# Snuffler: Geophysics Software from Sussex University: Introduction and Help File

After coming across a cheap resistivity meter provided by the 'Council for Independent Archaeology' and 'TR Systems Ltd' I decided to try writing some Windows software to go with it. The software is not restricted to this particular meter however, and can be used for any resistivity or magnetometry dataset in electronic or paper format, and most importantly it is **FREE**.

The Main Screen
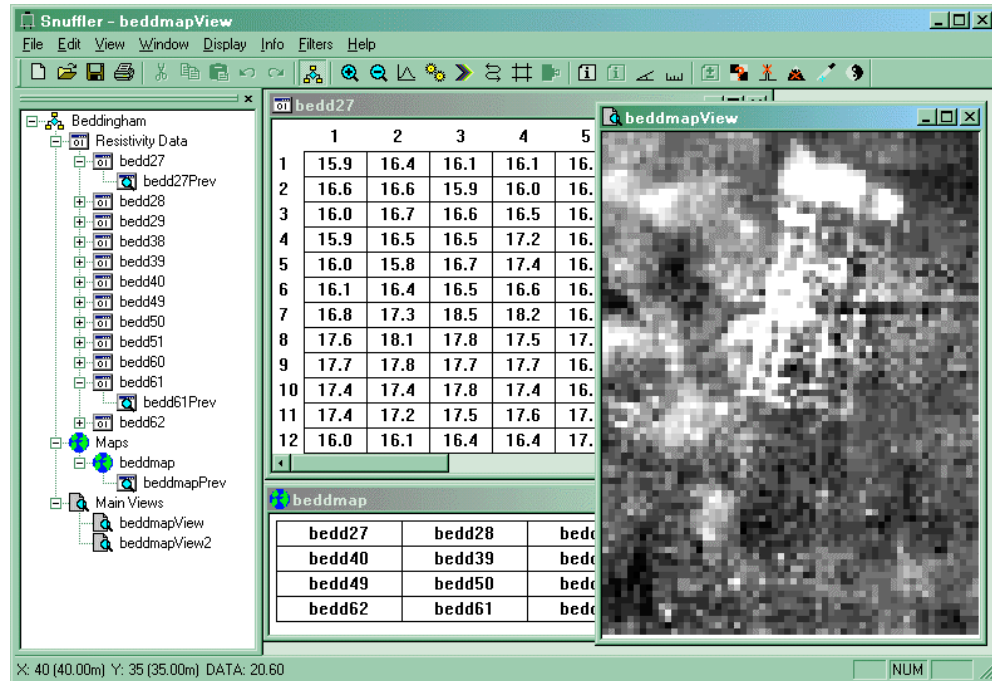
Display Settings
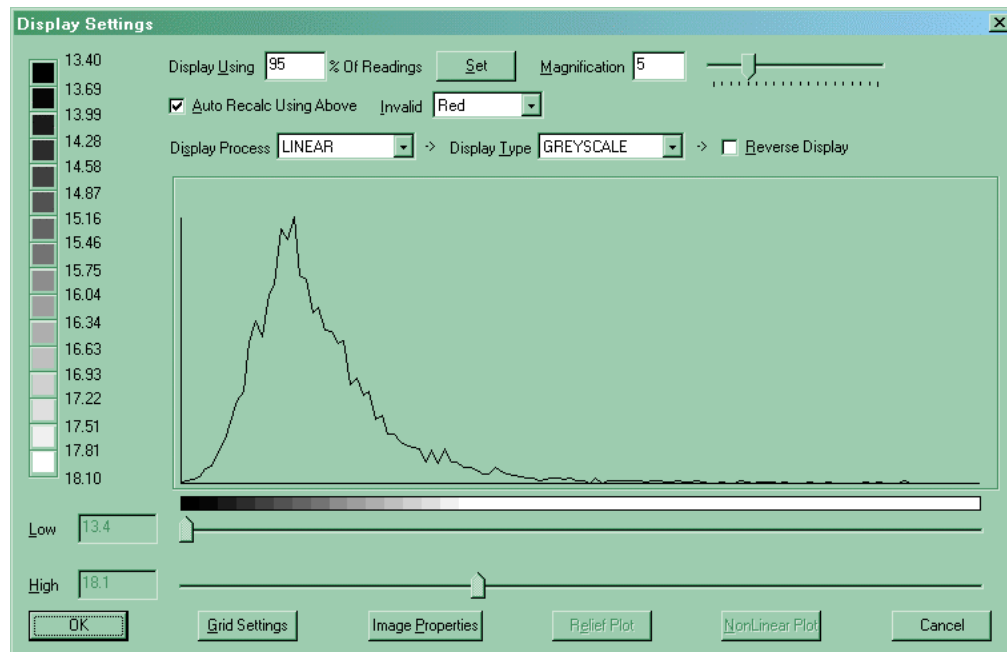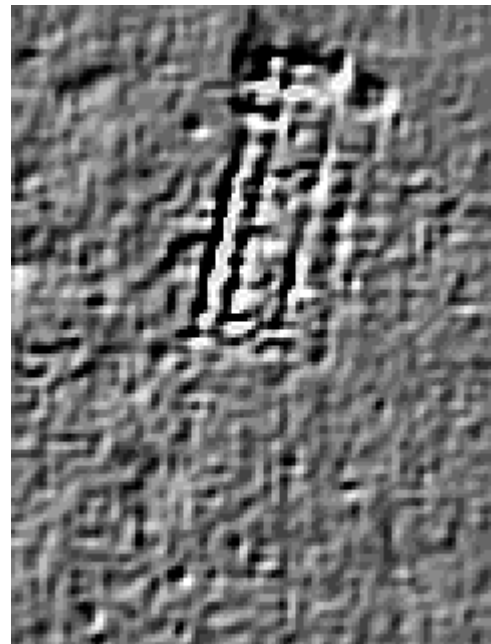
Grey-Scale Image

Dot Density Image

Grey-Scale Image After Filtering

Relief Plot Image

The above PNG image files were produced by Snuffler with no additional modification.

Features:

- Enter data from keyboard or text files
- Import from RM15 & TR Systems resistivity meters, FM18/36 magnetometers, Arc-Geo logger, Bartington GRAD601 and EPE Resistivity Meter
- Export data to text files
- Preview data sets
- Image view in Grey Scale, Dot Density and Relief
- Display range clipping
- Data and selection statistics
- Print images with image info
- Export images to PNG (Portable Network Graphic) image files and VRML
- Metadata Storage
- Continuously sampled data processing
- Filters, including:
  - Despike
  - Direct modification of data in a selection
  - Interpolation
  - Geological Flattening
  - Sharpen
  - Edge correction
  - Destripe
  - Clip Data
  - Destagger

Snuffler Help file

1. Main Help Page

Welcome to **Snuffler**, a Freeware geophysics program designed for Archaeological Resistivity and Magnetometry. Actually this is not Freeware, it is Hugware. If after 30 days of use, you decide to continue using the software, you must find someone you love and give them a big hug. If you are not feeling in a mood for hugs, but think the author deserves some reward for writing this, then there is a donate button on the website.

The version you are running is Beta software (v0.90), it is undergoing testing prior to a full release and is in no way polished, bug-free or stable. As this software is still in development, I would very much appreciate if you let me know of any bugs you come across or features you would like to see.

In addition to problems with the software, I would also like to know about problems with this help file. As I have written this software, everything about it seems obvious to me, yet it may seem obtuse to everyone else. So please let me know if I have not explained something properly, or indeed if I have not explained it at all.

1.1 Getting Started

If you are reading this, you have already successfully installed the software. Snuffler will create itself a directory in your documents folder, but if you want to change this, you can do so in the Options Menu.

Once you have set the software up to your satisfaction, please read the File Overview section. If you don't know much about the basic processes involved in geophysics, check out the Resistivity Refresher. Once you understand how the program works, there is some Sample Data for you to play around with.

1.2 Resistivity Refresher

This section is for those who don't know the basics of Resistivity. Resistivity is a type of Archaeological Prospecting that works by measuring the 'Resistivity' of the ground in a grid of points across a site.

The process itself works like this. A section of ground to be 'measured' has a set of probes pushed into the surface, which pass an electrical current through the ground. As electricity conducts well through water, the amount of water in the soil will affect how much resistance there is to the current being passed through it. If there is little moisture, the electricity meets greater resistance in passing through the soil, which is said to have a high resistance value. If there is a lot of moisture in the ground, the current passes through it easily and is said to have low resistance. A numerical value representing exactly how much resistance is met is calculated by the resistivity meter. Given a set of such measurements in a regular pattern across a site, a picture can be created, which is where this software comes in.

What does this have to do with archaeology?

The amount of moisture in the soil can be affected by a range of underground archaeological features. For example, if there is a pit cut into the bedrock, this pit may have a greater capacity for storing moisture than the surrounding rock, so the topsoil above will dry out slower as there is a supply of stored moisture, which will give a low resistance reading. Alternatively, if you have the foundations of a brick wall underneath the topsoil, there is less room for stored moisture and the topsoil dries out quicker, giving a high resistance reading. Many other factors can affect this, such as

soil type and density, but without getting into the nitty gritty, just remember that it is the differences in resistance across a site that we are interested in, as these show up as recognisable patterns on the images produced by this software.

1.3   Sample Data Set

Included with the other files in this software is a sample data set of a Roman Villa in XYZ format. The filename is testdata.txt and can be found in the same directory that the software was installed. Do take the time to look at the file yourself to see what the raw data looks like. To use this yourself, start by creating a blank Project by selecting 'New Project' from the file menu and choosing a new name for the project.

Now you will need to import the file into Snuffler. You can do this by going to the file menu and selecting **Easy XYZ Import Into New File**. You will be prompted for a filename, at which point, you will need to find the directory on your computer where the software is installed, and locate the testdata.txt file. The software will look at the file and bring up the screen with some options, which you can ignore for the moment. Just Press **OK** and the file will be read. You now have a file full of data. These files are described in greater detail in the Geophysics Data Files section of this help file.

Now comes the part where we create an image from the data file. For this you will need to use the Project Window on the left hand side of your display. This lists all of the files currently in the project you are working on in what is known as a tree display. This tree has branches that can be expanded and collapsed. To the left of each icon in this display is either a + or - sign in a small box. Clicking on this will expand or collapse that branch of the tree. So if you click now on that box, you should now see another branch called 'Geophysics Data' which contains all of your data files. Clicking on the box next to this branch should show you the data file you have created. Right clicking on the icons (not the boxes) in the Project Window will bring up a submenu. You now want to do this with your data file. Right-clicking on the icon will bring up a sub-menu, from which you want to select 'Spawn Main View'. This will add another branch to the tree and create a basic image for you to see. These images are described in the View Files section of this documentation.

2.   User Interface

2.1   Menus

The **Menus** at the top of the Snuffler window will change according to which type of file you have open at the time, giving access to functions appropriate to that file. Nevertheless, there are menu options that are available with whatever type of file you are editing. For other menu options, see the help pages specific to the different file types.

File Menu

Some menu options are available even when you don't have a project open:

- **New Project**   Creates a new, empty, project
- **Open Project**   Opens an existing project
- **Print Setup**   Sets how your images will appear when Printing
- **Options**   Sets options controlling the behaviour of the software

Other menu options in the file menu are only available with a project open:
- **Save Project**   Save current project. This only affects the Project Options, as all other files are saved separately
- **Close Project**   Close the currently open project
- **New**   Create new Geophysics Data, Preview, View, Map or Import file

- ■ **Open**   Open an existing file within the project
- ■ **Project Options** Sets the Options for the current project only (these are copied initially from the main options when the project is created).
- ■ **Project Metadata** Store various pieces of information about the current project
- ■ **Easy XYZ Import** Allows you to read in an XYZ file

View Menu

Allows you to hide or show the Toolbar, the Status Bar (at the bottom of the screen, and the Project Bar. The help menu allows you to see this file!

Toolbar

The **Toolbar** at the top of the Snuffler window is a useful shortcut for performing a lot of tasks:
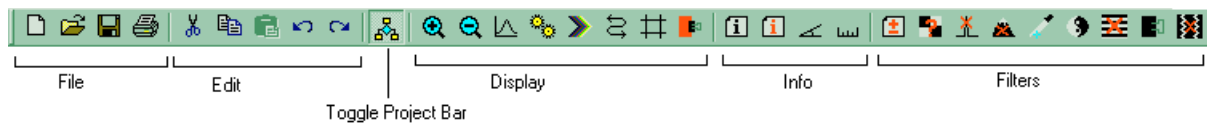
- ■ The three icons in the **File** section represent **New**, **Open**, **Save** and **Print**, which act the same as the functions on the File Menu.
- ■ The five icons in the **Edit** section represent **Cut**, **Copy**, **Paste**, **Undo** and **Redo** from the Edit Menu. The first three are detailed in the page on View Files. Undo is used to put back a change that you have made to an image if you don't like it. Redo undoes the Undo.
- ■ The **Toggle Project Bar** button turns the Project Bar on and off, in the same way as the **Project Bar** option in the View Menu.
- ■ The two magnify icons can be used to increase and decrease magnification of the displayed image without going into the Display Settings. These two icons are only available in the Preview and View windows.
- ■ In the **Display** section of the toolbar, there are eight buttons, which are only available in the Preview and View windows. The first two increase and decrease magnification, the next button brings up the main Display Settings window. The next two change the display process and display type respectively. The sixth, **Reverse Display**, will reverse the palette if you are using a linear process, but will move the horizontal angle on 45 degrees if you are using the Relief plot process. The seventh will activate or deactivate the **Display Grid** around the grid squares of your image. Finally, the last button will set the display clipping bounds to the high and low values within the area you have selected.
- ■ The **Info** section of the toolbar contains four buttons which perform exactly the same tasks as the options within the info menu.
- ■ The **Filters** section of the toolbar contains nine buttons, which are only available when working in a View. They are (in order) the filters, **Modify Selection**, **Interpolate**, **Remove Spikes**, **Remove Geology**, **Sharpen**, **Edge Correction**, **Destripe**, **Clip Data** and **Destagger**.

As well as using the Toolbar, many functions can be accessed using Keyboard Shortcuts.

Keyboard Shortcuts

As well as the menus and the Toolbar, many of the functions in Snuffler can be controlled by the keyboard. Following is a list of keys used in Snuffler.

- ■ **Ctrl+N**   New Document
- ■ **Ctrl+O**   Open Document
- ■ **Ctrl+P**   Print Document
- ■ **Ctrl+Alt+P**   Print Preview
- ■ **Ctrl+S**   Save Document
- ■ **Alt+Backspace**   Undo
- ■ **Ctrl+Backspace**   Redo

- **F1**　　　　　　Help
- **F6**　　　　　　Next Document
- **Alt+P**　　　　 Toggle Project Window
- **Ctrl+Shift+P**　Set the focus to the project bar

The following keys are used in Main Views and Previews only :

- **Alt+C**　　　　　Set Clip To Selection
- **Alt+D**　　　　　Display Settings
- **Alt+G**　　　　　Toggle Grid
- **Alt+R**　　　　　Reverse Display
- **Alt+T**　　　　　Next Display Type
- **Alt+N**　　　　　Next Process Type
- **Ctrl+A**　　　　 Select All
- **Ctrl+C**　　　　 Copy
- **Ctrl+X**　　　　 Cut
- **Ctrl+V**　　　　 Paste
- **Ctrl+Shift+V**　Transparent Paste
- **Ctrl+Alt+V**　　Paste As New View
- **Ctrl+R**　　　　 Rotate Clockwise
- **Shift**　　　　　Holding this down whilst selecting or pasting will align to grid square edges
- **Ctrl**　　　　　 Holding this down whilst selecting will align to lines within grid squares

2.2　Projects

Projects And File Overview

To use Snuffler, you will need to know about the different types of files it uses.

- **PROJECT FILES:** The first thing you will need to do is create a project. A 'project' encompasses all of the data you will need for a site you are surveying. The details of the project and the various data files within it are displayed in the Project Window on the left side of your screen. To create a project, select 'New Project' from the file menu. You will be prompted to enter a name for the project. When this is done, Snuffler will create the project and allow you to create the other types of files listed below, which form part of the project.
- **IMPORT DATA FILES:** An Import Data File is the file containing the raw data imported from your resistivity meter, which is just a string of numbers. The next stage in the import process is to export to individual data files, or grids, from which an image can be compiled.
- **Geophysics DATA FILES:** A Geophysics Data File contains readings for a single grid square. The default size for these squares is 20x20, but can be changed to whatever size you want. The readings can be keyed into the file manually, read in from a text file or imported directly from whatever geophysics equipment you are using via an import file.
- **MAP FILES**: A Map File types holds information on the location of the above data files in relation to eachother. Composite images can then be generated from this map.
- **PREVIEW FILES:** A Preview is a graphical display of a set of data. Either of an individual grid square or of a composite image generated from a map. As the preview is linked directly to the data, it changes as the data changes. Also, this means that no filters or other changes can be made to the preview, as this would affect the original data it is generated from. Preview files are not necessary for the process of creating an image, they are designed so you can see the image changing as you type in data from the keyboard, to make the process less boring.
- **VIEW FILES:** A View File is similar to a preview file, except once it has been created, it is independent from the data it was created from. This means that changes to the original

data will not affect it, and changes, such as filtering, can be applied to the view itself. This is the main file used for viewing the results created from your data.

As well as files used directly by Snuffler, there are other file formats used independently by Snuffler, that it can import or export.

■ **PNG FILES:** PNG (Portable Network Graphics) is the graphics file format that Snuffler exports. It is used as opposed to other file formats because it is unencumbered by patents, is lossless, and is well supported. For more information on this file format see the official website at http://www.libpng.org/pub/png/

■ **XYZ FILES:** XYZ files are text files formatted in a certain way that contain data with a location. Snuffler can both import and export XYZ files. The name of the file format refers to the position of the data (X & Y), and the data itself (Z), and this is how that data is arranged on each line of the file: eg, if the X position is 20 metres, Y position 25.5 metres and the data is 45.67, the XYZ file reads "20.0 25.5 45.67".

■ **RES2DINV FILES:** RES2DINV is a software package that produces resistance tomography images, that is using resistance to take a vertical slice through the ground. The process involved in doing this, called Inversion, is quite complex, so Snuffler simply provides an export in the appropriate format for RES2DINV to read. This export was originally designed with the TR Systems tomography setup in mind, but should work with data from any meter that can produce the data in the same way. The data is exported on a per grid basis, from the data files, and those files must be in a certain order to export correctly. The size of the grid should be the number of probes used by the number of lines. Dummy readings are always put in at the end of lines, never at the beginning. The first line should have three dummy readings at the end, with each subsequent line having three less again. Contrary to the instructions given in the TR Systems documentation, you do not need to go back to the beginning of the line each time. You can zig-zag if you wish, you just need to tell Snuffler that you have done so when creating the grid from the import file. Thus if you do not zig-zag, all the dummy readings will be at one end of the grid, but if you do zig-zag, the dummy readings will alternate between each end between lines.

2.3   Project Window

The **Project Window** is the large white bar on the left side of your screen when Snuffler starts up. When a project is created or loaded, details of the files contained within the project are shown in this window. The files are arranged in what is known as a tree, the nodes of which can be opened and closed using the +/- icons on the tree, just like in **Windows Explorer**. The project itself is shown at the top with the name of the project next to an icon consisting of a blue diamond surrounded by three yellow boxes. The same icon on the Toolbar will make the Project Window appear and disappear if pressed. An example of how the project bar may look is shown below. The project window can be made to float by double-clicking on the bar at the top of the window, and can be resized by dragging the right side of the window.

Below the project itself in the project window is a list of the files in the project that expands
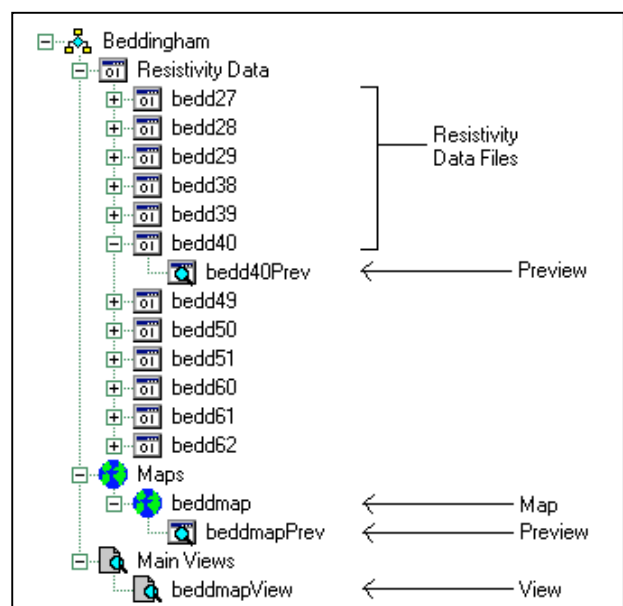
as new files are created. New files can be added to the project either using the 'new' menu option in the 'file' menu, or the new file button, which is the first button on the toolbar at the top of the Snuffler window.

Once files have been created, they can be opened (if not already so) by simply double clicking with the left mouse button on the relevant icon in the tree. A menu of functions that relate to these files can also be accessed by right clicking on the icon. Three menu options which are common to all file types are **Open**, which acts in the same way as double-clicking on the file, **Delete**, which will delete the file from the list, destroying it forever without any hope of return (you have been warned), and **Rename**, which allows you to change the name of the file.

Additionally, the following types of files will have additional functions available on their pop-up menu.

- ■ Geophysics Data Files You can also use the **Preview Window** option to create a graphical Preview for your grid square and create a View File incorporating the single data file using the **Spawn Main View** option. They also have an **Export Data** submenu, which allows the raw data contained within the file to be exported to a **text file** in the order selected, an **XYZ file**, or a **RES2DINV file** if the data is in the correct format for a pseudo section. For this last option, you will be asked to confirm the order in which the data was taken.
- ■ Map Files also have the same **Preview Window** option as the Data Files above, and can also create a View Window using the **Spawn Main View** option and save the map as an easily viewed text file using the **Export Map As Text File** option.
- ■ Import Files can't be deleted, for your own good, but they do have an 'Export To Text File' option to allow you to dump the raw data into a text file, and 'Create Data Grids', which will allow you to split the raw imported data into individual grid squares.

In addition to these, you can access the Project Options and Project MetaData by right-clicking on the project entry in the project window. New files can also be created by right-clicking on the file group headings.

2.4 Project MetaData

Project MetaData means data about the project. It is here that you store the various pieces of information that would normally be in a notebook or on the back of an envelope. While it is not essential, it is good practise to store this information for those people who didn't actually take part in the survey and may not be able to get this type of data any other way. Thanks to the irritating obtuseness of human memory, you will undoubtedly find it useful yourself in many years to come, no offence intended :)

The MetaData screen is accessible either by using the **Project MetaData...** option in the **File Menu**, or by right clicking on the Project Name in the Project Window. The Project MetaData window is divided into three subsections, which can be accessed using the tabs at the top. They are **Survey**, which relates to the nature of the survey and what is intended to be accomplished, **Geographical**, which relates to the location and geology of the area under survey, and finally, **Instrument**, which relates to the hardware used, and its configuration.

In the **Survey** section, the following entries are available:

- ■ **Survey Dates**: The dates over which the survey was carried
- ■ **Weather**: The weather at time of survey. Rain is especially relevant to Resistivity
- ■ **Monument Type**: What you are expecting to find or have found. e.g. Villa, Causewayed Enclosure
- ■ **Monument period**: The chronological period(s) of the monuments found
- ■ **Surveyor**: The individuals/organisations involved in performing the survey
- ■ **Comments**: Any other comments on reasons for survey / interpretation of results.

In the **Geographical** section, the following entries are available:

- **Survey Name**: Full name of survey, e.g. Ditchling Beacon Resistivity Survey 2001
- **Reference**: If you have any relevant internal or external references for this survey, store them here
- **Map Coordinates**: The grid references for the limits of the survey
- **Country**: The country in which the survey took place
- **Administrative Area**: The country/parish in which the survey took place
- **Solid Geology**: Underlying solid geology under survey area, e.g. Chalk, Limestone
- **Drift Geology**: Temporal Geology, e.g. Alluvium, Colluvium, Dunes
- **Soil Condition**: Information on condition of soil due to weather/geology/agriculture
- **Land Use**: What the land has historically been used for

In the **Instrument** section, the following entries are available:

- **Instrument Type**: e.g. Resistivity meter, magnetometer
- **Instrument Make/Model**: Who made it, and the model number
- **Instrument Configuration**: e.g. Twin Probe, Wenner, Schlumberger
- **Transverse Separation**: Distance between the lines transversed within the grid
- **Reading Interval**: How far between each reading along the line of survey
- **Magnetic North**: Clockwise offset between magnetic north and the top of the survey grid, needed for magnetometer surveys

2.5   Options and project options

In the 'File' menu are two items marked **Options** and **Project Options**. When selected, a window will appear with a set of preferences to change the behaviour of the software. Though they both contain the same preferences, the difference between the two is that 'Options' contains items that are set in the project when it is created. These can then be changed for a single project using the 'Project Options' menu item.
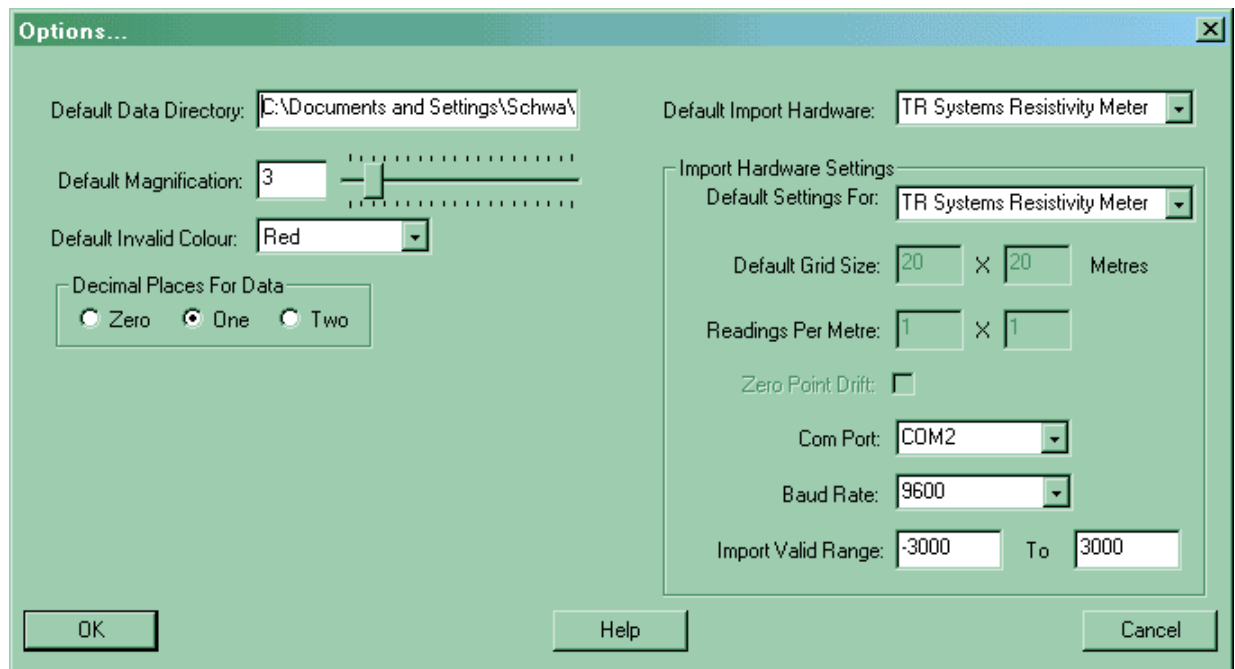
The options are divided into two sections. Those on the left are general options relating to the software, the options on the right relate to the setup of individual pieces of hardware.

The general options on the left are as follows:

- **Default Data Directory:** the directory to which Snuffler writes its files. For the 'Options', this is the main directory in which the project subdirectories are created. In the 'Project Options', this is the name of the subdirectory for this project, which cannot be changed. If you want to change the location of a project on your hard disk, simply move the files somewhere else. NB: the project considers any files that are in its directory as part of that project, so don't get them mixed up.
- **Default Magnification:** the magnification level that images start on when first created.
- **Readings Per Metre:** also defaulted when you are asked for the dimensions of a new set of geophysics data.
- **Default Invalid Colour:** the default colour used in images where there is no data to display.
- **Import Valid Range:** the range, outside which imported data is marked as invalid.
- **Decimal Places For Data:** the number of decimal places (zero, one or two) used for storing geophysics data.

The hardware-specific options are on the right. You can select the **Default Import Hardware**, which is the machine first shown when you start an import. If you have a favourite piece of hardware, then set this so you don't need to change it when doing an import each time.

If you change the **Default Settings For** options, the rest of the right hand area will display the options specific to that piece of hardware. Those options are as follows.

- **Default Grid Size:** the width and height defaulted when you are asked for the dimensions of a new set of geophysics data.
- **Readings Per Metre:** relates to the default grids as above.
- **Zero Point Drift:** defaults for the **Fm18/FM36** whether or not this option is active
- **Com Port:** the default com port that the machine is plugged into
- **Baud Rate:** the default speed of transfer from the machine
- **Import Valid Range:** the range of readings, outside which the data will be marked as a dummy reading

2.6   File types

2.6.1   Import files

Unless you are importing your data from some sort of file, or keying it in by hand, the first step towards producing an image is to import the data from your geophysics meter. At the moment, Snuffler supports downloading from the following :

- Geoscan Research RM15
- TR/CIA Resistivity Meter
- Geoscan Research FM18/36
- Arc-Geo Logger
- **Bartington GRAD601**
- EPE Resistivity Meter

Please note, the download from these meters is entirely unofficial. The companies that produce the hardware are in no way responsible for the download features available in this software. Having said that, if you wish your meter to be supported by Snuffler, then just pop one in the post, and I'll sort it out for you :)

To start reading in data from your meter, the first thing to do, is create an import file, which can be done from **File > New > Import File** or by clicking the New button on the toolbar and selecting **Data Import**.
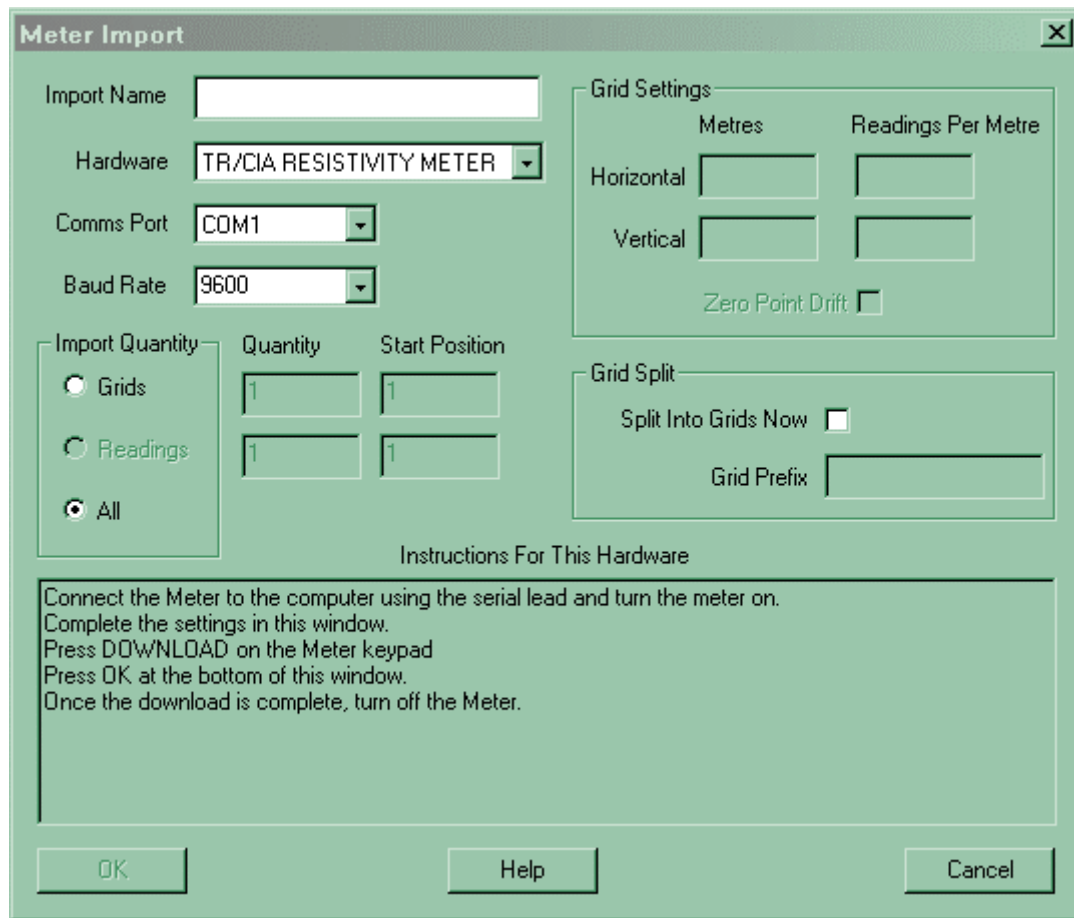
You will then be asked for several pieces of information. First of all, the name of the import file you wish to create should be entered in **Import Name**, which must not be the same as any other filename already created. There is also a choice of **Hardware**, i.e. RM15, TR, FM18/36, Arc-Geo, GRAD601, EPE. You also need to say which **Comms Port** that your meter is attached to, and the **Baud Rate** used, all of which is defaulted from the Project Options.

Next you have to tell Snuffler how much data you want to read, and there are three ways of doing this. If in the **Import Quantity** box you have selected **Grids**, then you can enter two more values. The **Quantity** in this case is the number of complete grids you wish to download, and the **Start Position** is the grid you wish to start at. For the **TR Systems** meter, the **GRAD601** and the **EPE meter**, the grid information is downloaded with the data. For the **RM15** and **FM18/36**, you have to specify it yourself by entering the **Grid Settings**, which is dictated by the settings in the Project Options. The **Arc-Geo** is similar to the RM15, though you do not download the grids all at once. You can set an import for multiple grids and then you have to set the Arc-Geo to download each grid, which Snuffler will collect in a single import file. The **EPE** meter data consists of a single 128x128 grid, which is downloaded in its entirety each time.

If you have an **RM15**, you also have the option of importing a number of readings rather than grids. You do this by selecting **Readings** in the **Import Quantity** box, then entering the appropriate numbers in the **Quantity** and **Start** boxes. The third option, **All**, is only available on the **TR Systems** meter and the **GRAD601** because the **RM15** and **FM36** do not stop sending data when it reaches the end! This option will read all the grids in the memory of the meter.

At this point, you can also split into grids, rather than waiting until later. First select **Split Into Grids Now**, then enter the prefix which you want to use for the data grid filenames. If you do decide to split the data into grids now, you will be asked for the order in which the readings will be taken after

the download has completed. If you are using a magnetomer, such as an FM18 or FM36 and have logged drift readings, you should tick the **Zero Point Drift** box to make sure this is processed correctly.

After you have made your selections, there are separate procedures to start the download.

- ◼ **RM15/FM18/FM36:** With any Geoscan meter, you then need to press the **OK** button on the Meter Import window. A small window will appear that will show you how many readings have been downloaded, which will read zero until you start the download. You can press **Stop** at any time to abort the process. Snuffler is now waiting for data to be sent from the meter, so start the download process on your meter, which with an RM15 is started by pressing the DUMP button on the meter itself, and Snuffler will read the data until it has read as many as you have asked for, at which point the read process will automatically stop, and you can press the **Cancel** button on your meter to stop the process, and turn the meter off.

- ◼ **TR Systems:** With the TR systems meter, you first need to turn the meter on and press the **DOWNLOAD** button on the meter itself. This will not start sending the data as with the RM15, but allows the computer itself to activate the download process. You can now press the **OK** button on the Snuffler 'Meter Import Window', which will tell the meter to start downloading, displaying the number of readings in the same manner as the RM15. When the process has finished, you can turn the meter off.

- ◼ **Arc-Geo Logger:** For the Arc-Geo Logger, you must follow these steps after you have entered the correct details. Firstly, set the **AUTO/MANUAL** switch in the **AUTO** position on the logger and then set the bank and grid switches to choose which grid to download. Press the **OK** button on the Snuffler 'Meter Import Window' then press **D/LOAD** followed by **YES/LOG** on the logger.

- ◼ **GRAD601:** Turn on the meter and arrow down to select the **Output Data** option on the meter. The meter will then wait until you press the **OK** button on the Snuffler 'Meter Import Window', which will tell the meter to start transmitting. Once the download is complete, turn the meter off.

- ◼ **EPE Resistivity Meter:** Turn on the meter. Press the **OK** button on the Snuffler 'Meter Import Window', followed by the **Download** button on the meter. Once the download is complete, turn the meter off.

You now have a file containing the imported data, and the next stage, if you have not already done so by entering the appropriate information into the grid split box, is to split this up into individual grids, and there are two ways of doing this. The quickest and easiest way is to right click on the import file in the Project Window and select **Create Data Grids**. You will first be prompted to enter a file name prefix. Snuffler will create grids beginning with this name, also followed by the next available number in a sequence beginning at one (unless you are exporting a single grid). Secondly, you will be prompted to enter the order in which the readings were taken. For the TR meter, this will default to that shown in the manual, though you are not limited to this. Snuffler will then create a set of Data Files. For the **RM15**, which does not store grid information for download, the grid size dictated by the settings in the Project Options. The downside of this method is that all the grids have to be the same size with the same readings order. For the TR Systems meter, the grid sizes are stored for download, so you can have different grid sizes created from an import file. For the **EPE** meter, you are not asked for the order in which the readings progress, as the order is kept within the meter itself.

A more flexible but much slower method is to create individual grids yourself and import data a grid at a time by right clicking within the Data File window itself and selecting **Import Data > From Import File** from the menu that appears. The size is then dictated by the size of the grid you have created, and the data order can be changed for each grid you do.

2.6.2 Geophysics Data Files

A **Geophysics Data File** contains the raw data produced by the geophysics equipment you are using. Each file represents a single grid square. To create a geophysics data file in your project, select **Geophysics Data File** from the 'file' menu and within it the 'New' menu. You will be asked for a name for the grid square, which must be unique in your project. A common prefix followed by a number for the grid is a good name to use. You will also be asked to specify the size of the grid square, which defaults to 20x20 (or whatever is specified in the Project Options) and also the number of readings per metre, which will be important later on.

When the file has been created, it will in the project on the left hand side of the Snuffler window, as well as showing the empty grid on the right. Now you have this empty grid, you can start to enter your data into it. There are several ways of doing this. First of all, points for which there are no data can be marked by simply double-clicking in them with the left mouse button, which will mark it with an X. Part of a completed grid is shown below.


If you want to edit the value of a single point in the grid, click within it with the right mouse button and select 'Edit Cell' from the menu that appears. You will be asked to enter the value for this point, after which you press enter or click ok to save it. You can also mark the point as having no data by clicking in the invalid box or using the ALT-I key combination, which acts in the same way as if you double-clicked within the point with the left mouse button, to mark it with an X. You will see that the data you are entering is to one decimal place. If you are working with two, or zero, you can change this in the Project Options.

This is of course a very slow way to enter in your data. If you don't have the benefit of reading in your data from a file, there is still a quicker way to enter in your data from the keyboard. If you right click anywhere within the grid square and then select 'Import Data > From Keyboard', you can enter in the data without having to select every single point.


First of all, you will be presented with a box asking you in which order you are entering the data. You can select which corner you are starting from as well as whether you are to go horizontally or vertically. Finally, you can select whether you want to double-back when you get to the end of the line you are keying, or go back to the start of the line, with the 'Bi-Directional' tick box.

Once you have chosen the order in which you are keying, you will be presented with the same data entry box as you saw when changing the data in a single point. The difference here is when you have entered your data, the box will appear again
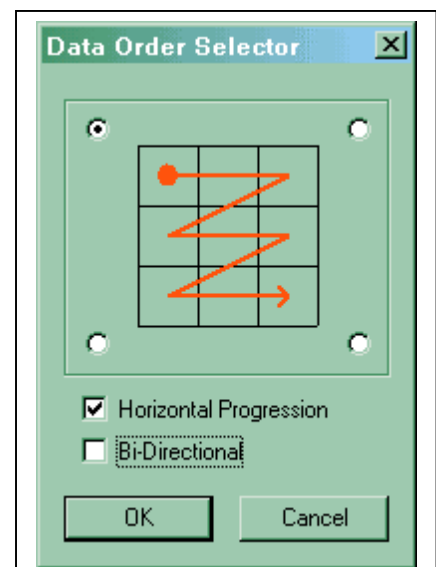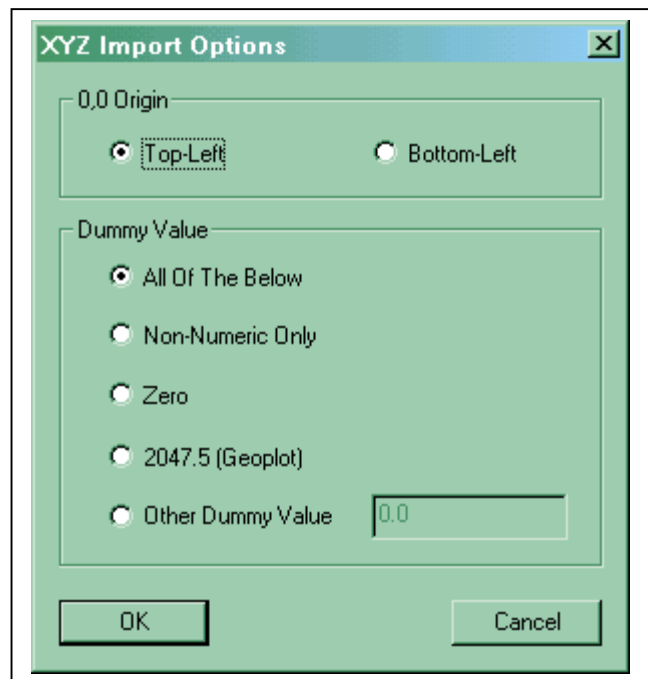
asking for the next point along, until you stop it, or the grid is full. Another feature that is activated in this mode that is not available when editing a single cell, is the ability to enter multiple invalid values with a single keypress. The count shown under 'Fill with' is defaulted to the number of cells that are left in the line you are keying, so you can just use ALT-V or click on the 'Invalid Values' button to fill the rest of the line with invalid values. You can of course change the value to enter a different number of invalid values.
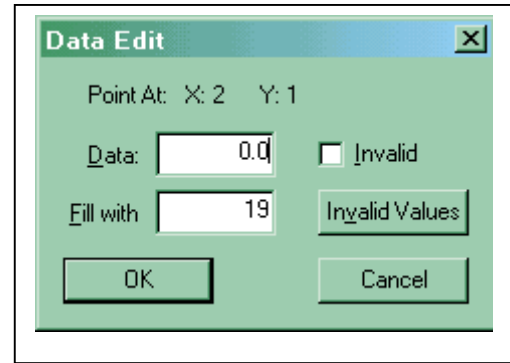
The ideal way to enter data into Snuffler is from a text file. Snuffler treats any number, '.' or '-' as numerical data, separated by anything that doesn't fall into this category. The exception to this is 'X' or 'x' which is treated as a point with no data. To read in from a file. Click the right mouse button in your grid and select 'Import Data > From Text File' from the menu. You will be asked for the order in which to import the data, in the same manner as importing from the keyboard above. Snuffler will then check that the number of data items found in the file matches the number of empty points within the grid. If it matches, the file will be read into the grid. If invalid points are represented in the file by something other than an 'x', or not represented at all, the invalid sections of the grid can be selected first using the left mouse button, as detailed above. Remember, the software will read your text file in sequential order and enter those values into the **Grid** in the order that you specify. If you want to see how this works, try entering data from the keyboard to see how you progress around the grid as you enter values. With this type of file import, and the other two listed below, there is a threshold of what is considered valid data. Outside of this, the data is marked as invalid. The default range is from -3000 to 3000, though this can be changed in Options and Project Options.

Another type of text file is called an XYZ file, which has on each line, the x position, the y position and the data, one line for each piece of data. Snuffler can read these files, but you must first make sure your data grid is the correct size, and most importantly, empty. To use this feature, use the menu option 'Import Data > From XYZ File'. After selecting the file you want to import, you will be presented with the window shown on the left. The first option, **0,0 Origin** is useful for software compatibility. Though the XYZ format has absolute positioning of data, not all software agrees on where 0,0 is. For example, Geoplot and Snuffler have 0,0 in the **Top-Left**, whilst Surfer and the TR-Systems software have it in the **Bottom-Left**. Chosing the right option now will save flipping your data later on. The second option allows you to select what you want as a dummy (invalid) value. Any non-numeric value in the Z column of the data will be entered as invalid, and the **Non-Numeric Only** option will leave it as just that. Geoplot uses **2047.5** as a dummy value, so select that if you are importing a file produced by Geoplot. If you want **Zero** as the invalid number then there is an option for that, or you can enter a value under **Other Dummy Value** to use as invalid data. Finally, **All Of The Below**, the default, means any of those options will produce an invalid value. Please note that whilst this software can read XYZ files with X & Y values that are not

whole numbers, it cannot yet cope with continuous sampling data where the number of data point along a line is not the same as the number of lines. You can also export Text, XYZ and RES2DINV files using the 'Export Data' submenu, in the same way as the menu options in the Project Window. Further information on these file types can be found in the Projecta And File Overview

Another way to import data is from a Geoplot file. These files have an extension of 'DAT' for a single grid, and 'CMP' for a composite, and sometimes come with an associated file with an extension of 'CMD', which describes the data. You still have to set up the grid first and tell it how big it is, but the width and height can be found in the CMD file, which is a simple text file that can be viewed with notepad. Geoplot seems to represents invalid data with the number 2047.5. Since the Geoplot files are always in the same order, you will not be asked to specify which order to read in the data. Otherwise, the import process is much the same as for a text file.

As well as creating several grids at once from an Import File, you can copy data from one of these into a data file using the 'Import Data > From Import File'. The advantage of this is all of the imported grids don't have to be of the same size or survey direction. You just select the start grid or reading you want and the survey direction, and the data will be imported.

A final feature to take note of is very useful when keying in data manually. You can select blocks of readings by holding down the left mouse button and dragging the mouse. The selected area will be highlighted in red and can be manipulated using three menu options available on the context menu when you right click.They are all under the sub-menu 'Change Selected Cells', which contains 'Delete Cell Contents', which will clear the selected area of any data, 'Set Cells To Invalid' which will set all the readings in the area to invalid, and 'Shift Cells', which will move the readings in the selected area. This is especially useful if you are keying data and you have missed out a reading or a line. Rather than delete everything and start again, the mis-aligned data can be shifted to its correct position and the missing data entered in the correct place. Please note, shifted data will overwrite any data that it is shifted over. There is no undo, so be careful. In addition to these three options, the selected area will also be affected by the standard 'Cut', 'Copy' and 'Paste' from the 'Edit' menu.
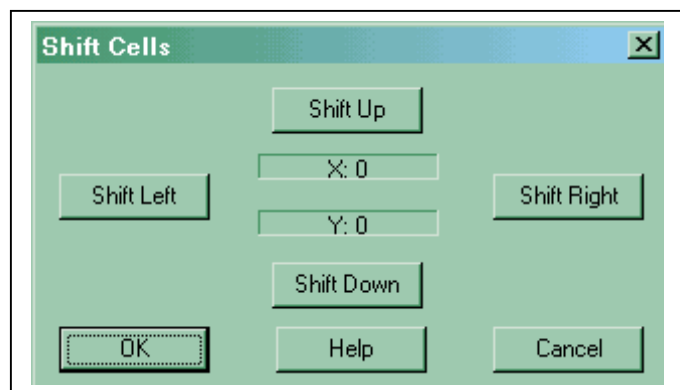
2.6.3   Map Files

A **Map File** collects together a set of Resistivity Data Files in a logical order that can be used to create a final image from your data. All of the data sets used should be of the same size, which will be dictated by the first data set added to the map. An example of how a completed map file may look is shown on the right.

Map Files are created by selecting 'Map File' from the 'file' menu and within it the 'New' menu. You will be asked for a width and height for the map. This is measured in the number of data sets rather

than metres. Once you have entered this data, you will be presented with a blank grid. There are two ways to fill in the map grid.

- ■ If you left-click within one of the squares of this grid, you will be presented with a list of available datasets. The dataset name will appear in the grid when selected.
- ■ A quicker way to select grids for inclusion in the map is using the right mouse button. This feature assumes all of the data grids in the project use the same prefix, followed by a number. E.G. 'griddat1', 'griddat2', 'graddat3'. If you click in the map with the right mouse button, Snuffler will take the data grid with the lowest unused number and put it in the map. So the first time you click, Snuffler will use 'griddat1' and the second time, it will use 'griddat2', etc. This will not work if there is already data in the grid or there is more than one prefix in the data sets of the project.

If you have an existing map and have surveyed more of the area around it, rather than just creating a new map and selecting all the grids you have already entered, you can resize the map by using the **Edit -> Resize Map** menu option.

When you have filled the grid, or as much of it as is needed, you can then create a Preview or View file from it using the Project Window. The preview is not necessary, to creating the final image. The View itself, which you will be able modify using Filters can be created by right clicking on the map in the Project Window and selecting **Spawn Main View**.

Map Files can be saved as an easily readable text file by right clicking on the map in question in the Project Window and selecting **Export Map As Text File**.

2.6.4   Preview Files

A **Preview File** is one of two display files, the other being the View File. The difference between the two is that a Preview File is directly linked to the data (either a Data File or Map File) that it represents, so as you update the data, the Preview is also updated to reflect the changes. The View File on the other hand, is independent of the data it was created from.

The use of preview windows is not necessary in the process of creating an image. It was included in this program so when you are typing in data using the keyboard, you can see the image being generated as you type, which makes the process a little less boring. If you are not interested in this, just use View Files

To create a Preview Window for a data set or map, right click on your chosen item in the Project Window and select 'Preview Window' from the menu that appears. You can only create one preview for each data set or map. You will be asked for a name for the preview, which defaults to the name of the map file plus the word 'Prev'. Another way to create a Preview for a set of data is to use the New menu option in the file menu or the New File icon on the Toolbar. You will then be asked from which data set to create a preview for.

What you see in the preview window is a graphical display of your numerical data. You can't apply Filters to the Preview Window, but you can change the Display Settings and use the info menu.

As in a View File, the **Copy** option from the edit menu is activated in a Preview Window, though not the cut and paste options as the data cannot be changed.

2.6.5   View Files

A **View File** is similar to a Preview File, except that instead of the data being read from the file it is linked to, a View File holds its own set of data and is not dependant on the data it was created from. Because of this independence, Filters can be used to change the view data. This View File is the

main place where you display and modify your results, Preview Files are not necessary in the process of generating a final image.

View Files can be created from Map Files and Resistivity Data Files, though a blank view can also be created using the **New** option from the **File Menu** or the New File icon on the Toolbar. In the latter case, you will be asked to give a size for the newly created view. This view is blank but can be edited to fill it with data using the **Cut/Copy/Paste** option explained below. As with Preview Files, View files are created using the Project Window. Clicking with the right mouse button on the map or data of your choice will bring up a menu, from which you should select 'Spawn Main View'. You will be asked for a name for the view, which defaults to the name of the map/data file plus the word 'View'.

As with the Preview Files, you can change the Display Settings, but you can also use Filters to modify the View.

The **Cust/Copy/Paste** options in the **Edit Menu** and on the Toolbar can all be used on Views, to copy a section of an image to the clipboard, drag the mouse with left button down to select the area you want to copy, then just use the copy menu option, icon or Ctrl+C to copy to the clipboard. Cut (Ctrl+X) acts in much the same way, except it blanks the area you have copied to the clipboard. To Paste the contents of the clipboard to the View, select Paste (or use Ctrl+V). You will notice the mouse pointer has changed, and it is at this point that you select a point in the view with the left mouse button to place the top-left corner of where you want the data pasted. The paste operation can be cancelled with the right mouse button. Another useful feature when using paste is that after you have selected the paste option, you can hold down the shift key when selecting where to paste to, and the software will place your data against the top-left hand corner of the grid square you have clicked in. There are two additional Paste options in the Edit Menu. **Transparent Paste** (Ctrl+Shift+V) is the same as the normal Paste, except any area that does not contain valid data will not be copied. This is useful when you are copying an area with an irregular outline and the rectangle you are pasting would otherwise overwrite an area containing data with blank data. **Paste To New View** (Ctrl+Alt+V) takes the contents of the clipboard and pastes it into a new view, which you are prompted for a name.

It should also be noted that copying or cutting an image will place a copy of that image on the windows clipboard. Unfortunately, this is currently limited to what you can see on the screen at the time, but this will hopefully be rectified in a future release.

Also in the **Edit Menu**, are three options, which will **Flip Horizontal**, **Flip Vertical** and **Rotate 90 Deg Clockwise** and **Rotate 180 Degrees**. Useful if you realise you have the image the wrong way up. These will also work on selected areas if they encompass entire grids, but the rotate 90 function will not operate if the grid size and pitch are not the same.

If you right click within an open View File image, a small menu will appear with the following options. **Display Settings**, **Image Information** and **Selection Information** act the same as in the Filters Menu

In the **File** menu, you will also have access to an **Export** submenu, which has the following options:

- ◼ **To Text File:** This option will export the data to a text file, with one reading on each line. You will be asked in what order you wish to export the data.
- ◼ **To XYZ File:** This option will export the data as an XYZ file, which is a standard data file recognised by many pieces of geophysics software. Each line stores the position of the data (X & Y) and the data itself (Z).
- ◼ **To VRML:** A VRML file is a file which contains 3D data, and the value of the readings in the file are taken as the height. These files can be viewed by browser with a suitable plugin.

■ **PNG File:** Whilst the first three files export the data underlying the image, this option will export the image itself. The PNG file format is a popular open file format replacement for GIF, and is considered most suitable for archive purposes.

Finally, a note on selecting parts of your image, which also applies to Preview Files. Several functions in the program require you to select part of your image to work. This is done by moving the mouse pointer to one corner of the area you want to select, holding down the left mouse button and dragging the mouse to the opposite corner. The area you have selected will be highlighted and any function which requires an area to be selected will be activated. The selection can be de-selected by clicking at a single point on the image without moving the mouse. There are other means of selecting parts of the image. By pressing **CTRL+A**, you will select the entire image. By holding down the **Shift key**, and selecting an area, as you normally would, you will select entire grid squares that the mouse pointer passes through. By holding down the **Ctrl key**, and selecting an area, as you normally would, you will select lines within grid squares that the mouse pointer passes through. The extent of the selection you have made will be shown in the status bar at the bottom of the Snuffler window.

2.7 Display Settings

The **Display Settings** window controls how an image is displayed can be accessed from the Preview and View windows by right clicking with the mouse and selecting 'Display Settings', or in the case of the View window, you can also select it from the display menu at the top of the screen or using the relevant icon on the toolbar. Below is an example of what the Display Settings window may look like.
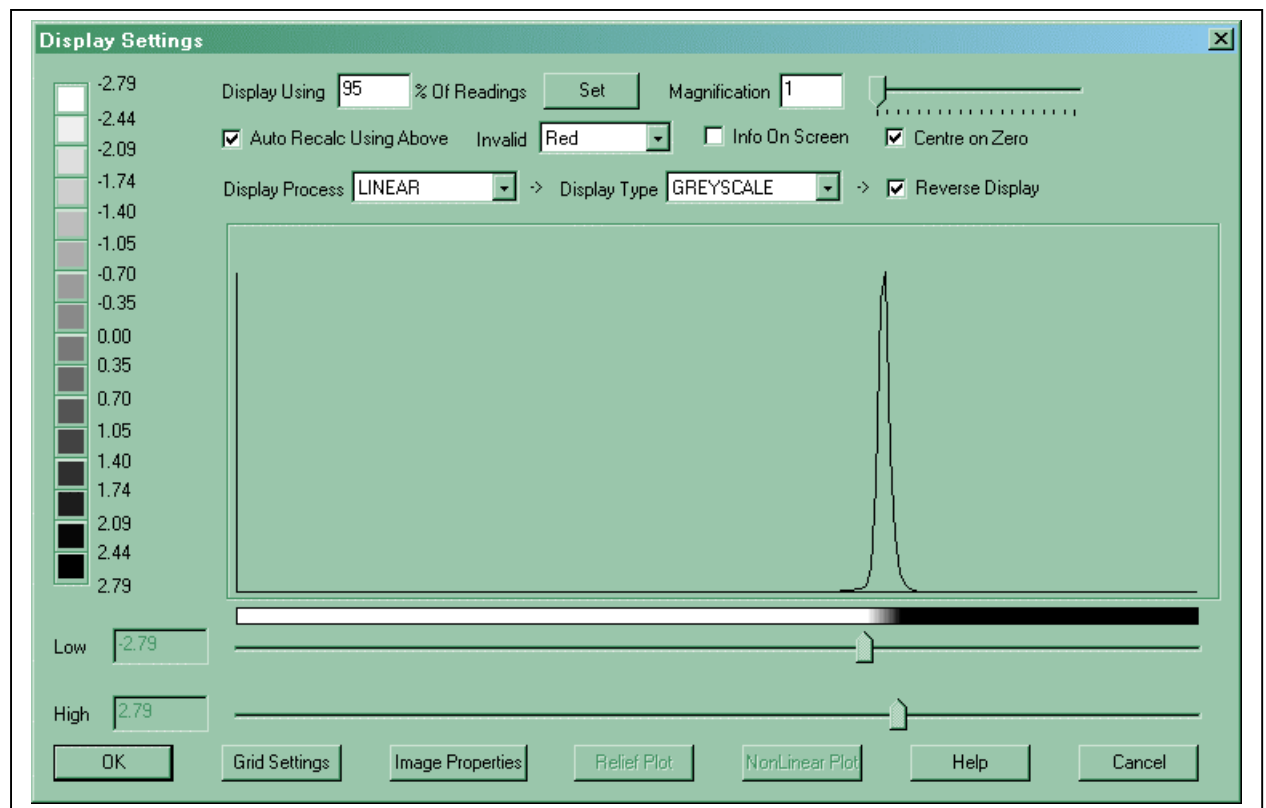
The main focus of this window, and the first part we will learn about is the clipping. Clipping is where you set an upper and lower value to display, so anything outside of these bounds will be displayed just as the highest or lowest value. The reason for doing this, is if you use the full range of

readings to display with just the 16 shades available, you will have very large blocks of readings displayed using the same colour, which is not very helpful for interpretation. By clipping the display of the image, we can reduce the range of values represented by a single shade.

In the middle of the display settings window you will see a graph representing the values in the data. The horizontal axis of the graph measures resistance in ohms whilst the vertical axis measures the number of readings with this resistance. The purpose of this graph is to help you decide the high and low bounds you want for clipping. For an average set of data, you will see something like a bell curve displayed on the graph. Below the graph are two sliding bars with numbers next to them which represent the low and high values used for the clipping. You will find that you will not be able to change these. This is because the computer is handling the clipping itself.

The automatic clipping system is represented by two controls above the left hand side of the graph and are called 'Display Using ***% Of Readings' and 'Auto Recalc Using Above'. The latter tickbox turns the auto clipping on and off, it is on by default. If you turn it off, you can manually set the clipping bounds using the two sliders below the graph. When it is on, the computer will take the percentage value shown in the first control, and that percentage of the readings closest to the average as within the clipping bounds. If you change this percentage, the computer will recalculate the clipping bounds using the new percentage. This automatic clipping applies to changes made to the data itself. Say you apply a [Filter](#) to the image. When it is done, the computer will recalculate the clipping bounds automatically. Whether the bounds are decided by yourself or by the computer, the high and low values for each shade in the scale will be displayed to the left of the graph.

For magnetometer data, which has a range of values that goes into the negative, a tickbox is activated called 'Centre on Zero' that will centre the automatic clipping on Zero. This is beneficial for the de-stripe filter, and is activated for magnetometer data by default, but if you do not wish it to do this, you can turn off this feature by un-ticking the box.

Moving on from clipping, some of the other controls should be explained. 'Invalid' is the colour used for invalid areas of data, you can choose from Red, Yellow, Green, Blue, Black and White. The 'Magnification' slider and value control how small or large the resulting image is. 'Info On Screen' displays the extra information associated with a printout, such as the scales, on the screen, so they can be outputted in PNG files. 'Display Process' controls how the software processes the data to produce a display. At the moment, this can either be 'LINEAR' which is the standard process by which a range of values are assigned to a specific colour on the output, and 'RELIEF PLOT', where the data is taken as height values and an artificial light is shone to produce areas of light and dark, or 'NONLINEAR' where there is still a simple scale like the linear plot, but the colour boundaries are not all equal. This process is explained further down this page. 'Display Type' is how the data is displayed once processed, and is a collection of palletes of colour or greyscale, which are explained below. The 'Reverse Display' flag will flip the scale, so that low readings come out light and high readings come out dark. Many of these functions can also be controlled by buttons on the Toolbar.

GREYSCALE is the standard means of viewing an image. It is made up of 16 shades of grey and any resulting images exported to a PNG file are browser safe. DOT DENSITY is not as nice on the eyes, but is useful when printing out to a black and white printer that cannot handle. RELIEF PLOT creates a '3D' illuminated image, described further below. EXT GREYSCALE, or more fully, EXTENDED GREYSCALE, is like the normal greyscale except there are 31 rather than 16 shades of grey. This is useful when you have a heavily interpolated image where you want smooth shading. RGB,EXT RGB and RAINBOW can be used if you want something more colourful with more contrast.

The **'Relief Plot'** button brings up a window that controls the display characteristics of the **Relief Plot**. This is a display mode that treats the image as a 3D object, with the high resistance readings being treated as a high point and the low resistance readings as a low point. A virtual light source is shone on this object, which will be lit accordingly. The origin of this light source can be controlled from the Relief Plot Window, in which you can change the horizontal (0-359 degrees) and vertical (0-90 degrees) angles from which the light source shines. The relief plot is good for showing up features in geologically noisy areas as it shows changes in readings relative to the adjacent readings rather than relative to the image as a whole. A good vertical angle to use is 40 degrees, whilst the horizontal angle can be quickly selected using the small squares around the horizontal angle indicator. Features can easily appear and disappear depending on which horizontal angle you use, so try a few. It should also be noted that a better result can be achieved in a lot of cases if you use the interpolate filter first before trying the Relief Plot. You will also notice a 'False-Relief' tickbox. If you select this, the rest of the options for the relief plot will be turned off. The purpose of this is not to shine a light from a specific direction, but have the hue generated dependant of the contrast of the readings with their immediate neighbours. Whilst this works as a process, the results are not particularly helpful, so this is left as a feature of limited interest, just to show that it can be done.
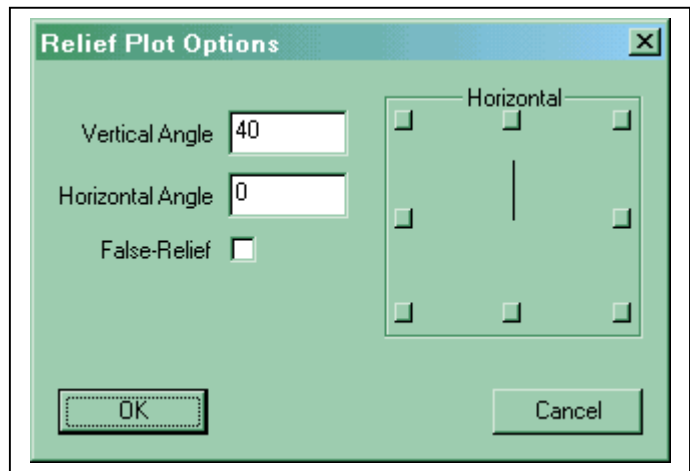
The **'Nonlinear Plot'** encompasses several processes under one banner. What they have in common is they still assign colours to a range of readings like the linear plot, but the ranges each colour are assigned to are not equal. When you select Nonlinear as a process, a button marked 'NonLinear Plot' will become active at the bottom of the Display settings window. Clicking this will bring up the window shown on the left. As you can see, there are four sub-processes that you can select. The default process 'Use Data Distribution' is probably the most useful. Whereas the linear plot will assign blocks of colour to equal ranges of values within the clipping bounds, this process will assign the colours to equal numbers of readings, so the colour bands are quite wide at the edges of your clipping area where there are few readings, but narrow near the centre, where most of your readings will be clustered. This has the effect of increasing the contrast in your image. You will notice at the bottom of the window a 'Severity' bar. This is not active for the Data Distribution
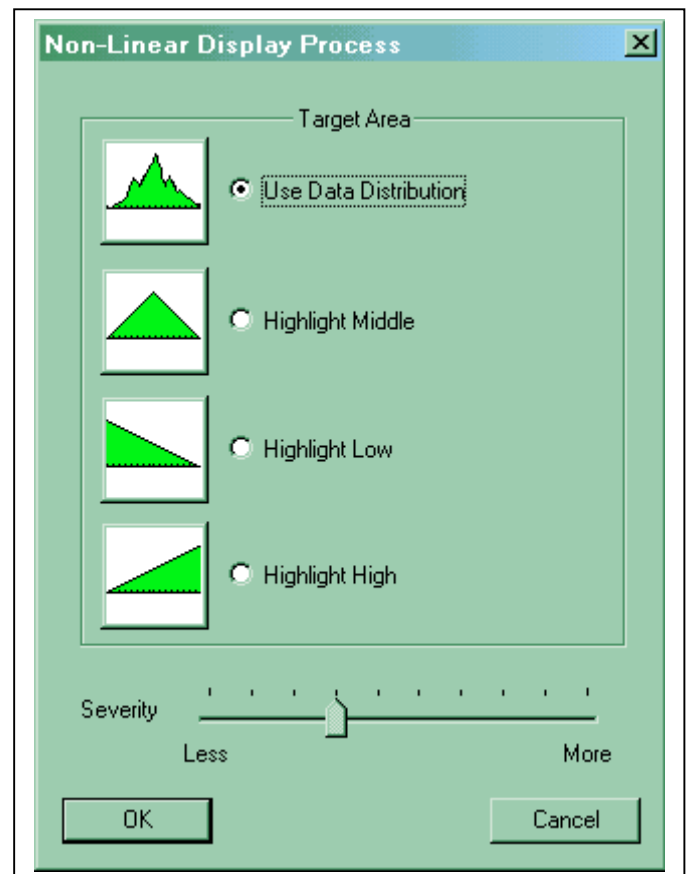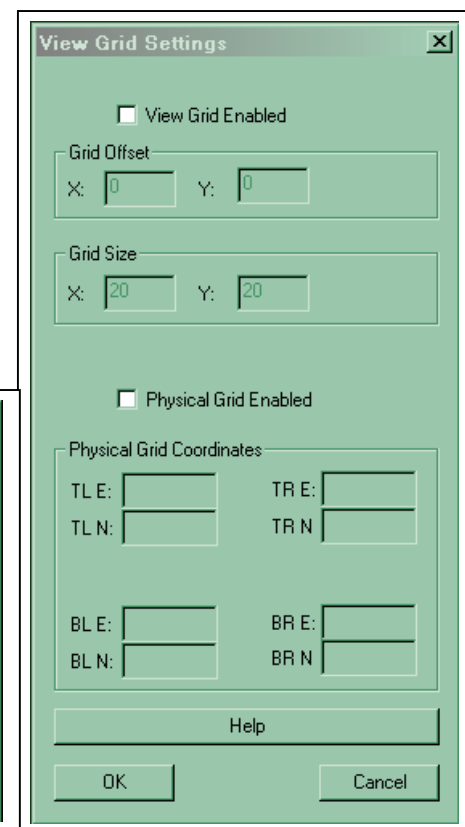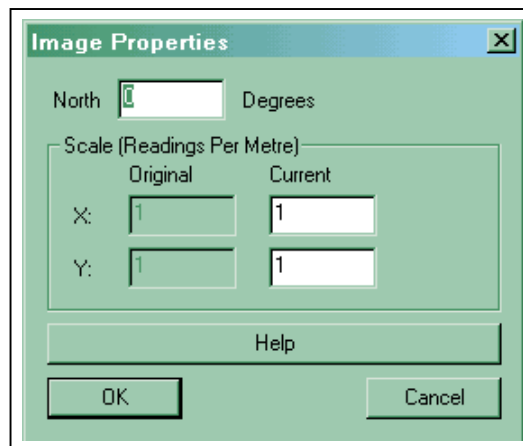
option, as the process does not support it, but the other three options do. These options highlight particular blocks of readings by narrowing the range for a colour in the area you wish to higlight. The 'Highlight Middle' option will produce similar results to the data distribution option, as the shape used to generate the colour boundaries is similar to the shape of the average distribution curve. The severity slider at the bottom can be used to increase or decrease the effect produced. The 'Highlight Low' and 'Highlight High' also assign the colours based on a shape, but in this case at the lower and upper ends of your clipping boundary. These two options are not as useful and you would have to be after a specific effect to want to use them.

The **Grid Settings** button at the bottom of the window controls the grid that is shown around each grid square of 20x20 (or whatever you have it set to). It is turned off by default. Certain filters, such as the edge matching, will use the grid size here, so if is wrong for some reason, it can be corrected here.

The physical grid setting in the second part of the window allows you to store real world, or site, coordinates for the image. You have to enter the coordinates for all four corners for this to work, which the software will check make sense before accepting them. Once the coordinates are accepted, you will be able to move the mouse over the image, and have the physical coordinates of the mouse pointer displayed in the status bar at the bottom of the Snuffler window. This will allow you to get physical coordinates for features you wish to excavate without having to calculate them yourself.

The **Image properties** window contains information such as the number of readings per metre and which way is north, that is unique to this individual view. The 'Original' readings per metre are for your record only, they do not affect the display. The 'Current' readings per metre is used to display the readings in the right proportion. They can be changed by you and by filters such as the Interpolation filter. This information can also appear on a Printout.

Going back to the display menu itself, 'Display Settings' will display the main window discussed above, the 'Next Process Type' and 'Next Display Type' will move on to the next relevant type, whilst 'Reverse Display' has the same effect as setting or unsetting the flag in the main settings window. 'Display Grid' toggles the grid on and off. Finally, 'Set Clip To Selection' will only work if you have selected a portion of the image by holding down the left mouse button and dragging the mouse. This tool will set the high and low clipping bounds to the high and low within the data selected. This is useful if you want to highlight a particular area to search for features, especially is there is a great range of values in your data.

2.8   Filters

Filters are processes that can be applied to an image for various to make certain things clearer. Since we are changing the data, this process wont work on **Preview Files**, you can only apply Filters to a **View Files**. Snuffler has several filters, which can be accessed from the Filters menu or from the Toolbar, and are described below. Remember, if you don't like what the filter has done to your image, you can put it back to how it was using the Undo button on the Toolbar. A list of filters applied to a view can be seen using the **Filter History** option on the Filters Menu.

- ◼ **Remove Geology** is a filter that removes the slow change in the background soil depth. This is useful in sites on slopes where there is a change in soil depth as you go down the hill. This produces a greater range of resistance readings for a site, meaning each shade in your grey scale will represent a large spread of resistance readings. The filter goes through each point and finds its 'geological background' by taking the average of a circle of points around it. This background is then removed from the image, highlighting the high frequency changes caused by archaeological features. The first stage of the process attempts to work out the best size of circle to use when finding the geological background. You will then be presented with a window which will allow you to adjust the size of this circle up or down. If you are not sure about this, just leave it alone, but generally, a higher value will reduce the flattening effect, whilst a lower value will start to remove larger features. It is best to experiment until you are happy with it. This filter is only really suitable for large images with pronounced geological gradients. The downside is strong features develop 'halos', where a high resistance feature, for example, will develop a ring of low resistance around it.

- ◼ **Remove Spikes** attempts to remove lone 'spikes' in the image caused by a bad reading. This is generally more useful for magnetometer data, but can be useful before using the 'Remove Geology' filter, where these spikes can seriously affect the background calculations. The user is asked two things. The first is the 'Threshold', which is the difference between the point in question and the points around it necessary for the point to be flattened. This value is defaulted by Snuffler to something reasonable for the image you are working on. The second thing is how much to flatten it, ranging from 'Light', through 'Normal' to 'Sit On It Like A Moose'.

- ◼ **Interpolate** is a filter that smooths the image by increasing the number of readings and filling in the gaps by taking averages of surrounding points. This is useful for producing a less blocky, prettier picture that may in some cases show up more features, but it is not much help when you are taking the image out into the field and trying to work out where your feature is on the ground. Interpolation cannot be used more than twice due to the internal structure of the software and is not recommended for use more than once on exceptionally large data sets.

- ◼ **Sharpen** attempts to find edges and make them more visible. This Filter is useful for finding walls under rubble. It is basically a High Pass Filter. How much the image is sharpened, from light to heavy, can be selected by the user when they use this filter. The sample area it uses is shown by the spidery feature at the bottom right of the sharpen window, which changes when you use the directed feature. The directed feature is used when you have regular features such as a Roman Villa where all the walls go in the same direction. If you know which direction these features run (and they are uniform in their direction) then tick the 'Directed' Box and select which angle the walls run. This angle can be between 0 and 89 degrees and represents the angle clockwise from the vertical and is defaulted using the 'Measure Angle' tool in the **info** menu. The sample diagram in the bottom right will change to show which direction the data is coming from.

- ◼ **Modify Selection** actually contains six separate, but similar filters. Firstly, you need to select an area that the filter should be applied to by dragging the mouse across it. Once that is done, you can use the menu option to bring up a window which will ask you for two pieces

of information. The first is a value, which will be defaulted to the last 'Average' found using 'Selection Information' in the info menu. The second is how to apply this value to the selected area. The six options are 'Add/Sub Average', 'Add', 'Subtract', 'Mult/Div Average', 'Multipy' and 'Divide'. The second and third will simply add or subtract the value specified from the readings in the selection. Add/Sub Average will take the given value and modify the selection so that the readings will average to that value. For example, say you go out with your meter and do a grid square. It rains overnight and you go back the next day to do another grid square. The rain will affect the image so that the second square will come out uniformly darker than the first. To fix this, select the first grid square and find the average using 'Selection Information', then use the 'Add/Sub Average' using that on the second square to make the average the same, and therefore making the two squares appear as if they were done on the same day. Features within the two squares will affect the average, so you should tweak the second square using add and subtract until the edges of the squares broadly match. The 'Multiply' and 'Divide' do exactly as they say. The 'Mult/Div Average' basically works the same as the 'Multiply' filter except the value is defaulted to the value necessary to make the selection have the same average as the 'Selection Information' value. This may sometimes be preferable to using 'Add/Sub Average', as the range of the resulting values will be affected in a way that the latter does not do.

■ **Edge Correction** automates a process which can be performed manually using the Modify Selection option detailed above. Where there is a discrepancy in the edges of grid squares, as detailed above, you can use the edge correction tool to correct this. First, select the Edge Correction option from the toolbar or filter menu. The mouse pointer will change, prompting you to select the first grid, which will be reference grid, to which the second grid is matched. Then select an adjacent grid, which will then be matched to the first. As with the Modify Selection option, it is not exact, but will suffice for most cases. Please note that if you do not select an adjacent grid for the second grid you select, you will get an error message. It may help you to turn the grid lines on before using this. You can continue edge matching rather than selecting the option again if you hold down shift as you match grids. This filter is designed for resistivity. For magnetometry, destripe should remove the need for this filter.

■ **Destripe** is a filter generally unused with resistivity. It is designed for a common problem with magnetometer data, where there is a consistant difference between the lines surveyed walking in different directions or recorded with different sensors, which leads to a stripey effect on the resulting image. This filter uses the display bounds to clip the data used for averaging, so it will perform better if there is a narrow display range, e.g. +/-2nT. You can also decide to affect only a selected area,such as a grid or set of grids selected by holding down shift and left-click dragging the mouse. Thus if you have certain grids that have a large metal pipe through them, which destriping would make worse, you can avoid them by only selecting the grids that you want. There are three methods used for destriping. The first and most commonly used, is zero mean line. This is the simplest method and treats each line as a separate entity. The downside of this is if you have particularly noisy data, the filter can create artifacts near the noise, and features parallel to the direction of survey may be filtered out completely. These effects can be mitigated by collecting the average values for each sensor/direction, either across each grid, or across the image as a whole. Averaging the image as a whole is theoretically better, but in practice, instrument drift will still most likely leave you with stripes, so the average per grid will usually be a better option. Please note that the sensor/direction options will not be available for files generated before version 0.90, but you can use it if you regenerate everything from the original import file.

■ **Clip Data** is a filter for getting rid of spurious data, for example if your machine has produced some spikes which despike can't deal with, or if it has malfunctioned and have produced incorrect data in some parts. The area affected can be the whole image, or just

the selection if you have one. The maximum and minimum are defaulted to the max/min display settings and you can choose to either set data outside that threshold to the threshold you have set, or set it to be invalid.

■ **Destagger** is a filter used for magnetometer data only. When collecting data, there may be a tendancy to walk so that you are ahead or behind where you are supposed to be. Either due to operator fault, or surveying on a hill. There may also be sensor lag, where the actual readings as regards location are somewhat delayed. All of these can lead to a noticable zig-zag effect on linear features. When you use this filter, you will be asked for several pieces of information. The destagger filter can be used to correct this by shifting lines so that they no longer appear with a zig-zag. *Lines* controls whether you have been walking horizontally or vertically, and should default correctly due to there being more readings along the line per metre than there are lines per metre. *Sensors*, which you must set yourself, is the number of sensors on your magnetometer, so if adjacent lines were taken walking in the same direction, then you must select two as opposed to one. *Affect* is the area of the image to be affected. If you have selected entire grids on the image, then you have the option of using Selection, otherwise the filter will act on the Entire Image. Finally, 'Movement' is the direction and number of readings you wish to destagger. The image below the slider will show you how the image will be staggered in relation to the top-left corner of the image. The amount of stagger is controlled by how far the slider is moved.

Finally, a note on the use of filters. The best thing to do first is always a **Despike** and then **Clip Data** (If necessary), as rogue heavy spikes can cause problems with all other filters. If you have large discrepancies between grid squares due to changes in the soil conditions over the time of the survey, or if you are using a twin probe configuration and the remote probes were incorrectly moved, it is useful to try and make the grid squares match using the **Add/Subtract/Multiply/Divide**, or **Edge Correction** filters, not only for aesthetic reasons, but because the edge between the grid squares will produce undesirable artifacts under some of the other filters and plots. After this, if you are using a magnetometer, you will probably need to **Destripe** and **Destagger** your data. The **Interpolate** filter should always be applied last, as **Interpolating** before using any of the other filters will render their algorithms useless. Interpolating will also substantially increase the amount of data the software has to deal with, slowing it down. **Interpolating** gives better results when you are using the **Relief Plot**, but if you are using that plot, try to steer clear of using **Remove Geology** as that will remove some of the lumps and bumps that the plot depends on. If you are using both plots, produce two views, using **Remove Geology** on only one of them. **Remove Geology** is only really useful when you have massive changes in the background soil depth, usually because of a slope. The **Sharpen** filter is useful for removing rubble from around walls, especially when directed, but you may need to do a second **Despike** afterwards, particularly if you intend to **Interpolate**, which is usually necessary after a **Sharpen**, just to clean things up a bit.

2.9   Printing

You can print images to your printer from both [Previews](#) and [Views](#). As with many windows programs, there are three relevant options in the **File** menu. **Print...** will start the process of printing your image to the printer, whilst **Print Preview** will give you an idea of what it will look like on paper. By default, the image is printed as large as possible on the paper, though this and other settings can be changed by selecting **Print Setup...** from the **File** Menu. The Print Setup window looks like this:
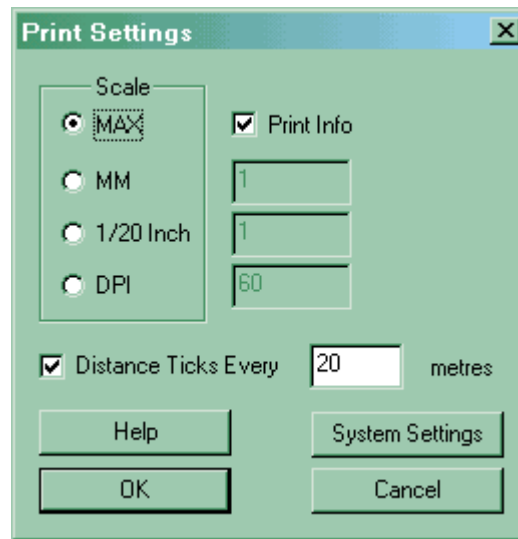
The default setting of **Max** for the **Scale** options will print the image as large as possible on the page. **MM** and **1/20 Inch** mean that a single cell on your printout will be printed at the size you specify. With **DPI**, the number specified is the number of cells that will be fitted into an inch on the printout. The **Systems Settings** button will bring up the standard Windows printer settings, in which you can specify Landscape Mode, which is useful if your image is wider than it is tall. The **Print Info** tickbox tells Snuffler to print information on the printout along with your image. This information, which will appear at the bottom of your image, consists of the name of the View, the width and height in cells and in real terms, the sample size at which the survey was done, an arrow pointing north and scales showing the clipping boundaries and distance. The direction of north along with the sample size can be changed by selecting **Image Properties** in the Display Settings. The **Distance Ticks** option will put small marks at the edge the printed image so you can judge distance without having to break up your image with a grid. Once this is turned on the software will put one of these distance ticks at an interval that you specify. If the value is set to zero, it will use the grid size in whatever image you are printing.

2.10 View Info

The **Info** menu and section on the toolbar contains four options, which will give you various bits of information about the image you have created.

Image Information gives you a set of statistics about the image you are working on. The related **Selection Information** gives you the same information, but works on a selected part of the image rather than the whole image. A part of the image can be selected by clicking and holding the left mouse button on the image on one corner of your selection area and dragging it to the opposite corner. Your selection is now highlighted in red and the 'Selection Information' menu option can be used. The other difference between the two option is that with the latter, the 'Average' figure is held by the computer for use in the 'Modify Selection' filter. The various pieces of information that you are given are as follows:
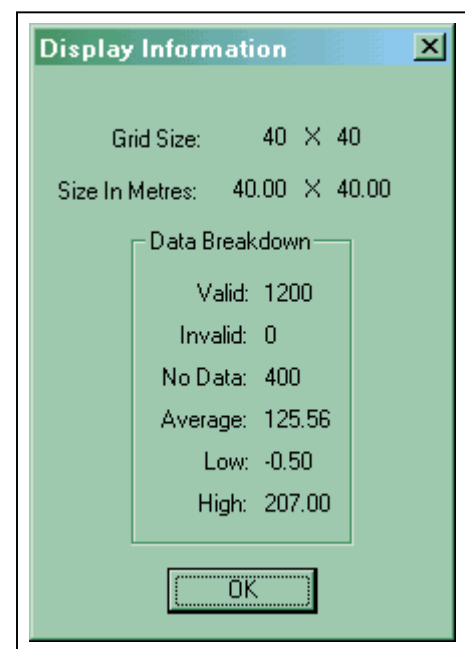
■ **Valid** - The number of cells containing data in the image
■ **Invalid** - The number of invalid cells, where you have specified there is nothing

- **No Data** - The number of cells where you have said nothing at all
- **Average** - The mean of the data values within the image
- **Low** - The value of the lowest reading
- **High** - The value of the highest reading

Measure Angle is a tool used to measure the angle between the nearest vertex in the anti-clockwise direction and the line specified by two points. After selecting the Measure Angle option, the mouse pointer will change, prompting you to select the first point, which is the point around which the angle is calculated. The second point you select will complete the line used to calculate the angle. The best way to understand this is to use it a few times to see what it is doing. The angle is stored byt the software for subsequent use in the Sharpen filter.

Measure Distance asks you to select two points on the image in the same way as the Measure Angle tool above, but will give you a distance between the two points based upon the Scale given in the Display Setting/Image Properties. This is useful in the field if you want to set out a trench for excavation. If you know the location of at least two points on the ground that are on the image, you can measure two distances from these points to the point you want to find and triangulate using two tapes to find it on the ground.

VRML Export

Right clicking on a View or Preview and selecting the **Export** option will give you several means to export your data, one of which is **To VRML**. VRML stands for Virtual Reality Modelling Language, which is a type of data file which describes 3D worlds. To view these files, you will need a suitable plugin for your web browser. I recommend Cosmo Player. Snuffler will produce a file which will show your data as a landscape with hills for high readings and valleys for low readings.

When you select the option to export VRML, you will see a window that looks something like this:

The first three items are the X Readings / Metre, Y Readings / Metre. These are defaulted from the Image Information window in Display Settings, but you can change these values for the VRML export. The Maximum Height for the data is shown in metres, since everything in a VRML world is measured in metres. That height is used for the highest point in your data, with everything else in proportion to it. Interpolating your image beforehand is recommended, as you will get a more pleasing landscape image with less jaggedness.

The Ground Colour and Sky Colour can be selected from a short list. If the Use Clipping flag is set, the high and low data will be clipped in much the same way as on your normal image, which will leave you with flat areas in places, though can remove unsightly spikes. The View From options allows you to select at which corner of the image you want the initial viewpoint to be. After you have made your choices and clicked **OK**, you will be given a standard file requester to select the name of the file to save the data to, which will default to the name of your document, with an extension of **.wrl**. You can now view this file with your browser, or upload it to your web site to be viewed by others. You can now fly or walk around the landscape created. It is particularly satisfying to walk along a ditch or along the corridor of a villa.
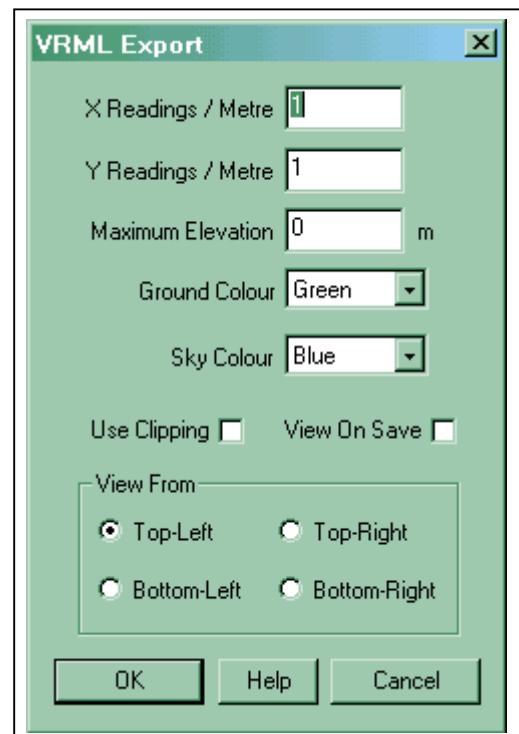
Finally, the **View On Save** flag will tell Snuffler to run your default application for viewing VRML files. If you do not have one set up, nothing will happen. Please note that some plugins like Cosmo Player, which is detailed above, will assign the default application to the plugin itself, rather than your browser. This will also cause nothing to happen, so if this is the case, you must tell Windows (using the File Types tab in Folder Options) that your web browser is the default application for the wrl extension.