***DETAILED INSTRUCTIONS FOR RUNNING* ‘BINARY_TRAVERSER’**

- These instructions are also available at http://www.geo.umass.edu/climate/lewis/analysis/
- Install ImageJ from http://rsb.info.nih.gov/ij/download.html. The macro requires version 1.41o or greater.
- Load the macro in ImageJ by clicking Plugins > Macros > Install (or CTRL+SHIFT+M). The macro is called 'binary_traverser_v4.txt'.
- Run the macro by clicking Plugins > Macro, then choose the current version of the macro at the bottom of the menu (Fig. B1).

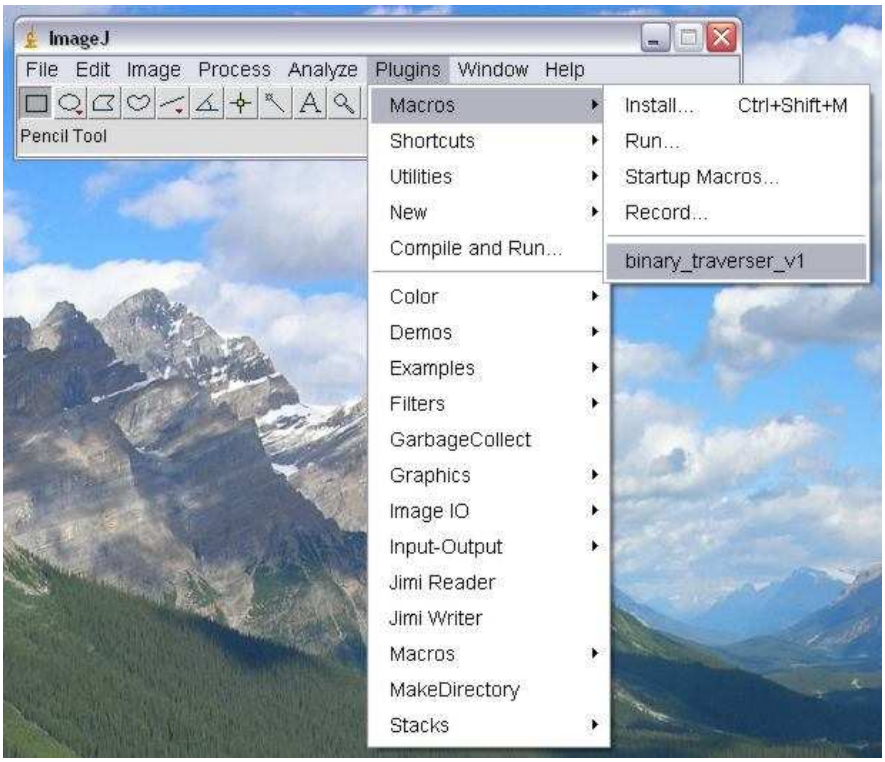

Figure B1. Loading the *binary_traverser* macro.

- You are presented with the following control panel (Fig. B2):

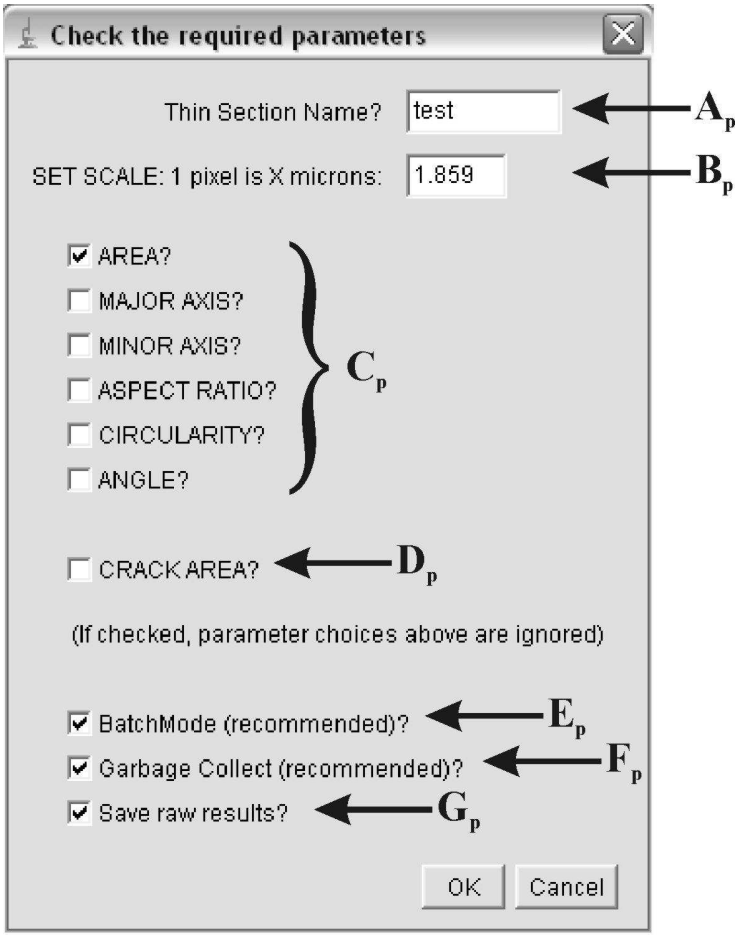

Figure B2. The parameter Control Panel

PARAMETER CONTROL PANEL:

All settings applied for each parameter: area, major axis, minor axis, aspect ratio, circularity and angle. This dialog is displayed once regardless of the number of parameters chosen.

A_p **– Thin Section Name:**

This is the name that will be used for naming output files and directories (see inputs/outputs file, parts 1-5). The macro quits if nothing is input into A_p.

B_p- **Set Scale:**

1 pixel represents this many microns. All output files use this scale.

C_p- Parameters

Possibilities include area, major axis, minor axis, aspect ratio, circularity, and angle.

Area: the particle area; output is in microns-squared;

Major axis: the primary axis of the best fitting ellipse, output is in microns.

Minor axis: the secondary axis of the best fitting ellipse, output is in microns.

Aspect ratio: 1-(MinorAxis/MajorAxis). Aspect ratio is 0 for a perfect circle (or square), and approaches one with increasing particle elongation.

Circularity: 4pi(area/perimeter^2). "A value of 1.0 indicates a perfect circle. As the value approaches 0.0, it indicates an increasingly elongated polygon." (from http://rsb.info.nih.gov/ij/docs/menus/analyze.html).

Angle: "the angle between the primary axis and a line parallel to the x-axis of the image." (from http://rsb.info.nih.gov/ij/docs/menus/analyze.html).

D_p- **Crack Area?**

Checking this box allows the area of disturbed areas on binary images to be quantified. Disturbed areas are typically cracks, but other disturbances can be quantified as well. The macro will ask for a 'binary crack image'. One way to construct such an image is to trace disturbances in black on a new layer in an image editing software package, then save only the traced image as a new file. Another way is to use the '*threshold_pause*' macro and image editing software. If D_p is checked, then measurements chosen in C_p are ignored. The macro will also ask for an input file containing ROI coordinates. The input file should be the same structure as described in the inputs/outputs file, part 1. Only one output file is produced when the macro runs in this mode, and the file structure is described in the inputs/outputs file, part 5.

E_p**- Batch Mode?**

When this is chosen, the binary particle image is not shown on screen. If 'raw results (G_p) was chosen, then measurements are also not shown on the screen. The macro will complete in substantially less time when this is checked, particularly if G_p was chosen, and ImageJ will use substantially less memory.

F_p**- Garbage collect?**

If checked, this reduced the accumulation of leaked memory. This function is called at several strategic points in the macro. (Calls "java.lang.System.gc")

G_p **– Save Raw Results?**

Saves the 'raw' measurement data for each ROI in individual text files (see inputs/outputs file, part 4). By saving the raw results, the user can double check that the statistics are being calculated correctly, or additional statistics can be calculated. However, choosing this option makes a 'Log' window open on screen for each ROI while the particles are being measured. This increases the amount of time the macro needs to run.

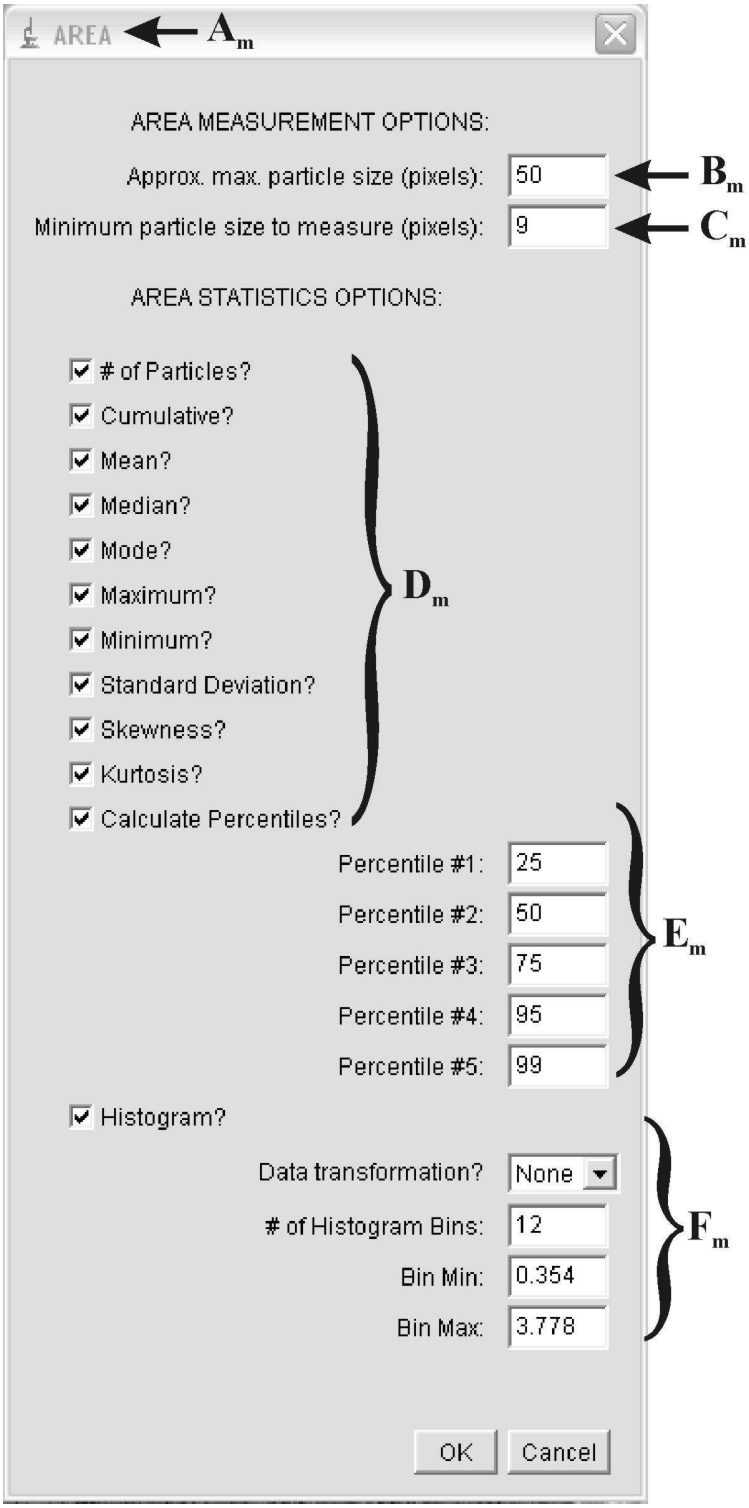

Figure B3. The measurement Control Panel

MEASUREMENT CONTROL PANEL:

This dialog box will appear once for each chosen parameter (area, major and minor axes, aspect ratio, circularity, or angle).

$A_{m=}$ **Measurement**

Area, major and minor axes, aspect ratio, circularity, or angle.

B_m**= Approx. Max Particle Size (pixels):**

Particle counting criteria are described in Chapter 5 (Fig. 5.3). Testing these boundary criteria for all the particles in a thin section would be very time consuming. Therefore, to save time, the macro builds a 'fat' ROI around the user-defined ROI, and only implements the boundary criteria within the fat ROI. The macro triples B_m, so, the user does not have to accurately estimate the largest particle; tripling B_m ensures that unless the user was very wrong, the big box will encompass all necessary particles (Fig. B4).

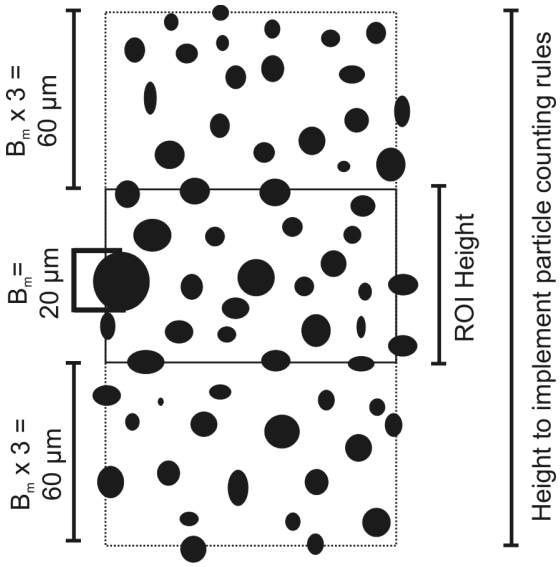

Figure B4. An illustration of how particle counting rules are implemented over a 'fat' ROI. The ROI height is increased by (B_m x3) x 2.

The advantage of using these boundary criteria is that ROI area can be very small in relation to particle area.

C_m= **Minimum particle size to measure (pixels):**

Enter an appropriate minimum number of pixels for the parameter being measured. Appropriate C_m varies for different parameters (*cf.* Francus and Pirard, 2004), and as such, it can be individually set for each parameter in each measurement box.

D_m= **Statistics Options:**

The checked statistics will be calculated. If unchecked, the appropriate column in CORENAME_PARAMETER_STATISTICS.txt (see inputs/outputs file, part 2) will contain 'NA'. Unchecking a statistic will only marginally speed up processing, so as a default, all statistics are checked.

E_m= **Calculate Percentiles?**

Input five desired percentiles here. For a description of the percentiles output, see inputs/outputs file, part 2.

F_m = **Histogram?**

The user defines the upper and lower histogram bin boundaries (in pixels), the number of bins, whether the bin boundaries scale linearly or on a log scale.

Data transformation: Determines how data are manipulated before being placed in histogram bins. If 'None' is chosen, the data are not manipulated at all. If $\log_{10}$ is chosen, each measurement is log transformed before being placed in a bin. For 'phi', measurements are transformed to $-\log_2$ (Boggs, 1987). Phi or $\log_{10}$ transformation is recommended when dealing with negatively skewed distributions. Bin boundaries (see below) apply to the transformed data.

# of Histogram Bins: the number of bins between 'bin min' and 'bin max'.

Bin Min: The lowermost threshold to begin counting (explained in more detail in the histogram section of the inputs/outputs file, Part 2). If data transformation was chosen, then 'Bin Min' must reflect this.

Bin Max: The lowermost threshold to begin counting (explained in more detail in the histogram section of inputs/outputs file, Part 2). If data transformation was chosen, then 'Bin Max' must reflect this**.**

CHOOSING FILE LOCATIONS:

After clicking 'OK' on the Measurement Control Panel, the user is asked where output files should be placed. This includes:

- a folder for raw data (see inputs/outputs file, part 4) if G_p was checked
- a file describing the upper and lower bin limits if the checkbox in F_m was selected (see inputs/outputs file, part 2).
- statistics files for each chosen parameter (see inputs/outputs file, part 2)

Next, the user is asked for the following input files:

1. A binary particle image.

   Tips:

   - All pixels should be black (grayscale value=255 or white (grayscale value=0). The image must be binary; there should be no gray pixels (grayscale values between 0 and 255).
   - The image must have no scale set (Fig. B5). If there is a scale set, go to the ImageJ menu Analyze > Set Scale. Choose 'Reset'. When done, 'Save As' the image, close then and reopen it.

(A)

(B)

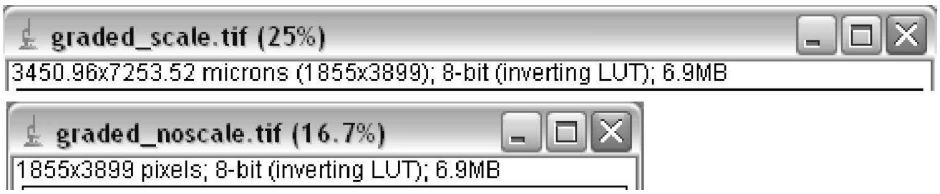

Figure B5. (A) The title bar for an image in ImageJ with scale information. (B) The title bar for an image in ImageJ without scale information.

2. A coordinate file containing the coordinates of each ROI (see inputs/outputs file, part 1).

Finally, the macro will run. A Log window indicating the length of time the macro took to run will pop up when finished.