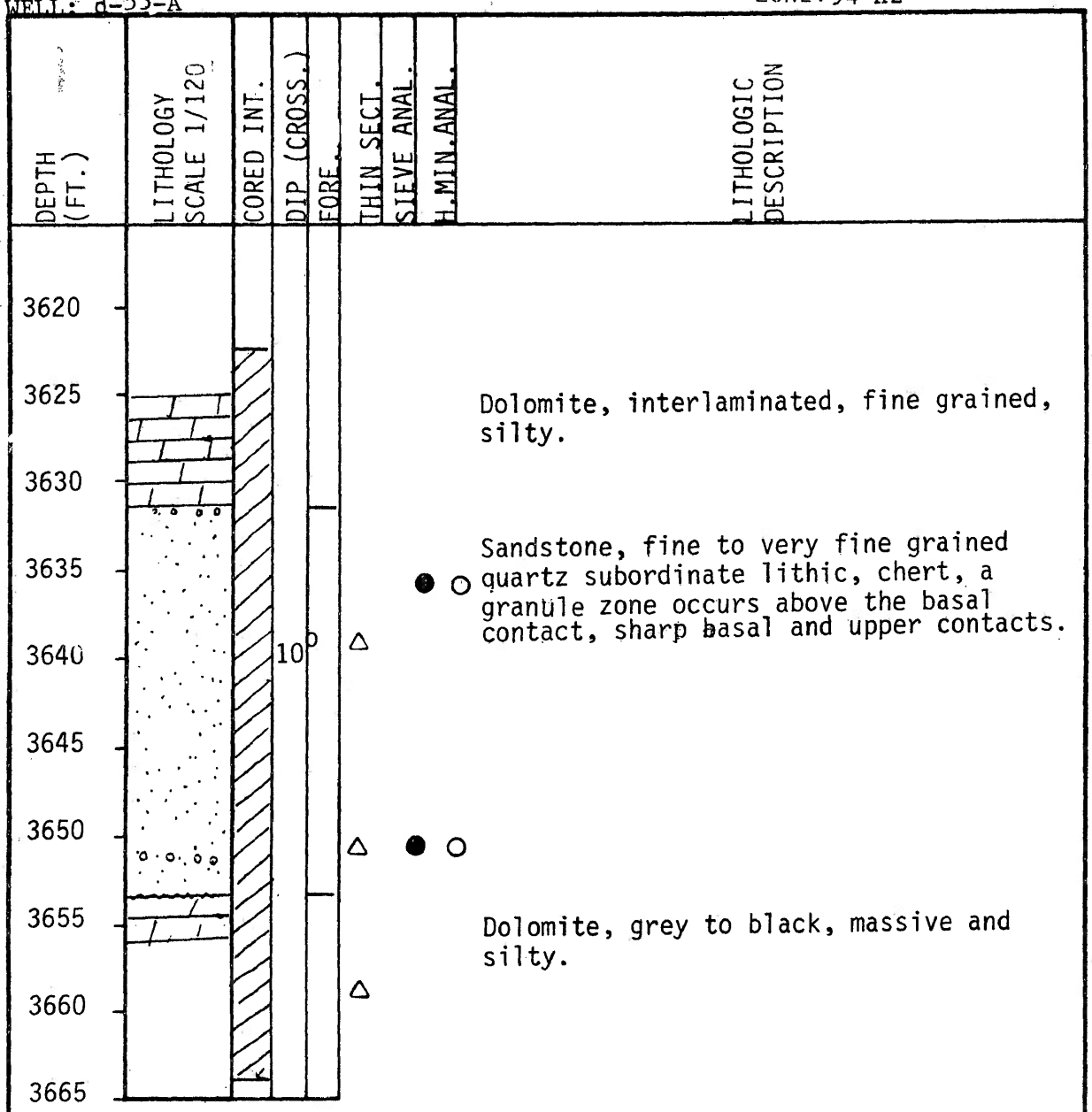
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3694			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: d-55-A ZONE: 94-H2



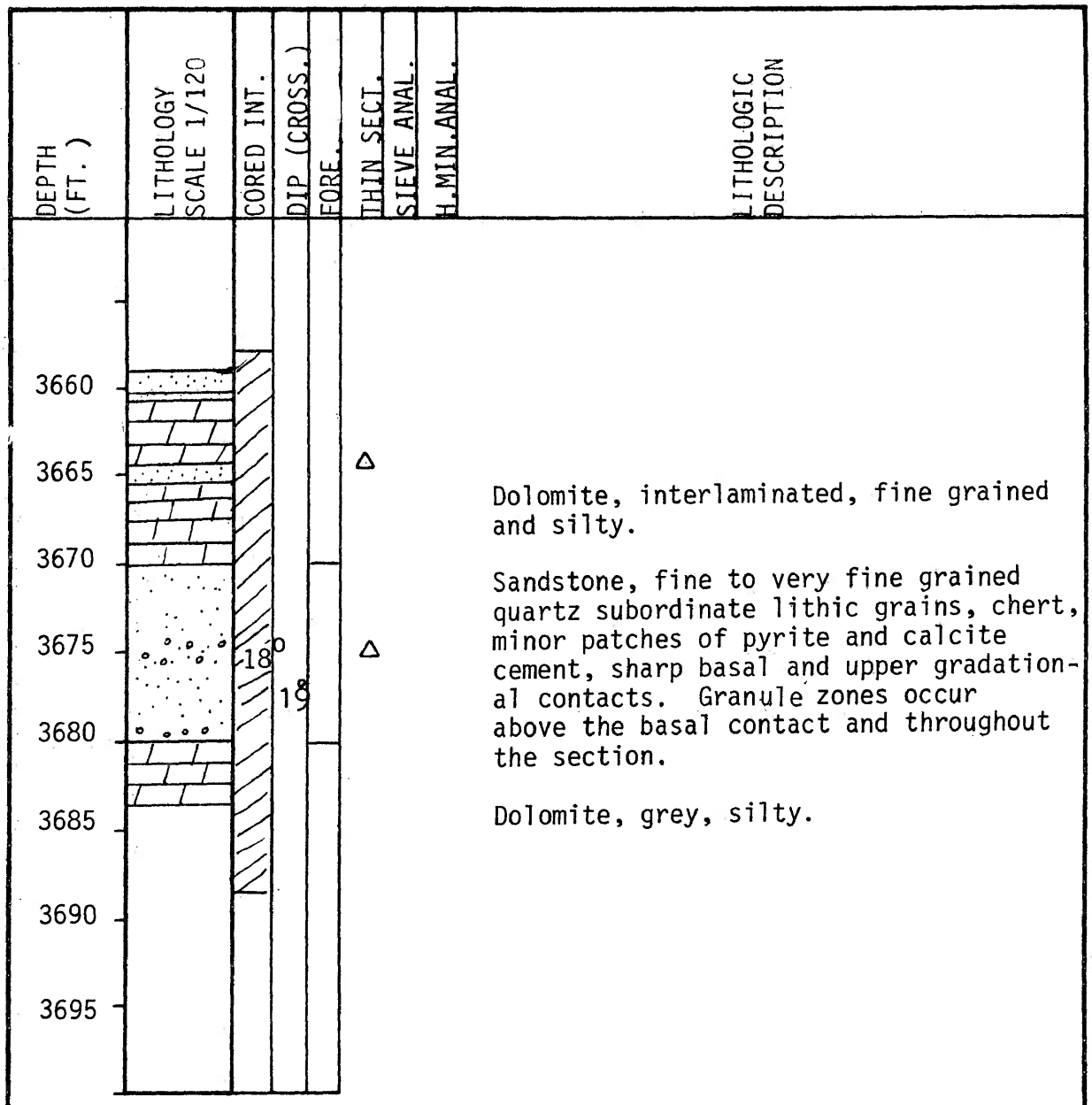
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3636.10			x	x	x	x	x
3651.4					x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3639	x	x				x		x				
3646	x								x			
3659	x						x					

WELL: b-65-A ZONE: 94-H2



Dolomite, interlaminated, fine grained and silty.

Sandstone, fine to very fine grained quartz subordinate lithic grains, chert, minor patches of pyrite and calcite cement, sharp basal and upper gradational contacts. Granule zones occur above the basal contact and throughout the section.

Dolomite, grey, silty.

HEAVY MINERAL ANALYSIS

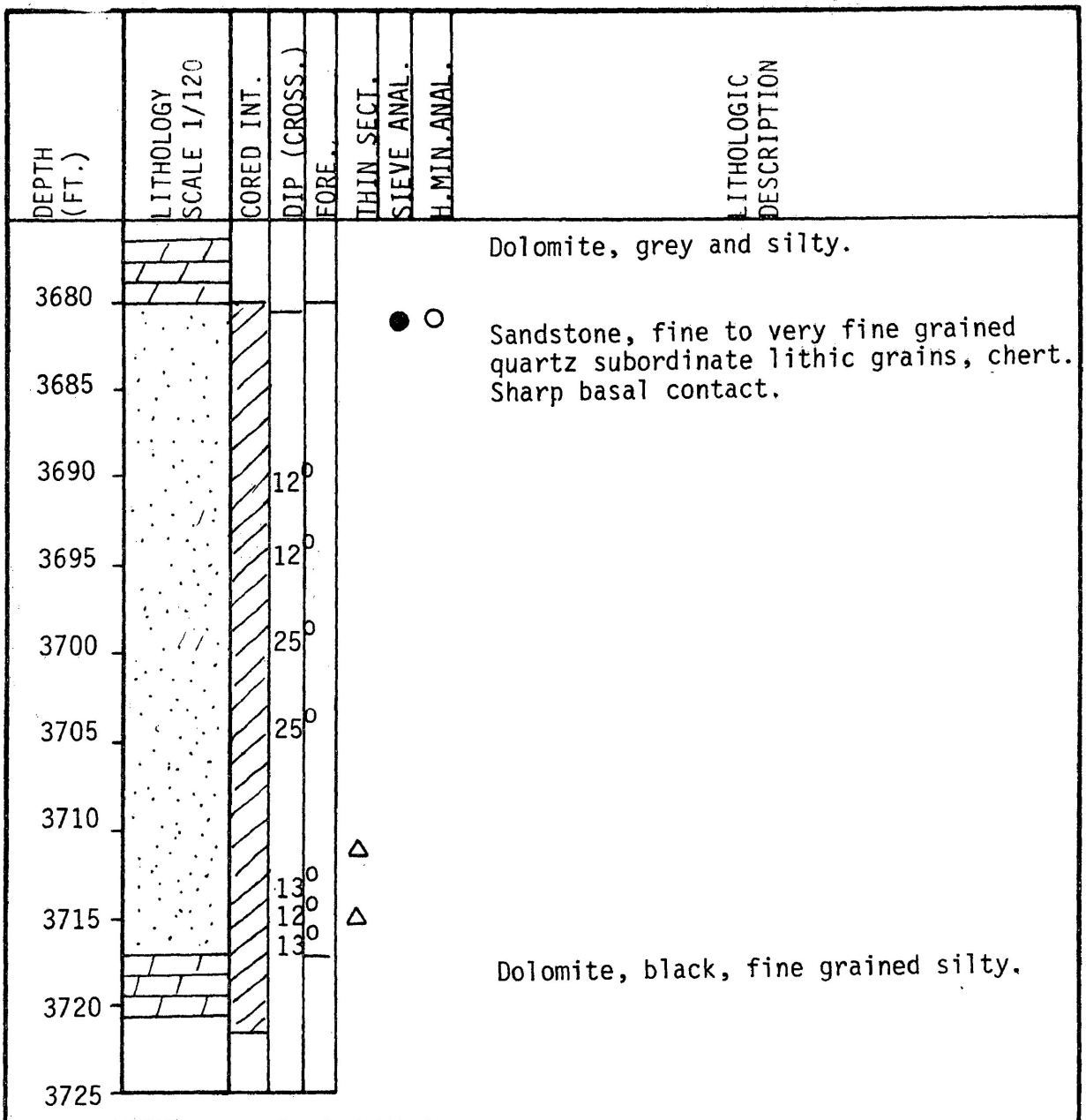
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3664	x							x	x			
3675	x	x		x							x	x

WELL: c-66-A

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

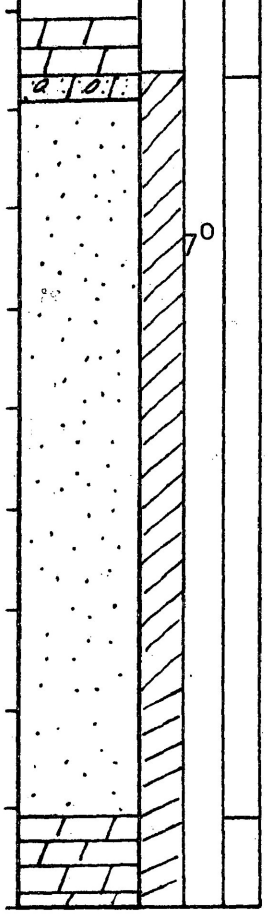
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3680			×	×		×	×

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3712	×	×	×	×							×	×
3717	×			×				×				

WELL: d-66-A

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

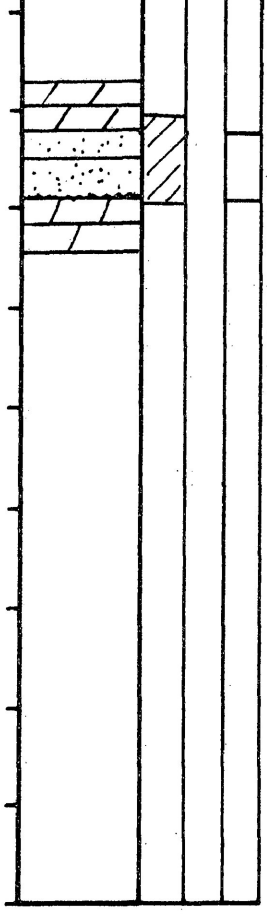
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3671			x	x		x	x
3688			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: d-96-A

ZONE: 94-H2



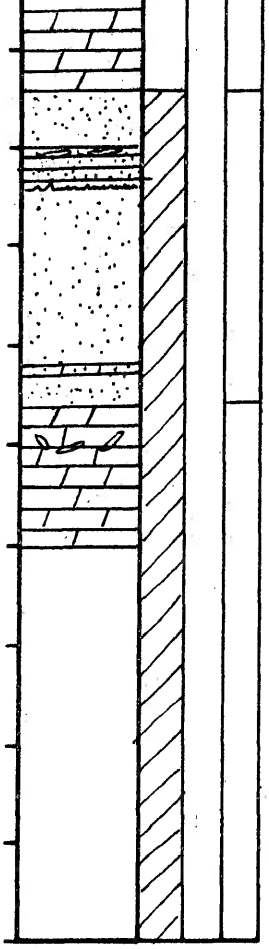
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3642.2	x	x		x				x				
3644	x	x	x	x							x	

WELL: da-5-B ZONE: 94-H2



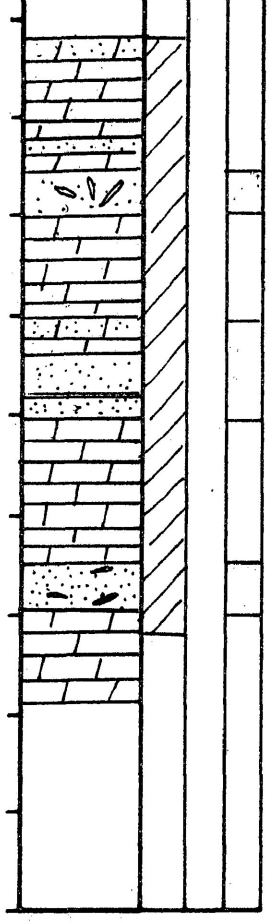
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3845						x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3840			x	x				x				
3852	x		x	x								
3853	x		x	x								

WELL: d-9-B ZONE: 94-H2



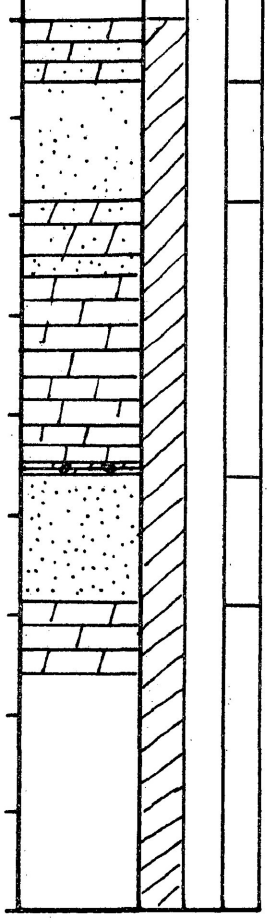
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3917		x	x	x					x			
3921	x		x	x					x		x	

WELL: d-13-B ZONE: 94-H2



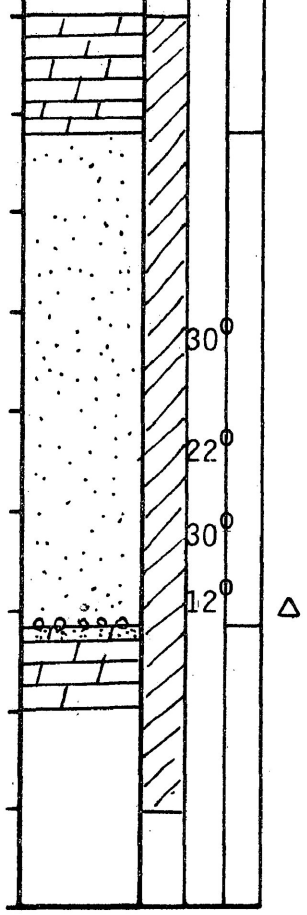
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3757		x	x	x					x			
3775	x	x	x	x					x			

WELL: b-14-B ZONE: 94-H2



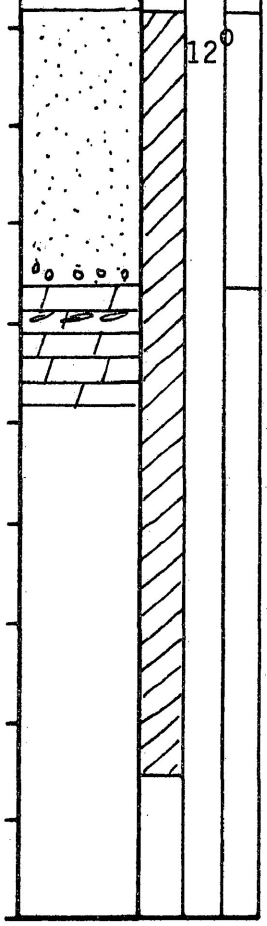
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3813			x	x	x	x	x
3814			x	x		x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3820	x	x	x	x							x	

WELL: d-15-B ZONE: 94-H2



HEAVY MINERAL ANALYSIS

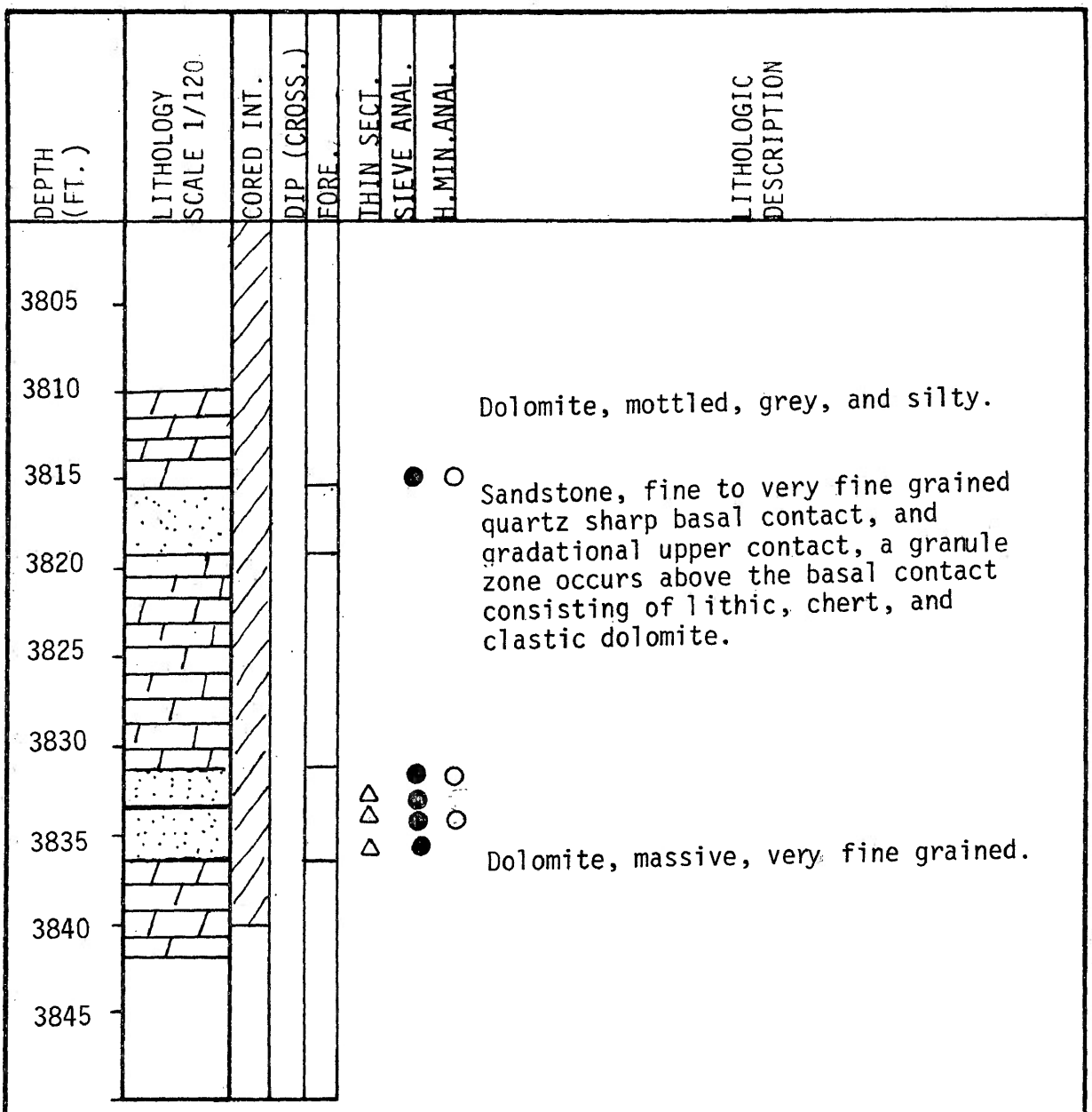
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3836			x	x	x	x	x
3839			x	x	x	x	x
3846			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3839	x	x	x	x							x	
3848	x	x	x	x					x		x	x

WELL: d-25-B

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

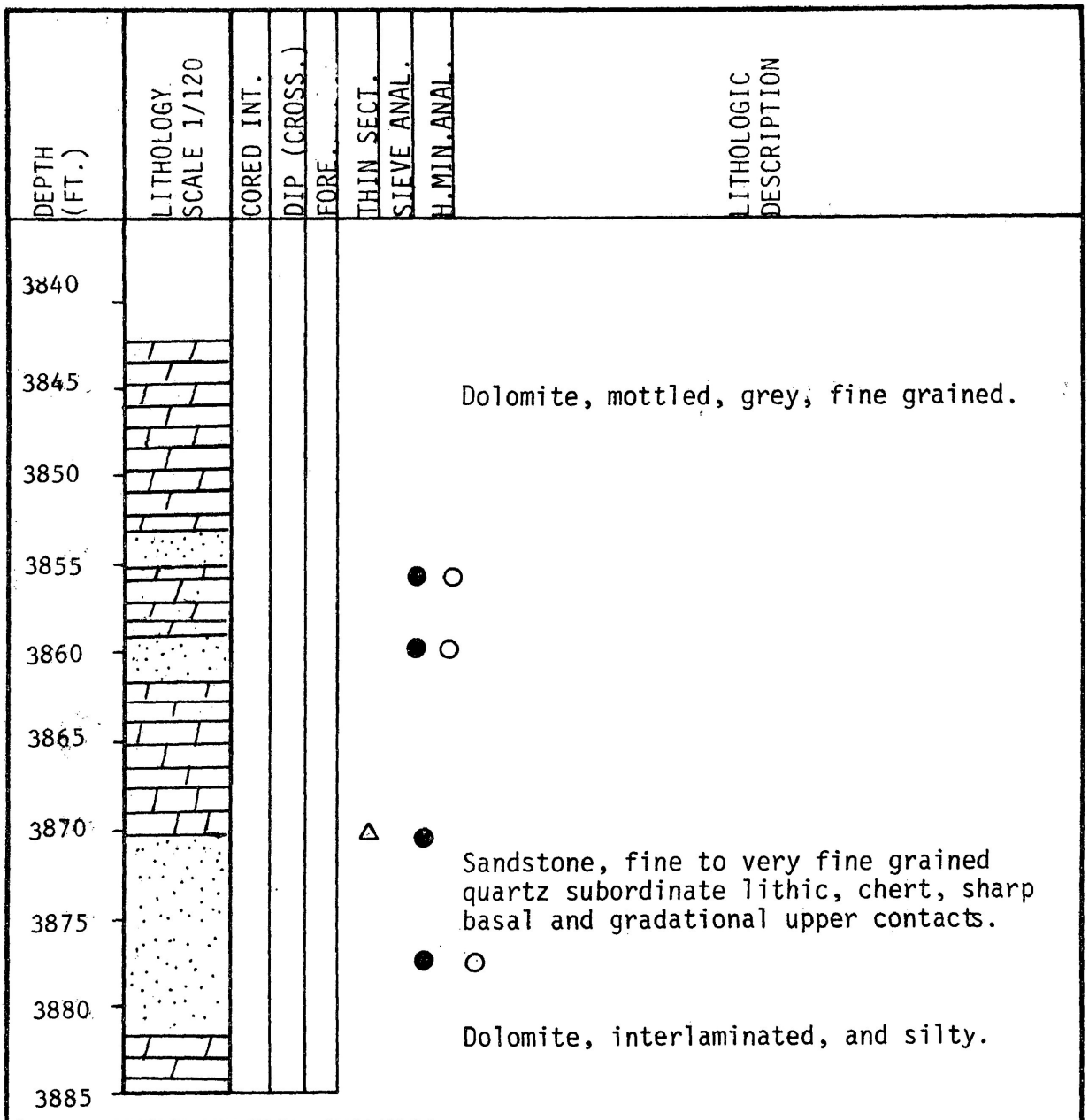
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3815			x	x	x	x	x
3831			x	x	x	x	x
3834			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3833		x	x	x					x			
3834	x		x	x					x		x	x
3836	x	x	x						x		x	x

WELL: d-47-B

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

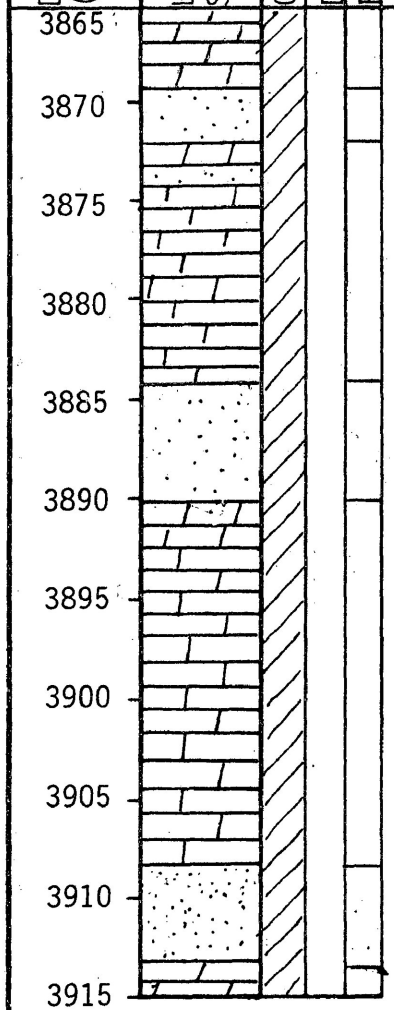
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3856			x	x	x	x	x
3860			x	x		x	x
3878			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3870	x		x	x					x			

WELL: d-13-C

ZONE: 94-H2



Dolomite, grey-vuggy, subordinate coquina and fine grained.

Sandstone, fine grained quartz, calcite cement, sharp basal contact and gradational upper contact.

Dolomite, massive, and silty.

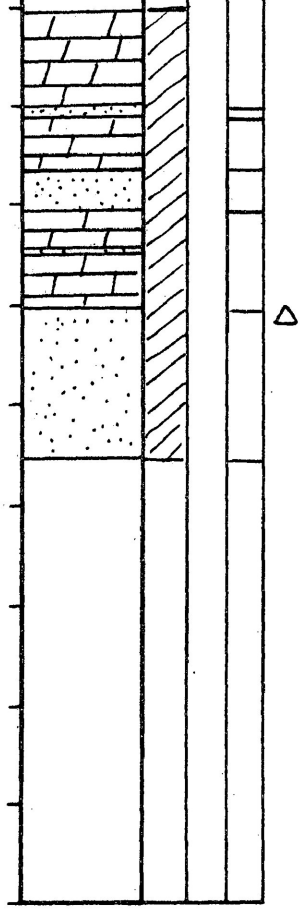
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3870.8			×	×				×				

WELL: d-73-C ZONE: 94-H2



DEPTH (FT.)	LITHOLOGY SCALE 1/120	CORED INT.	DIP (CROSS.)	FORE./INCH	THIN SECT.	SIEVE ANAL.	H.MIN.ANAL.	LITHOLOGIC DESCRIPTION
3755								Dolomite, vuggy, fine grained
3760								
3765								
3770					△			Sandstone, fine to very fine grained quartz Subordinate Lithic grains, chert, calcite cement, gradational upper contact.
3775								
3780								
3785								

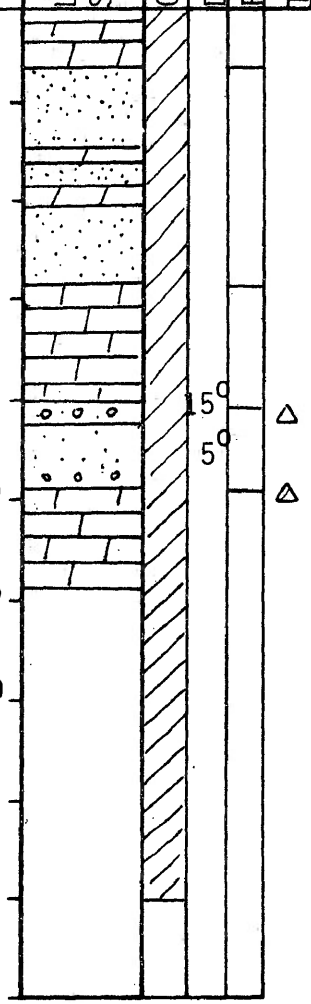
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
~~3771~~			×	×				×				

WELL: b-81-C ZONE:. 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, grey, very fine grained and silty.

Sandstone, fine to very fine grained quartz subordinate lithic and chert, a granule zone of chert and lithic grains. Sharp basal contact and gradational upper contact.

Dolomite, massive, grey, and silty.

HEAVY MINERAL ANALYSIS

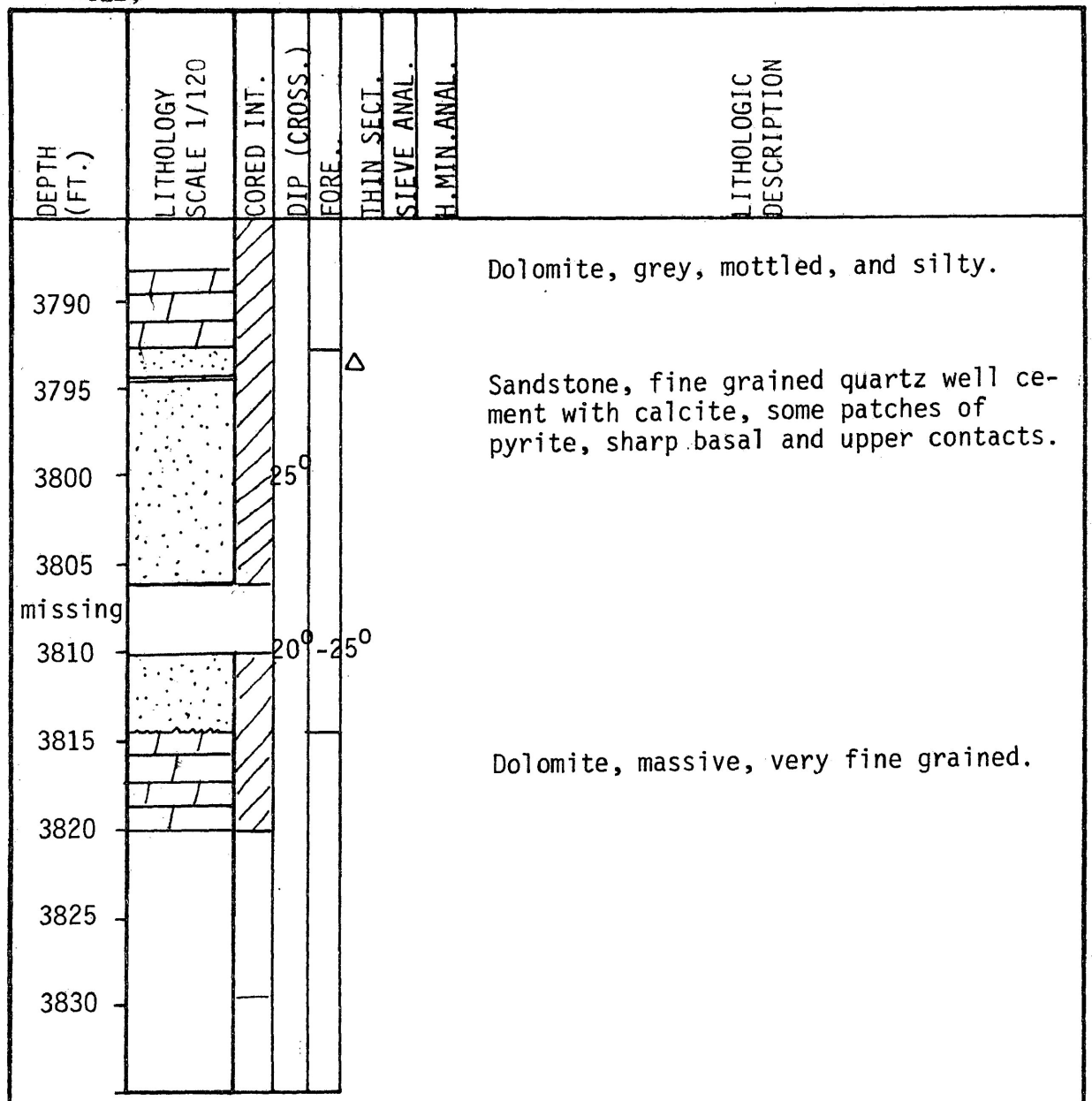
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3786	x	x							x		x	x
3790	x	x		x					x		x	x

Well; d-95-C

ZONE: 94-H2



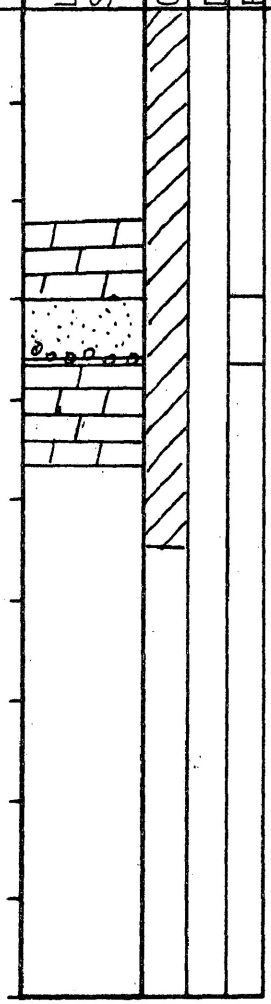
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3794	x			x				x				

WELL: d-32-F ZONE: 94-H2

DEPTH (FT.)	LITHOLOGY SCALE 1/120	CORED INT.	DIP (CROSS.) FORE.	THIN SECT.	SIEVE ANAL.	H.MIN.ANAL.	LITHOLOGIC DESCRIPTION
3780							Dolomite, grey to black, fine grained and silty. Sandstone, fine to very fine grained quartz subordinate lithic grains and clastic dolomite, calcite cement, sharp basal contact. Dolomite, grey and silty.
3785							
3790							
3795							

HEAVY MINERAL ANALYSIS

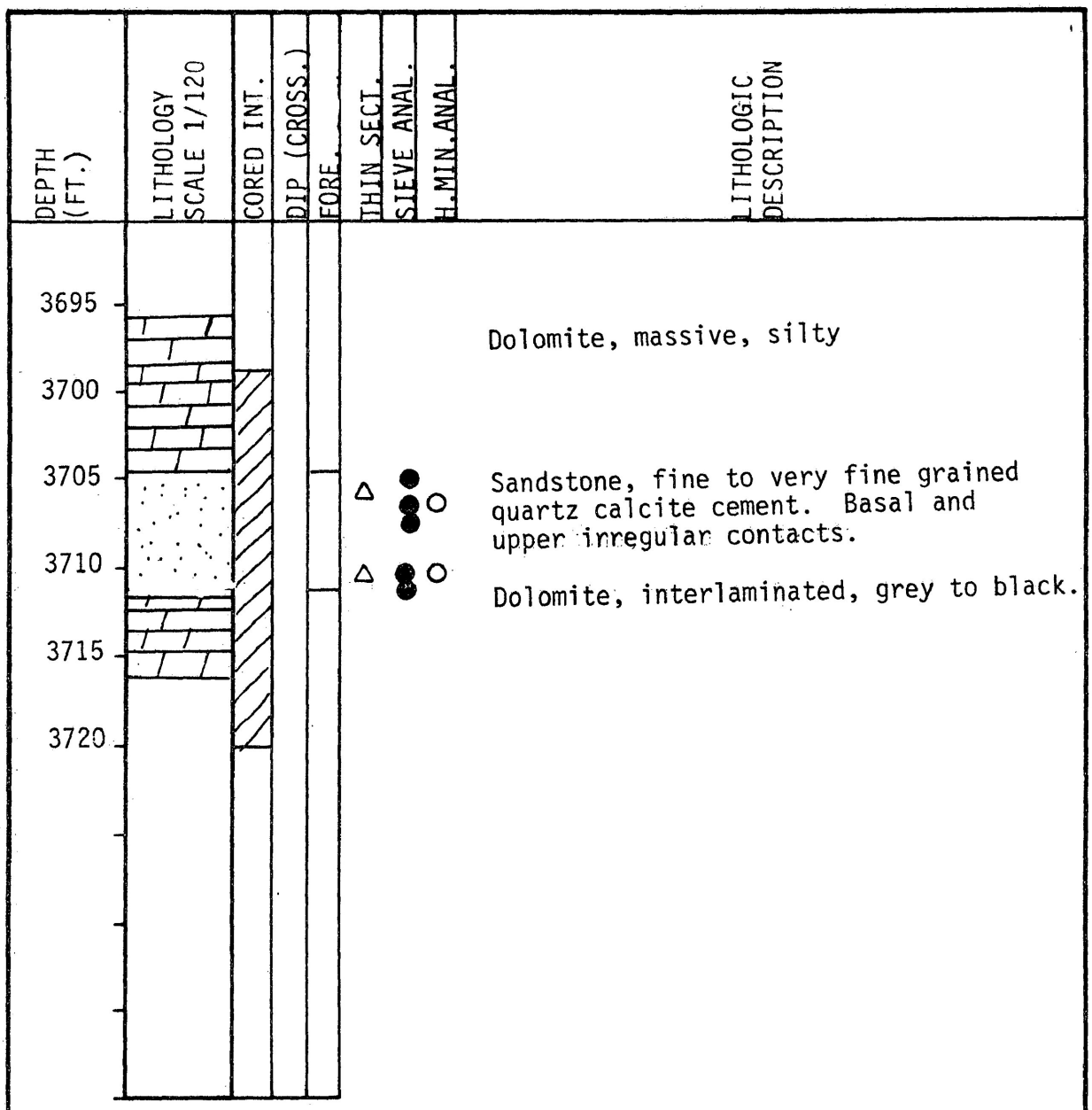
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: c-32-G

ZONE: 94-H2



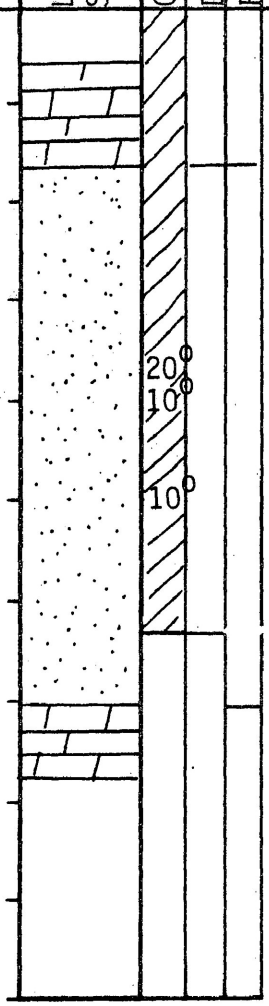
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3704				x	x	x	x
3711			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3707	x									x	x	x
3711	x								x	x	x	x

WELL: b-42-G ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, white, very fine grained.

Sandstone fine to very fine grained, quartz subordinate lithic, chert, clastic dolomite granule zones. (The lower contact was not cored.)

HEAVY MINERAL ANALYSIS

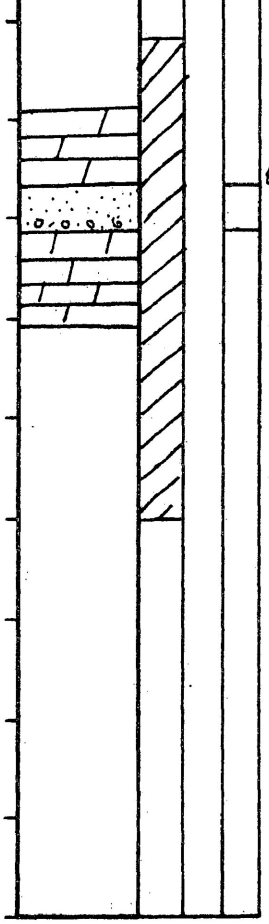
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3702			x		x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3686	x	x							x		x	x
3688	x	x							x		x	
3693	x	x							x		x	x

WELL: b-51-G

ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, white

Sandstone, fine to very fine grained, quartz subordinate lithic, chert and clastic dolomite, irregular basal and upper contacts.

Dolomite, interbedded.

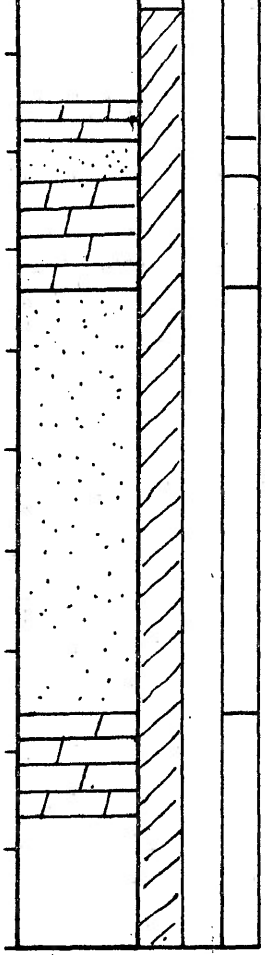
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3688.2	x			x			x	x	x		x	
3688.5	x			x			x	x				
3691	x							x	x			

WELL: b-52-G ZONE: 94-H2



HEAVY MINERAL ANALYSIS

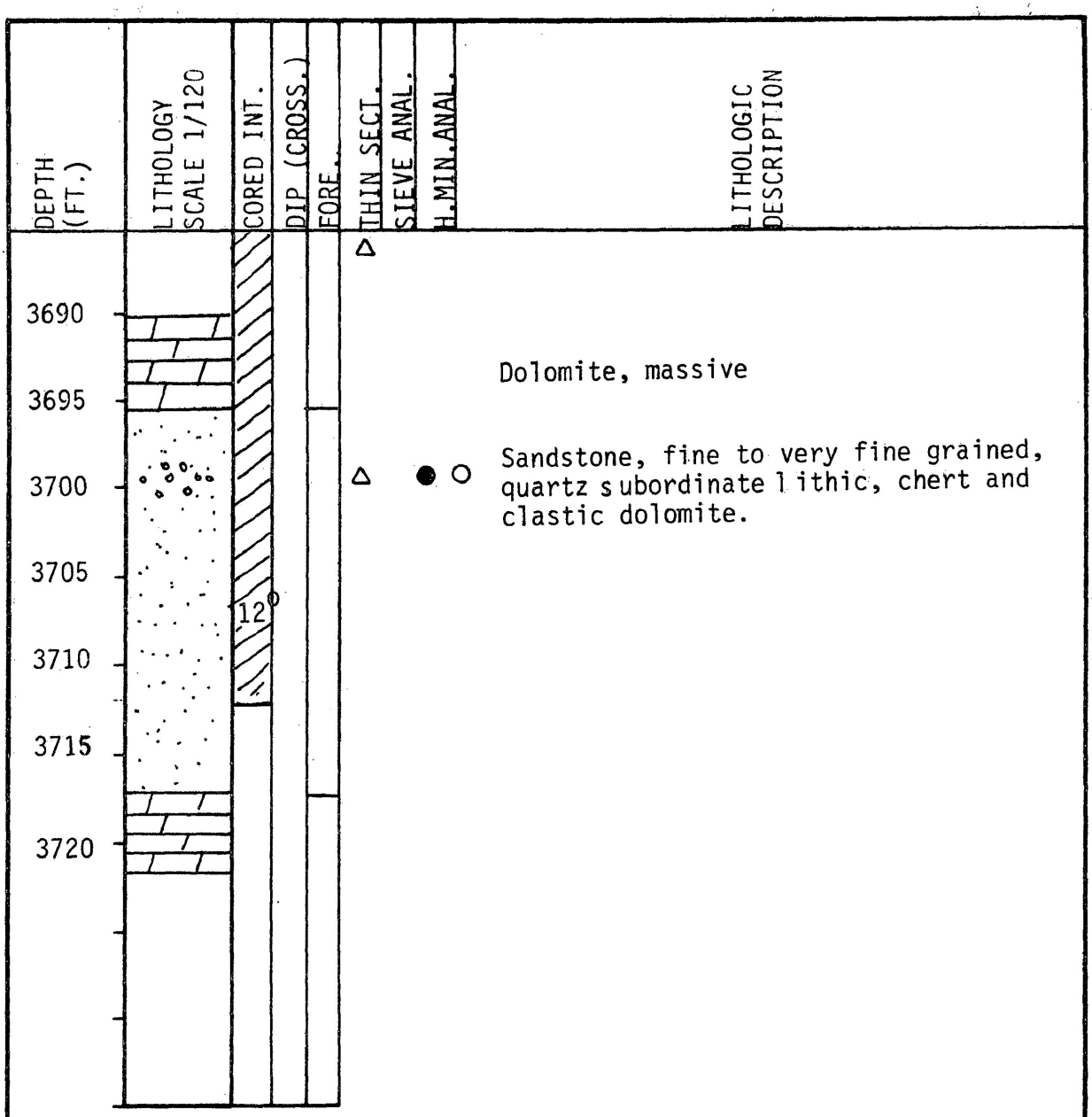
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3686			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: d-53-G

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

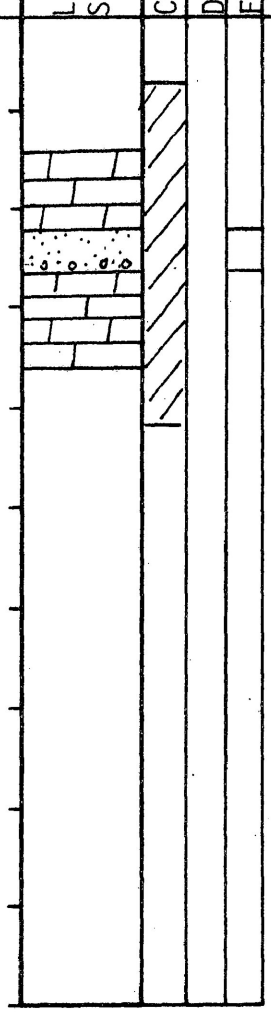
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3699			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3685	x		x	x					x			
3699.6	x		x	x					x		x	

WELL: b-61-G

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

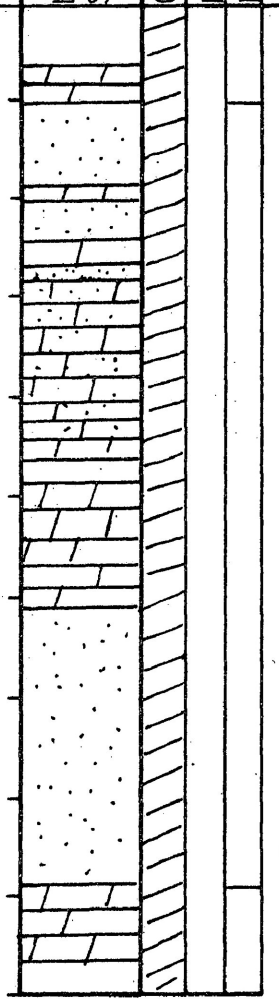
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3681.4					x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3681.4	x			x				x				
3688.5	x			x			x	x	x			

WELL: d-63-G

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

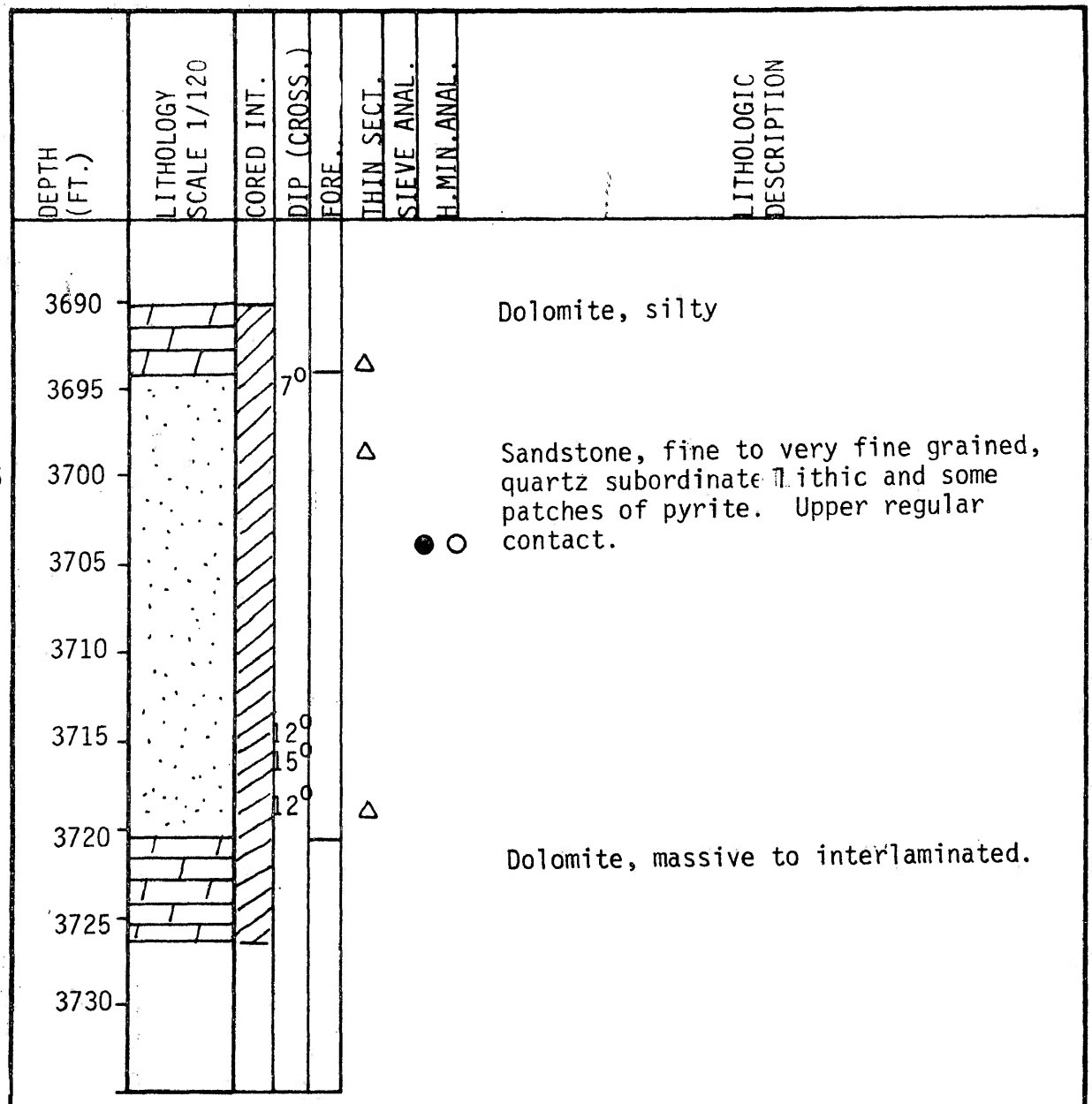
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3724			x	x	x	x	x
3724.9			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3723	x	x									x	x

WELL: d-64-G

ZONE: 94-H2



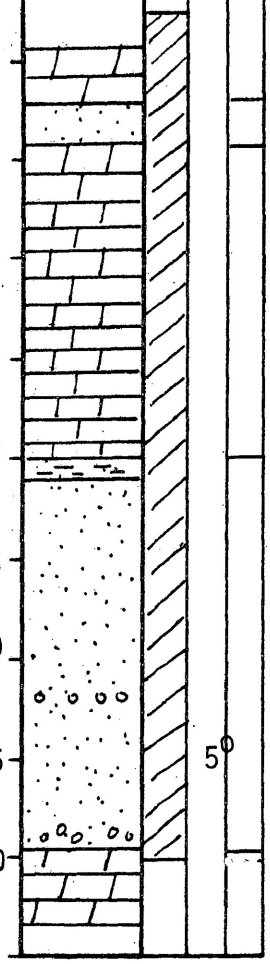
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3704				x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3694.1	x			x			x	x				
3699.4	x	x		x							x	
3719.9	x	x							x		x	x

WELL: d-65-G ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, grey, very fine grained, interbedded.

Sandstone, very fine grained, quartz subordinate lithic, thin granule zone throughout the section, gradation upper contact, sharp basal contact overlain by a thin granule zone.

Dolomite

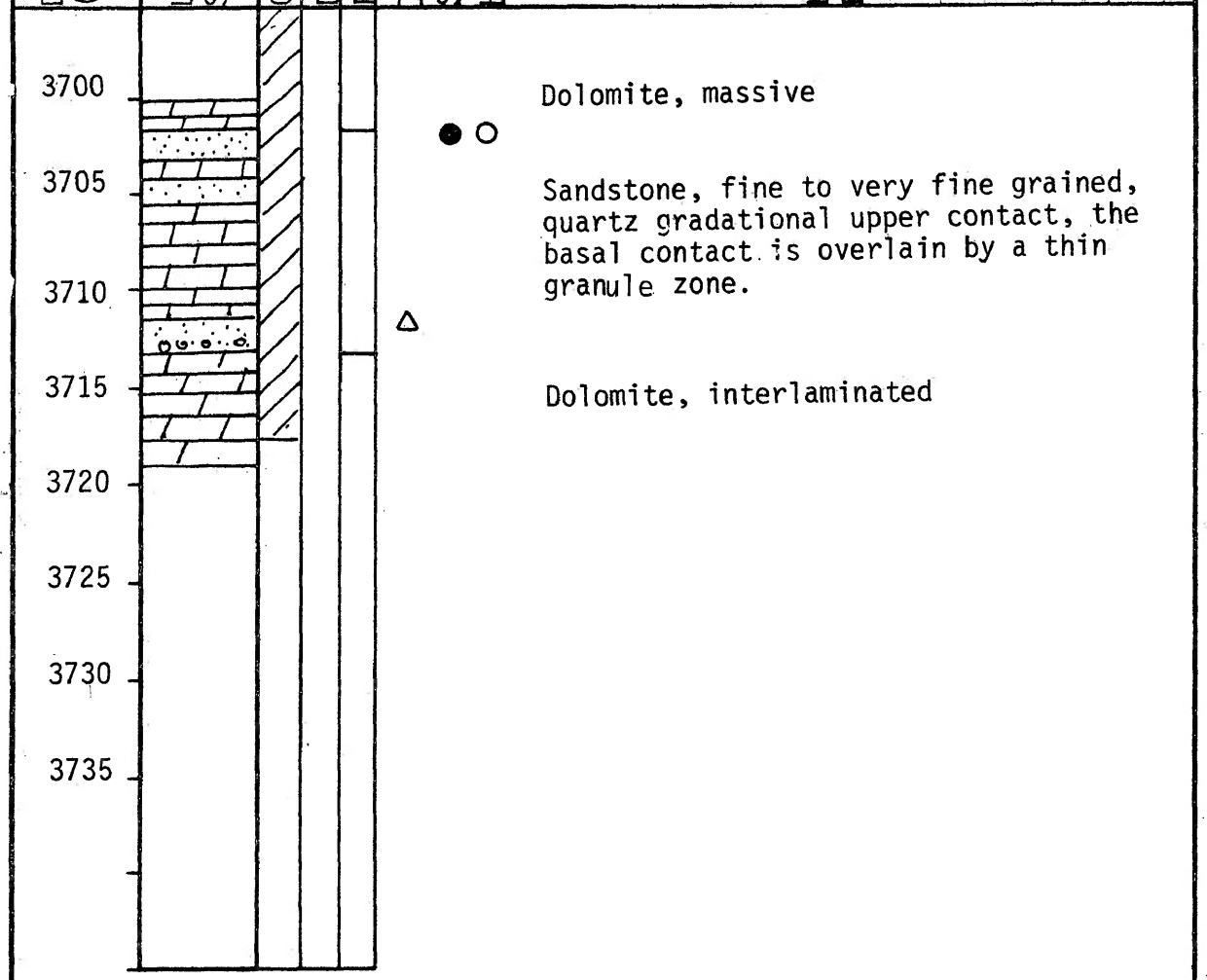
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3694	x			x		x		x				
3706.3	x			x				x				
3728.8	x	x		x					x		x	x

WELL: d-66-G ZONE: 94-H2



HEAVY MINERAL ANALYSIS

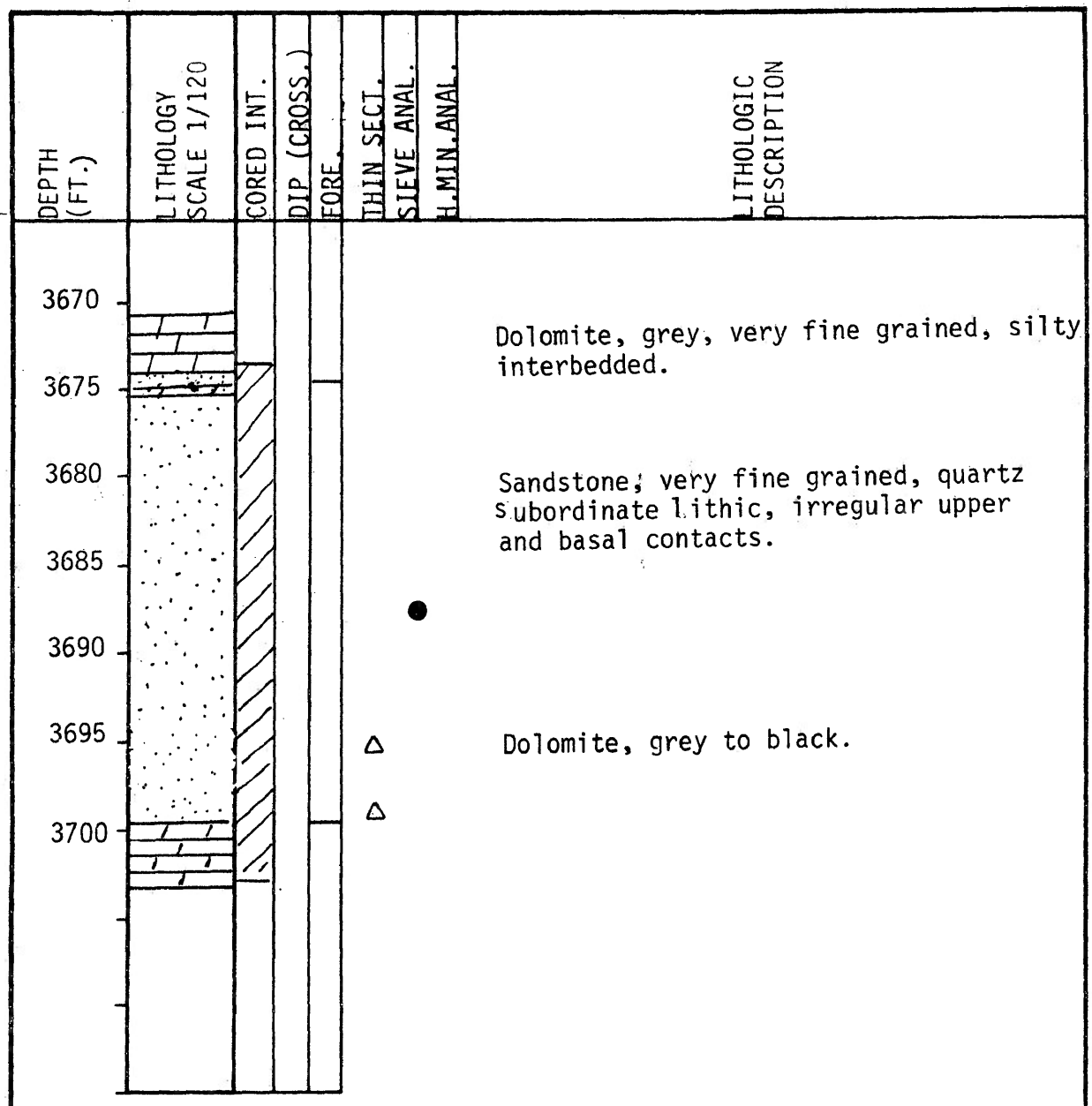
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
~~3702~~			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3712.4	x	x		x					x		x	x

WELL: b-72-G

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

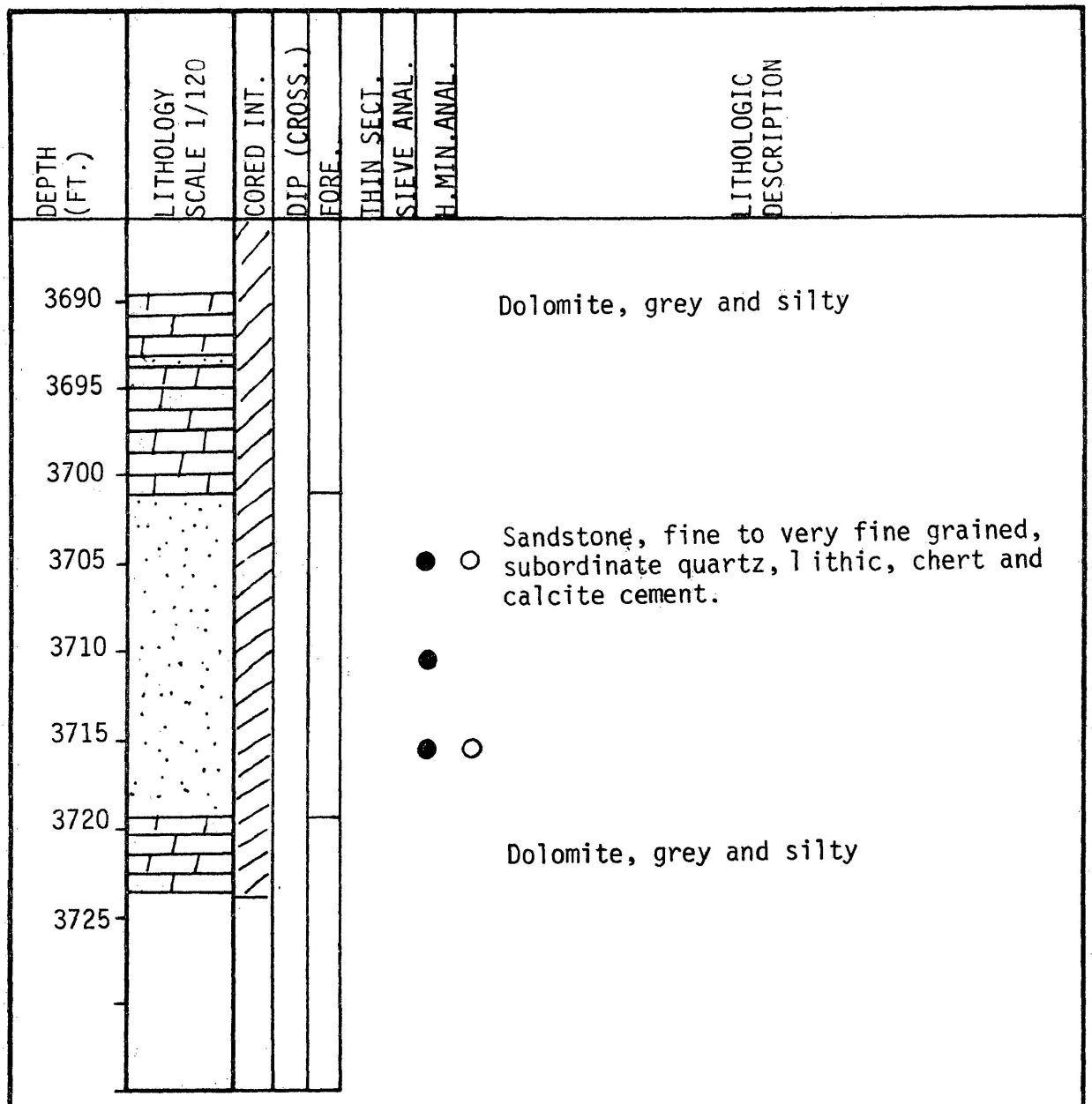
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3688					x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3696	x	x									x	
3699.4	x	x		x							x	x

WELL: d-74-G

ZONE: 94-H2



HEAVY MINERAL ANALYSIS

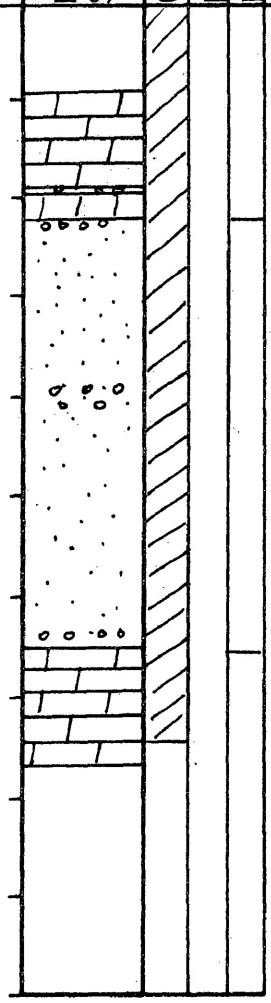
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3705.5			x	x	x	x	x
3715			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3703	x	x						x	x		x	
3707	x		x	x				x	x		x	

WELL: d-75-G

ZONE: 94-H2



DEPTH (FT.) | LITHOLOGY SCALE 1/120 | CORED INT. | DIP (CROSS.) FORE... | THIN SECT. | SIEVE ANAL. | H.MIN.ANAL. | LITHOLOGIC DESCRIPTION

Dolomite, grey, silty.

Sandstone, fine to very fine grained quartz subordinate lithic, chert, a thin granule zone overlies the basal contact and below the upper contact, there are some patches of pyrite.

Dolomite, grey, interlaminated

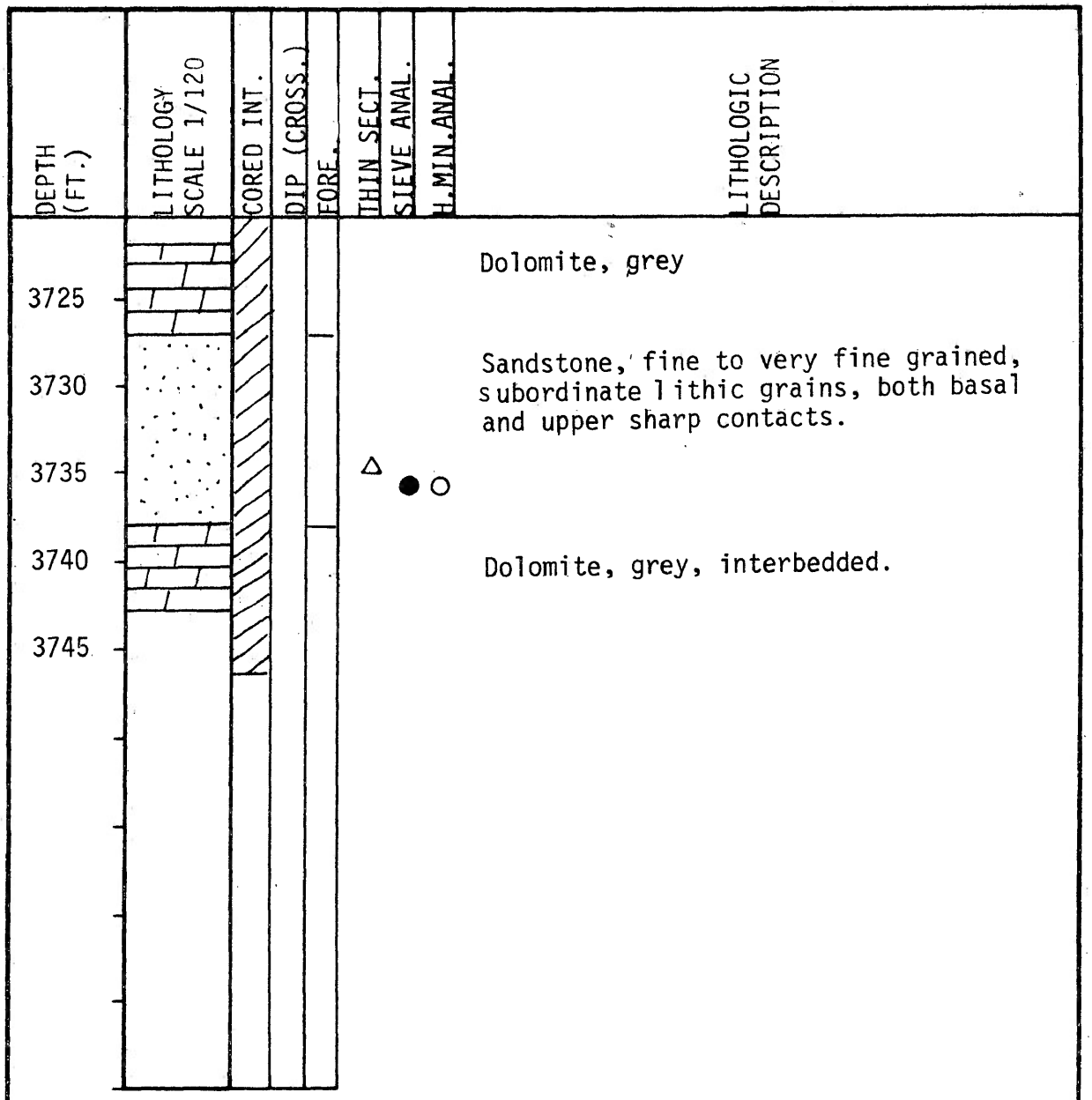
HEAVY MINERAL ANALYSIS

	Epid	Gar	Tim	Leuc	Py	Tour	Zirc
3712			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3705.5	x	x		x					x			

WELL: d-76-G ZONE: 94-H2



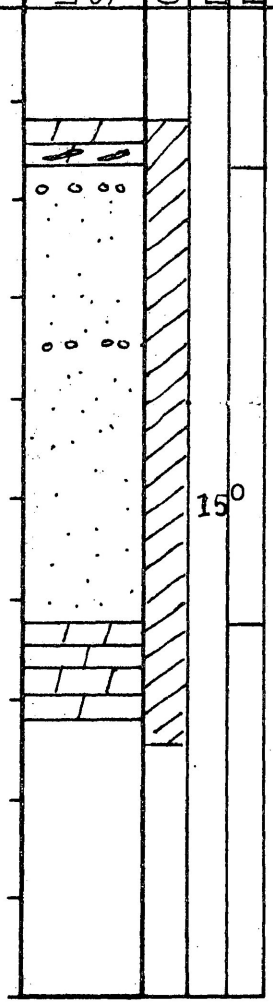
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3736.4					×	×	×

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3735	×	×									×	×

WELL: d-83-G ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, grey, coquina in part

Sandstone, fine to very fine grained, quartz subordinate lithic, chert, a granule zone throughout the section of lithic, quartz and chert. Sharp basal and upper contacts.

Dolomite, massive, grey.

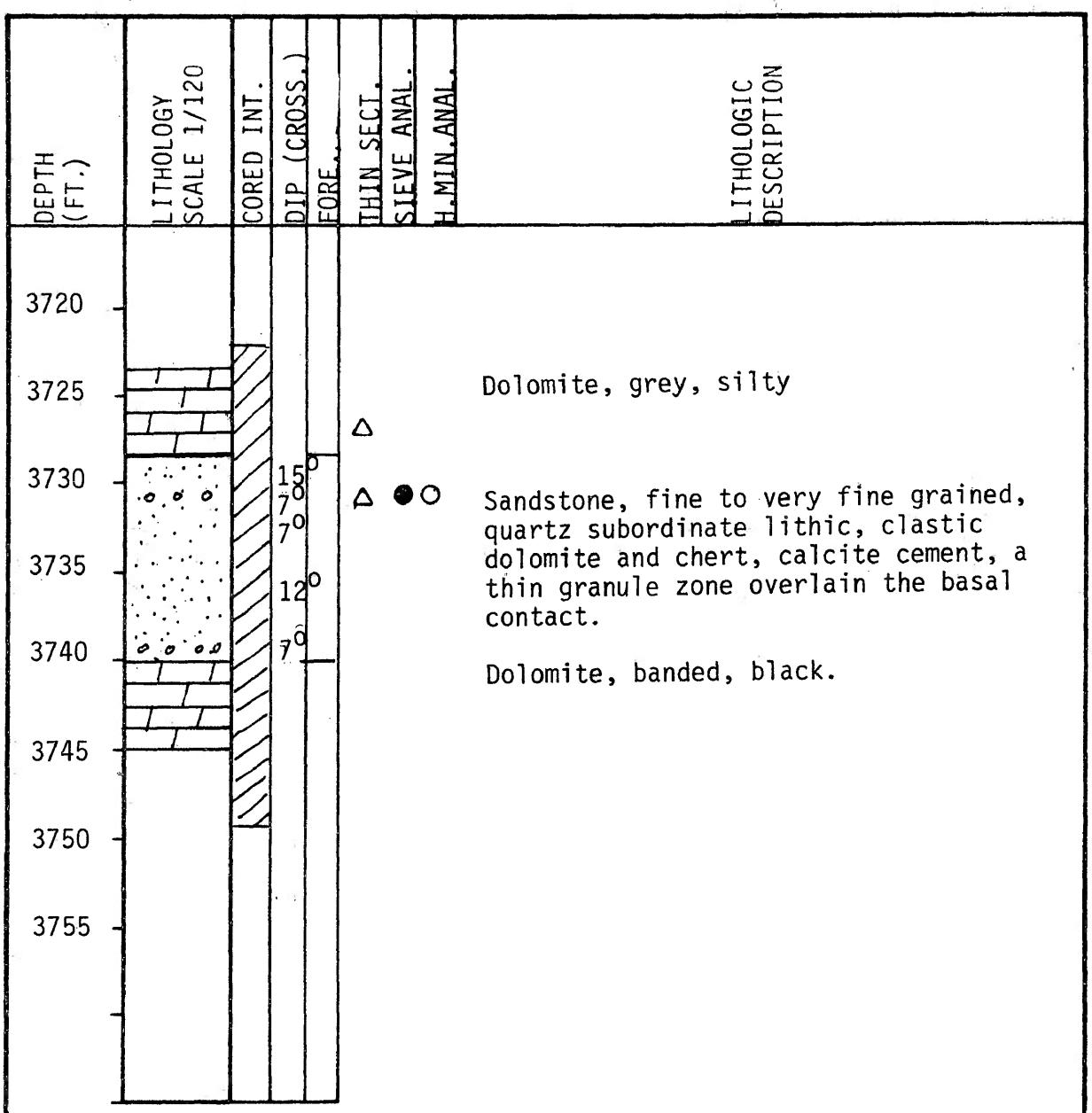
HEAVY MINERAL ANALYSIS

~~3670.3~~	Epid	Gar	lim	Leuc	Py	Tour	Zirc
			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3685	x	x		x							x	x

WELL: d-84-G ZONE: 94-H2



HEAVY MINERAL ANALYSIS

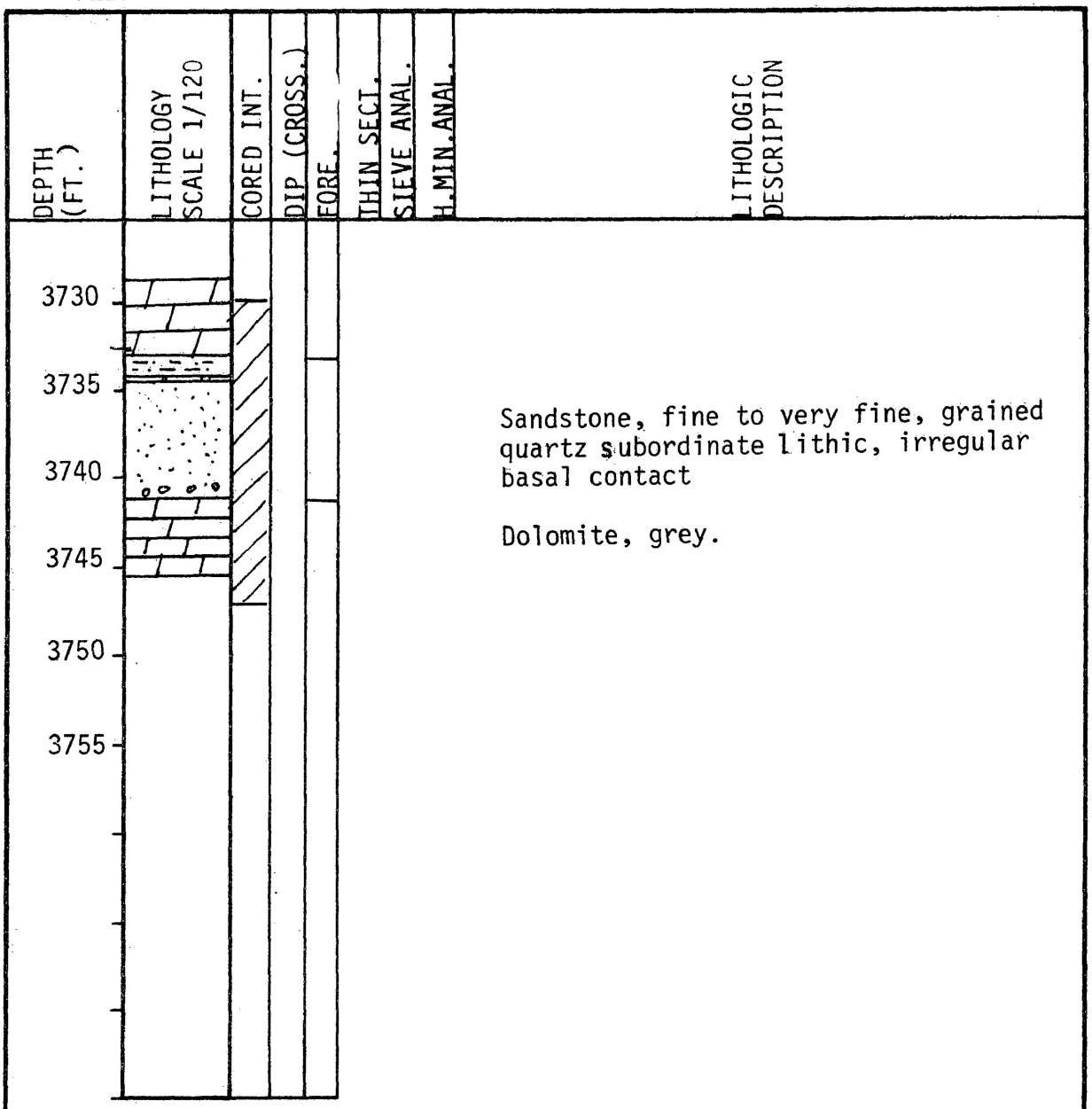
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3731					x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3727	x			x		x	x	x				
3731.1	x	x		x					x		x	x

WELL: d-85-G

ZONE: 94-H2



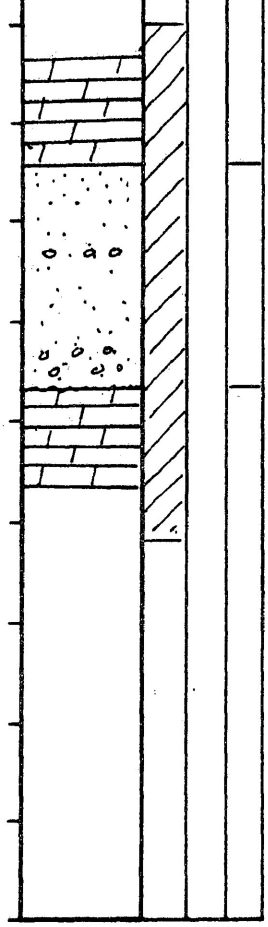
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: b-86-G ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, grey

Sandstone, fine grained quartz subordinate, lithic, clastic dolomite, chert, granule zones throughout the section, sharp basal and upper contacts.

Dolomite, massive

HEAVY MINERAL ANALYSIS

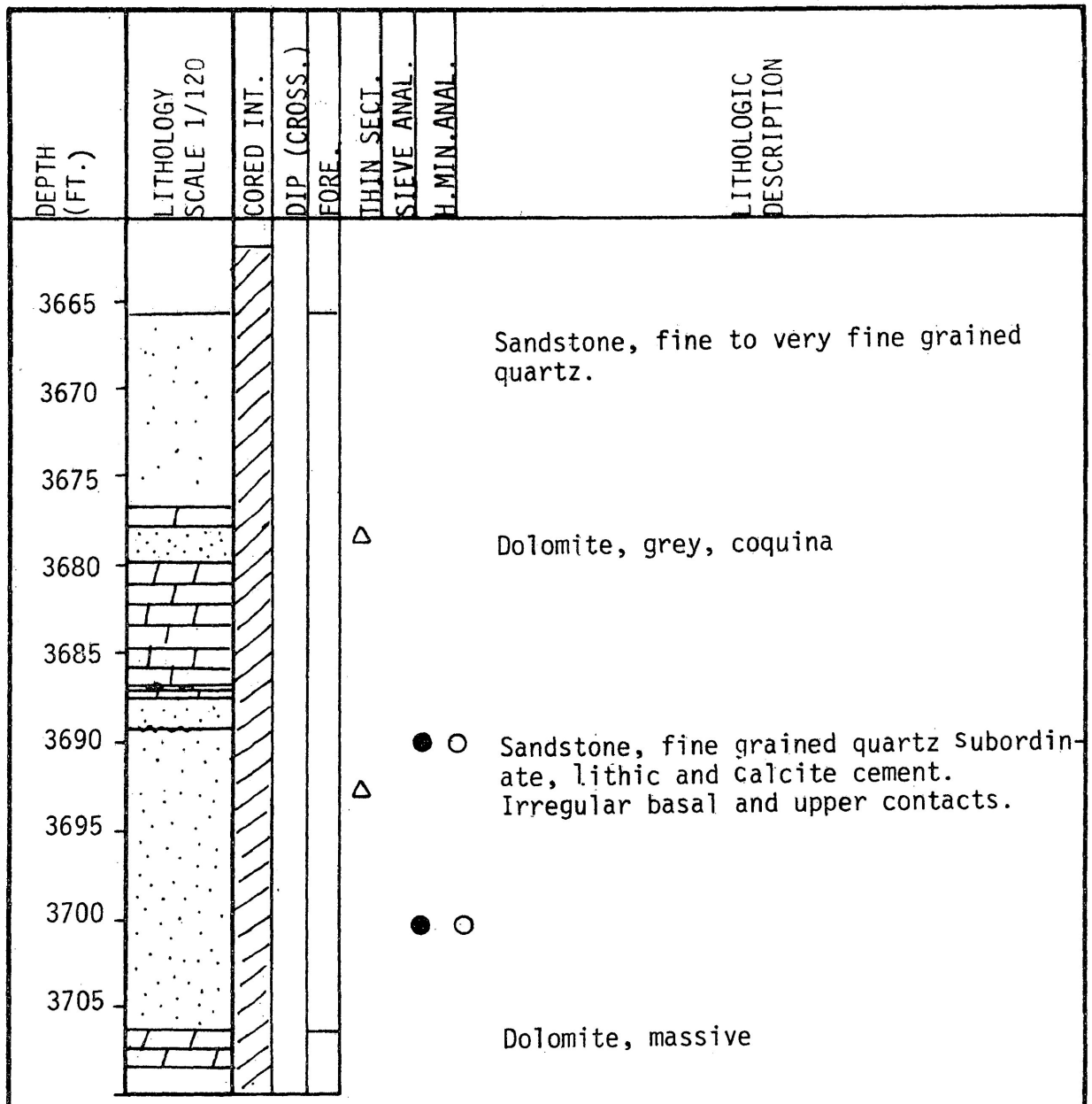
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3741.5	x	x		x					x		x	x

WELL: d-94-G

ZONE: 94-H2



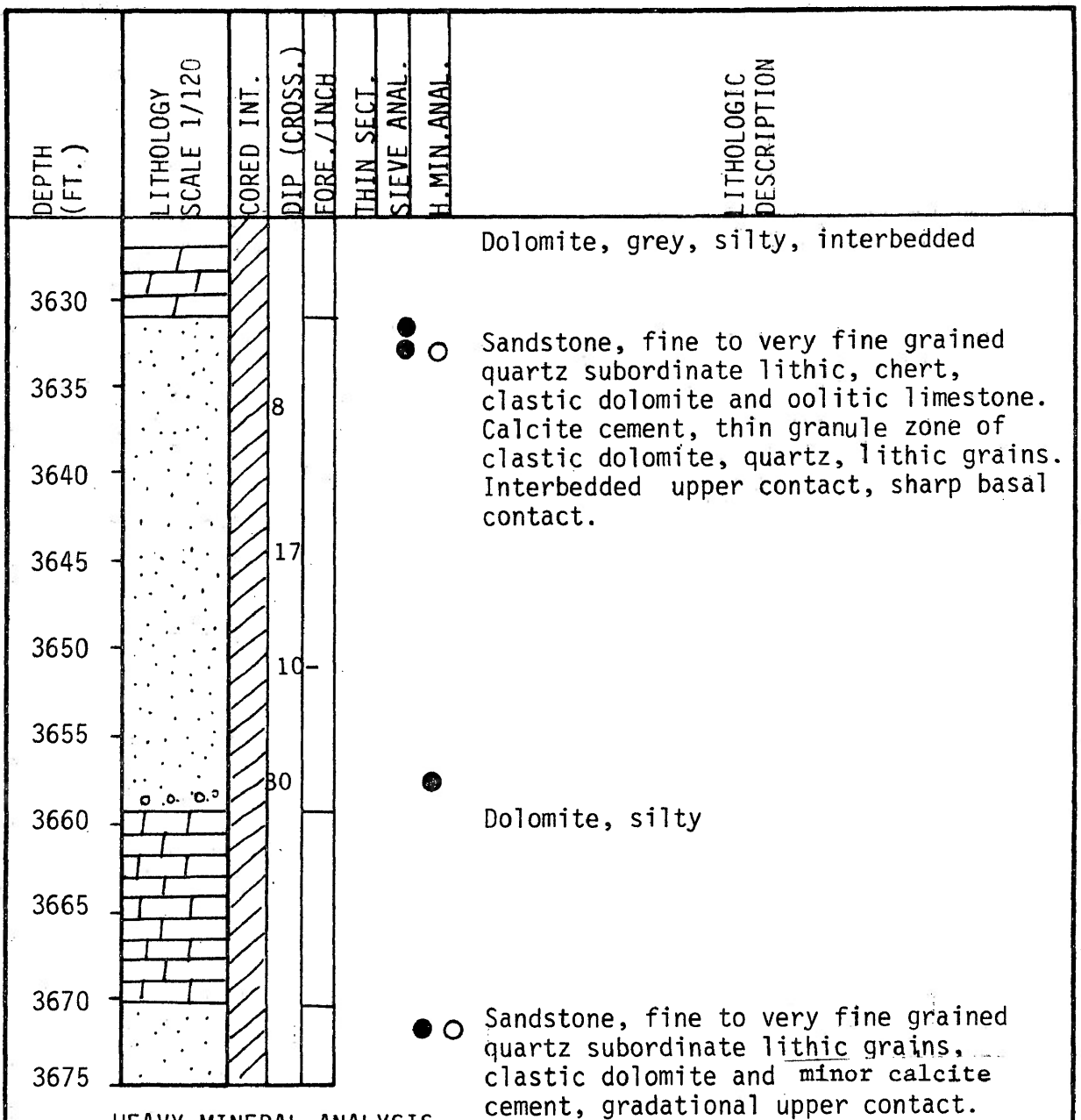
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3690							
3700							

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3679	x			x				x				
3693	x	x							x		x	

WELL: b-10-H ZONE: 94-H2



HEAVY MINERAL ANALYSIS

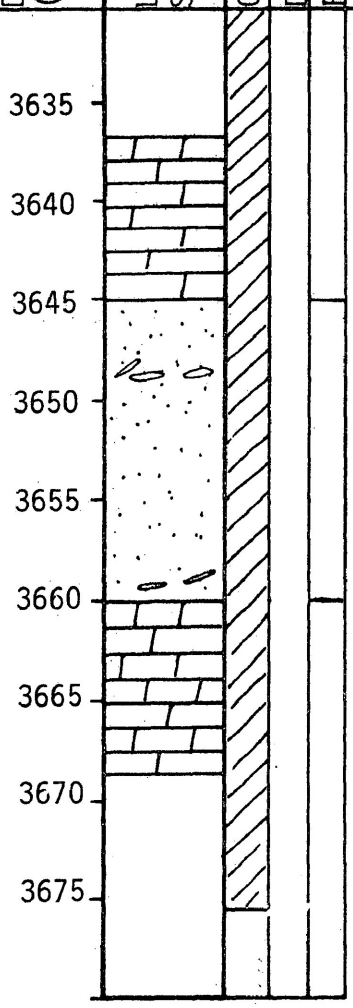
	Epid	Gar	Tim	Leuc	Py	Tour	Zirc
3632			x	x	x	x	x
3658			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3552	x	x		x				x	x		x	
3647	x	x		x				x			x	
3657	x	x						x	x		x	x
3672	x	x		x					x		x	x

WELL: d-20-H

ZONE: 94-H2



LITHOLOGIC DESCRIPTION

Dolomite, grey, silty

Sandstone, fine grained quartz subordinate lithic grains ooids and chert with coquina vuggy pelecypoda molds, fine grained matrix.

Dolomite, grey, interlaminated

HEAVY MINERAL ANALYSIS

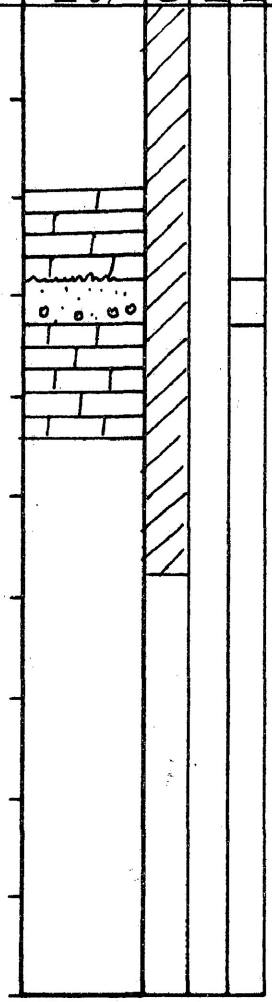
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3648	x	x	x								x	

WELL: d-4-J

ZONE: 94-H2

DEPTH (FT.)	LITHOLOGY SCALE 1/120	CORED INT.	DIP (CROSS.)	FORE.	THIN SECT.	SIEVE ANAL.	H.MIN.ANAL.	LITHOLOGIC DESCRIPTION
3720								Dolomite, grey, massive Sandstone, fine to very fine grained quartz, subordinate lithic grains, chert, clastic dolomite, minor patchy calcite cement, irregular sharp basal and upper contact. Sharp basal contact overlain by thin granule zone. Dolomite, grey and silty.
3725								
3730								
3735								
3740								

HEAVY MINERAL ANALYSIS

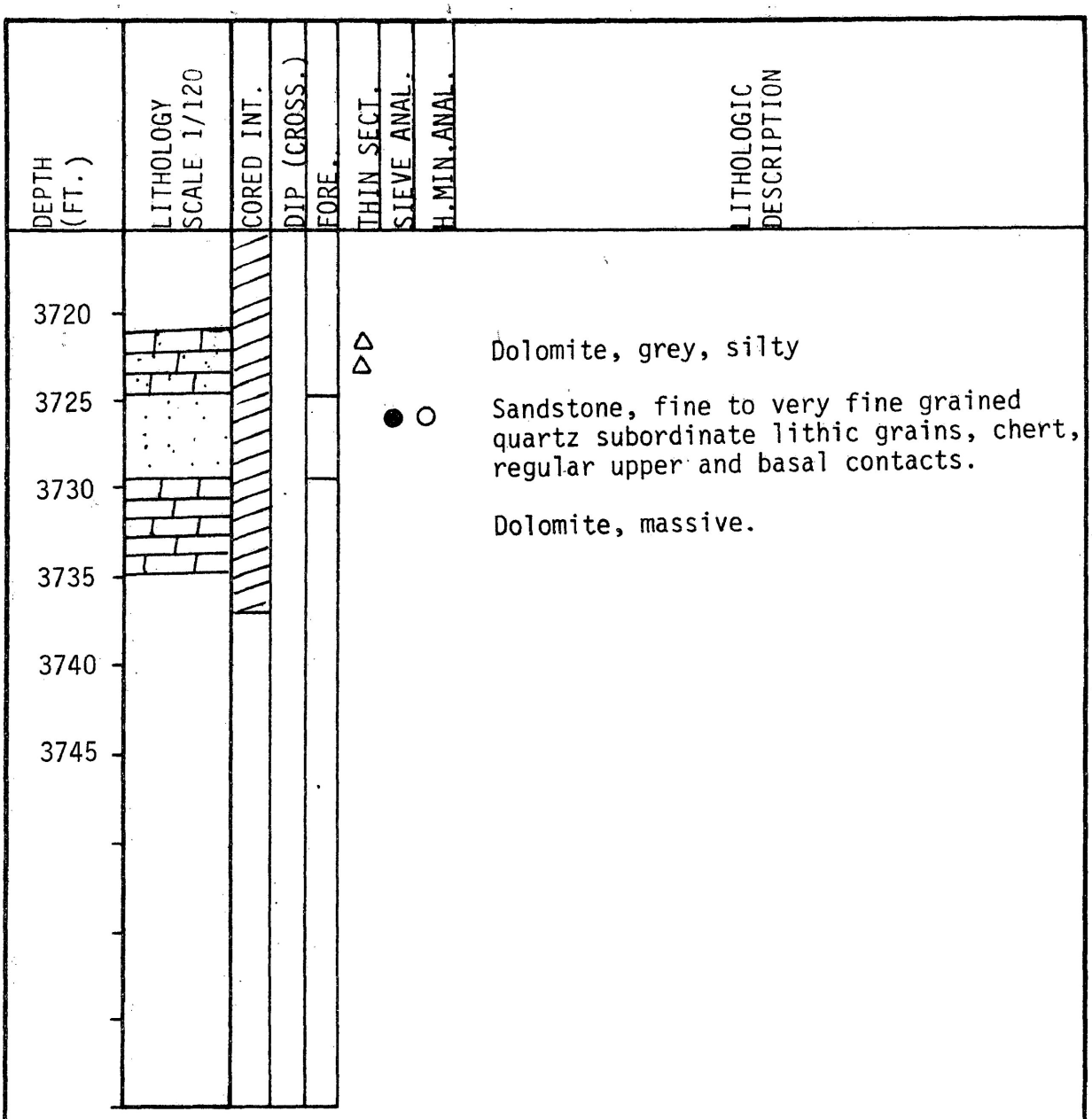
	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: d-8-J

ZONE: 94-H2



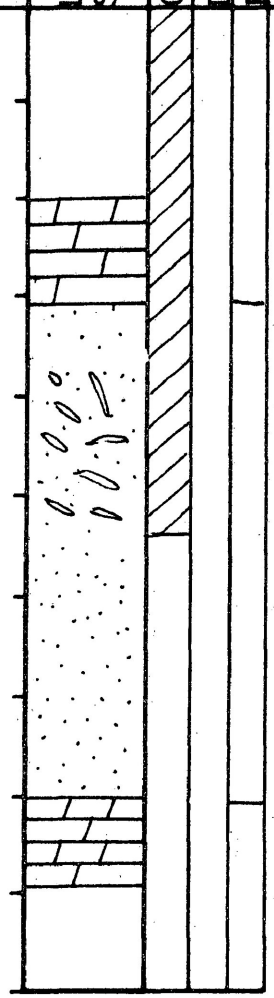
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3726			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3723	x			x		x	x	x	x			
3724.4	x			x			x	x				
3729.4	x	x									x	

WELL: d-9-J ZONE: 94-H2



LITHOLOGIC DESCRIPTION

△ Dolomite, massive

Sandstone, fine grained quartz, coquina, regular upper contact, (the basal contact was not cored)

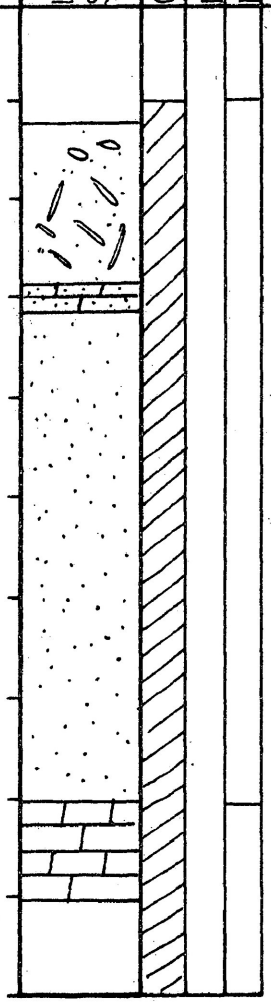
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3720.4	x			x		x	x	x				

WELL: d-10-J ZONE: 94-H2



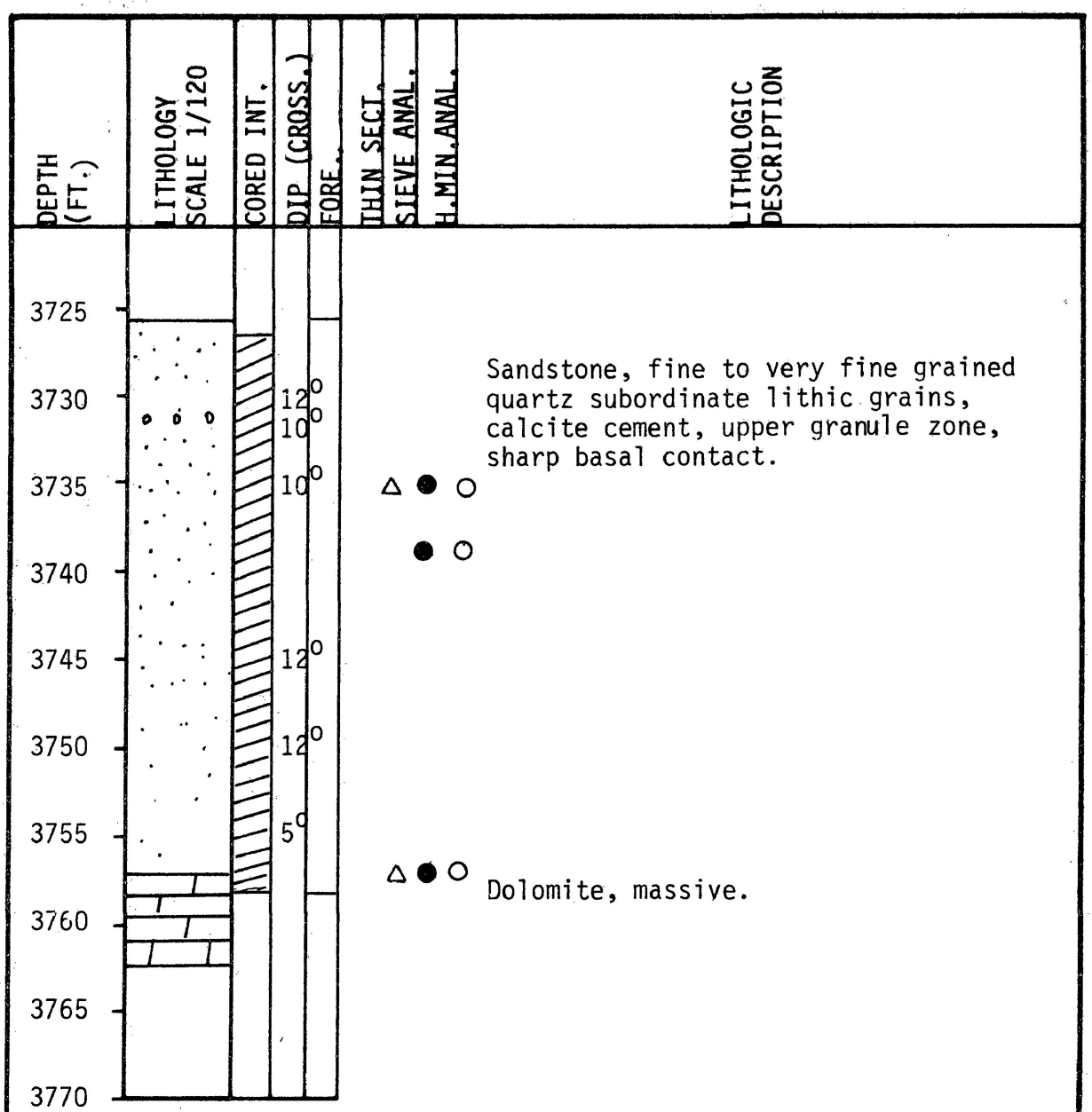
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3743.5			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc

WELL: b-28-J ZONE: 94-H2



HEAVY MINERAL ANALYSIS

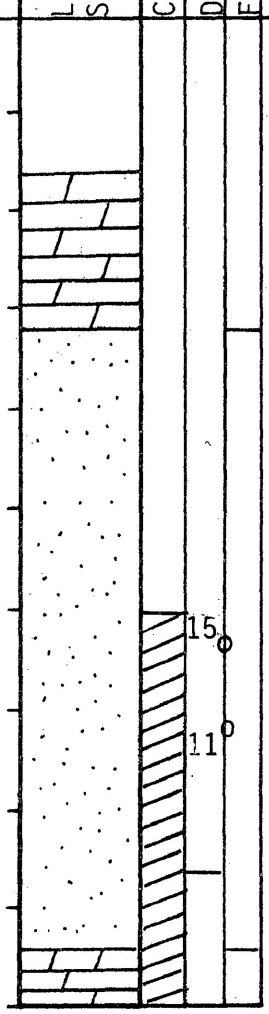
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
~~3735~~			x	x	x		x
3737.11			x	x	x	x	x
3757.5			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3735	x			x					x			
3757	x			x					x			

WELL: d-29-J

ZONE: 94-H2



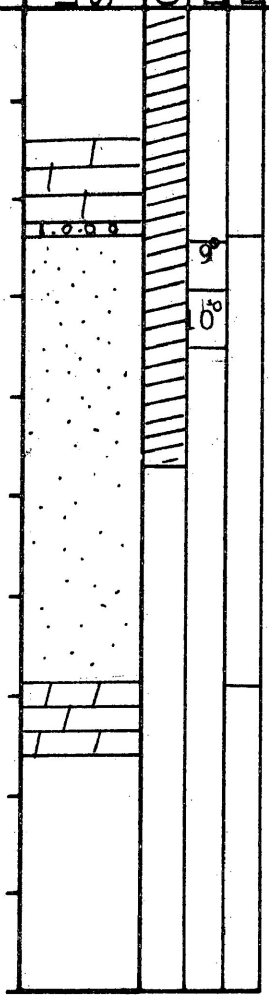
HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3742			x	x	x	x	x
			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3752.7		x	x								x	
3753.7	x	x	x						x		x	y

WELL: d-49-J ZONE: 94-H2



Dolomite, massive, grey.

Sandstone, fine to very fine grained quartz subordinate lithic grains, chert, sharp upper contact with a granule zone underlying the upper contact, the basal contact was not cored.

HEAVY MINERAL ANALYSIS

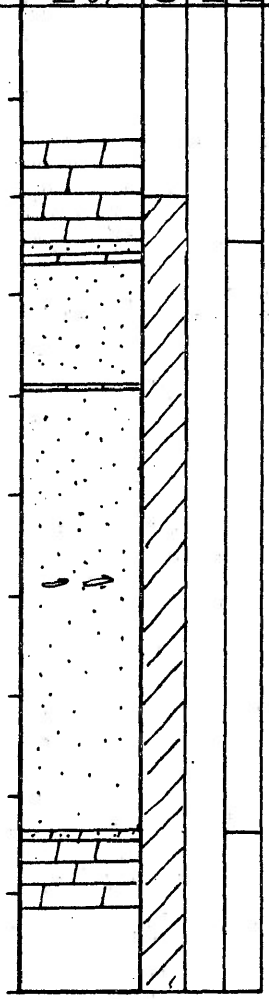
	Epid	Gar	lim	Leuc	Py	Tour	Zirc
3733			x	x	x	x	x

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc
3722		x	x	x					x			
3728	x	x	x	x					x		x	

WELL: d-1-K

ZONE: 94-H2

DEPTH (FT.)	LITHOLOGY SCALE 1/120	CORED INT.	DIP (CROSS.)	FORE.	THIN SECT.	SIEVE ANAL.	H.MIN.ANAL.	LITHOLOGIC DESCRIPTION
3715								Dolomite, massive, fine grained, and silty.
3720								
3725								Sandstone, fine to very fine grained quartz subordinate lithic grains, clastic dolomite, minor chert and coquina calcite cement, irregular banded layers of dolomite and sandstone forming the basal contact.
3730								
3735								
3740								
3745								
3750								
3755								Dolomite, massive, and silty.

HEAVY MINERAL ANALYSIS

	Epid	Gar	lim	Leuc	Py	Tour	Zirc

THIN SECTION ANALYSIS

	Lth	Cht	Ool	Bls	Glau	Micr	Musc	Plag	Py	Px	Tour	Zirc