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This document is a short step by step tutorial on how to use simply Teseo² 2.0.14 (S. Pintore and M. Quintiliani) to vectorize historical seismograms.

🔴Step #1: Open the TIF image of the seismogram with The Gimp (a warning "message image tiff" is displayed, but do not mind about it).

🔴Step #2: Check if an image rotation is necessary. Click on Tools/Measure.

Then, just left click and drag along a line of the seismogram : length and angle values will appear at the bottom of the image window.
Of course, you can always zoom in by pressing the + key.

🔴Step #3 (Optional, case of an inclined image): Teseo is able to rotate the seismic signal. Nevertheless, the easiest way to proceed is to work on a previously rotated image.
Click on Tools/Transformation/Rotation. In the rotation information window, you have to specify the rotation angle (of course, this value should be the opposite of the angular value measured in step #2). Then press the rotate button to perform the rotation.

🔴Step #4 (Optional): Save your rotated image (File/Save As...)

🔴Step #5 (Optional): Improve the image dynamic for a better vectorization.
The histogram is checked by clicking on Layer/Colors/Levels.
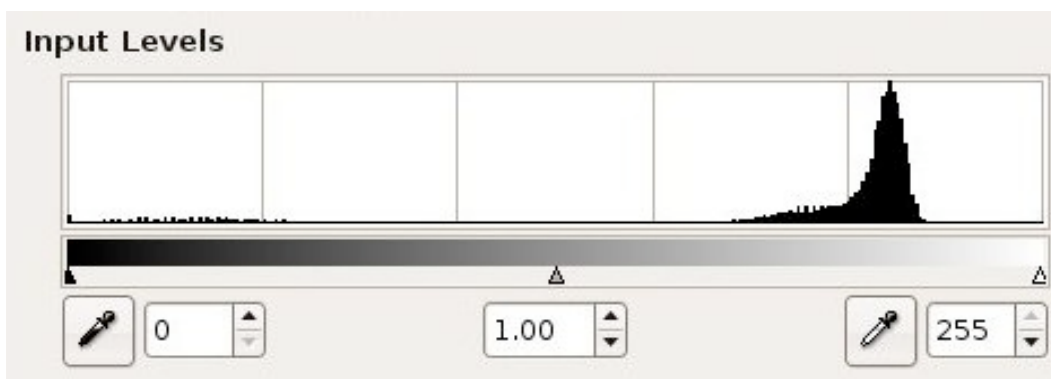
In "Input Levels", drag the endpoint arrows so that they line up with the beginning of actual shadow values of the image.

If the new image is too dark or too light, adjust the image's midtones by moving the middle arrow of the level dialog window.
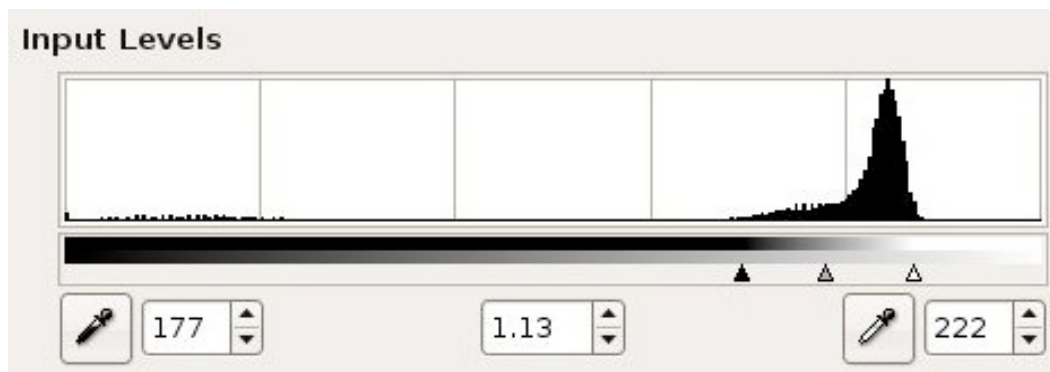
The icing on the cake in this image enhancing process consists in running an unsharp mask filter (Filters/Enhance/Unsharp Mask) with the following parameters
Radius: 1.0
Amount: 0.30
Threshold: 0

●Step #6: Save your image in xcf type (File/Save As...).

●Step #7: Click on Teseo.

●Step #8: Fill in the boxes of the "Record" tab of Teseo. Important fields concern the Station's name, latitude and longitude.
The paper speed is determined with the measure tool (see step #2). The unit of measure is set to mm (lower left corner of the image window).
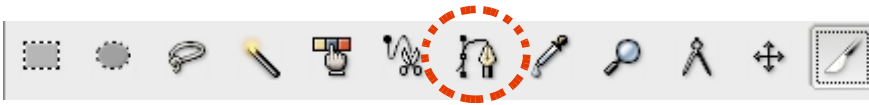

Then, the measure tool is used to determine the distance separating two minute marks.
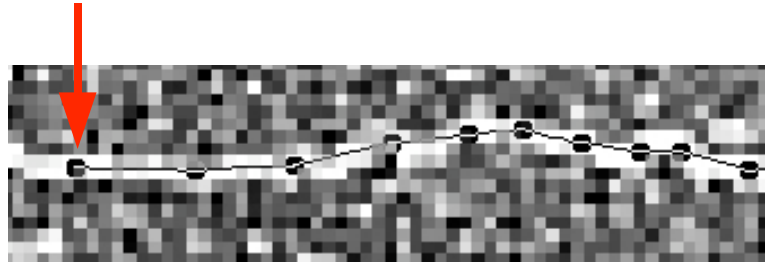
●Step #10: Save the information as parasites of the xcf image file (File/Parasites/Export in the Teseo window). Remember to save the image to apply changes.

Step #11: Vectorizing
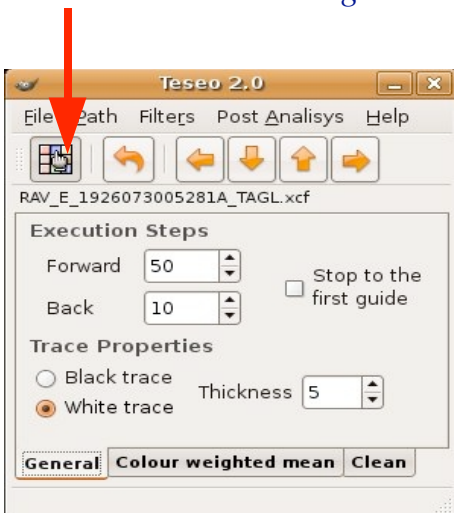
Click on the create and edit paths button

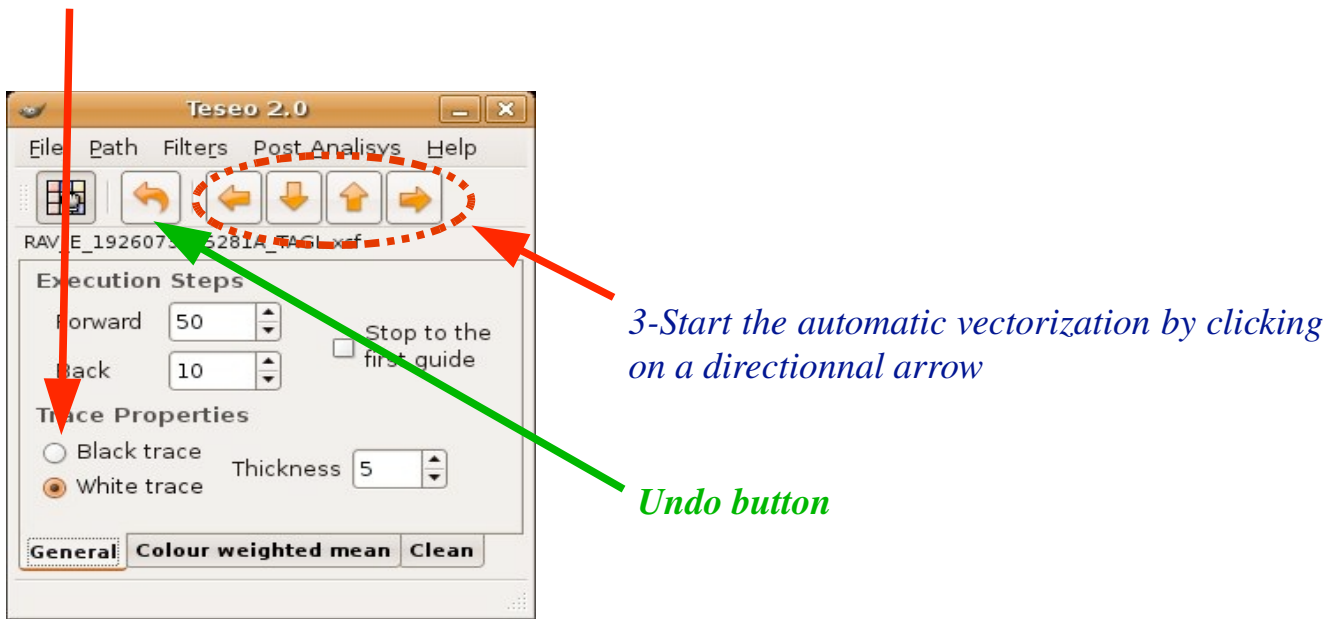Then, put the first point of the path on the signal

When the signal shows gentle variations, Teseo provides a powerful automatic vectorization procedure:

1-Click on the colour weighted mean button

*2-Select the suitable trace properties (black or white trace)*

3-Start the automatic vectorization by clicking on a directionnal arrow

Undo button

The automatic vectorization procedure can also deal with sudden amplitude variations in the signal. However, when signal's amplitude are strong, manual vectorization may be faster than the automatic procedure.

Manual vectorization can be performed:

point by point (then, you simply click on the trace to add each point to the path)
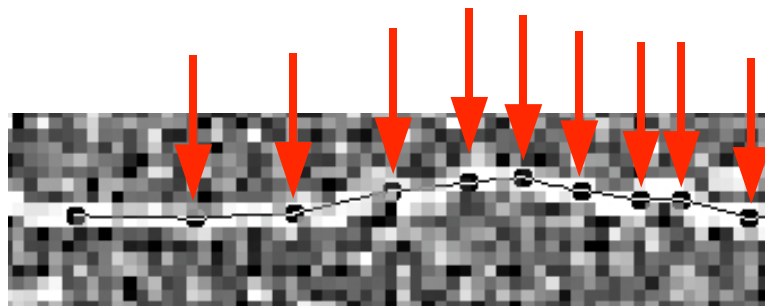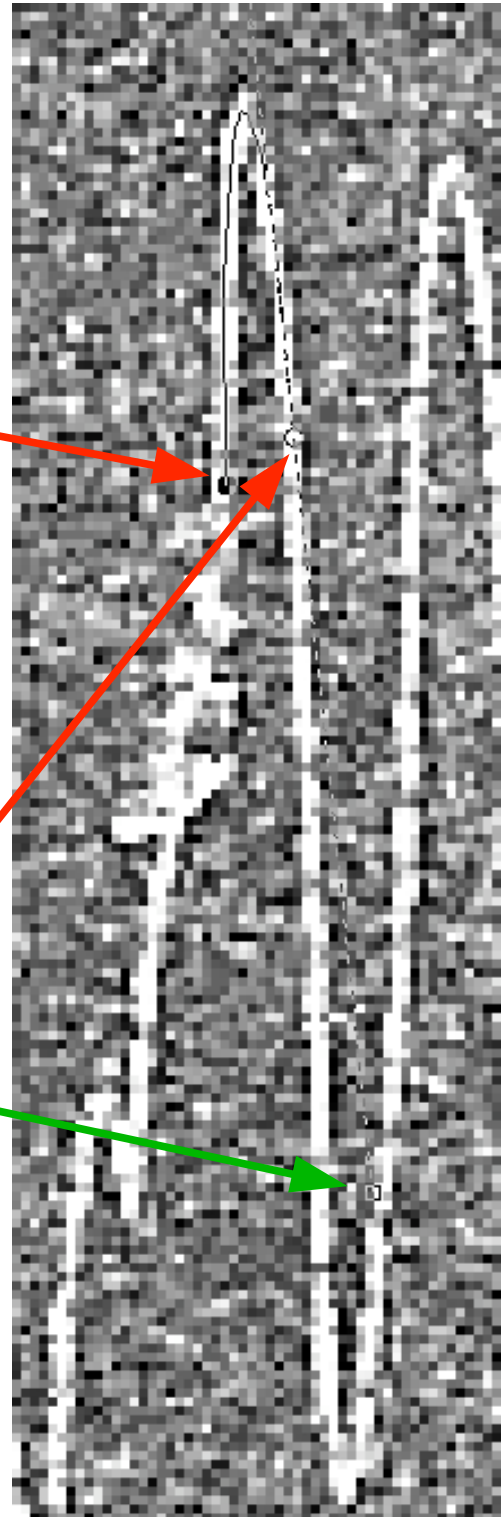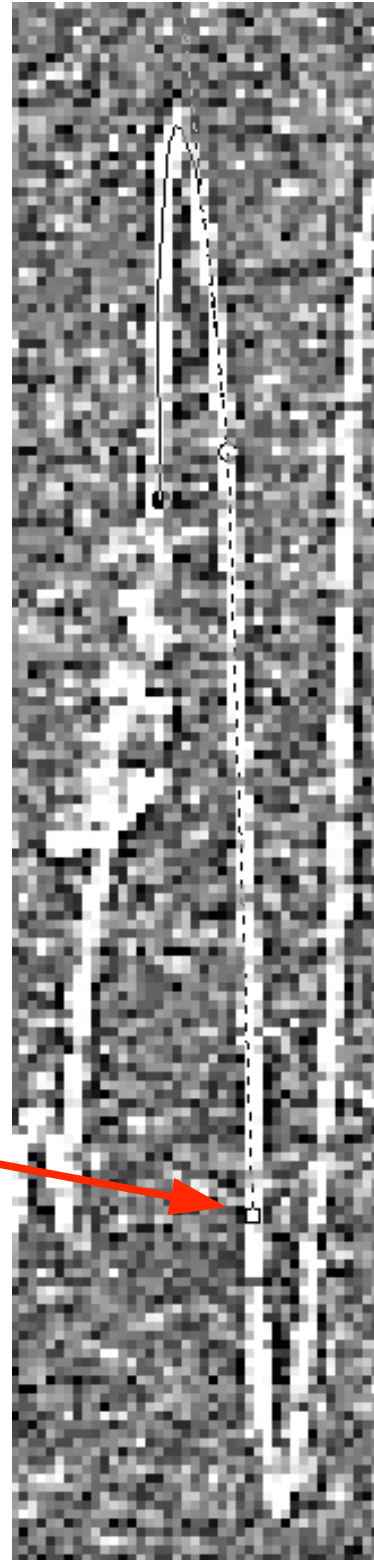
or through <u>Bézier curves</u>

Pierre Bézier (1910-1999)
automotive engineer

<u>Stage 1</u>-Click on the last point of the current path

<u>Stage 2</u>-Click on the next point holding down the left mouse button. Drag the handle until the Bézier curve fit the considered portion of the seismic trace (Release the mouse button when you have achieved the desired shape).

Stage 3-Click on the handle and drag it to the desired position on the seismic trace.
Release the mouse button to place the point.

Stage 4-Click on the seismic trace where you want to add the next point. Start again from stage #2

Of course, to vectorize a trace, you can use alternatively the 3 modes (automatic, point by point and Bézier curves).

🔸Step #12: Resampling.

Just click on Path/Resample in the Teseo window.

🔸Step #13(Optional): Solving the problem of broken paths.

Teseo works on unbroken paths. If the path is broken, the Teseo resampling tool shows the message 'Path ..... contains more than one component'. Therefore, you have to join up the path segments before resampling.

Identifying a broken path is quite easy by adding a white layer as a background image (you create a white filled layer with Layer/New layer. This new background layer can be activated in the Dialogues/Layers window).

Teseo is able to join up the path segments:

Stage 1-Right click on the path in the Dialogues/Paths windows and select 'export path'. Give a name to the exported path in the 'Export Path to SVG' window.

Stage 2-Edit the exported path file. In this file, look for lines like this:

1012.50,239.00 1025.00,245.50 1025.00,245.50M 1040.50,242.00 C 1040.50,242.00 1047.00,230.50 1047.00,230.50

and modify these lines like that:

1012.50,239.00 1025.00,245.50 1025.00,245.50 1040.50,242.00 1047.00,230.50 1047.00,230.50

Save the file.

Stage 3-Import the file (File/Path/Import/SVG Combine in the Teseo window)

Then, this new path can be resampled.

🔸Step #14: Save your image.

🔸Step #15: Post Analysis (Curvature correction).

Click on Post Analisys in the Teseo window.

The curvature correction window appears:

Enter the suitable values in the following fields:

-Paper velocity in mm/minute (see Step #8).

-Lateral velocity in mm/hour : use the measure tool (see Step #8) to determine the vertical distance between 2 horizontal lines (if the seismogram is a one line per hour recording) or between 4 horizontal lines (if the 24h seismogram shows 96 lines).

In our example, the paper velocity value is 15 mm/minute and the lateral velocity is 3.5 mm/hour

Then, press the '**Axial distance**' and the '**Arm shift**' buttons in the curvature correction window. An 'Arm shift' window appears. If everything is ok, this windows shows a concave and symmetric curve.

Close the 'Arm shift' window, check the **shift option** and press the '**Slopes**' button in the curvature correction window. The 'histogram window' appears. If everything is ok, the histogram value is zero when the slope is 90° degrees.
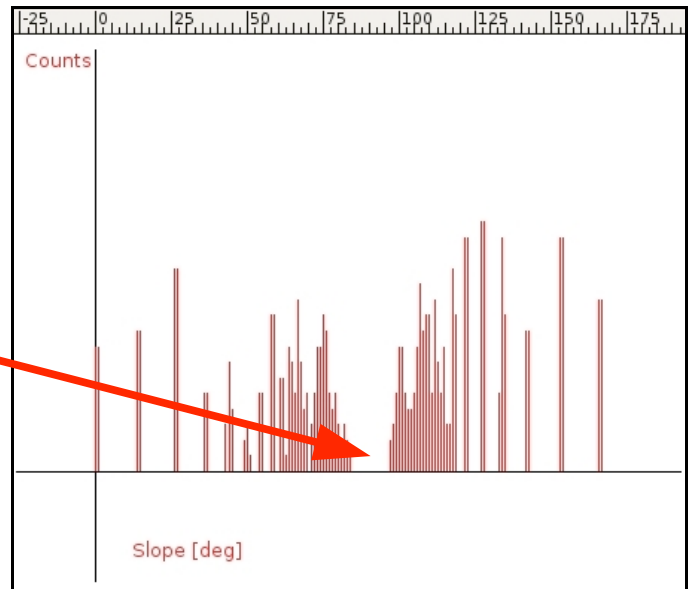
If this is not true, then close the 'histogram window', change the arm length and cylinder radius values and start again the procedure (press the 'Axial distance' and the 'Arm shift' buttons, press the 'Slopes' button,...).

When, the 'histogram' seems acceptable, press the '**Correct**' button in the curvature correction window. Then, a new path appears in the Dialogues/Paths window. The name of this new path ends with the quality of the correction. For instance, if the name ends with 'Q88', it means that the curvature correction shows a 88 % quality factor.
Of course, you can try various seismograph parameters in order to obtain several corrected signals. You are free to finally choose the best one.

🟠Step #16: Resampling the corrected signal.

Check 'Constant abscissa ascendent' in the Path tab of File/Session/Properties in the Teseo window.
Click on Path/Resample in the Teseo window.
A new path with the name ending with 'R1' appears in the Dialogue/Paths window.

🟠Step #17: Export to SAC format.

Click on File/Path/Export/SAC in the Teseo window.
A SAC format file is created in the specified folder.

🟠Step #18: That's the end of the tutorial!

Save your image.
File/Quit in the Teseo window
and Quit The Gimp.