Symbols and formulas

T – thickness (cm)
A – area (km^2)
V – volume (km^3)
$-k$ – slope (km^{-1})
M/A – mass per unit area (kg/m^2)

One slope

$$T = T_{0s} \exp(-k_s\, A^{1/2})$$

$$V = \frac{2\, T_{0s}}{k_s^{\,2}}$$

Two slopes

$$T = \begin{cases} T_o \exp(-k\, A^{1/2}) & 0 \le A \le A_{ip} \\ T_1 \exp(-k_1\, A^{1/2}) & A_{ip} \le A \le \infty \end{cases}$$

$$V = \frac{2\, T_o}{k^2}$$
$$+\, 2\, T_o \left[\frac{(k_1 A_{ip}^{1/2} + 1)}{k_1^2} - \frac{(k A_{ip}^{1/2} + 1)}{k^2} \right] \exp(-k\, A_{ip}^{1/2})$$

There are four parts to the tephra volume spread sheet:

1   Data are in columns A and B.
2   Calculations for $A^{1/2}$ and $\ln(T)$ are in columns C and D. (Note: Although $\ln(T)$ is calculated in the spread sheet, the plot uses T with a log scale.)
3   Calculations for volume using a single slope are in columns E, F, and G in rows 2 to 13. Note that the volume in G12 is the total volume, and the volume in G13 is the volume beyond the 1-cm isopach.
4   Calculations for volume using two slopes are in columns E, F, and G in rows 16 to 35. Note that the volume in G32 is the total volume, and the volumes in G33, G34, and G35 are subsets of that volume. The plot opens with the spread sheet to aid in selecting the data points for each of the straight lines.

Instructions for tephra volume spread sheet

1. Enter thicknesses and areas in columns A and B. Thicknesses should be entered from thickest to thinnest along with their associated areas.
2. Copy and paste formulas in columns C and D so that there are formulas for every row with thickness and area.
3. Choose range of points for line estimate for one slope in columns E and F row 3 by selecting both cells and entering new array range in LINEST formula. (Note that the array returns one value for the slope of the line and a second value for intercept. Accordingly, the range of cells in LINEST can only be changed if both cells in the array formula are chosen.) To close an array formula, one needs to use CLOVERLEAF (command) + RETURN on a MAC or CTRL+SHIFT+ENTER on a PC. Update the entry in cell G3 for the array range of row numbers.
4. Choose ranges of points for line estimates for two slopes in columns E and F rows 17 and 18 by selecting both cells in row 17 and entering new array ranges in LINEST formula. Do the same in row 18. Update the entry in cells G17 and G18 for the array range. Check your choices by looking at the chart; adjust if necessary. (Chart opens in a second window when you open the workbook.) In some cases, one data point ends up being used for the least-squares line estimate for both lines as in the example shown.

Instructions for tephra mass spread sheet

1. Need a deposit density in cell C1. If unknown, 1000 kg/m^3 is a representative value.
2. Enter mass per unit area and areas in columns A and C.
3. Copy and paste formulas in column B and columns C and D so that there are formulas for every row with mass per unit area and area. Thickness is then automatically calculated.
4. Choose range of points for line estimate for one slope in columns F and G row 5 by selecting both cells and entering new array range in LINEST formula. (Note that the array returns one value for the slope of the line and a second value for intercept. Accordingly, the range of cells in LINEST can only be changed if both cells in the array formula are chosen.) To close an array formula, one needs to use CLOVERLEAF (command) + RETURN on a MAC or CTRL+SHIFT+ENTER on a PC. Update the entry in cell H5 for the array range of row numbers.

5. Choose ranges of points for line estimates for two slopes in columns F and G rows 28 and 29 by selecting both cells in row 28 and entering new array ranges in LINEST formulas. Do the same in row 29. Update the entry in cells H28 and H29 for the array range. Check your choices by looking at the chart; adjust if necessary. (Chart opens in a second window when you open the workbook.) In some cases, one data point ends up being used for the least-squares line estimate for both lines.