GRADISTAT
Version 8.0

A Grain Size Distribution and Statistics Package for the Analysis of Unconsolidated Sediments by Sieving or Laser Granulometer

Developed by **Dr Simon J Blott**

Kenneth Pye Associates Ltd.
Crowthorne Enterprise Centre
Old Wokingham Road
Crowthorne
Berkshire RG45 6AW
UK

E-mail: s.blott@kpal.co.uk
Tel/Fax: +44 (0)1344 751610

The development of this program was inspired by Dave Thornley and John Jack at the Postgraduate Research Institute for Sedimentology at the University of Reading, UK, and the Department of Geology at Royal Holloway University of London, UK. It is provided in Microsoft Excel format to allow both spreadsheet and graphical output. The program is best suited to analyse data obtained from sieve or laser granulometer analysis. The user is required to input the mass or percentage of sediment retained on sieves spaced at any intervals, or the percentage of sediment detected in each bin of a Laser Granulometer. The following sample statistics are then calculated using the Method of Moments in Microsoft Visual Basic programming language: mean, mode(s), sorting (standard deviation), skewness, kurtosis, D_{10}, D_{50}, D_{90}, D_{90}/D_{10}, D_{90}-D_{10}, D_{75}/D_{25} and D_{75}-D_{25}. Grain size parameters are calculated arithmetically and geometrically (in microns) and logarithmically (using the phi scale) (Krumbein and Pettijohn, 1938[1]; Table 1). Linear interpolation is also used to calculate statistical parameters by the Folk and Ward (1957)[2] graphical method and derive physical descriptions (such as “very coarse sand” and “moderately sorted”). The program also provides a physical description of the textural group which the sample belongs to and the sediment name (such as “fine gravelly coarse sand”) after Folk (1954)[3]. Also included is a table giving the percentage of grains falling into each size fraction, modified from Udden (1914)[4] and Wentworth (1922)[5] (see Table 2). In terms of graphical output, the program provides graphs of the grain size distribution and cumulative distribution of the data in both metric and phi units, and displays the sample grain size on triangular diagrams. Samples may be analysed singularly, or up to 250 samples may be analysed together.

singularly, or up to 250 samples may be analysed together.

The program is ideal for the rapid analysis of sieve data and is freely available from the author at the above address. Please note that the copyright for the program is held by author, and any distribution or use of the program should be acknowledged to him.

S. Blott November 2010

[1]Krumbein, W.C. and Pettijohn, F.J. (1938) *Manual of Sedimentary Petrography*. Appleton-Century-Crofts, New York.

[2]Folk, R.L. and Ward, W.C. (1957) Brazos River bar: a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, **27**, 3-26.

[3]Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *Journal of Geology*, **62**, 344-359.

[4]Udden, J.A. (1914) Mechanical composition of clastic sediments. *Bulletin of the Geological Society of America*, **25**, 655-744.

[5]Wentworth, C.K. (1922) A scale of grade and class terms for clastic sediments. *Journal of Geology*, **30**, 377-392.

Instructions on the Use of the GRADISTAT Program

Single Sample Analysis

1. Switch to the "Single Sample Data Input" sheet if it is not already active. Enter the aperture sizes of the sieves or Laser Granulometer bins used in the analysis into the cells in column B. Sizes may be entered either in ascending or descending numerical order. For convenience, you can click on one of the standard sieve or Laser Granulometer size intervals and GRADISTAT will enter the size classes for you. Any non-standard sieve sizes can be used, although some of the statistics may not be calculated if you have not used sieves with at least whole phi intervals. See the

some of the statistics may not be calculated if you have not used sieves with at least whole phi intervals. See the section below if the sample contains unanalysed sediment, such as material retained in the pan after sieving. At least one size class larger than the largest particles in the sample should also be entered. A large area to the right of the data columns is provided for the cut and paste of data from other spreadsheets, such as the import of Laser Granulometer data.

2. Enter the weight or percentage of sample beside each size class in column C. When you have finished, make sure there are no data further down the spreadsheet which could cause an error. The program will accept data down to row 230.

3. Enter the sample identity, analyst, date and initial sample weight (optional) at the top of the "Single Sample Data Input" sheet.

4. Click the "Calculate Statistics" button and wait a few moments for the program to finish running. When the dialog box appears, click "OK".

5. The results are summarised on the "Single Sample Statistics" sheet, which includes a distribution histogram of the sample. Select "Print..." from the file menu to print the Summary Statistics page. The data is also shown on triangular diagrams on the "Gravel Sand Mud" and "Sand Silt Clay" sheets. Further cumulative and distribution plots are given on other sheets.

Multiple Sample Analysis

1. Switch to the "Multiple Sample Data Input" sheet. Enter the aperture sizes of the sieves or Laser Granulometer bins used in the analysis into the cells in column B. The aperture sizes must be the same for all the samples. Sizes may be entered either in ascending or descending numerical order. For convenience, you can click on one of the standard sieve or Laser Granulometer size intervals and GRADISTAT will enter the size classes for you. Any non-standard sieve sizes can be used, although some of the statistics may not be calculated if you have not used sieves with at least whole phi intervals. See the section below if samples contain unanalysed sediment, such as material retained in the pan after sieving. At least one size class larger than the largest particles in the sample should also be entered.

2. Enter the weight or percentage of sample in column C onwards. Make sure there are no data further down the spreadsheet which could cause an error. The program will accept data down to row 230.

3. Enter the sample identity, analyst, date and initial sample weight (optional) in the green cells above each sample listing.

4. If you require a Summary Statistics printout for each sample, select a tick in the option box.

5. Click the "Calculate Statistics" button and wait for the program to finish running (this may take several minutes). GRADISTAT will give a warning if it detects a sample whose combined weight is greater than the given sample weight. Click "OK" when prompted on the dialog boxes.

6. The resulting statistics for all samples are summarised on the "Multiple Sample Statistics" sheet. The data for each sample included in the analysis are also shown on triangular diagrams on the "Gravel Sand Mud" and "Sand Silt Clay" sheets. Cumulative and distribution plots will show the results for the last sample in the analysis. If graphical plots for other samples are required, use separate single sample analyses (above).

Unanalysed Sediment

Occasionally, samples may contain sediment in a size fraction of unspecified size, such as material retained in the pan after sieving. Ideally, the whole size range in a sample should be analysed, and this may require further analysis of sediment remaining in the pan after sieving. The larger the quantity of sediment remaining in the pan, the less accurate the calculation of grain size statistics, with statistics calculated by the Method of Moments being most susceptible. Errors in Folk and Ward parameters become significant only when more than 5% of the sample is undetermined. If the sample contains sediment in the pan the user should do one of the following:

1. Enter the weight or percentage of sample in the pan with a class size of zero (or leave the class size blank). GRADISTAT calculates the statistics assuming all sediment in the pan is larger than 10 ϕ (1 μm). The grain size distribution graphs do not however plot the quantity of sediment in the pan.

2. Enter the weight or percentage of sample in the pan with a class size which the user considers to be the lower size limit of sediment in the pan. GRADISTAT calculates the statistics assuming all sediment in the pan is larger than this value and plots this quantity on the grain size distribution graphs.

The above two options are recommended where there is less than 1% of the sample remaining in the pan.

3. Do not enter the quantity of sediment in the pan at all. GRADISTAT calculates the statistics ignoring the sediment in the pan as if it were not present in the sample. This is recommended where there is more than 1% of the sample remaining in the pan.

Samples containing more than 5% of sediment in the pan should ideally be analysed using a different technique, such as sedimentation or laser granulometry. Great care must however be taken when merging data obtained by different methods.

Graph Scales

The size scale used in graphical plots is dependent upon the range of sizes specified on the sample input sheets: the first and last values provide the extreme values on the graphs. While one size class larger than the largest particles in the sample should be entered, other size classes outside the grain size range of the sample have no influence on the statistical calculations. These classes may be deleted to narrow the size scale on graphs. Note that unused size classes within the size range of the sample should also be deleted, otherwise GRADISTAT assumes that zero sample weight was present in those size classes.

Table 1. *Statistical formulae used in the calculation of grain size parameters, and suggested descriptive terminology.* f is the frequency in percent; m is the mid-point of each class interval in metric (m_m) or phi (m_ϕ) units; P_x and ϕ_x are grain diameters, in metric or phi units respectively, at the cumulative percentile value of x.

(a) Arithmetic Method of Moments

Mean	Standard Deviation	Skewness	Kurtosis
$\bar{x}_a = \dfrac{\Sigma f m_m}{100}$	$\sigma_a = \sqrt{\dfrac{\Sigma f (m_m - \bar{x}_a)^2}{100}}$	$Sk_a = \dfrac{\Sigma f (m_m - \bar{x}_a)^3}{100 \sigma_a{}^3}$	$K_a = \dfrac{\Sigma f (m_m - \bar{x}_a)^4}{100 \sigma_a{}^4}$

(b) Geometric Method of Moments

Mean	Standard Deviation	Skewness	Kurtosis
$\bar{x}_g = \exp \dfrac{\Sigma f \ln m_m}{100}$	$\sigma_g = \exp \sqrt{\dfrac{\Sigma f (\ln m_m - \ln \bar{x}_g)^2}{100}}$	$Sk_g = \dfrac{\Sigma f (\ln m_m - \ln \bar{x}_g)^3}{100 \ln \sigma_g{}^3}$	$K_g = \dfrac{\Sigma f (\ln m_m - \ln \bar{x}_g)^4}{100 \ln \sigma_g{}^4}$

Sorting (σ_g)		Skewness (Sk_g)		Kurtosis (K_g)	
Very well sorted	< 1.27	Very fine skewed	< $^{-}$1.30	Very platykurtic	< 1.70
Well sorted	1.27 – 1.41	Fine skewed	$^{-}$1.30 – $^{-}$0.43	Platykurtic	1.70 – 2.55
Moderately well sorted	1.41 – 1.62	Symmetrical	$^{-}$0.43 – $^{+}$0.43	Mesokurtic	2.55 – 3.70
Moderately sorted	1.62 – 2.00	Coarse skewed	$^{+}$0.43 – $^{+}$1.30	Leptokurtic	3.70 – 7.40
Poorly sorted	2.00 – 4.00	Very coarse skewed	> $^{+}$1.30	Very leptokurtic	> 7.40
Very poorly sorted	4.00 – 16.00				
Extremely poorly sorted	> 16.00				

(c) Logarithmic Method of Moments

Mean	Standard Deviation	Skewness	Kurtosis
$\bar{x}_\phi = \dfrac{\Sigma f m_\phi}{100}$	$\sigma_\phi = \sqrt{\dfrac{\Sigma f (m_\phi - \bar{x}_\phi)^2}{100}}$	$Sk_\phi = \dfrac{\Sigma f (m_\phi - \bar{x}_\phi)^3}{100 \sigma_\phi{}^3}$	$K_\phi = \dfrac{\Sigma f (m_\phi - \bar{x}_\phi)^4}{100 \sigma_\phi{}^4}$

Sorting (σ_ϕ)		Skewness (Sk_ϕ)		Kurtosis (K_ϕ)	
Very well sorted	< 0.35	Very fine skewed	> $^{+}$1.30	Very platykurtic	< 1.70
Well sorted	0.35 – 0.50	Fine skewed	$^{+}$0.43 – $^{+}$1.30	Platykurtic	1.70 – 2.55

Well sorted	0.35 – 0.50	Fine skewed	0.43 – 1.30	Platykurtic	1.70 – 2.55
Moderately well sorted	0.50 – 0.70	Symmetrical	$^{-}0.43$ – $^{+}0.43$	Mesokurtic	2.55 – 3.70
Moderately sorted	0.70 – 1.00	Coarse skewed	$^{-}0.43$ – $^{-}1.30$	Leptokurtic	3.70 – 7.40
Poorly sorted	1.00 – 2.00	Very coarse skewed	< $^{-}1.30$	Very leptokurtic	> 7.40
Very poorly sorted	2.00 – 4.00				
Extremely poorly sorted	> 4.00				

(d) Logarithmic (Original) Folk and Ward (1957) Graphical Measures

Mean	Standard Deviation	Skewness	Kurtosis
$M_Z = \frac{\phi_{16} + \phi_{50} + \phi_{84}}{3}$	$\sigma_I = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6.6}$	$Sk_I = \frac{\phi_{16} + \phi_{84} - 2\phi_{50}}{2(\phi_{84} - \phi_{16})} + \frac{\phi_5 + \phi_{95} - 2\phi_{50}}{2(\phi_{95} - \phi_5)}$	$K_G = \frac{\phi_{95} - \phi_5}{2.44(\phi_{75} - \phi_{25})}$

Sorting (σ_I)		Skewness (Sk_I)		Kurtosis (K_G)	
Very well sorted	< 0.35	Very fine skewed	$^{+}0.3$ to $^{+}1.0$	Very platykurtic	< 0.67
Well sorted	0.35 – 0.50	Fine skewed	$^{+}0.1$ to $^{+}0.3$	Platykurtic	0.67 – 0.90
Moderately well sorted	0.50 – 0.70	Symmetrical	$^{+}0.1$ to $^{-}0.1$	Mesokurtic	0.90 – 1.11
Moderately sorted	0.70 – 1.00	Coarse skewed	$^{-}0.1$ to $^{-}0.3$	Leptokurtic	1.11 – 1.50
Poorly sorted	1.00 – 2.00	Very coarse skewed	$^{-}0.3$ to $^{-}1.0$	Very leptokurtic	1.50 – 3.00
Very poorly sorted	2.00 – 4.00			Extremely leptokurtic	> 3.00
Extremely poorly sorted	> 4.00				

(e) Geometric Folk and Ward (1957) Graphical Measures

Mean	Standard Deviation
$M_G = \exp \frac{\ln P_{16} + \ln P_{50} + \ln P_{84}}{3}$	$\sigma_G = \exp\left(\frac{\ln P_{16} - \ln P_{84}}{4} + \frac{\ln P_5 - \ln P_{95}}{6.6}\right)$
Skewness	Kurtosis

Skewness	Kurtosis
$$Sk_G = \frac{\ln P_{16} + \ln P_{84} - 2(\ln P_{50})}{2(\ln P_{84} - \ln P_{16})} + \frac{\ln P_5 + \ln P_{95} - 2(\ln P_{50})}{2(\ln P_{95} - \ln P_5)}$$	$$K_G = \frac{\ln P_5 - \ln P_{95}}{2.44(\ln P_{25} - \ln P_{75})}$$

Sorting (σ_G)		Skewness (Sk_G)		Kurtosis (K_G)	
Very well sorted	< 1.27	Very fine skewed	$^-0.3$ to $^-1.0$	Very platykurtic	< 0.67
Well sorted	1.27 – 1.41	Fine skewed	$^-0.1$ to $^-0.3$	Platykurtic	0.67 – 0.90
Moderately well sorted	1.41 – 1.62	Symmetrical	$^-0.1$ to $^+0.1$	Mesokurtic	0.90 – 1.11
Moderately sorted	1.62 – 2.00	Coarse skewed	$^+0.1$ to $^+0.3$	Leptokurtic	1.11 – 1.50
Poorly sorted	2.00 – 4.00	Very coarse skewed	$^+0.3$ to $^+1.0$	Very leptokurtic	1.50 – 3.00
Very poorly sorted	4.00 – 16.00			Extremely leptokurtic	> 3.00
Extremely poorly sorted	> 16.00				

Table 2. *Size scale adopted in the GRADISTAT program, modified from Udden (1914) and Wentworth (1922).*

Grain Size phi	Grain Size mm	Descriptive term	
		Very Large	Boulder
-10	1024		
		Large	
-9	512		
		Medium	
-8	256		
		Small	
-7	128		
		Very small	
-6	64		
		Very coarse	
-5	32		

		Coarse	
-4	16		
		Medium	Gravel
-3	8		
		Fine	
-2	4		
		Very fine	
-1	2		
		Very coarse	
0	1		
	microns	Coarse	
1	500		
		Medium	Sand
2	250		
		Fine	
3	125		
		Very fine	
4	63		
		Very coarse	
5	31		
		Coarse	
6	16		
		Medium	Silt
7	8		
		Fine	
8	4		
		Very fine	
9	2		
		Clay	

Single Sample Data Input Screen

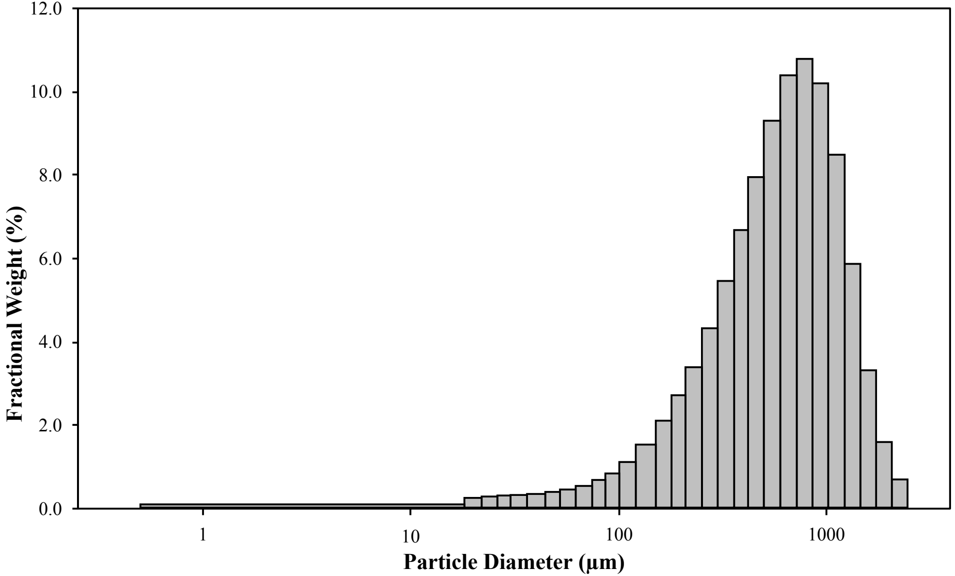
Enter your data in the columns below, and then click the "Calculate Statistics" button. See the "Information" sheet for more information.

Sample Identity: **livin_Amann_6**
Analyst:
Date:
Initial Sample Weight: (optional)

Auto. add apertures at:

Aperture (microns)	Class Weight Retained (g or %)
3500	
2940	0
2460	0
2060	0.66
1740	1.48
1460	3.25
1220	5.89
1020	8.5
860	9.73
720	10.72
600	10.6
500	9.49
420	7.74
360	5.75
300	5.56
250	4.39
210	3.3
180	2.33
150	2.14
120	1.9
100	1.11
86	0.69
74	0.55
62	0.51

52	0.43
44	0.35
36	0.37
30	0.31
26	0.23
22	0.25
18	0.26
0.5	1.51
0	



12.0
10.0
8.0
6.0
4.0
2.0
0.0
Fractional Weight (%)
1
10
100
1000
Particle Diameter (µm)

Multiple Sample Data Input Screen

Enter your data in the columns bel
"Calculate Statistics" button. Ente

Auto. add
apertures
at:

☐ Print summary sheets for each sample?

Aperture (microns)	Class Weight Retained (g or %) in Different Samples		
Sample Identity:	Olivin_Amann_4	Olivin_Amann_5	Olivin_Amann_6
Analyst:			
Date:			
Initial Sample Weight:			
3500			
2940	0	0	0
2460	0	0	0
2060	0	0.12	0.66
1740	0	1.55	1.48
1460	0.65	3.66	3.25
1220	4.75	6.75	5.89
1020	8.96	9.18	8.5
860	10.94	9.74	9.73
720	11.58	10.14	10.72
600	10.87	9.87	10.6
500	9.51	8.96	9.49
420	7.76	7.46	7.74
360	5.84	5.63	5.75
300	5.78	5.56	5.56
250	4.71	4.51	4.39
210	3.67	3.46	3.3
180	2.65	2.45	2.33

150	2.5	2.28	2.14
120	2.26	2.01	1.9
100	1.33	1.16	1.11
86	0.83	0.72	0.69
74	0.66	0.57	0.55
62	0.64	0.52	0.51
52	0.53	0.44	0.43
44	0.43	0.35	0.35
36	0.45	0.38	0.37
30	0.36	0.31	0.31
26	0.25	0.23	0.23
22	0.27	0.24	0.25
18	0.28	0.27	0.26
0.5	1.54	1.48	1.51
0			

columns below, and then click the
button. Enter Sample Info in the green cells.

SAMPLE STATISTICS

		Olivin_Amann_4	Olivin_Amann_5
	ANALYST AND DATE:	,	,
	SIEVING ERROR:		
	SAMPLE TYPE:	Unimodal, Poorly Sorted	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Poorly Sorted Coarse Sand	Slightly Very Fine Gravelly Coarse San
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	608.4	680.0
	SORTING (σ_a):	358.9	432.4
	SKEWNESS (Sk_a):	0.357	0.668
	KURTOSIS (K_a):	2.374	2.970
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	450.3	494.6
	SORTING (σ_g):	2.730	2.770
	SKEWNESS (Sk_g):	-2.375	-2.280
	KURTOSIS (K_g):	11.19	11.01
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	1.151	1.016
	SORTING (σ_ϕ):	1.449	1.470
	SKEWNESS (Sk_ϕ):	2.375	2.280
	KURTOSIS (K_ϕ):	11.19	11.01
FOLK AND WARD METHOD (μm)	MEAN (M_G):	501.3	548.8
	SORTING (σ_G):	2.214	2.255
	SKEWNESS (Sk_G):	-0.358	-0.288
	KURTOSIS (K_G):	1.125	1.105
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	0.996	0.866
	SORTING (σ_I):	1.147	1.173
	SKEWNESS (Sk_I):	0.358	0.288
	KURTOSIS (K_G):	1.125	1.105
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand	Coarse Sand
	SORTING:	Poorly Sorted	Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Fine Skewed
	KURTOSIS:	Leptokurtic	Mesokurtic
	MODE 1 (μm):	790.0	940.0

MODE 2 (μm):		
MODE 3 (μm):		
MODE 1 (ϕ):	0.346	0.095
MODE 2 (ϕ):		
MODE 3 (ϕ):		
D_{10} (μm):	151.9	166.7
D_{50} (μm):	574.7	611.3
D_{90} (μm):	1112.9	1289.4
(D_{90} / D_{10}) (μm):	7.328	7.735
(D_{90} - D_{10}) (μm):	961.0	1122.7
(D_{75} / D_{25}) (μm):	2.735	2.828
(D_{75} - D_{25}) (μm):	548.1	617.5
D_{10} (ϕ):	-0.154	-0.367
D_{50} (ϕ):	0.799	0.710
D_{90} (ϕ):	2.719	2.585
(D_{90} / D_{10}) (ϕ):	-17.626	-7.048
(D_{90} - D_{10}) (ϕ):	2.873	2.951
(D_{75} / D_{25}) (ϕ):	7.884	23.74
(D_{75} - D_{25}) (ϕ):	1.451	1.500
% GRAVEL:	0.0%	0.4%
% SAND:	95.9%	95.9%
% MUD:	4.1%	3.7%
% V COARSE GRAVEL:	0.0%	0.0%
% COARSE GRAVEL:	0.0%	0.0%
% MEDIUM GRAVEL:	0.0%	0.0%
% FINE GRAVEL:	0.0%	0.0%
% V FINE GRAVEL:	0.0%	0.4%
% V COARSE SAND:	15.6%	22.0%
% COARSE SAND:	41.6%	37.6%
% MEDIUM SAND:	24.1%	23.2%
% FINE SAND:	10.7%	9.8%
% V FINE SAND:	3.8%	3.3%
% V COARSE SILT:	1.7%	1.4%
% COARSE SILT:	0.9%	0.9%

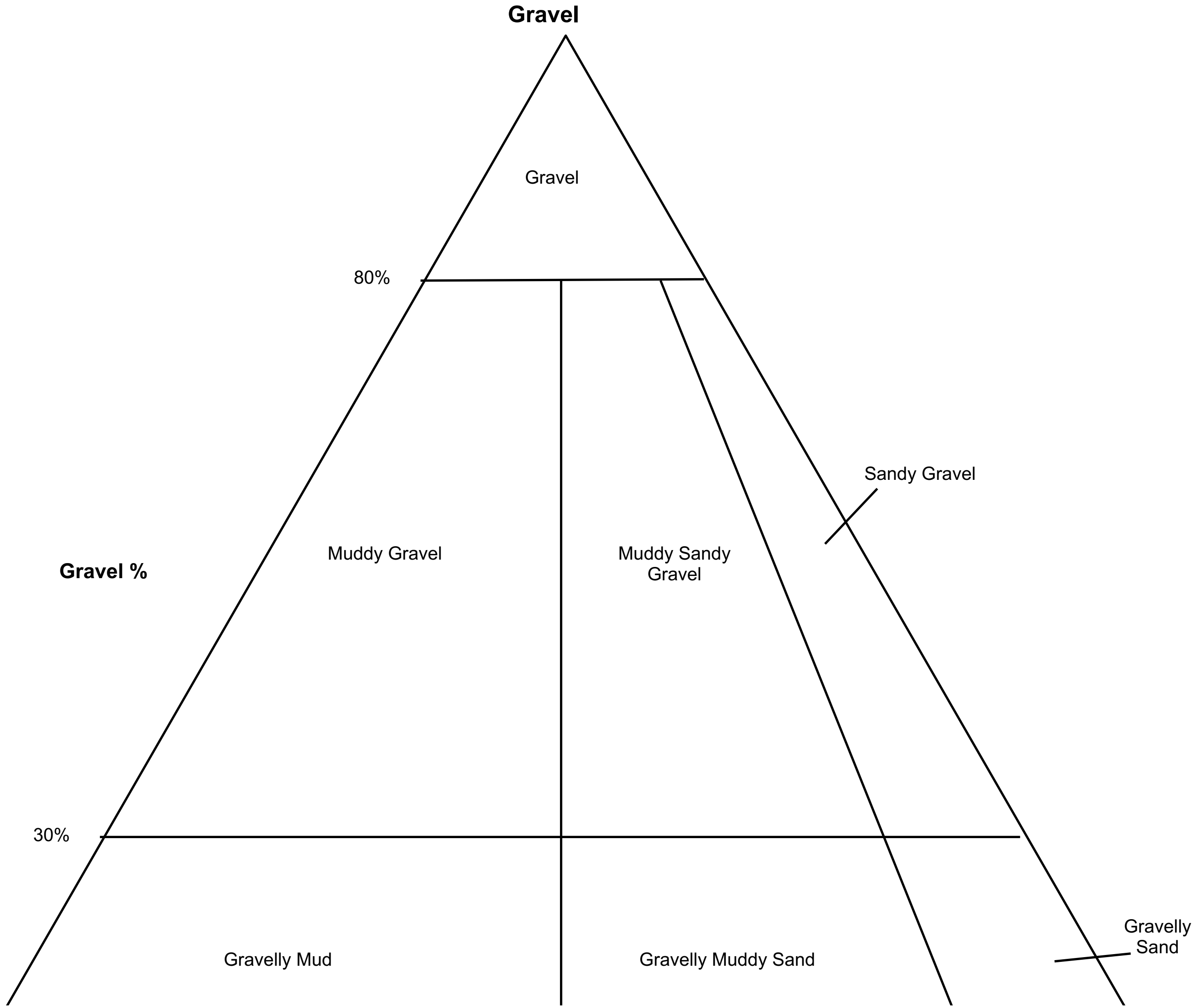
% MEDIUM SILT:	0.3%	0.3%
% FINE SILT:	0.3%	0.3%
% V FINE SILT:	0.3%	0.3%
% CLAY:	0.6%	0.6%

Olivin_Amann_6			
,			
Unimodal, Poorly Sorted			
Slightly Gravelly Sand			
Slightly Very Fine Gravelly Coarse Sand			
677.8			
435.3			
0.848			
3.659			
494.6			
2.760			
-2.331			
11.35			
1.016			
1.464			
2.331			
11.35			
549.5			
2.224			
-0.283			
1.161			
0.864			
1.153			
0.283			
1.161			
Coarse Sand			
Poorly Sorted			
Fine Skewed			
Leptokurtic			
790.0			

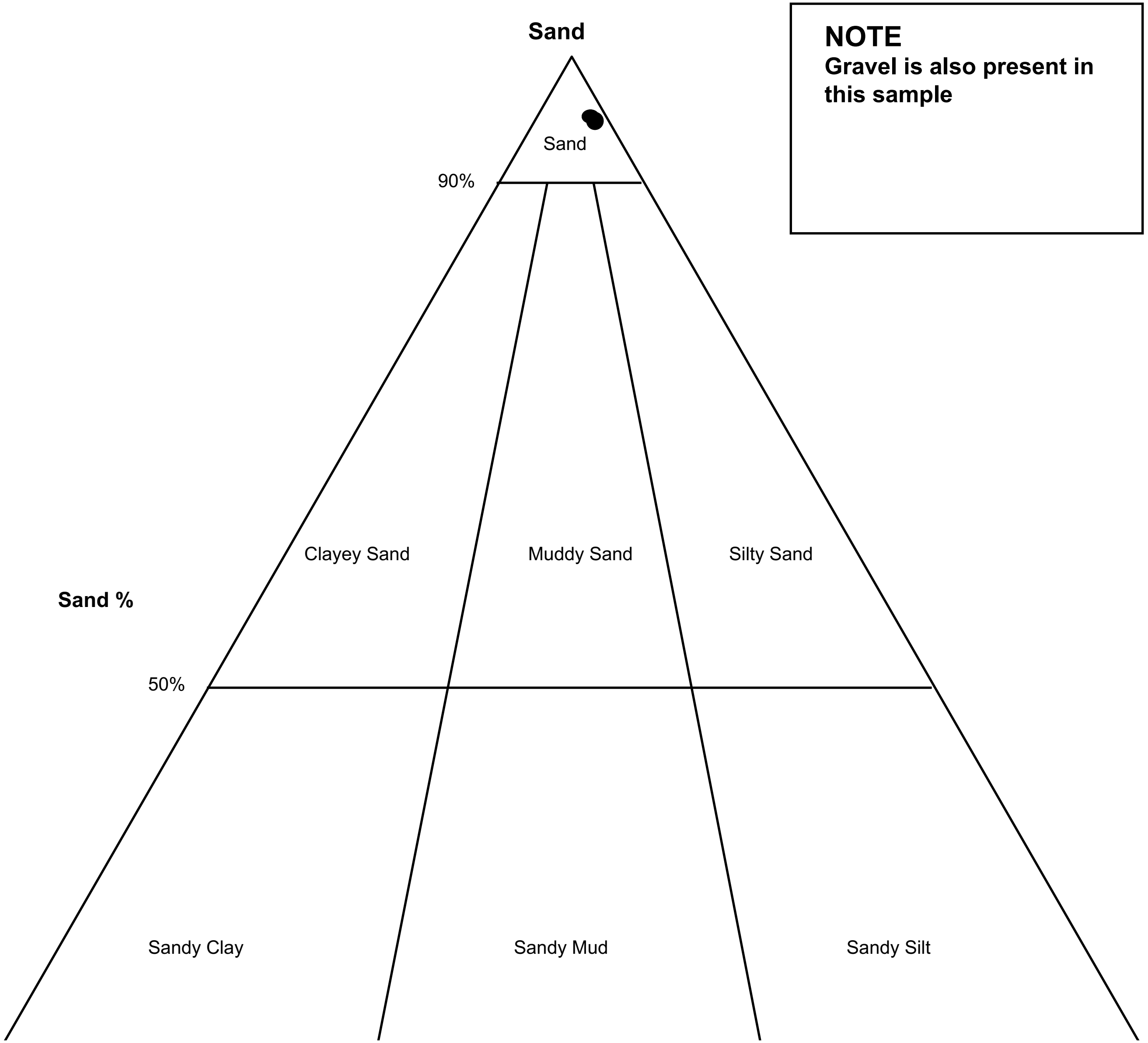
0.346			
170.9			
608.6			
1268.6			
7.423			
1097.7			
2.688			
584.6			
-0.343			
0.716			
2.549			
-7.427			
2.892			
14.79			
1.427			
0.9%			
95.3%			
3.7%			
0.0%			
0.0%			
0.0%			
0.0%			
0.9%			
20.0%			
39.4%			
23.4%			
9.3%			
3.2%			
1.4%			
0.9%			

0.3%			
0.3%			
0.3%			
0.6%			

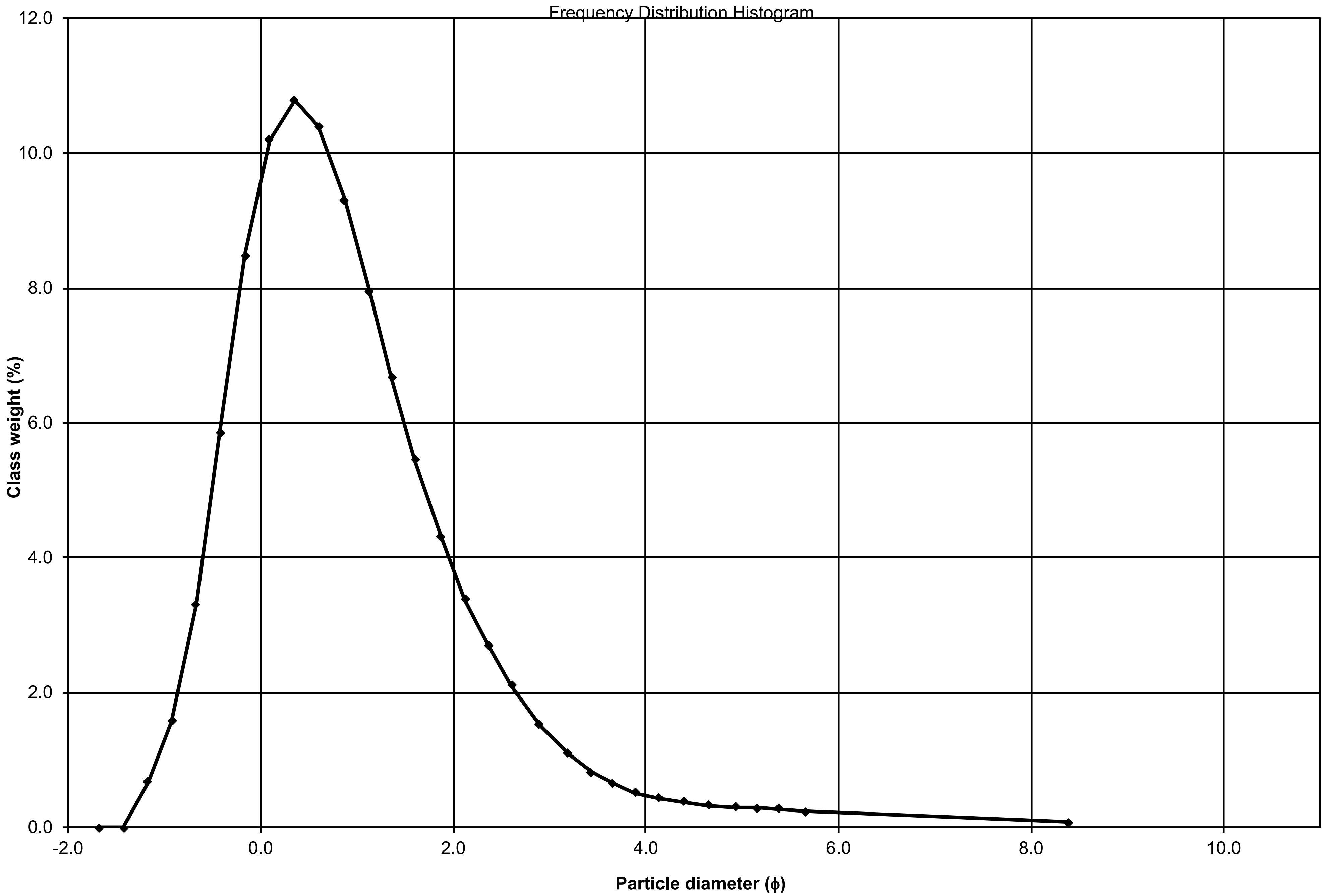
Triangular Diagram



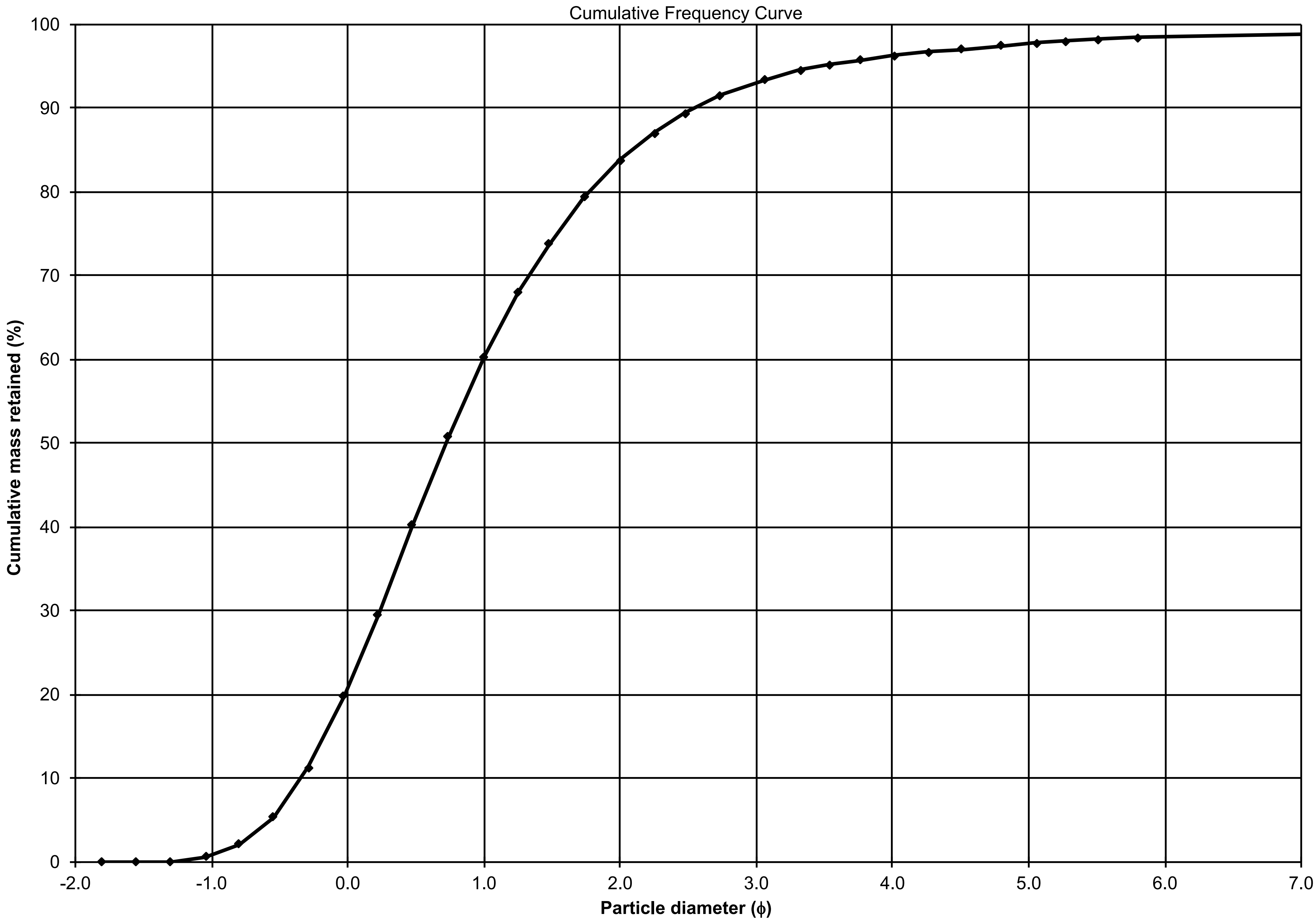
Triangular Diagram



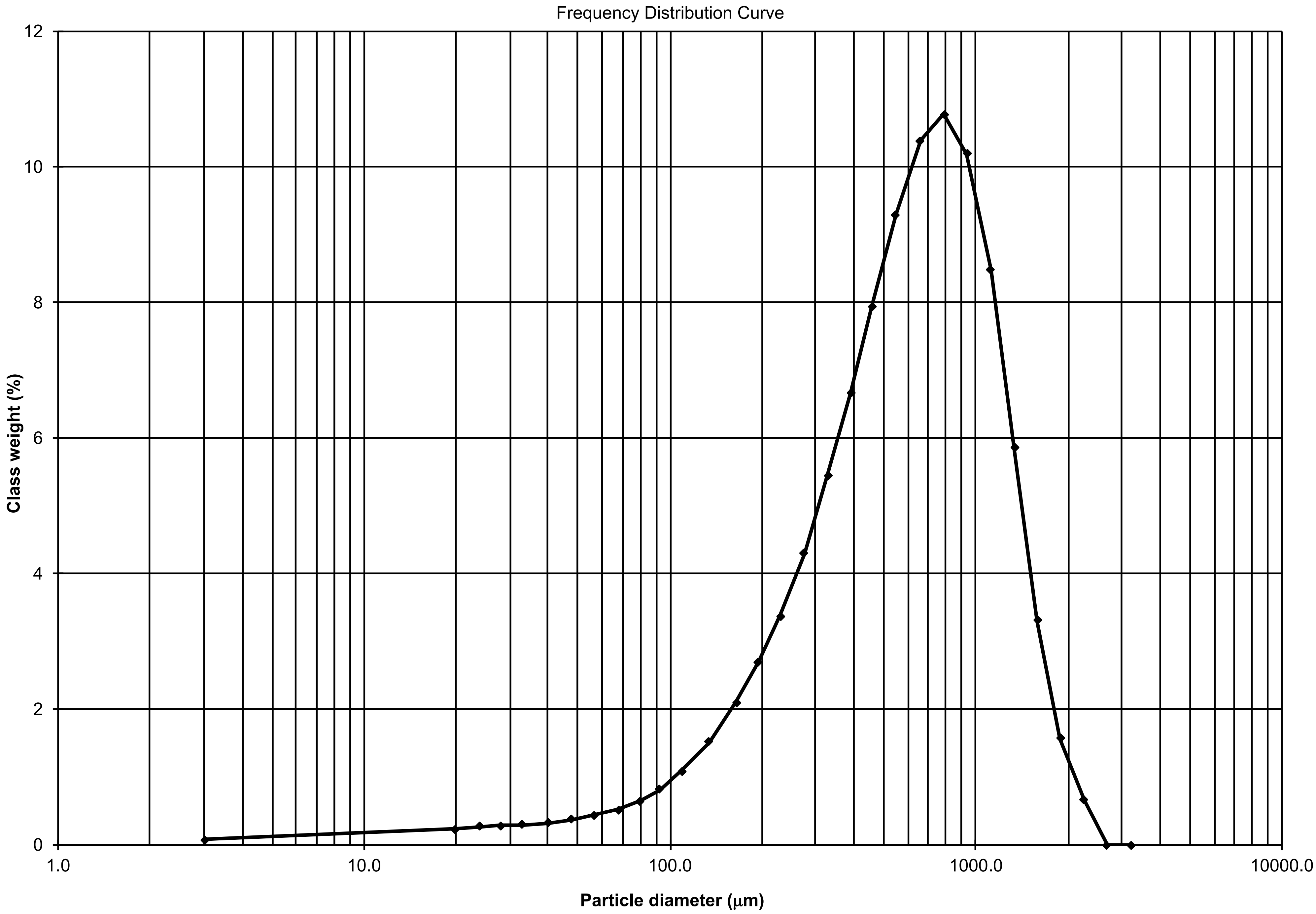
NOTE
Gravel is also present in this sample



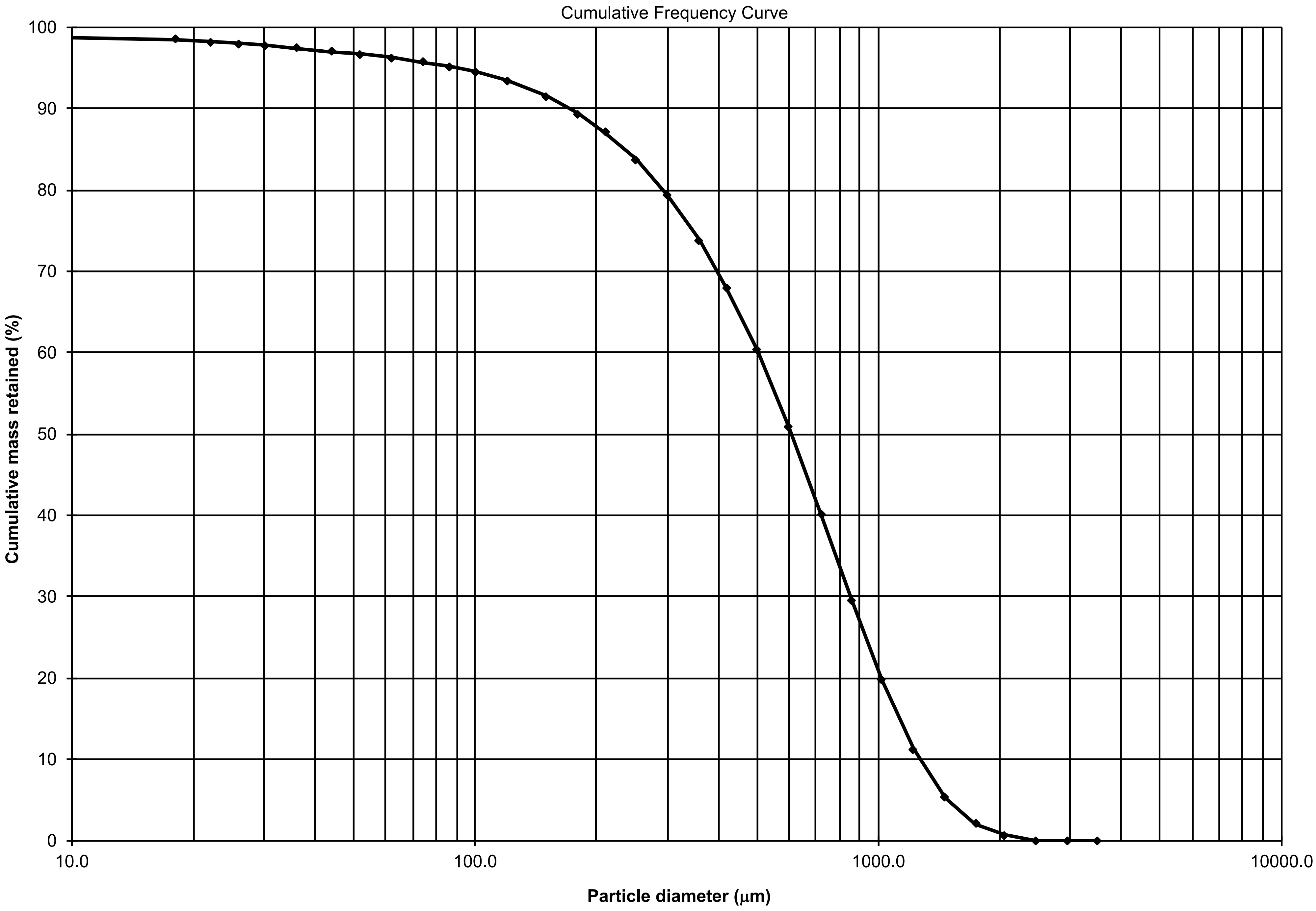
Frequency Distribution Histogram
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Class weight (%)
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Particle diameter (ϕ)



Cumulative Frequency Curve
Cumulative mass retained (%)
100
90
80
70
60
50
40
30
20
10
0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Particle diameter (ϕ)



Frequency Distribution Curve
Class weight (%)
12
10
8
6
4
2
0
1.0
10.0
100.0
1000.0
10000.0
Particle diameter (µm)


Cumulative Frequency Curve
100
90
80
70
60
50
40
30
20
10
0
Cumulative mass retained (%)
10.0
100.0
1000.0
10000.0
Particle diameter (μm)