

Estimating the volume of tephra deposits: a new simple strategy

Bonadonna, C. (1) & Costa, A. (2)

(1) Section of Earth and Environmental Sciences, University of Geneva, Geneva, Switzerland

(2) Environmental Systems Science Centre, University of Reading, Reading, UK and Istituto Nazionale di Geofisica e Vulcanologia - Napoli, Italy

[illegible]

Description

The *Weibull-method Excel spreadsheet* is designed to determine the volume and mass of tephra deposits based on the integration of the Weibull fit of thinning (or mass/area) data versus square root of area of isopach contours (from Bonadonna and Costa, 2012). The Excel Solver gives a good approximation of the Weibull parameters, but a more accurate statistical analysis can be obtained by using freely available statistical software, such as R and Grace. The thickness, mass/area and density data of the Ruapehu 1996 eruption are used here as an example (from Bonadonna and Houghton, 2005, Bulletin of Volcanology, 67:441-456).

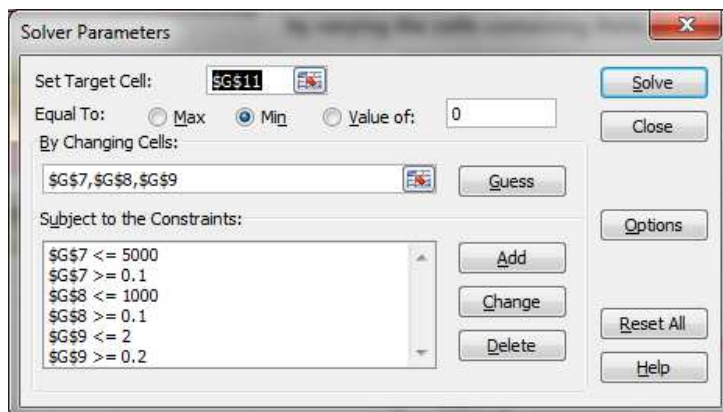
How to use the Weibull-method Excel spreadsheet

In order to use the *Weibull-method Excel spreadsheet* and calculate the volume (and mass) of a tephra deposit you need to:

- 1) determine the square root of area (A) of each isopach contour (Sqrt(A)) associated with a given thickness (T-Obs) or mass/area (mass/area-Obs);
- 2) copy and paste the values of square root of area (Sqrt(A) in km) and observed thickness (T-Obs in cm) into Column "A" and "B" respectively (starting from row 8) (in the *Weibull-thickness* worksheet). In case you have mass/area values please use *Weibull-mass-area* worksheet and paste your mass/area values (in kg/m²) into Column "B";
- 3) minimize the value of the Sum of Squared Relative Residuals (SSRR in cell G11) by running the Excel Solver (see below how to install the Solver add-in for Excel) in order to determine the Weibull parameters (*theta*, *lambda* and *n* in cells G7, G8 and G9) (SSRR is based on weighting factor $w_i = 1/T_i^2(\text{obs})$). If the Weibull parameters are not initialized (i.e., if no values are listed) the user should set all of them to 1. The appropriate range for each Weibull parameters is already set in "Subject to the Constraints" within the Solver window (see main text for the appropriate range of Weibull parameters to use);
- 4) the volume (or mass) of the tephra deposit is automatically calculated in cells F16 (in km³ or in kg respectively) once the SSRR (cell G11) is minimized and the Weibull parameters are determined (cells G7, G8 and G9). Volume is converted into mass (in the *Weibull-thickness* worksheet) and mass is converted into volume (in the *Weibull-mass-area* worksheet) based on the deposit density. So, make sure you have the correct value of deposit density in cell F20;
- 5) the calculated thicknesses (or mass/area) and corresponding residuals are automatically calculated in Column C and Column D respectively. The Weibull fit (red line in plots of Thickness (or mass/area) vs Square root of area) plots values of Sqrt(A) (Column "A") versus T-Calc or mass/area-Calc (Column "C").

How to install and use the Solver in Excel for Windows

- 1) Click the Office Button (top left "bubble") for Excel 2007 or "File" for Excel 2010.
- 3) Click Excel Options (bottom right).
- 4) Click Add-Ins.
- 5) Click Go (Bottom middle).
- 6) Check the box for Solver Add-In.
- 7) Click OK.
- 8) If prompted that Solver is not installed, click Yes to install. Insert the install media if prompted.
- 9) Verify that Solver is installed by clicking the Data tab and look for Solver in the Analysis box.
- 10) Then you need to choose the settings as shown in the "Solver-settings" below.



How to install and use the Solver in Excel for Macs

In Excel 2008 and 2011 for Macs the "Solver" function is located in the "Tools" menu. If you do not see it there, you may have to add it using the "Tools, Add-Ins" menu item or download it from www.solver.com/mac (or other providers). Then you need to choose the settings as shown in the "Solver-settings" below.

