G302 - Graphing Techniques Applied to Earth Science

I. Graphing Review

A. Purpose of graphing - to plot data and allow general relationships to be visualized.

B. Basic X-Y (scatterplot) graph

1. Axis

a. Y axis = vertical axis (ordinate)

b. X axis = horizontal axis (abscissa)

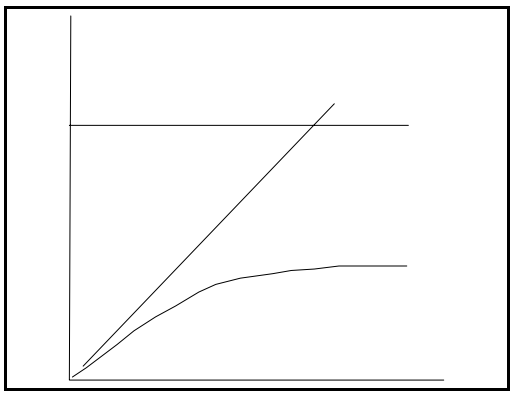
C. Graph Trends (see attached figures)

1. Linear Increase / Decrease
2. Constant
3. Parabolic (curvilinear) Increase / Decrease

Linear Increase

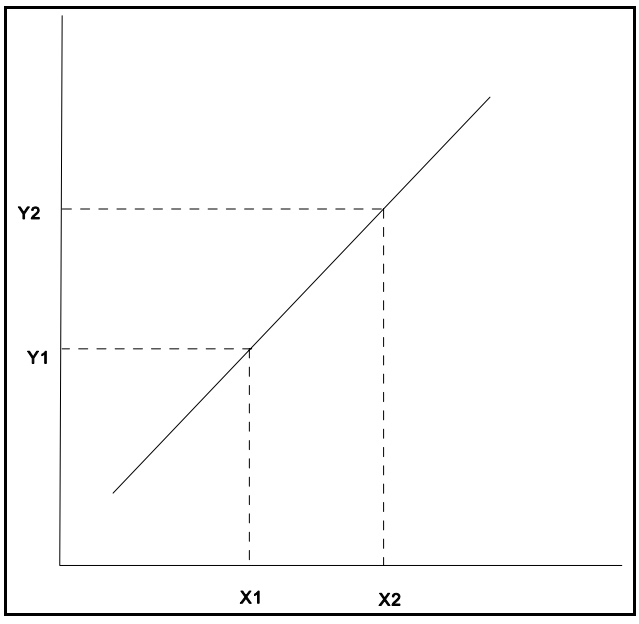
Constant

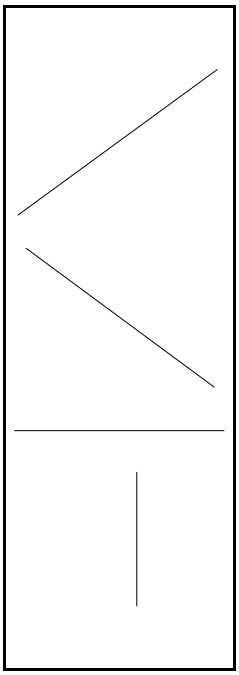
Parabolic



D. Determining Slopes of Lines

1. slope of any line on a graph = rise / run = $(Y_2 - Y_1) / (X_2 - X_1)$





Positive Slope

Negative Slope

Zero Slope

Undefined Slope

E. Linear Relationships - represented by uniform change of y relative to x

1. General Equation for Line: $Y = mX + B$

where Y = variable on ordinate axis, X = variable on abcissa, m = slope of line, B = y-intercept (value on y axis where line intercepts it)

a. Sloping line downward to right = negative slope
b. sloping line downward to left = positive slope

F. Relationships other than linear

1. Quadratic Equation
   a. form: $Y = aX^2 + bX + C$

where y is a function of x, while a,b, and c are constants

2. Polynomial Functions of higher order (expanded quadratic equation)

   a. e.g. form: $Y = aX^4 + bX^3 + cX^2 + dX + e$

3. Power Functions
   a. form: $Y = aX^b$ equivalent to: $\ln Y = b(\ln X) + a$

4. Log Function
   a. form: $Y = b(\ln X) + a$

5. Exponential Function
   a. form: $\ln Y = bX + a$ equivalent to: $Y = aX^{bX}$

G. Best-Fit Functions

1. process of fitting functions to data using regression analysis
   a. regression - curve fitting process that maximizes the trend of the fitted curve with the distribution of data
      (1) Residuals - difference between fit Y values and actual Y values of data at given X values

      (2) Coefficient of Determination

      $r^2 = 1 - SSe / (SSe + SSr)$

where r = coefficient of determination, SSe = sum of squares of all residual values, SSr = sum of squares of the difference between all actual Y values and the fit Y value at each X location where the data point occurs

(a) Interpretation:
   i) r^2 values between 0.7 - 1.0 = good fit of function to data distribution
   ii) r^2 values between 0.5-0.7 = moderate to poor fit
   iii) r^2 values < 0.5 = poor fit to data

II. More on Logarithms

A. logarithms = inverse of exponential functions

1. examples

a. $Y = 10^3 = 1000$, then $\log_{10}(1000) = 3$

b. $Y = 10^{-2} = 0.01$, then $\log_{10}(10^{-2}) = -2$

c. If $Y = 10^n$, then $\log_{10}(10^n) = n$

d. If $Y = X^n$, then $\log_X(X^n) = n$

B. Uses for logarithms

1. re-arranging equations containing exponential functions
2. reducing exponential functions / curves to straight lines
3. compressing large data ranges

C. Natural Logarithms - logs to the base "e", where e = 2.718

In-Class Example:

Logs are used in the classification of sediment grain sizes by use of the following equation:

$\phi = -\log_2(d)$ where ϕ = "phi" (greek letter f), and d = diameter of sediment grain in millimeters

If a grain has a diameter of 8 mm, what is it's corresponding "phi" size? show all work.

If a grain has a diameter of 4 mm, what is it's corresponding "phi" size? show all work.

If a grain has a diameter of 0.2 mm, what is it's corresponding "phi" size? show all work.

III. Overview of Graph Types

A. X-Y Scatterplot Graphs

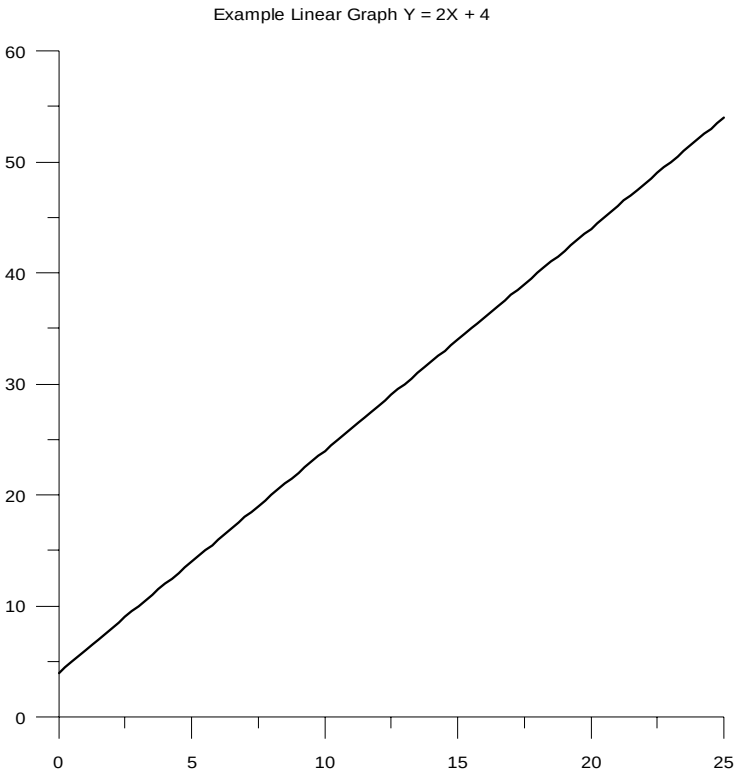
1. linear axes
2. log-linear axes
3. log-log axes

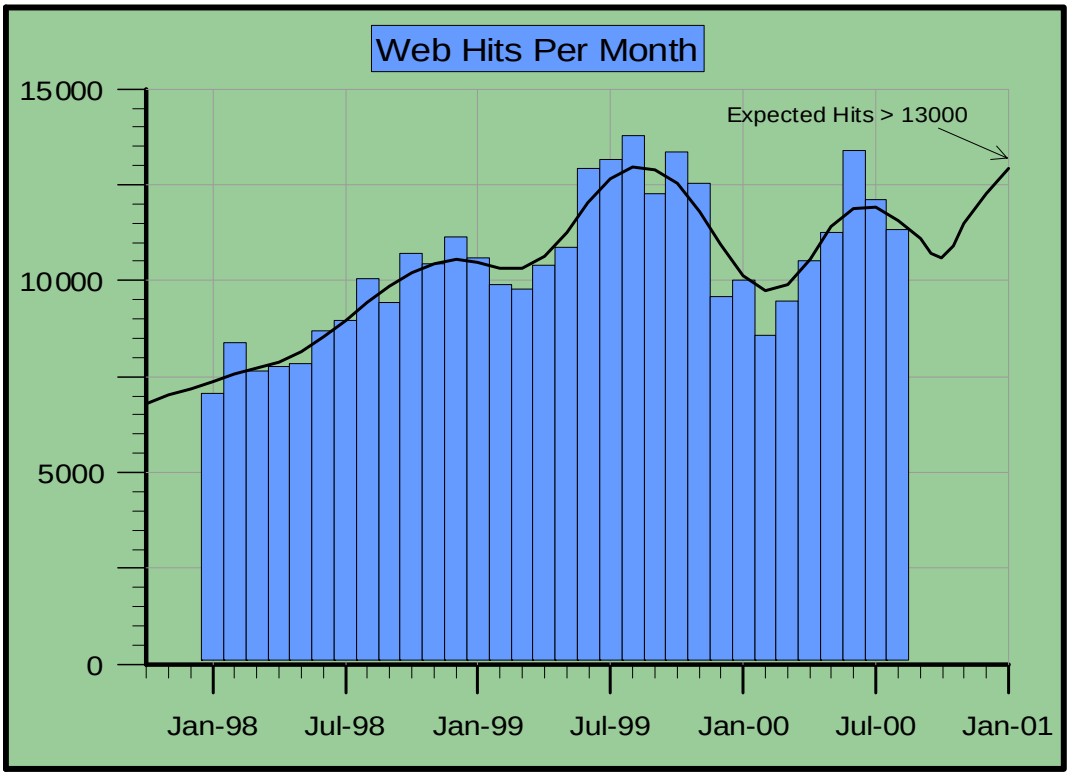
B. Bar Graphs

C. Triangular Graphs (three end-member composition plots)

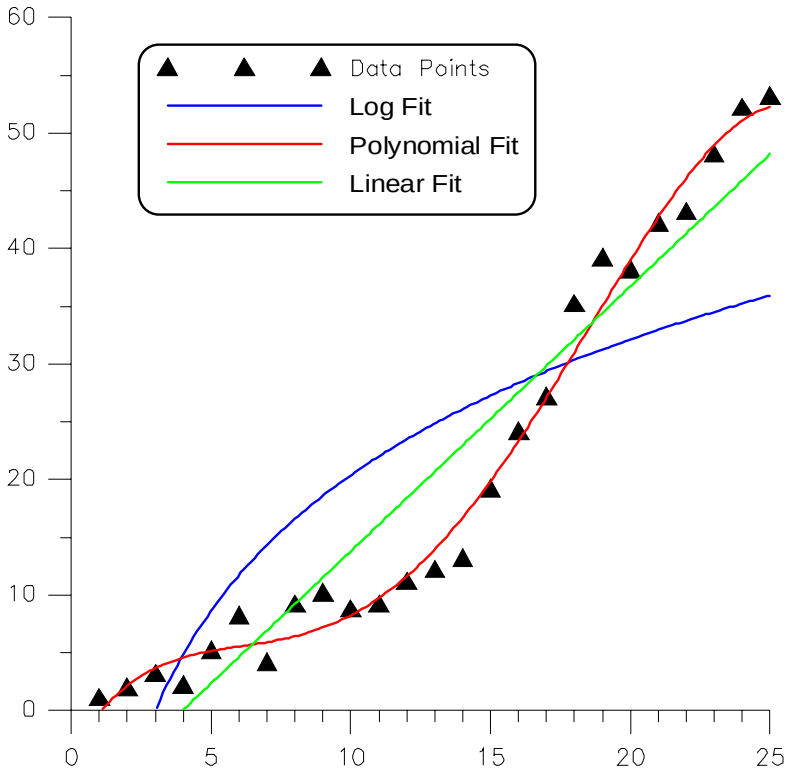
D. Polar-Azimuthal Graphs (directional scatter plots)

E. Rose Plots (directional histograms)



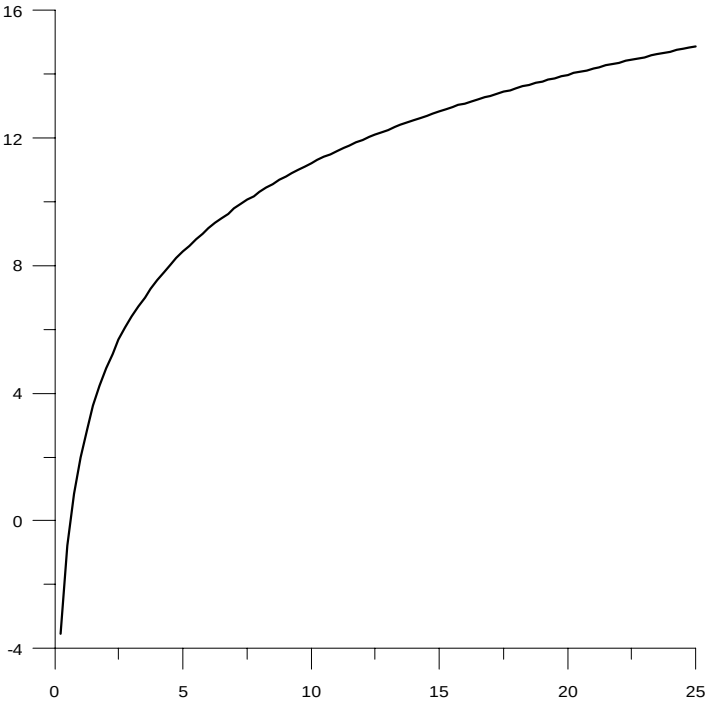


Example Bar Graph



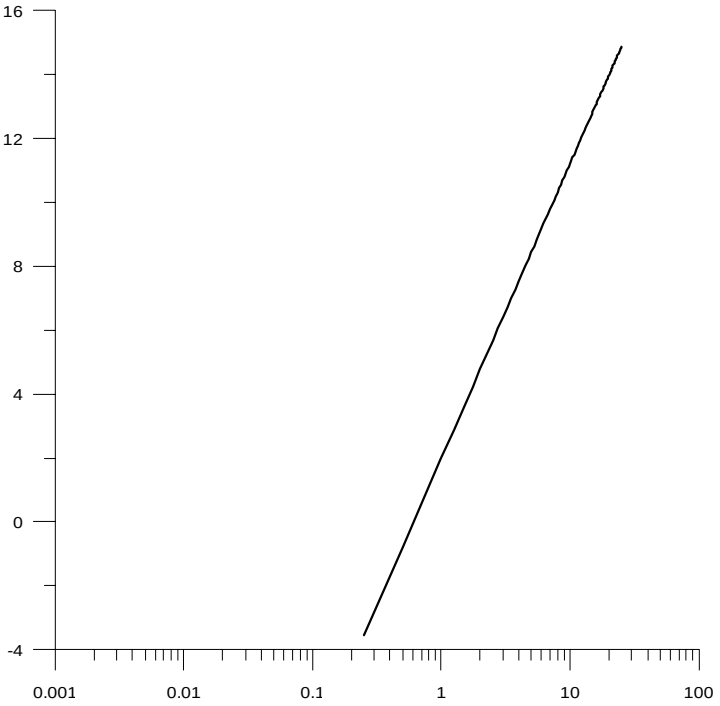
Example Log Equation Y = 4Ln(X) + 2

Plotted on Linear Axes



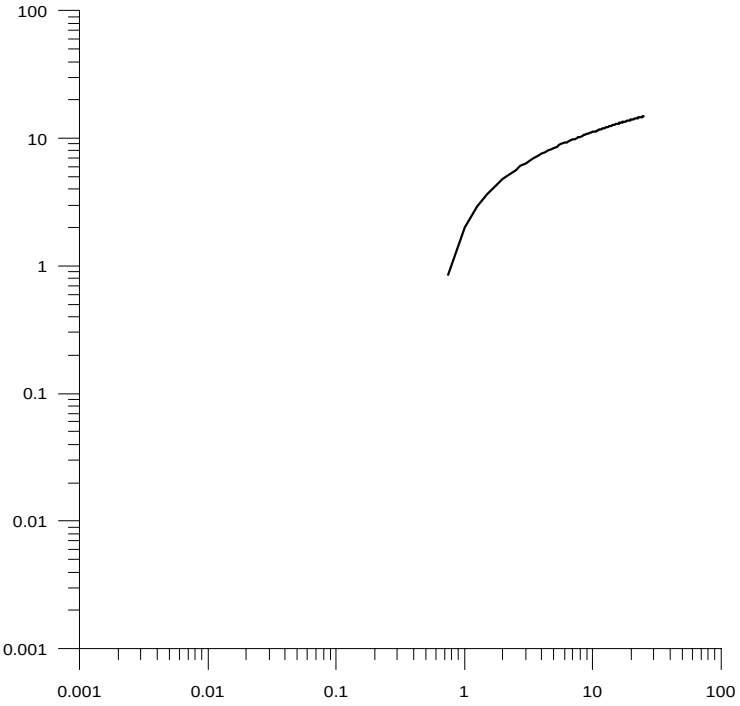
Example Log Equation Y = 4Ln(X) + 2

Plotted on Semi-Log Axes

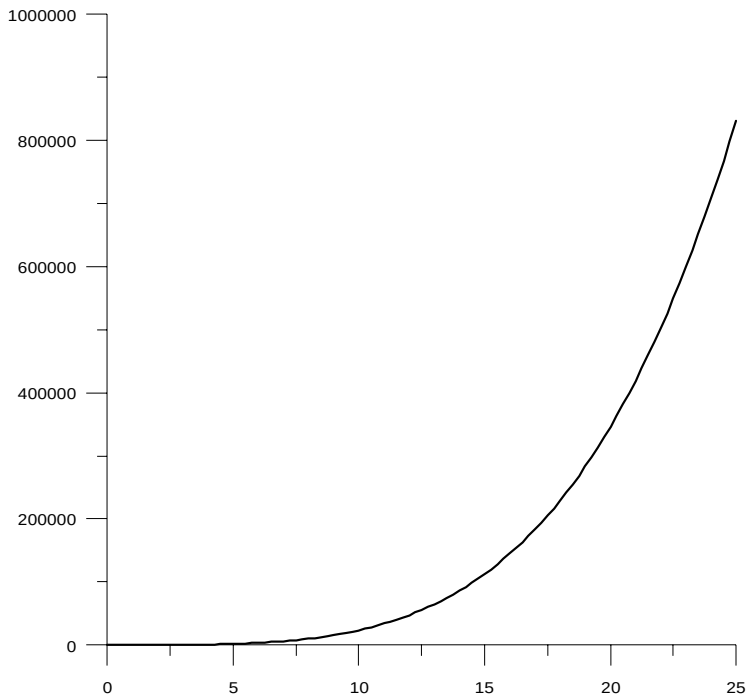


Example Log Equation Y = 4Ln(X) + 2

Plotted on Log-Log Axes

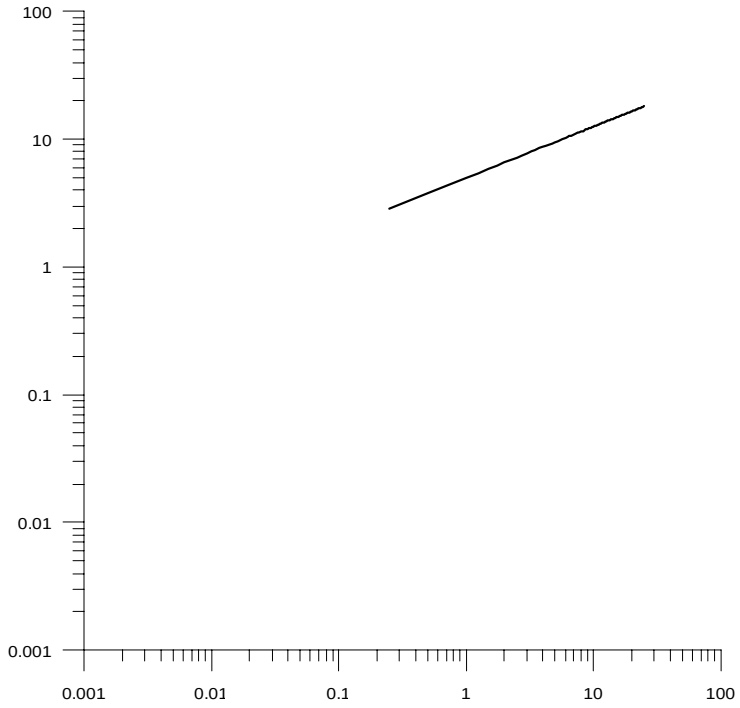


Example Polynomial Equation $Y = 2X^4 + 3X^3 + 5X^2 + 4X + 5$

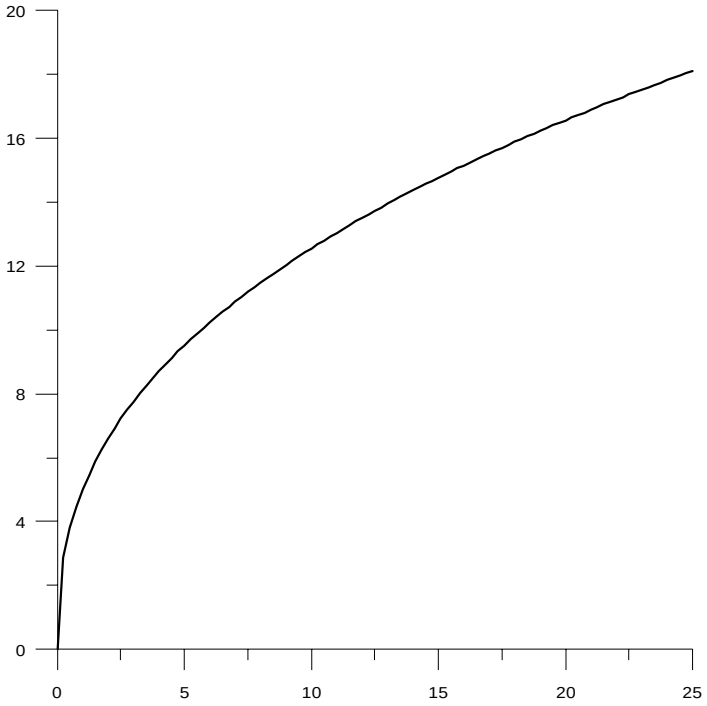


Example Power Equation $Y = 5X^{0.4}$

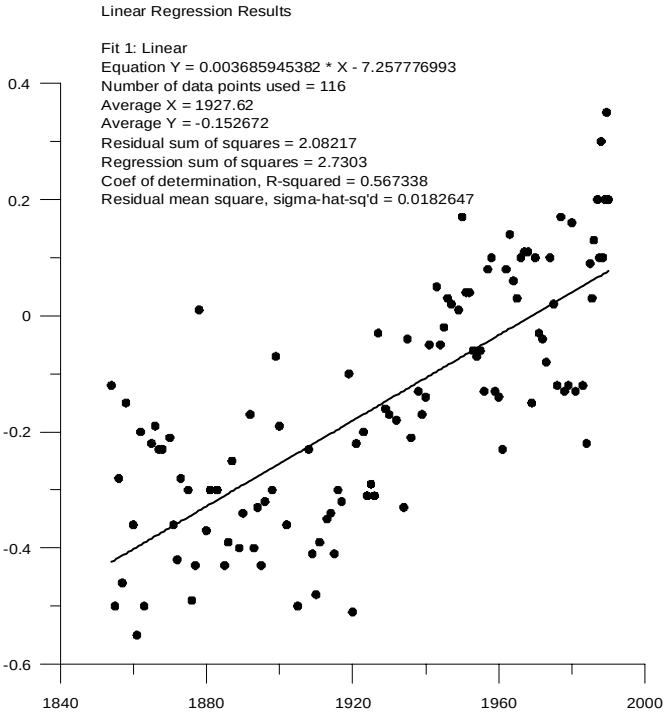
Plotted on Log-Log Axes

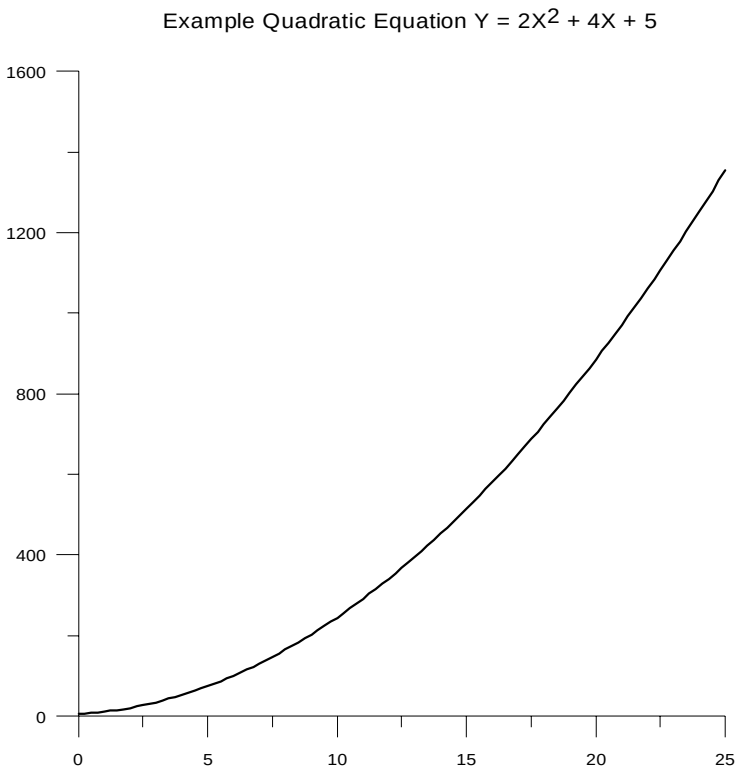


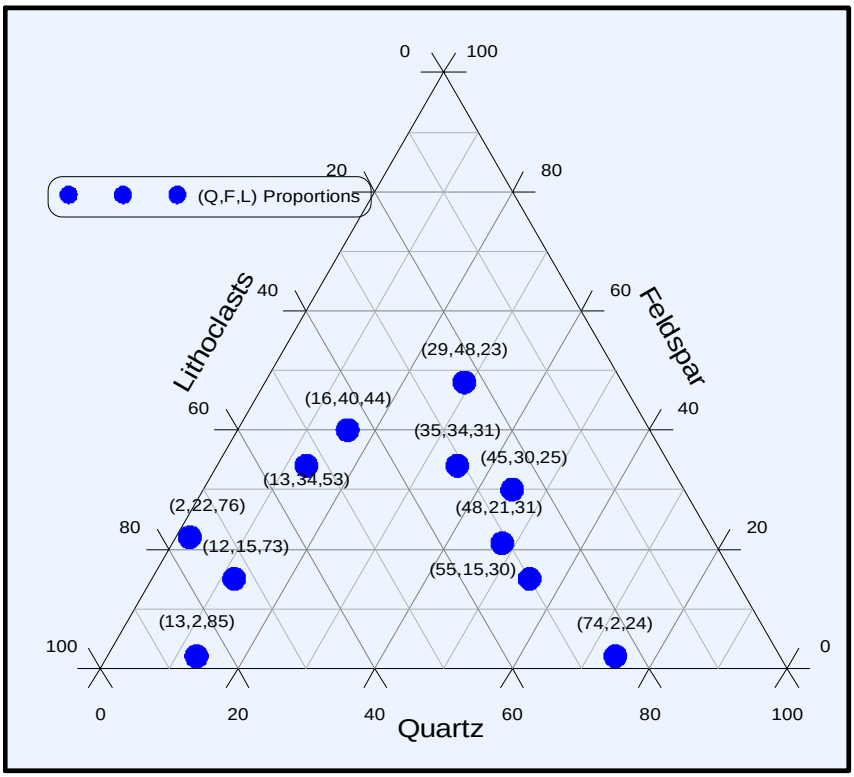
Example Power Equation $Y = 5X^{0.4}$

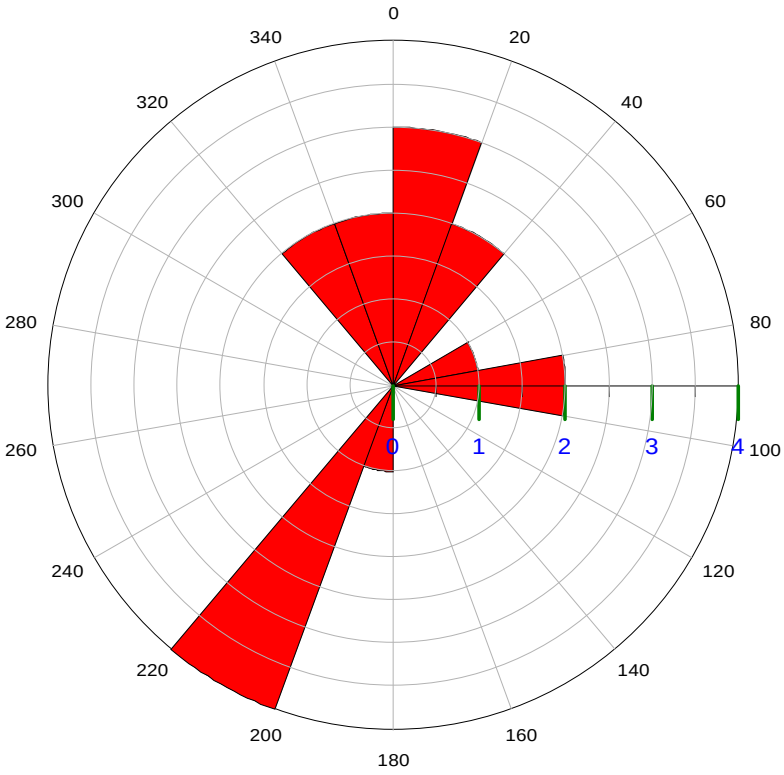


Example linear regression of scatter plot data

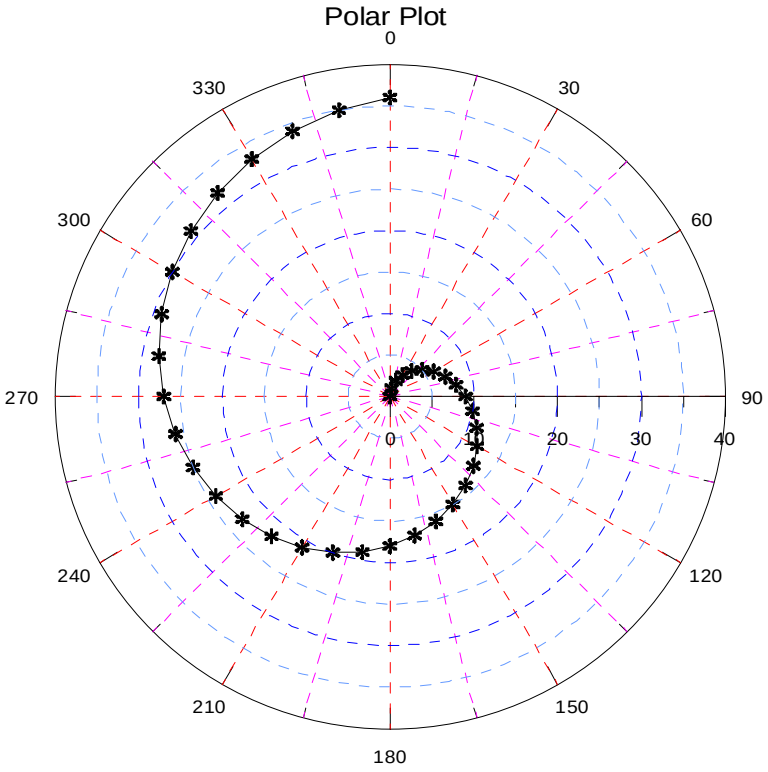



Example Quadratic Equation Y = 2X2 + 4X + 5
1600
1200
800
400
0
0
5
10
15
20
25


(Q,F,L) Proportions
Lithoclasts
Feldspar
Quartz
0
100
20
80
40
60
60
40
80
20
100
0
(29,48,23)
(16,40,44)
(35,34,31)
(45,30,25)
(13,34,53)
(48,21,31)
(2,22,76)
(12,15,73)
(55,15,30)
(13,2,85)
(74,2,24)



Example Rose Diagram



Example Polar Plot