Hazard assessment of volcanic ballistic projectiles – Supplementary Material 3: How to use the ballistic calculator

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Abstract

This guideline accompanies the article: Bernard, B. 2018. "Rapid hazard assessment of volcanic ballistic projectiles using long-exposure photographs: insights from the 2010 eruptions at Tungurahua volcano, Ecuador", *Volcanica*, 1(1), pp. 49–61. doi: https://doi.org/10.30909/vol.01.01.4961. If this guideline document or the spreadsheet tools provided are used, Bernard (2018) should be cited accordingly.

1 How to use the ballistic calculator

1. Scaling

a) Fill the Camera and Vent coordinates
b) Fill the photo metadata

2. Profiles

a) Using the theoretical limits of the picture in the Scaling sheet create a topographic profile on your DEM
b) Copy-paste the profile with coordinates in the "Topography orthogonal to the line of sight". (For this I used the profile tool in QGIS 2.18)
c) If you want info on a different profile (e.i. parallel to the line of sight) repeat 2.b) with different coordinates and paste in the columns L, M, N and O

3. Ballistic

a) Open the photograph in ImageJ
b) Scale the photograph: Analyze => Set Scale => Distance in pixels = 1 => Known distance = $Scaling$B$24 => Pixel aspect ratio = $Scaling$B$26 => Unit = m => OK
c) Set Measurement => Invert Y coordinates
d) Use the point tool to extract the coordinates of the vent (X = $Ballistic$B$2, Y = $Ballistic$C$2), if hidden by the vent subtract the rim-vent topographic difference.
e) Use the point tool to extract the coordinates of 5 points from the ballistic trajectory (X = $Ballistic$F$2:$Ballistic$F$6; Y = $Ballistic$G$2:$Ballistic$G$6)
f) Use the segment tool to measure the width of the trajectory => $Ballistic$B$18
g) Solve the derivative = 0 using the solver as following:

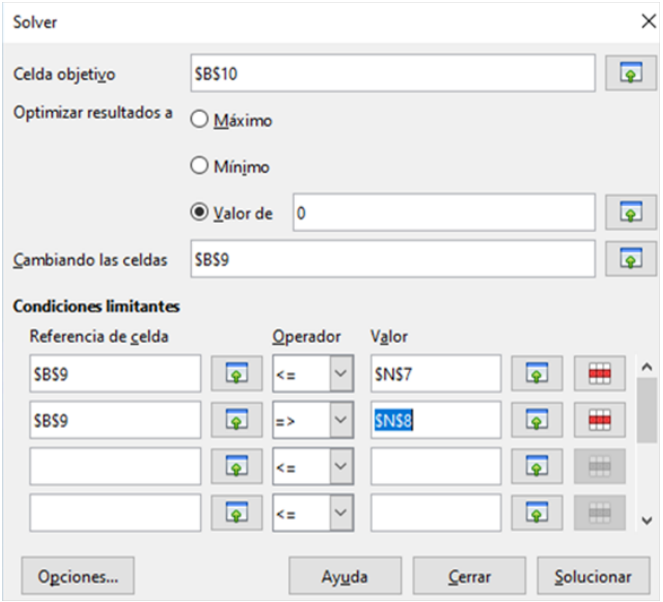

Figure 1

4. Impact

a) Use the point tool to extract the coordinates from the lowest impact block (X = $Impact$F$2, Y = $Impact$G$2) and lowest rolling block (X = $Impact$F$3, Y = $Impact$G$3)

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