RAMAG™

Instruction Manual

Version 2.2 - USB

VLF Survey Planning and Interpretation Software

For the Abem Wadi and other instruments that record VLF dip angle measurements

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Quick Start

Program Installation: If the RAMAG software has not been installed yet, follow the instructions in Section 2.4.

Starting the program: assumes that the software was installed on drive C: in a folder called RAMAG2**.**

Using Windows Explorer:

1. Navigate to the c:\ramag2 folder
2. Double click RAMAG2.EXE to start the program

Using the Windows Start button:

1. From the Windows desktop, click the Start button, then Run
2. Type c:\ramag2\ramag2.exe and press <Enter> or click OK

Step	Description
1	Load a Wadi data file (.WAD) by selecting [Data] / [Load File] from the Main Menu**.** Then choose which profile to read.
2	Select [Data] / [Set Data Units] and enter distance units (feet or meters). Only the first letter " f " or "m" is used. Feet is the default when the program begins for the first time.
3	Set filter depth by selecting [Plot] / [Set Filter Depth]. Maximum depth allowed is 100 units (feet or meters).
4	To plot a line graph of the raw unfiltered data, select [Plot] / [Unfiltered Data]
5	To print the unfiltered line graph, select [File] / [Print Setup] from the graph window menu. Choose which printer to use if more than one is installed. You can also choose page orientation (portrait or landscape) and other properties available through the Windows Printer driver. To print the graph, select [File] / [Print Selected Graph].
6	If you want to re-scale the graph to a different size, click on the graph selector button (red square) in the upper right corner of the graph window or select [Graphs] / [Parameters] from the graph menu. Change the graph width and height values in the Graph Parameters dialog box. For example, to make the graph 50% of it original size change the width and height to 50%. To

make the graph fill the entire page when printed, select [File] / [Print Options] and choose [Print graphs to max size] in the Print Style grouping.

7 To close the graph window, select [Close Graph] / [Close].

8 To plot a filtered line graph, select [Plot] / [Filtered Data].

9 To plot a filtered current density cross section, select [Plot] / [Cross Section]. Maximum length is 300 data units (feet or meters). Cross sections are displayed in color by default. If grey scale is preferred, select [Plot] / [Set Color]. Filtered in-phase (real) data is also the default. If both in-phase and quadrature (imaginary) is desired, select [Plot] / [Set Plot Type] and choose both by entering “2".

10 To save line graphs or cross sections as Windows bitmap files (.BMP), select [Save] / [Filename] from the Main Menu. After entering a filename for the bitmap, select [Save] / [Save As .BMP] to save the contents of the graph window.

11 If you want to explore the interactive graphics design capabilities built into RAMAG, see Section 5.0 Interactive Graph Design or run the Tutorial in Section 6.0.

12 To end the program, select [Quit] / [Quit Program].

1. Introduction

In geophysical VLF work, it is the magnetic component of the electro-magnetic field from distant radio transmitters that is used. RAMAG stands for radiomagnetics and it is software designed for the planning of a VLF survey and for the interpretation of recorded geophysical VLF data. In this application, VLF stands for very low frequency referring to transmitters in the range of 15-30 kHz.

1.1 Program description

RAMAG transfers data from the Abem Wadi and transforms field data into line graphs of original (raw) or filtered data in either single profile or multi-profile format. Graphs can be scaled to any size supported by the currently installed printer. A current density cross section can also be produced in color or grey scale.

All graphs, except the multi-profile plot, can be completely customized by using the interactive editing tools that are built into the software. Graph components such as text labels and fonts, X and Y axes, axis labels and ticks, line attributes (thickness, color, solid, dashed etc.), spline smoothing, and data point symbols are examples of features that can be edited and changed by the user while the graph is on screen. However, an internal set of default parameters will always produce a good looking graph on an 8.5x11 page without using the interactive options. Line graphs and cross sections can be saved as Windows bitmap (.BMP) files. This allows the saved files to imported into other graphics programs or word processors for additonal annotation or for inclusion with text documents.

The linear filtering process used herein is based on the Karous and Hjelt algorithm published in 1983. This filtering algorithm has been combined with a weighted running average smoothing function.

A survey planning module is accessed by selecting [Transmitters/Locate] from the Main Menu. The Survey Planner has input boxes for entering the latitude, longitude and local time zone of the proposed survey site. The program then searches a database and produces a listing of all transmitters within 7000 km radius. For each transmitter found, the listing provides the distance in km, the bearing relative to true North, the effective transmitting range and the off-air schedule in local time (if known).

This manual assumes that the user is familiar with the VLF surveying method and is knowledgeable on how to apply and interpret the graphical results produced by this software. For those who need a review or some additional guidance**,** please refer to the *Abem Interpretation Guide - Theory, practice and case stories for Wadi operators* issued by Abem Instruments.

1.2 Warranty

The author has performed a variety of quality control tests using various computers, processors, and output devices to ensure that the RAMAG software and the Instruction Manual are free from errors. However, the author does not assume any responsibility for results obtained using this software.

No warranty is granted by the author regarding the RAMAG software or its fitness for a particular use or purpose. The author assumes no responsibility for steps that are either taken or not taken as the result of decisions based on the use of the RAMAG software. The author is not liable for any lost revenues or profits which may result from the use, or inability to use this software.

It is the user's responsibility to make sure that the interpretation derived from the use of this software is accurate and correct.

2. Software Installation

2.1 The RAMAG distribution disk

The software is provided on CD-ROM and contains the following 14 files:

RAMAG2.EXE	SETUP.EXE
VBHOOKR3.DLL	SPI721.EXE
WCT32FR3.DLL	WADIDL.EXE
WTZ.FRX	SAXCOMM.OCA
MSVBVM50.DLL	SAXCOMM.OCX
EXAMPLE1.WAD	AUXDB.DAT
EXAMPLE2.WAD	MANUAL2.PDF

MANUAL2.PDF is an Adobe Acrobat PDF version of the hard copy Instruction Manual. It can be viewed on screen using Adobe Acrobat Reader Version 4 or later. It is usually bundled as part of the Windows operating system. A free copy can also be obtained directly from Adobe.

2.2 Hardware requirements

To use the RAMAG Version 2.2 - USB software you will need a computer with one of the following Microsoft Windows operating systems: 2000 or XP. The computer monitor and graphics card should be capable of standard SVGA resolutions. A USB port must be available for the software protection key (USB dongle). Graphics will be output to the current active Windows printer.

2.3 Software limitations

Maximum number of profiles within a data set is limited to 10.
Maximum number of data points per profile is limited to 400.
Current density cross sections can not exceed 300 distance units in length.

2.4 To install the RAMAG software

Important Notes:

–> Do not plug in the USB hardware key (dongle) until after the software is installed.

–> Installing a USB device driver with Windows 2000 or XP requires that the user be logged in to an account with administrator privileges. To check your account status follow these steps: click Start > Control Panel, then double-click the User Accounts icon.

To install the RAMAG software on your computer, proceed as follows:

1. Create a folder(directory) on the C: drive called RAMAG2. Other drives such as D: can also be used.
2. Copy all 14 files on the CD-ROM to the C:\RAMAG2 folder.
3. Create a folder named VLFDATA and copy the example data files EXAMPLE1.WAD and EXAMPLE2.WAD and any other field data files (*.WAD) to this folder. This will speed up the process of loading data into memory because the default search path is c:\vlfdata\
4. From the RAMAG2 folder, run the set up program by double clicking SETUP.EXE or choose the “Run” command from the Start Menu and type c:\ramag2\setup.exe. Once the set up program has started, click the Install button. The installation process is completely automated and requires no input from the user. Click Exit when finished.
5. Plug in the USB hardware key. A message will indicate that New Hardware has been found and is installed and ready to use. Installation is now complete.

2.5 Starting the software

The following two examples assume that the software was loaded onto drive C: in a folder (directory) called Ramag2.

Using Windows Explorer:

1. Navigate to the C:\Ramag2 folder
2. Double click the RAMAG2.EXE file to start the program

Using the Windows Start button:

1. From the Windows desktop, click the Start button, then Run
2. Type c:\ramag2\ramag2.exe and press <Enter> or click OK

2.6 Uninstall the software

To uninstall the software, click the Start button > Control Panel > Add or Remove Programs Highlight the Sentinel Protection Installer 7.2.1, then select Remove.

3. Main Program Menu

Upon starting the software, the Main pull-down menu headings shown below will be displayed at the top of the window. This screen is the primary RAMAG work space.

Data Plot Save Transmitters Wadi CloseGraph Quit

3.1 Data

3.1.1 Load File	Select a VLF data file and a particular profile within that data set for display and processing. If you are loading an edited data file, make sure there are no blank lines at the end of the file. Blank lines will produce an “Input past end of file” error.
3.1.2 Change Profile....	Select a new profile for processing.
3.1.3 Data Info	Display the data information screen. This is useful for reviewing a data set and for selecting X-axis limits for current density cross sections.
3.1.4 Set Default Folder	Select a new default folder for retreiving data files. When RAMAG starts, it looks for c:\vlfdata. If data is stored in another folder, use this menu option to reset the default.
3.1.5 Set Data Units	Set the distance units to feet (default) or meters. Upon exiting the program, the data units currently in use will be saved and automatically reloaded the next time the program is started.

3.2 Plot

The first three menu items will allow the user to plot line graphs or a multi-profile line graph in an X - Y axis format. The X axis is displayed in distance units (feet or meters). The data units for the Y axis is In-phase (%). This is the percentage of the total in-phase response

produced by the subsurface conductor (anomaly). Quadrature refers to the out-of-phase response measurement. Note: In the Wadi Instruction Manual, the terms Real and Imaginary are used to represent the In-phase and Quadrature measurements, respectively.

3.2.1 Unfiltered Data ... Plot a line graph of raw unfiltered data

3.2.2 Filtered Data..... Plot a line graph of filtered data. The Y axis is the output from the Karous Hjelt filter operator. Units are % In-phase.

3.2.3 Multi-Profile ..... Displays the Multi-Profile window. The Graph button produces a filtered graph of every profile in the data file using a filter depth = 60 ft or the value set in 3.2.5. If profiles are clipped along the Y-axis, increase the Y-axis limits (%) using the New Scale button. Default is -30 30. The Print button sends the Multi-Profile plot to the currently installed printer. The Exit button clears the plot window and returns to the Main Menu window.

3.2.4 Cross Section.... Displays the X-axis Limits input box for current density cross sections. X-axis length cannot exceed 300 distance units, (default is 0 to 250). A color cross section is displayed by default. If a grey scale image is preferred see 3.2.6 Set Color. Values along the color bar are In-phase (%) which represents the approximate percentage of the total In-phase signal being produced by the subsurface conductor.

3.2.5 Set Filter Depth... Sets the filter depth for line graphs, multi-profile plots, and current density cross sections. Default = 60 (feet or meters). Maximum depth allowed is 100.

3.2.6 Set Color ..... Sets the color scheme (color or shades of grey) for current density cross sections. Default is color. Select grey for output on non-color printers.

3.2.7 Set Plot Type Allows the user to select the type of current density cross section to plot**.** Enter 1 for in-phase only or 2 for both in-phase and quadrature. Default is in-phase only.

3.3 Save

This menu item allows the on screen graphics (line graphs and cross sections) to be saved as Windows bitmap files.

3.3.1 File name — Enter a file name for the bitmap file to be saved. Include drive:\folder\filename if you want to save it to a different folder. Use the .BMP file extension.

3.3.2 Save As .BMP — Saves the file using the specified file name.

3.4 Transmitters

This is the entry point to the VLF survey planning module. After entering the longitude, latitude, and local time zone of the survey site, the program will list suitable VLF transmitters, distance to the transmitters and approximate range of the transmitter. If known, the scheduled off-air periods for maintenance will also be given in local time and date.

3.4.1 Locate ..... — Displays the Survey Planner dialog box. Input boxes are provided for entering latitude, longitude, and local time zone. The Time Zone Map button loads a world map with time zones onto the screen. The Transmitters button provides a detailed listing of all transmitters within 7000 km.

To save a copy of the listing to a default file named "temptx.dat", select Copy from the menu bar. The Return button clears the screen and returns to the Main Menu.

The following information is presented on the tabulated transmitter listing:

Code	Three digit station identification code
Freq kHz	Transmitter frequency in kilohertz
Station, Country	Station name and host country
Powr kW	Power output in kilowatts
Sched. Off	This is the regularly scheduled time and day that the transmitter will most likely be off the air for maintenance and repairs etc. relative to the local time of the survey site. If the schedule is unknown, 0-0 will be displayed.
Dist km	Distance in kilometers between the survey site and the transmitter.
Dir deg	The bearing (0-360) to the transmitter relative to true (geographic) North.
Range km	This is the estimated effective range of the transmitter (in kilometers). The range calculation is based on an empirically derived equation that uses power output and the modeling results of Hauser and Rhoads (1974).

3.5 Wadi

The Wadi download module provided with this software is contained in the executable file called WADIDL.EXE. It is used to transfer data from the Wadi to a PC through the serial port. This is a stand-alone program and can be started two different ways: it can be initiated from within the RAMAG program by selecting [Wadi] / [Data Transfer] or it can be run independently by double clicking on WADIDL.EXE. You can also use the run command in the Windows Startup menu. Type c:\ramag2\wadidl.exe then <Enter>. If RAMAG is running on an older laptop or desktop with limited memory, it is recommended that WADIDL.EXE be run independently to avoid possible out-of-memory errors.

3.5.1 Data Transfer..... Starts the down-load module which transfers data from the Wadi to the host computer using the RS232 port.

On-screen instructions are provided that guide the user through the transfer process from beginning to end. A summary is provided below.

Initial Steps:
1) Connect the Wadi to the computer serial port (Com1, 2, 3, 4) using the interface cable.
2) Turn on the Wadi
3) Start RAMAG and select [Wadi/Data Transfer] from the Main Menu. Click [UserInput] on the Wadi down-load menu bar. This opens the User Input window. Enter the filename and file header, then select the appropriate Com Port. Click OK to accept or Cancel to abort.
4) On the Wadi: Press the [::] button two times for a listing of stored profiles. Enter the profile to be down loaded next to the word Coordinate:
   Example: Coordinate: 100-> where 100-> is the profile designation.
5) Click the Start button on the computer screen to initialize transfer.
6) On the Wadi: Press F => 1, F 2 to start sending the in-phase (real) data. The => symbol represents the large green arrow. The raw data will be displayed line-by-line in the Com Port window. The computer speaker beeps when transfer is complete.
7) On the Wadi: Press F => 3, F 2 to start sending out-of-phase (imaginary) data.

When transfer is complete, a User Input dialog box displays the following:

> Do you want to:
> 1) Down-load another file to the Active File
> 2) Open a new Active File for data transfer
> 3) EXIT program
>
> Enter (1, 2, or 3)

Entering 1 allows the user to add another profile to the currently open data file. Steps 4, 6, and 7 are then repeated.

Entering 2 closes the active data file and prompts the user to click the [UserInput] menu item again and enter a new file name and file header. If the Wadi contains data from several different survey sites, this allows the data to be stored in separate files. Steps 4-7 are then repeated.

Entering 3 terminates the data transfer process, closes the down-load screen and returns to the RAMAG Main Menu.

3.6 Close Graph

3.6.1 Close ..... Closes the graph window and releases memory.

3.7 Quit

3.7.1 Quit Program ..... Exits the Ramag program and returns to the Windows operating system.

4. Graph Menu

The graph window is a sub-window that fills the main program screen when Unfiltered, Filtered, or Cross Section is selected from the Plot Menu. A separate menu bar is used to manipulate the contents of the graph window. A description of the graph pull down menus is provided below.

4.1 File

4.1.1 Save As Metafile Saves a line graph as a Windows Metafile. The user is prompted for a filename. Current density cross sections cannot be saved as Windows metafiles. To save cross sections as Windows bitmap files see Sections 3.3.1 and 3.3.2

4.1.2 Print Current Page(*) Sends a copy of the graph to the currently installed printer. (Select Print Setup first)

4.1.3 Print Selected Graph(*) Currently the same as 4.1.2. In future versions, a page may contain more than one graph that can be printed separately. (Select Print Setup first)

4.1.4 Print Setup(*) ..... Displays the printer dialog box that allows the user to change configuration settings of the currently selected printer or to select a new printer.

4.1.5 Print Options ..... Displays a dialog box that allows the user to select various printing options such as graph size and page position.

Printing Note (*): Some Windows printer drivers need to be initiated prior to printing. In RAMAG this is accomplished by selecting [File] / [Print Setup] from the graph menu. Simply opening and then closing the Print Setup dialog box will initiate the driver and it will stay active until the program is closed.

4.2 Edit

Edit options, Copy Graph and Copy Page, are for line graphs only. Current density cross sections will not copy properly to the Windows clipboard.

4.2.1 Copy Graph ..... Copies the graph to the Windows clipboard. This allows the image to be pasted into other applications. (Line graphs only)

4.2.2 Copy Page ..... Currently the same as 4.2.1 (Line graphs only)

4.3 Graphs

4.3.1 Parameters ..... Displays the Graph Parameters dialog box that lets the user change the position, size, color, and border attributes of the graph. This editing option can also be activated by using the graph selector button (red square) in the upper right corner of the graph.

4.3.2 Fill Page ..... Enlarges the graph window to fill the screen (default).

4.3.3 Delete Graph ..... Removes the graph from the graph window.

4.4 Options

4.4.1 Show Selectors... Both options are reserved for future versions where multiple graphs may appear on one page.

4.4.2 Highlight Selected Graph Same as 4.4.1.

5. Interactive Graph Design

5.1 Types of graphical objects

A graph consists of a collection of graphical objects. The following object types can be edited or changed by the user: axes, axes labels, axes titles, graph titles and text, graph data and the line plot.

5.2 Graphical object properties

Examples of object properties that can be changed are: color, line attributes (style, width, color), font style and size for titles and labels, and spline smoothing for line graphs.

5.3 Selecting objects for editing

To edit a graphical object, it must be selected. This is done with the mouse arrow cursor. If the cursor is positioned over a graphical object and the left mouse button is clicked, the object will be highlighted by a blinking rectangular border. A double mouse click will briefly highlight the object and then open the appropriate dialog box for editing that object.

6. Tutorial

Load a data file and view the profile information screen

Start RAMAG and select Load from the File Menu. The program looks for a folder called c:\vlfdata that contains Wadi files. If this folder is not found it defaults to the currently active folder. Load the file EXAMPLE1.WAD and select profile 100W. Go to Data Info under the File Menu to display a data information window. Data Set information pertains to the entire group of profiles contained in EXAMPLE1.WAD. Profile information is relevant to the selected profile, in this case 100W. This is useful for reviewing profile coordinates and line lengths and for determining X axis limits for current density cross sections. Click Return to close the window.

Plot unfiltered and filtered data using preset and interactive graphics

Select Unfiltered data under the Plot Menu. A plot window opens and displays a basic line graph of unfiltered in-phase and quadrature data. Close the plot window by clicking (CloseGraph/Close) on the Main Menu or by clicking the Windows close button [X] in the upper right corner of the plot. Now select Filtered Data from the Plot Menu. The plot window shows Profile 100W filtered at a depth of 60 ft, which is the default filter depth. To change the filter depth, go to Set Filter Depth under the Plot Menu.

Position the tip of the arrow pointer anywhere on the Y axis and double click. This opens the vertical axis display box for editing. Click the check box next to Major in the Grids Group, then click on the style button and change solid to dashed. Click OK, then OK again to close the editing windows and update the filtered graph. The Y axis now ranges from -20 to 40 and dashed lines are projected across the graph at major tick intervals. Double click the X axis and change the maximum to 250, then OK. The X axis is now 0 to 250.

Now move the arrow pointer to any point on the in-phase (dark red) line graph and double click. Click the Spline check box, then OK. The line graph is now displayed as a smooth

spline curve. If you want to fill in the area below the curve with a solid color, return to the curve editing box and check the Fill Area option.

Double click the data curve again and select the Data button. Here the filtered data can be edited and revised. To edit the raw data, first display an Unfiltered graph. To send a copy of the edited data to the Windows clipboard, select the Copy button.

Any of the graph titles or axis labels can be edited by double clicking on the text. For example, change the Example title to a bold font. Close the graph window.

Viewing current density cross sections in color and grey scale

Select Cross Section under the Plot Menu. Accept the default axis limits of 0 and 250. Cross sections are limited to 300 data units (ft or m). If profiles are long, use the x axis limits box to specify which section of the profile is to be used for filtering. Click OK to display the cross section in color. The display shows two shallow conductive anomalies that merge at a depth of 50-60 feet. Close the graph window and return to the Plot Menu. Change the filter depth to 70 feet by selecting [Plot] / [Set Filter depth]. Also, select Change Color under the Plot Menu and enter a 2 for shades of grey. Now display the cross section again. Grey scale cross sections look good on laser printers and non-color ink jets.

At any time, you can print the line graph or cross section by choosing Print Setup under the File Menu in the graph window. This will initialize the Windows print driver and allow print orientation (portrait or landscape) and other properties to be set. See Print Setup and Print Options in sections 4.1.4 and 4.1.5.

Multi-Profile Plots

First change the filter depth to 20 by selecting [Plot]To produce a stacked line plot of all profiles in a data set, select Multi-Profile under the Plot Menu. Click the Graph button to filter and plot the graphs. If the individual line graphs appear to overlap, they can be adjusted by using the New Scale button. For the EXAMPLE data set, change the scale to -50 50 and then click the Graph button again to re-draw. The maximum number of profiles that can be displayed is 10.

Retreiving information from the Transmitter Data Base

Select Locate under Transmitters on the Main Menu. A survey site coordinates screen is displayed showing input boxes for latitude, longitude, and time zone. If you are not sure of the time zone, click the Time Zone Map button to display a scrolling map of the world. Click the Transmitters button to accept the default coordinates for Fallbrook, CA. The survey planner produces a listing of all transmitters within a 7000 km radius. One of the headings on the list is Dir(degrees). This is the direction to the transmitter relative to true

North and is useful in the field when laying out the survey grid so as to optimize signal strength. The effective transmitting range and the off-air schedule (if known) in local time is also provided. Select copy from the Menu bar to write a copy of the listing to a file called "temptx.dat" in the default folder. This is an ascii text file and can be printed using the Windows notepad program or any other text editor. Click Exit to close the listing window.

7.0 Transmitter data base

The RAMAG software is delivered with a worldwide VLF transmitter data base contained in the file AUXDB.DAT. When new VLF transmitters are found or when information about a known station change, it may be desirable to update the data base.

7.1 Updating the VLF transmitter data base

If you would like to add a new station, revise a station frequency or update the scheduled off-air time or day, simply load the AUXDB.DAT file into a text editor, make changes to the appropriate columns, save as AUXDB.DAT and copy the revised file back into the RAMAG directory.

7.2 VLF transmitter data base file format

The transmitter data base format used by RAMAG is shown below. The column assignments must be strictly adhered to.

Example transmitter data base entry

NAA 24.0 Cutler,Maine,USA 1000 067W17 44N39 5600 1000-1800Mo -5

Columns	Example	Description
1-3	NAA	Station Code
7-10	24.0	Frequency in kilohertz
13-32	Cutler,Maine,USA	Transmitter location, country
34-37	1000	Power output in kilowatts
40-45	067W17	Longitude (degrees/direction/minutes)
48-52	44N39	Latitude (degrees/direction/minutes)
55-58	5600	Transmitter range (if unknown, leave blank)
61-69	1000-1800	Off-air in Universal Time (blank if unknown)
71-72	Mo	Off-air day of week (Mo Tu We Th Fr Sa Su)
75-77	-5	World time zone relative to Greenwich Mean Time (West is -, East is +)

8. Input data file format

Input data files for RAMAG can be created using any text editor. The VLF readings must be entered as [distance coordinate, in-phase (real), quadrature (imaginary)] beginning on line 5 and can be separated by a comma or, one or more blank spaces (no Tabs). The distance coordinate must be an integer and should be negative for South or West coordinates. If measurements were taken along a series of parallel profiles within the same area, then all data should be entered into a single data file.

An example of a RAMAG data file is shown below. The comments are for descriptive purposes only and are not part of the data file.

```
Boulder Ridge              <-- Header title, columns 1-20
0000W                      <-- Profile ID, columns 1-5
21.4                       <-- Frequency in kHz, columns 1-4
 21                        <-- Number of data points along 0000W, columns 1-3
-50  41.7  5.8             <-- Distance, Real, Imaginary (space or comma delimited)
-40  35.2  5.8
-30  33.6  5.2
-20  37.0  8.1
-10  36.6  7.0             Important Note: When using a text editor to create a data
 0  20.6  3.4              file, make sure there are no blank lines beyond the last
 10  -4.5  0.7             data point, or "Error: Input past end of file"
 20  -12.2 2.4             will occur.
 30  -13.6 4.0
 40  -10.7 6.1
 50  -13.8 7.2
 60  -5.6  10.0
 70  -2.1  12.3
 80  -9.8  10.9
 90  -13.5 10.3
 100 -21.2 10.7
 110 -17.1 14.8
 120 -10.7 20.6
 130 -6.4  17.3
 140 -6.7  17.8
 150 -6.3  16.2
0030W                      <-- Next Profile ID
21.4                       <-- Frequency in kilohertz
 26                        <-- Number of data points along 0030W
 0  19.3  -4.7
 10  26.1  -0.3
 20  29.7  1.9             ... and so on for all profiles in the data set
```

9. Interpretation Notes

The recommended way to use the RAMAG software is to download and plot line graphs of the raw data, inspect the quality and look for signs of cultural noise and interference from powerlines, buried pipelines, grounded metal fences and atmospheric magnetic storms. Data that has a saw-tooth appearance should be considered suspect. If the data looks good, then select areas for filtering at various depths and for producing current density cross sections. Data units are in % In-phase, which is the percentage of the In-phase response produced by the subsurface conductor (anomaly).

If you are exploring for water-bearing bedrock fracture zones or mineralized bedrock with high conductivity, you should look for large positive anomalies on the filtered line graphs. It is very important to understand the local geologic setting and to have an idea of the strata and geologic structures that may be present beneath the surface. Examples of other geologic features that can produce filtered anomalies (peaks) are mineralized contacts, clay deposits, vertical conductive dikes, and fault zones with clay gouge.

There is no direct relationship between the colors on the current density cross sections and the absolute detection of groundwater. Neither the Wadi or any other VLF instrument is a water detector. These instruments simply detect and map electrically conductive zones in the subsurface. The colors reflect the degree of conductivity. Red is very conductive, blue is very resistive. Bedrock that is broken and fractured (more porous) and contains groundwater is more likely to be electrically conductive than massive, hard, and unfractured crystalline rock.

For a full discussion of the VLF method, case histories and how to use and interpret the filtered graphs and current density cross sections see the *Abem Wadi Instruction Manual (Appendix A)* and the *Wadi Interpretation Guide - Theory, practice and case stories for Wadi operators.*

10. Error messages and solutions to common problems

The following error messages and problems are the most frequently reported by first time users of the software. If you encounter an error that is not listed below, make note of the exact wording and the sequence of events or steps just prior to error message. Send to the e-mail address listed on the front cover of the Instruction Manual.

Error message: “Hardware key not found”

Solution: The security hardware key (dongle) is not attached to the USB port or is not pushed in all the way. Check that the key is properly installed. The LED light on the key should be on if the software and key are properly installed.

Error message: “Subscript out of range”

Solution: Some clients attempt to edit or revise bad data points by loading the raw Wadi files into a word processor or text editor. Many times the file is re-saved with the same name but the original file format has been altered. Make sure the text editor does not alter or reformat the file. Windows Notepad is recommended.

Common problem: “Files ending with .EXE, .DAT, .PDF are not seen on the RAMAG CD.”

Solution: The files are not missing. The reason you do not see them is that Windows Explorer has been set to hide file extensions. To reconfigure you computer to show the complete filenames, do the following: open Windows Explorer, on the menu bar click Tools > Folder Options > View. Remove the check mark in the box next to “Hide extensions for known file types”, then click the Apply button. You will now see all file types.