ENVI PRO

OPERATION MANUAL

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0	Initial Release	4933	May 2009	AM
1	p. 10-1 corrected for GPS accuracy	5578	10/03/2011	ZL
2	p. 10-1 corrected for Total Field Range	6246	11/09/2013	RL

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Chapter 1 Preface

Congratulations on purchasing the ENVI PRO environmental magnetometer/gradiometer from Scintrex Limited. You are in possession of one of the most advanced magnetometers for environmental, geotechnical, archaeological and mineral exploration uses of today.

The ENVI PRO is a portable, proton-precession magnetometer that also is inexpensive, lightweight and rugged. In its trademarked WALKMAG mode it is ideal for applications where high productions, fast reading and high sensitivity are required. It is quite versatile and can be optionally configured as a total-field magnetometer, a gradiometer or as a base-station.

Features

The main features of the ENVI PRO include:

- Interactive menus for easy operator use
- Selectable sampling rates as fast as 2 times per second
- WALKMAG mode for rapid data acquisition
- True simultaneous gradiometer option with the WALKGRAD mode for rapid data acquisition
- Single-frequency GPS antenna allowing the user to acquire non-differential positional data along with the magnetometer data
- Large internal memory, expandable to 188,000 readings
- Easy to read, large LCD screen that displays data both graphically and numerically
- Easy review of the data and Datacheck quality control

The complete ENVI PRO consists of several basic modules:

- Lightweight console with a large screen alphanumeric display and high capacity memory
- GPS receiver antenna
- Staff or back-pack mounted sensor and sensor cable
- Rechargeable lead-acid battery and battery charger
- RS-232 cable for downloading data

Upgrades and Options

There are optional upgrade kits available for the ENVI PRO to provide the following:

1. True simultaneous gradiometer – An additional processor module is installed in the console, a second sensor with a staff extender and a ruggedized backpack for the WALKGRAD mode are provided in this kit.
2. Base-station applications – An accessory kit allows the sensor and staff to be converted into a base-station sensor and the cabling allows a field ENVI PRO or ENVI MAG to be connected for automatic magnetic operations down to minus 40°C.

3. Low temperature operations – An external battery pouch along with a thermostatically controlled display heater will permit field operations down to minus 40°C.
4. External trigger interface – This kit provides a tool for acquiring evenly spaced data when no survey grid has been established in advance. The kit is an interface between the ENVI PRO and a triggering device (such as a measuring wheel or a hip-chain that you supply). It works by triggering a station increment at intervals in the WALKMAG mode. Detailed instructions for installation, interfacing and usage are provided with the kit.

Chapter 2 Introduction

This section is the reference for the ENVI PRO instrument itself. You will find all the information you need to know about setting up the unit for field use, its operation, maintenance and trouble-shooting. It is divided into eleven chapters with the information flow from chapter to chapter following a natural progression, as shown in the following table:

Chapter	Description
1. Preface	Features, upgrades and options.
2. Introduction	Outlines what the instrument can do.
3. Preparing	Describes the assembly of the system for use.
4. The Instrument	This chapter is about the instrument itself.
5. Operating Displays	Describes the various display screens.
6. Setting Up	Describes how to initialize the ENVI PRO and program it for different modes of operation.
7. Operating	Guides you through typical instrument operation using basic, search and advanced configurations in a WALKMAG and a Stop-and-go type of survey.
8. Date Output	Shows examples of data output formats and explains how to dump the acquired data.
9. Maintenance	Describes basic maintenance, trouble-shooting and repair.
10. Reference	Contains the technical specifications, instrument parts list and warranty information.
11. Applications	Magnetic Surveying Overview and basic magnetic theory

Cold Boot

Please read the section “First time operation” on page 6—1 so that you will know how to do a *cold boot* of the instrument. This is needed the first time you use it, whenever you wish to change operating configurations or after the batteries have been removed for more than 10 minutes.

Instrument Overview

The SCINTREX ENVI PRO is an easy-to-use, lightweight, battery-powered, portable magnetometer. The magnetometer is a total field instrument using the proton-precession technique to measure the local magnetic field. Optional magnetometer upgrade kits allow the instrument to be used as a gradiometer or as a base-station. The standard configuration has the sensor mounted in a backpack mode permitting rapid data acquisition in the trademarked *WALKMAG* mode.

Measured data is stored in the ENVI PRO console memory along with the coordinates where the measurement took place. You can

also enter descriptive notes of up to 32 characters at any station. The data can be displayed either numerically or graphically for quick inspection of the data quality and spotting of anomalies. Data can also be recalled from memory for visual inspection, dumped either to the serial port (RS-232) of a computer or directly to a printer. You can also automatically correct your magnetic data for diurnal variations when another ENVI PRO is used as a base-station or when you conduct your survey in the TIE mode.

The operating modes of the ENVI PRO can be manual, semi-automatic or fully automatic. In the WALKMAG *(walk*ing *magnetometer*) mode, data are acquired and recorded at rates of up to two readings per second, as you walk at a steady pace along the survey line. At desired intervals, you *trigger* a station marker by pressing a single button and the co-ordinates are automatically assigned to the recorded data. You can even introduce delays in the automatic recording to compensate for walking over rugged terrain.

The ENVI PRO comes with a Single-frequency GPS antenna allowing the user to acquire non-differential positional data along with the magnetometer data. Being a non-differential receiver, the positional accuracy is of the order of a few meters, which is sufficiently accurate for most magnetometer surveys. Should you require more accurate position and sensitivity, you should consider our NAVMAG cesium vapor magnetometer.

Chapter 3 Preparing the ENVI PRO

This chapter describes:

How the ENVI PRO is packaged, how to connect the components to get an operational unit, the various options you may have for powering the unit

The following photographs show the basic components (less packing materials) of the standard ENVI PRO.

The basic ENVI PRO kit

Unpacking

The standard ENVI PRO is shipped in a carrying/shipping case The ENVI PRO with its accessories is packaged in cut-out sections in the case. This provides a proper place for every item when you repack your instrument for shipping or storage. These foam layers are disassembled in the following order, starting at the top:

Repacking

Warning: The batteries must be *removed* from the ENVI PRO console prior to shipping or storage. **Failure to do so may result in damage.**

Assembly

In order to make the system as compact as possible for shipment and storage, and considering the various sensor configurations available, the ENVI PRO requires you to connect up the external components. This section will describe the steps required to completely assemble your instrument.

Connecting the magnetic sensor(s) to the cable

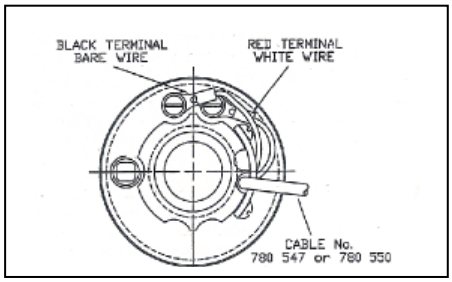
The following illustrations show the proper cable connections for each of the different magnetic sensor configurations. The sensors are shown being viewed from their bottoms looking at the screw terminals.

Important: All parts near the sensor are *non-magnetic.* It is highly recommended that you use only the *brass* screws and wire connectors supplied by Scintrex. There are additional screws for the terminals and cable hold-down in the minor spare parts kit (Scintrex p/n 788030). If you ever need to replace any of these parts under field conditions please ensure that they are made of non-magnetic materials.

Total-field sensor

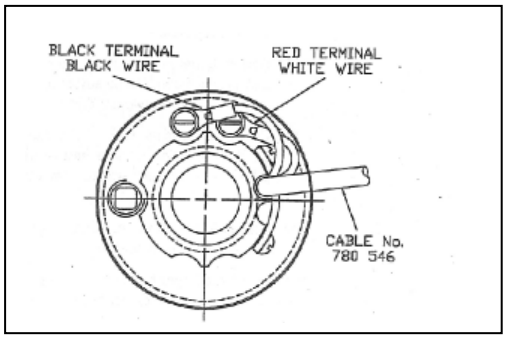
1. Orient the sensor so that as you look at the bottom of the sensor (the end with the terminals), the large square plug is at the 9 o'clock position.

2. Use either Scintrex cable number 780547 (the shorter one) for the backpack configurations or cable number 780550 for the staff configuration.
3. Remove the cable hold-down plate by unscrewing the screws at the 2 o'clock and 4 o'clock positions.
4. Connect the black spade-lug on the bare wire of the cable to the terminal at the 11 o'clock position.
5. Connect the red spade-lug on the white wire of the cable to the terminal at the 11 o'clock position.
6. Place the cable in the smaller slot just below the 3 o'clock position.
7. Re-attach the cable hold down plate.



Total Field Sensor Cabling

Base-station sensor
1. Orient the sensor so that as you look at the bottom of the sensor (the end with the terminals), the large square plug is at the 9 o'clock position.
2. Use Scintrex cable number 780546.
3. Remove the cable hold-down plate by unscrewing the screws at the 2 o'clock and 4 o'clock positions.
4. Connect the black spade-lug on the black wire of the cable to the terminal at the 11 o'clock position.
5. Connect the red spade-lug on the white wire to the terminal at the 1 o'clock position.
6. Place the cable in the larger slot just above the 3 o'clock position.
7. Re-attach the cable hold down plate.



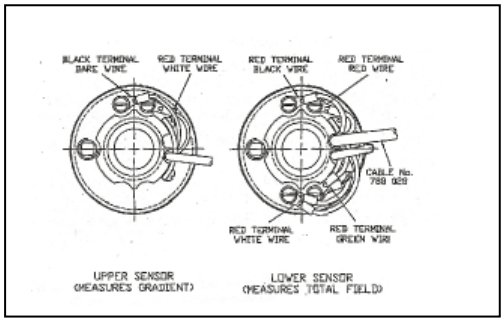
Base-Station Sensor Cabling

Gradiometer Sensors - Lower Sensor
1. Orient both the sensors so that as you look at the bottom of the sensors (the end with the terminals), the large square plug is at the 9 o'clock position.
2. Use Scintrex cable number 788028 - it has four conductors.
3. Select the lower sensor - it has pairs of terminals at the 12 o'clock and 6 o'clock positions, as well as an attached cable to the terminals at the 6 o'clock position. See Gradiometer sensor cabling on page 3—4.

4. Remove the cable hold-down plate by unscrewing the screws at the 2 o'clock and 4 o'clock positions.
5. Connect the red wire of the cable to the terminal at the 1 o'clock position.
6. Connect the black wire of the cable to the terminal at the 11 o'clock position.
7. Connect the green wire of the cable to the terminal at the 5 o'clock position.
Please ensure that the already attached bare wire of the smaller two-conductor cable remains attached.
8. Connect the white wire of the cable to the terminal at the 7 o'clock position. Please ensure that the already attached white wire of the smaller two-conductor cable remains attached.
9. Place the smaller two-conductor cable into the smaller slot just below the 3 o'clock position.
10. Place the larger four-conductor cable into the larger slot just above the 3 o'clock position.
11. Re-attach the cable hold-down plate.
Gradiometer Sensors - Upper Sensor
12. Select the upper sensor - it only has a pair of terminals at the 12 o'clock position. See Gradiometer sensor cabling on page 3—4.
13. Attach the upper sensor to the lower one by placing the shaft of the lower sensor into the socket of the upper one while rotating slightly counter-clockwise. When they are fully engaged, firmly twist them clockwise against each other.

Warning: Both sensors must have their directional marks aligned in the same manner, i.e. the N on the top sensor must be in-line with the N on the bottom sensor.

14. Remove the cable hold-down plate of the upper sensor by unscrewing the screws at the 2 o'clock and 4 o'clock positions.
15. Connect the white wire of the two-conductor cable coming from the lower sensor to the terminal at the 1 o'clock position.
16. Connect the black wire of the two-conductor cable coming from the lower sensor to the terminal at the 11 o'clock position.
17. Re-attach the cable hold down plate.



Gradiometer sensor cabling

Installing the terminal protective cover

A plastic cup-like assembly is included to slide over the base of the sensor(s) to protect the terminal connections from the elements.

To install the cover:
1. Slide it over the sensor shaft with the widest end pointing towards the sensor.
2. Slide the supplied O-ring into the grove on the shaft to lock it into place.
To remove the cover, just reverse the above procedure. First remove the O-ring and slide the cup away from the sensor.

Assembling the sensor / GPS staff

Note: You can disregard this section if you are going to be using the ENVI PRO in the backpack mode.

The sensor staff is shipped in four sections. These sections are located in the shipping case slot labeled Sensor and Staff. You should note that one of the sections has a sealed bottom, and you should start assembling the staff with this section.

Staff sections are assembled individually and connected to the sensors as follows:
1. Insert the male end partially into the female end and rotate counter-clockwise while gently pushing the two parts together.

2. When they are fully engaged firmly twist them *clockwise* against each other.

Staff Mounted Installation

A staff mounted configuration is the most convenient when carrying out a magnetometer survey in the stop-and-go mode.

The following steps are required to properly assemble the ENVI PRO sensor and GPS antenna in the staff mounted configuration.

1. Assemble the staff sections as illustrated.

2. Insert the GPS antenna mount as illustrated.

3. Insert another staff section in order to clamp the GPS antenna mount between two staff sections as illustrated.

4. Insert the magnetometer sensor on the top section as illustrated.

Back-pack Installation

A back-pack mounted configuration is the most convenient; providing a hands-free operation for the ENVI PRO.

The following steps are required to properly assemble the ENVI PRO sensor and GPS antenna in the back-pack configuration.

1. Insert a staff section in the staff mounting insert located on the back-pack as illustrated.

2. If you are using the GPS antenna, insert the GPS antenna mount on top of the previous staff section, as illustrated.

3. Insert a second staff section, as illustrated. The GPS antenna mount will thus be lodged between two staff sections.

4. Insert the magnetometer sensor at the top of the second staff section, as illustrated.



Complete Assembly

Warning: You need to consider your travel direction wile surveying when you attach the sensor. The magnetometer's performance is a function of the sensor's orientation with respect to the earth's magnetic field. Therefore you must ensure that the N mark on the sensor faces either magnetic north (or south – either is allowed due to symmetry). Please see Orientation on page 7-1.

Battery Installation/Exchange

The ENVI PRO is shipped *without* the battery installed. This is the proper procedure, while shipping and storing the instrument, to prevent *deep discharge* of the battery. Deep discharge can possibly cause permanent damage to the battery and will always shorten the battery life. This situation will occur because a small current is being drawn even if the instrument is turned *off.*

The following steps outline the battery installation:

1. **Turn** the instrument face down on a clean and even surface.

2. **Unscrew** both knurled screws on either side of the battery cover and lift the cover off.

3. **Place** the battery into the recess in the rear panel of the instrument.

4. **Connect** it carefully to the MAIN BATTERY connector. It is not important which side of the plug is up, as long as the connector pins are properly aligned.

5. **Replace** the cover and tighten both knurled screws.

6. If this is the first time installation proceed with battery charging.

The small size and low cost of the battery makes it convenient to carry an additional battery along as a spare.

Warning: An internal battery keeps the memory and the internal clock alive for about 10 minutes. It is strongly advised that the switching to the spare battery be done *quickly,* **to prevent the loss of your data.**

Note: You need not worry about a low battery causing data loss, since the memory power requirements are much less than those needed to make a valid reading of the magnetic field.

ENVI PRO battery pack

Using the external battery pack

Cold weather use and extended WALKMAG surveys may require more power than the standard battery together with a spare can provide. To satisfy this additional requirement, the *External Heavy Duty Battery Pack* (Scintrex p/n 788026) is available. It provides about *three* times as much power as the standard battery. This battery pack can be carried by the strap or attached to a belt.

To connect the external battery you must proceed as follows:

1. **Turn** the instrument face down on a clean and even surface.

2. **Unscrew** both knurled screws on either side of the battery cover.

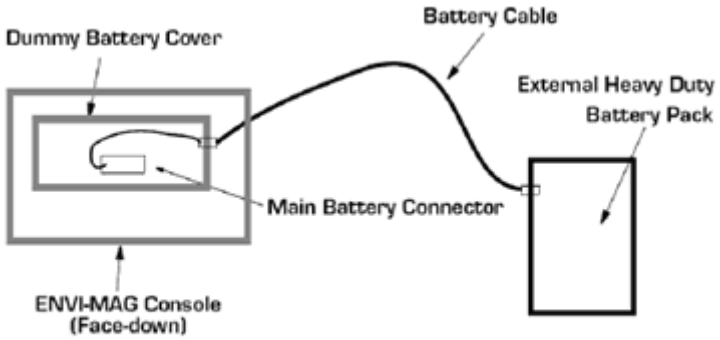
3. **Lift off** the cover and store it somewhere convenient for future use with the standard battery configuration.

4. **Remove** the ENVI PRO STANDARD battery.

5. **Connect** the connector in the dummy battery cover carefully to the MAIN BATTERY connector. It is not important which side of the plug is up as long as the connector pins are properly aligned.

6. **Place** the new cover on to the console by gently pushing it into place and **tighten** the knurled screws on the both sides.

7. Please check the battery voltage condition at this stage and charge the battery, if required.



External Heavy Duty Battery Connection

Using an external power supply

More demanding applications, such as an extended base-station operation, may require more power than can be provided with either of the Scintrex supplied battery packs. In this case you have two options:

a) AC Power

If a source of AC power is available, the instrument can be run while the charger is connected to it. You will also be charging the standard internal battery, if it is installed, at the same time.

Note: Please be aware of possible magnetic noise from generators, and ensure that all cabling and sensors are *as far away as possible* from the generator.

b) 12 volt battery (car or marine)

A 12 volt car battery may be more appropriate for other applications. The special *External Power Cable* (Scintrex p/n 788029) should be used for this purpose.

1. The standard internal battery may be left in place.

2. **Plug in** the end of the cable with the single plug into the Charger Connector at the right-rear side of the ENVI PRO console. See item 6 in the figure on page 4—2.

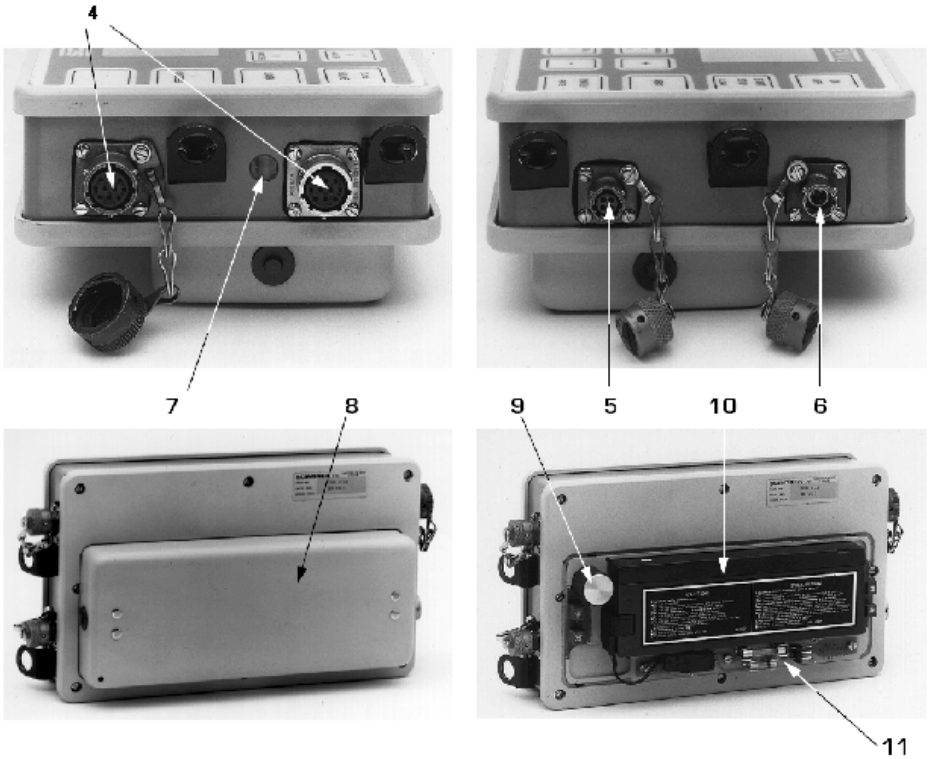
3. **Connect** the end with the clips to the battery terminals. The *red* cable-clip goes to the *positive* battery terminal. The *black* cable-clip goes to the *negative* battery terminal.

Important: The correct polarity must be used for the instrument to operate properly.

Chapter 4 The Instrument

This chapter is about the instrument itself and fully describes:

- The ENVI PRO console
- The keypad functions
- The various display menus
- The display formats that you will encounter



Console Description

#	Item	Description
1	Keypad	The fully sealed Keypad has 19 keys and a sound port.
2	Liquid Crystal Display (LCD)	The large 8 line by 40 character (64 x 240 dots) Supertwist LCD (with a wide temperature range) presents status and data in a numeric or graphic format.
3	Carrying Strap Attachment	Four rings at the side of the console that allow attachment of the carrying harness.
4	Sensor Connector	Up to two sensor connectors may be present at the left hand side of the console. The nearer one **J102, 10 Pin connector,** is reserved for the **magnetometer sensor**. The **J101, 8 Pin connector** is reserved for the **GPS antenna**.
5.	Data Output Connector	The data output connector carries RS-232 data dump signals, as well as the analog signal for a strip chart recorder and is located at the right hand side of the console. It has the following pin assignments: A – common (ground) B – RS-232 receive data C – RS-232 transmit data C – analog out 0-1 Volt
6	Charger/External Power Connector	This connector accepts the charger to recharge either the standard battery or the external heavy-duty battery pack. It also accepts external, well filtered, 11 to 16 Volt DC input. The center pin is negative (-) The shell is positive (+)
7	Charging Light	The charging light (visible through a window on the left side) indicates that the battery is charging at a high rate.
8	Battery Compartment	The battery compartment is located at the back of the console and contains one rechargeable lead-acid battery, the desiccant cartridge and the fuse. The battery cover is replaced with another cover with a cable attached when the external battery is used.
9	Desiccant Cartridge	The desiccant cartridge is a cylindrical re-usable capsule filled with a drying agent. It absorbs any moisture that my get inside the instrument.
10	Battery	A rechargeable lead-acid battery in the standard ENVI – MAG configuration.
11	Fuse	The standard 1.5A fuse to use with the standard battery.

Keypad Description

The keypad has 19 keys. Two of the most used keys are duplicated on the right and left sides of the console for easy access. Some keys have up to three separate functions assigned to them. The response of these multifunctional keys depends upon the operation in progress.

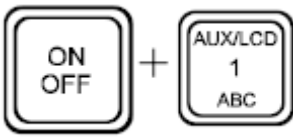
Note: The *function* mode of the keys has precedence over the *alpha-numeric* mode of the keys.

The ENVI PRO keypad

Key Functions

Key	Description
ON OFF	Turns the instrument on and off. Turning the instrument off during a reading abruptly terminates a reading with the loss of the current data.
START STOP CLEAR	Starts or stops an operation, such as data acquisition, data dumping, data recall, etc. *When the instrument is in the Notes operation, this button acts as a “backspace” key to delete entries.

	*Accesses the various setup displays. The actual setup menu that will be displayed depends upon the display screen in which this key is pressed.
	*Accesses the Auxiliary Functions display allowing: - setting of the LCD intensity - data output - locking of the setup parameters
	Moves the cursor to the left or up; to the right or down.
	2 identical keys: - opens and closes the parameter fields during setups - opens and closes the scaling option field for the graphics display - toggles the sample rate in the walking type survey.
	Allows escape from a deeper level in a program to a higher level, ultimately to the top level, which is signified by the Main operating display. Aborts a data dump.
	*Accesses the Info. Display, which allows: - setting of data and time - enabling and selecting GPS coordinates - entering of serial and job numbers, and operator identification - observation of memory availability.
	2 identical keys: - scrolls sequentially through numeric data display pages - scrolls sequentially through graphic data display pages - moves the cursor from one sub-page to the next sub-page - moves the cursor to the next character location during note entry - advances the station number by station separation in the walking mode.
	*Accesses the Note Entry display, which allows: - the entry of five common notes (macros) to be recorded repeatedly with selected readings - the entry of unique notes to be recorded with a particular reading.
	Toggles the data display between numerical and graphic data presentation during data acquisition only.
	*Presents the Recall display for selection of: - data item to be recalled - setting of the starting location or time of the recall.

	*Manually records measured data and notes in internal memory.
	Acts as the START key at a Tie-point. This is used for the Tie-point line and loop mode corrections.
	Facilitates the scrolling forward or backward through a list of items: - allows sign entry to numbers - allows panning along a line of data during recall - increments or decrements the line and station number in the Stop-and-Go mode.
1-9, ., A-Z	*Allows alpha-numeric entry for setups and notes.
BEEPER PORT	This blank “key” in the upper left corner of the console is not actually a key, but a flexible membrane to enhance the loudness of the beeper.
	Pressing the “ON” and “AUX/LCD” keys simultaneously performs the COLD BOOT operation, resetting the instrument to factory defaults.

* These items/key functions are only operational when you select the *advanced* operating modes (options 5 to 7) from the initial configuration menu.

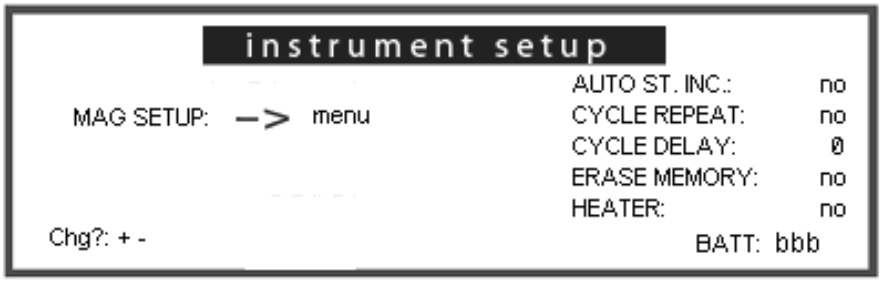
Display Screens

The ENVI PRO currently has the following types of displays:

- Help screens
- Confirmation screens
- Parameter selections screens
- Note entry screens
- Numeric data displays
- Graphical data displays
- Pop-up options and confirmations

General Information

Most of the screens consist of three bands of information as shown below:



General display information bands

The Title Line at the top indicates the current operating functions.
The middle six lines contain specific display information consisting of either instrument and survey parameters or data.

1. The bottom line usually contains prompts for actions, such as pressing the key required to start an operation. Miscellaneous messages may also appear here. The battery voltage (values between 100 and 140) is also shown on the right-side of this line.

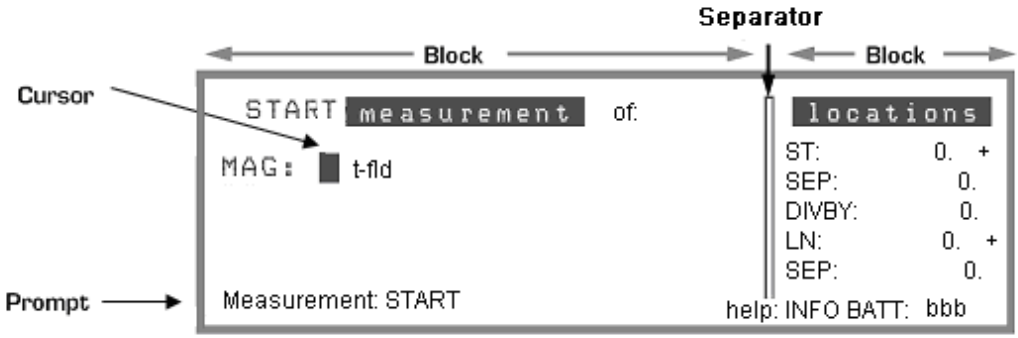
Note: The instrument automatically turns off (blank display) to conserve battery power, if there is no reading or key stroke detected for 30 minutes.

Cursor

A large, blinking *cursor* indicates the specific parameter that can be altered to change setups, starting station value, station or line spacing, and so on. The cursor is moved from parameter to parameter or line to line by pressing the arrow keys to move in the desired direction. The prompt on the bottom line will let you know which key to press to make any changes.

Display Blocks

Some displays are divided into two or more *blocks* or sub-panels. The blocks are separated by solid partition lines as shown in the following figure.



Instrument display showing information blocks (sub-panels)

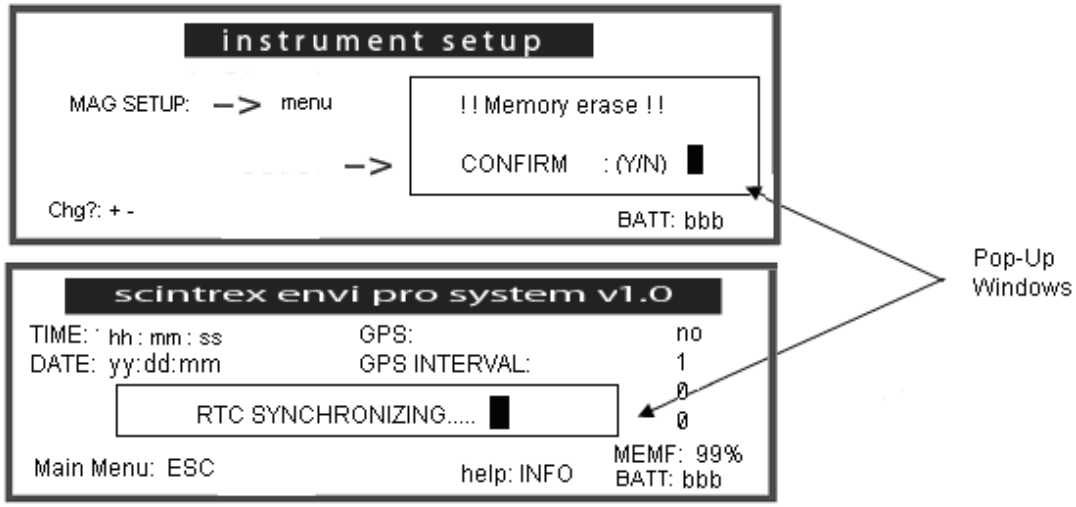
To move the cursor from one block to another, press the “NEXT” key.
Some measured data is displayed on more than one *page* (display screen). Switching between pages is also done by pressing the “NEXT” key. The display screens are designed so that these multi-page displays do not have separate sub-blocks. All of this is discussed in detail under “Advanced mode data displays” on page 5—8.

Pop-Up Windows

Some displays will have pop-up windows (either on the right or left side of the main display) that will contain:

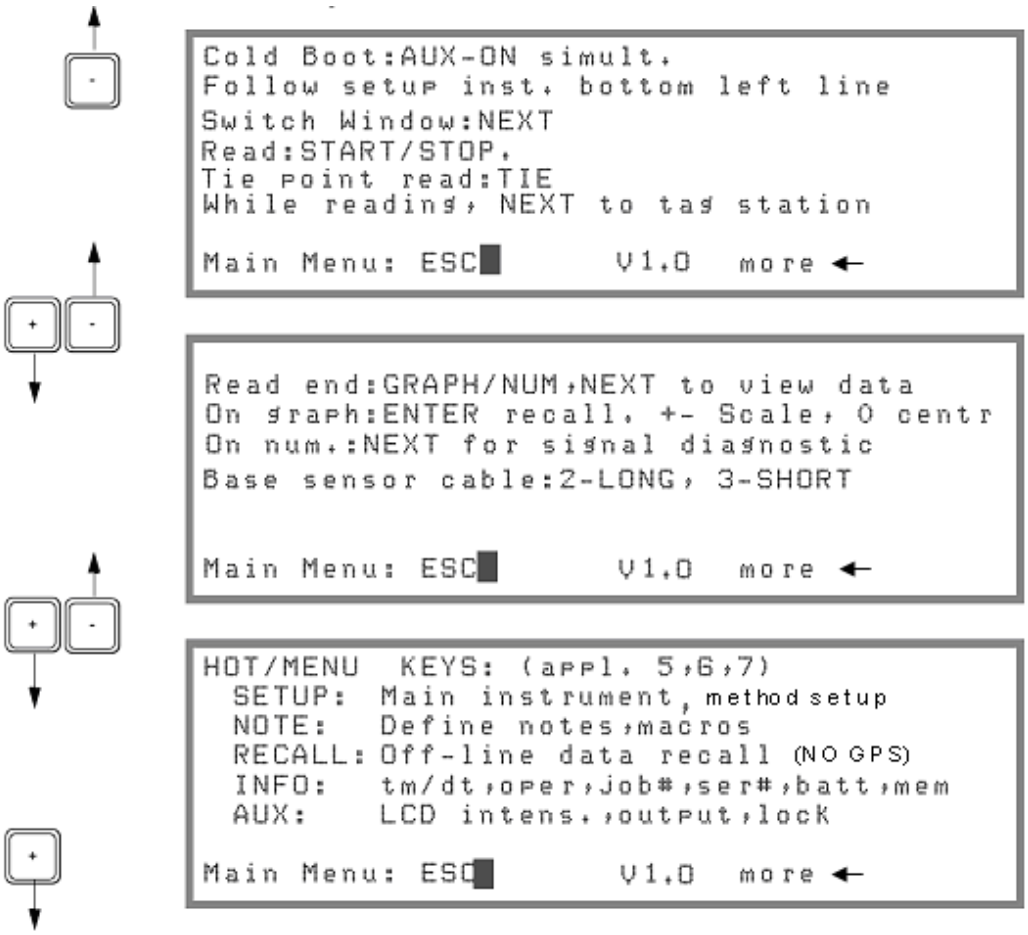
- Prompts for selecting or changing parameters
- Confirmations and warnings of impending operations requiring a Y(yes) or N (no) entry from the keypad
- Status indication of an operation under way, such as data output
- Synchronization of the Real Time Clock of the ENVI PRO console with the GPS time signal

Sample pop-up windows



Help Screens

On line help is also available. There are three screens of information providing a quick reference on how to do most operations and which buttons to push. The screens are as follows:



Help screens available

The help screens are displayed when you press the “INFO” button. Whenever you see the text “help: INFO” in the bottom prompt line of a display, you can activate the help screens.

To toggle to another help screen, press the “+” or “–“ key. The screens change in a cyclical manner.

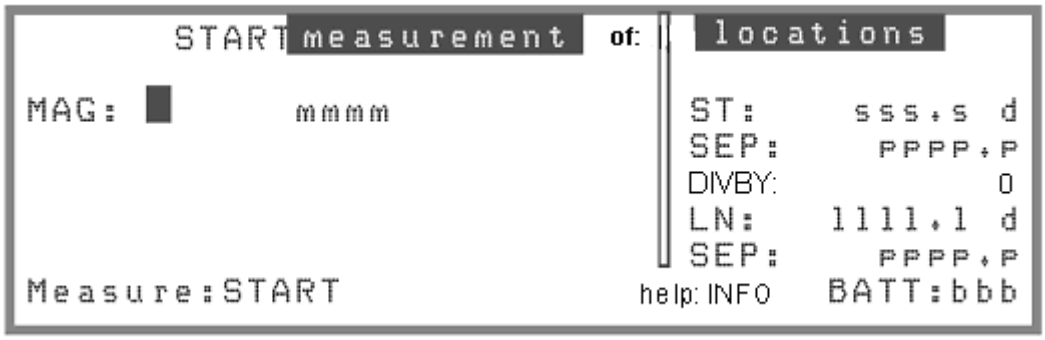
To return to the MAIN OPERATING menu, press the “ESC” key.

Chapter 5 Operating Displays

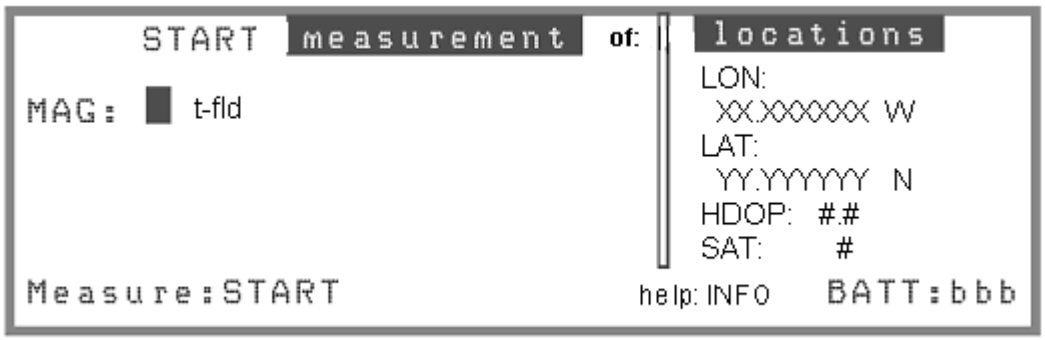
The various display screens with and without GPS will be discussed in this chapter.

Main Operating display

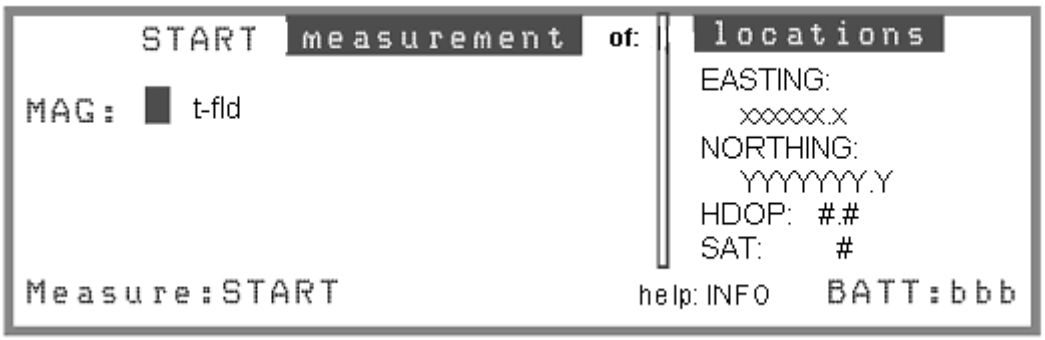
MAIN OPERATING display with and without GPS appears as follows:



Main operating display without GPS



Main operating display with GPS in Lat/Lon coordinate



Main operating display with GPS in UTM coordinate

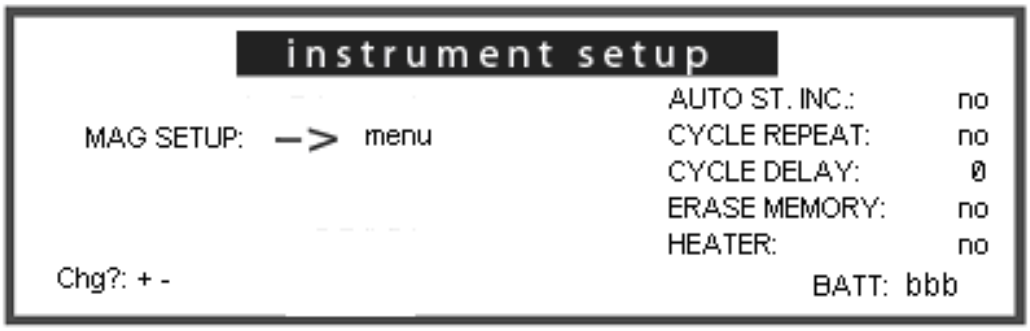
The configurable parameters of the MAIN OPERATING display are:

Parameter	Description
MAG	mmm shows which type of magnetometer measurement is currently enabled, and therefore ready to be started.
ST	The station number for this measurement. It consists of the numeric part (ssss.s) and the directional part (d). The range is from 0 to 99999 with a decimal point as required. The direction allows the entry of the geographical direction or the Cartesian co-ordinates. The allowed entries are N,E,S,W, + or -.
SEP	The line or station separation. The range is from 0 to 99999 with a decimal point, as required, and can either be positive (+) or negative (-). It may not necessarily represent the reading separation. See the “NEXT” key and AUTO. St. INC. for more information. When the separation is positive, the station number gets incremented by the separation. When the separation is negative, the station number gets decremented by the separation. NOTE: a *negative* (W,S,-) station, when incremented, becomes *less* negative, and vice versa.
DIVBY	Trigger switch closure counter.
LN	The line number, along which the measurements take place. It consists of the numeric part (1111.1) and the directional part (d). The range is from 0 to 99999 with a decimal point as required. The direction allows you to enter the geographical direction or the Cartesian co-ordinates as one of: N,E,S,W, + or -.
LON	The GPS longitude of this measurement in lat_lon coordinate. It consists of the positive numeric part (ll.llllll) and the directional part (W or E).
LAT	The GPS latitude of this measurement in lat_lon coordinate. It consists of the positive numeric part (ll.llllll) and the directional part (N or S).
EASTING	The GPS easting of this measurement in UTM coordinate. It consists of the positive numeric part (eeeeeee.e).

NORTHING	The GPS easting of this measurement in UTM coordinate. It consists of the positive numeric part (nnnnnnn.n).

Instrument setup display

This display enables you to configure the basic data acquisition portion of the ENVI PRO and is accessible with the “SETUP” key.



ENVI PRO instrument setup display

Parameter	Description	Default
MAG SETUP	Displays the magnetometer specific setup menu. Pressing the “ENTER” key gets the next menu.	
AUTO ST. INC.	A “yes/no” toggle that controls the automatic station increment (decrement). no - for the base station, walking or manual type of operation. yes – for semi-automatic operation.	No
CYCLE REPEAT	Determines whether the magnetometer will take one reading only, or will continuously take readings at the time interval specified by the DURATION parameter I the Mag. Setup. This is not applicable for Base Station operation, which is set in the Mag Setup.	No

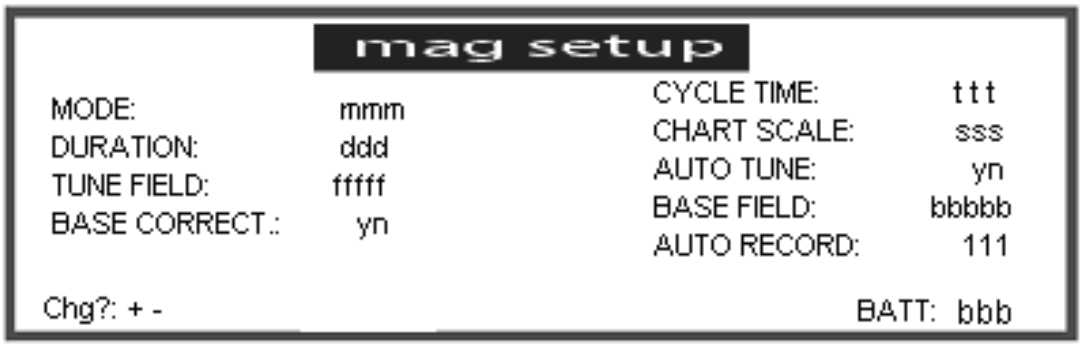
CYCLE DELAY	The delay between readings when the cycle repeat feature is enabled. It affects the total-field magnetometer or gradiometer only. The base-station repetition rate is controlled in the Mag. Setup under Cycle Time.	0
ERASE MEMORY	Allows clearing of the data memory. A request for confirmation will be displayed before the actual erasure takes place. NOTE: The setup parameters remain intact.	No
HEATER	Enables or disables the LCD display heater. If the temperature is above – 15° C, enabling this parameter has no effect.	No

Magnetometer setup display

This display is different depending on if GPS is enabled or not.

This display provides access to the parameters affecting the operation of the magnetometer portion of the ENVI. This display is accessible from either the Instrument setup display, or from the Main operating display (by using the *short-cut,* i.e. pressing the “ENTER” key).

Magnetometer setup display with GPS disabled



Magnetometer setup display with GPS enabled

Parameter	Description	Default
MODE:	Allows the selection of: - Total Field Magnetometer (default) - Gradiometer - Base Station - Off (will disable the ENVI PRO)	Tfld
DURATION	The measurement duration. A choice of 0.5, 1 or 2 seconds is available. The correct selection depends on the desired measurement accuracy and the spacing of the stations when using the WALKMAG mode of operation. The duration also controls the repetition rate if CYCLE REPEAT with a CYCLE DELAY of 0 (zero) was chosen in the ENVI instrument setup. The longest duration results in the highest precision.	0.5

TUNE FIELD	The value of the Earth's ambient magnetic field in the survey area. For best performance, the tuning field should match the ambient field as closely as possible, at least to within +/- 1000 nT. A map showing the approximate field intensity on the Earth's surface can be found in Section B: Applications. The values shown can be used as a starting point, and applied equally to the Total-field sensor or the Gradiometer sensor. See also AUTO TUNE.	0
BASE CORRECT	A "yes/no" toggle that applies a BASE-STATION correction using data supplied from a base-station ENVI PRO. You must press the "+" key to toggle the YES on. You need to have the base-station connected as described in "Using base-station data". A request for confirmation will be displayed in a pop-up window before your data is corrected. You must press the "9/YZ" (Yes) key to begin or the "5/MNO" (No) key to abort. NOTE: The original raw data is changed.	No
TIE CORRECT	A "yes/no" toggle that applies a tie-point correction using data collected in the TIE mode. Selecting this opens a window indicating which tie-point (loop or line) correction mode is in effect. You must enter "Y" to start the correction. NOTE: The original raw data is changed.	No
CYCLE TIME	The reading interval of the base station. The allowable range is 0 to 99999 seconds.	0

	Entering 0 (zero) results in a reading interval equal to the reading time. The instrument goes to “sleep” between readings, for 4 seconds and up.	
CHART SCALE	The sensitivity for the analog output for the strip chart recorder. The following choices are available: 1, 10, 100, 1000, 10000 nT.	1
AUTO TUNE	A “yes/no” toggle that controls the automatic tuning function. It is independent for the Total-field sensor and the Gradiometer sensor. The tuning value is updated after each reading in preparation for the next one. Auto tuning is particularly applicable if large variations of the ambient field are encountered over longer distances. Fixed tuning may be more appropriate in areas of large cultural electrical noise or very narrow, large amplitude anomalies. These may pull the tuning away from the desired frequency to that of the interfering frequency or to tuning field values greatly different from the background. As the setting of this parameter depends upon your particular survey conditions, it is not possible to suggest the best setting. The mode should therefore be established by experimenting. In general it is more applicable to use fixed tuning for the *site characterization* and *drum location* modes.	No
BASEFIELD	The base field is used in conjunction with the *base-station correction* procedure. The base-station correction technique removes variation in the ambient field during the time that the base station is running. However, variations taking place from day to day are not corrected. The base field	0

	value is used for this purpose. The actual value is not critical, as long as it is the same for all instruments in the survey. It is important that this value not be changed during the entire survey. A logical value is the first reading of the base-station on the first survey day.	
TIE MODE	Allows you to select either the Line or Loop type of tie-line correction. NOTE: The Tie-line correction method is substantially *less precise* than the base-station correction method.	Line
AUTO RECORD	A “yes/no” toggle. This function is used in the semi-automatic mode to save you from having to press another key. Auto Record is always in effect in the base-station operation *or* if the Cycle Repeat function is selected in the ENVI PRO Instrument Setup.	No

Data Displays

Data is displayed on a page by page basis in either numeric or graphic form. There are up to two pages each. The “NUM/GRA” key toggles between the two display forms. This display is different depending on if GPS is enabled or not.

Numeric data display

Numeric displays are only available when the instrument is recording data, i.e. you cannot “recall” the data in a tabular format as shown in the figure below.

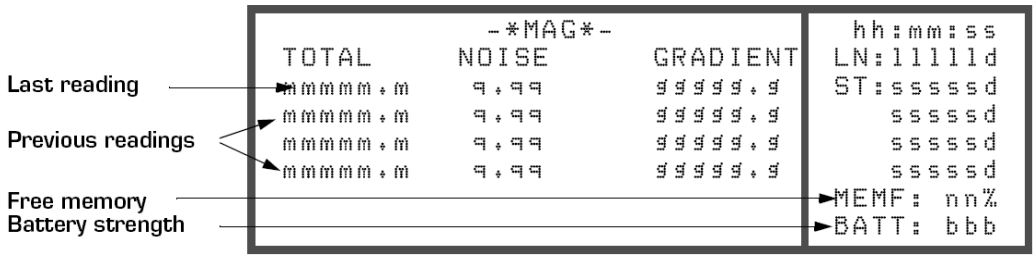
The displays shown in the examples that follow are *Pages 1* and *2* of the numeric data display for the gradiometer. The difference between the two display pages is that Page 2 shows the signal precession as a bar graph. This allows you to monitor the quality of each reading.

The total-field and the base-station displays *differ* in that the gradient column is absent.

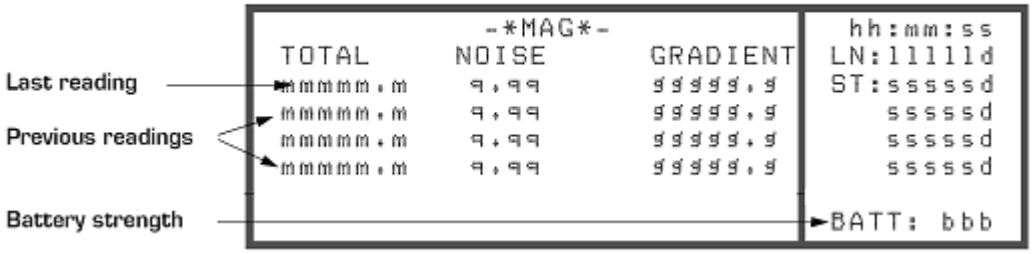
The following table shows the availability of a numeric display after pressing the “NEXT” key.

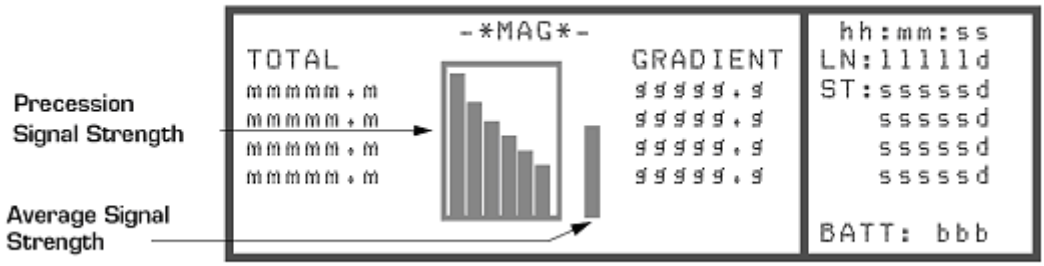
NEXT	After “ STOP” key & before “ ESCAPE” key*	While reading	Base-station
Page 1	yes	yes	yes
Page 2	yes	no	no

* You will have to use the “RECALL” function, if you have pushed the “ESCAPE” key.

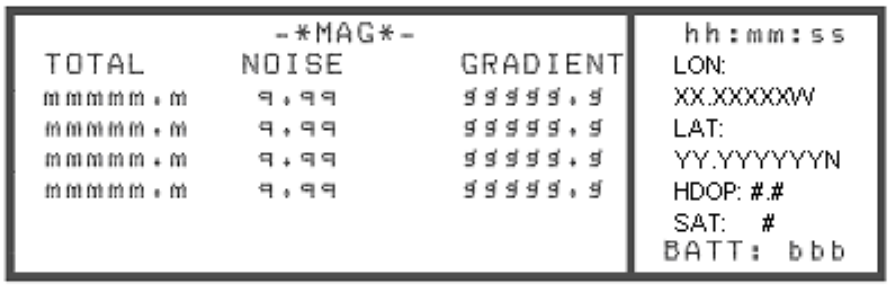


Page 1 of the numeric data display with GPS disabled

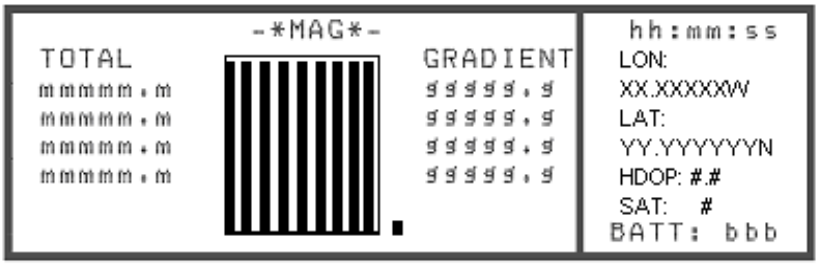




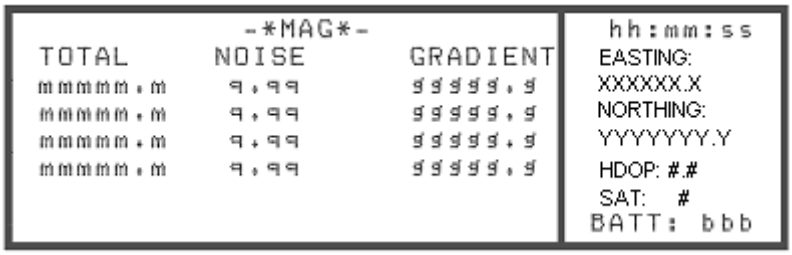
Page 2 of the numeric data display with GPS disabled – signal strength



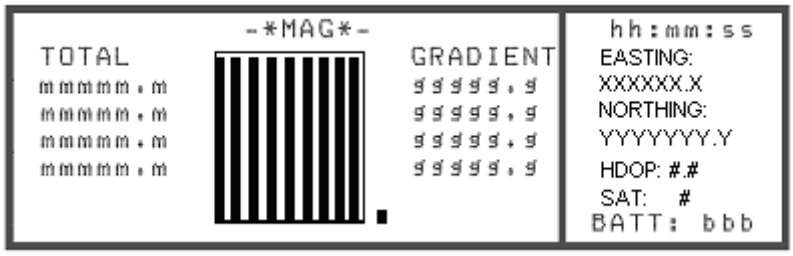
Page 1 of the numeric data display with GPS enabled
in lat_lon coordinate



Page 2 of the numeric data display with GPS enabled
in lat_lon coordinate – signal strength



Page 1 of the numeric data display with GPS enabled
in UTM coordinate



Page 2 of the numeric data display with GPS enabled
in UTM coordinate – signal strength

Display Item	Description
TOTAL	The magnitude measured by the lower total-field sensor in nanoTeslas (nT). The most current reading is the *top* most followed by preceding readings.

NOISE	A number indicating the quality of the reading. It is based on the noisiness of the individual periods of the precession signal. The *smaller* the value the *better* the quality of the reading.
GRADIENT	The magnetic gradient between the two sensors. Expressed in nT/m.
TIME	The current time in hours: minutes:seconds. It is used to time stamp each reading.
LN	The line number on which this measurement took place. The value consists of the numeric and directional parts.
ST	The station number to which the respective magnetic data applies. The value consists of the numeric and directional parts.
LON	GPS longitude in lat-lon coordinate on which this measurement took place. The value consists of the numeric and directional parts
LAT	GPS latitude in lat-lon coordinate on which this measurement took place. The value consists of the numeric and directional parts.
EASTING	GPS easting in UTM coordinate on which this measurement took place. The value consists of the numeric only.
NORTHING	GPS northing in UTM coordinate on which this measurement took place. The value consists of the numeric only.

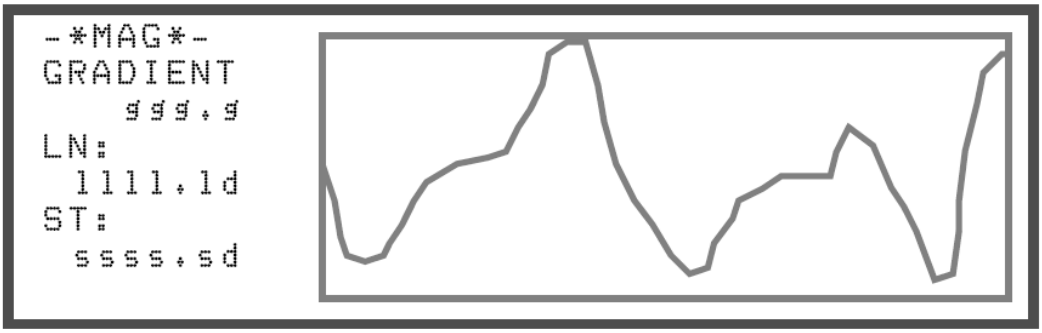
Graphic data display

The display shown below is page two of the graphic data for the gradiometer. Page one appears identical, except that the word ‘GRADIENT” is changed to “TOTAL” and a plot of the total field is shown. This display is different depending on if the GPS is enabled or not.

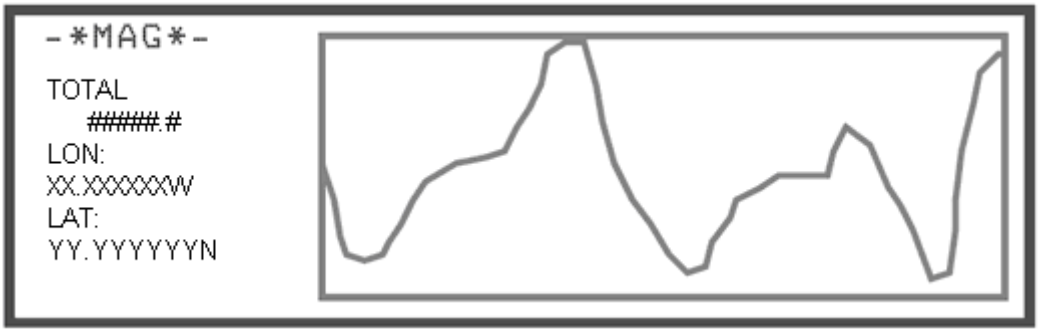
The following table shows the availability of graphic displays after pressing the “NEXT” keys.

NEXT	After " STOP" key & before " ESCAPE" key*	While reading	Base-station
Page 1	yes**	no	yes
Page 2	yes**	no	yes

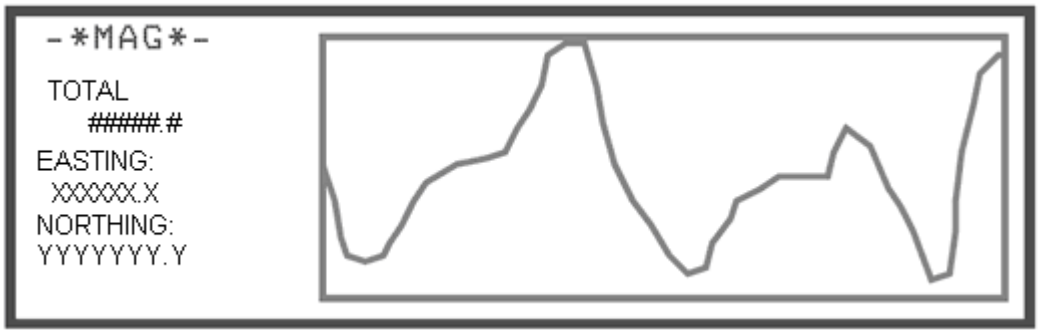
* You will have to use the "RECALL" function, if you have pushed the "ESCAPE" key.
** Depends upon the status before "STOP" was pressed.



Graphic data display of Page 2 – without GPS



Graphic data display of Page 2 – GPS Lat/Lon



Graphic data display of Page 2 – GPS UTM

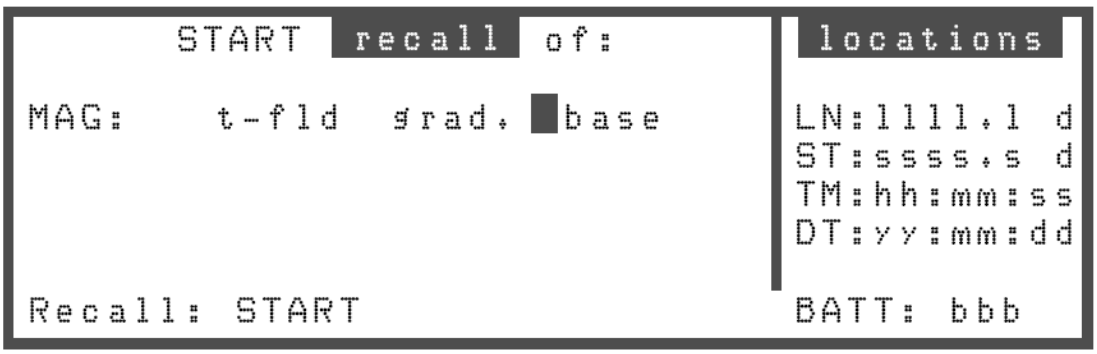
Display Item	Description
GRADIENT	The display title indicating the data shown by the graph. The numeric value indicated by ggg.g is the respective gradient, at the indicated Line and Station number
LN	The line number along which this measurement took place, consisting of the numeric and directional parts.
ST	The station number, at the cursor position, to which the respective magnetic data applies (consisting of the numeric and directional parts).
LON	GPS longitude in lat-lon coordinate on which this measurement took place. The value consists of the numeric and directional parts
LAT	GPS latitude in lat-lon coordinate on which this measurement took place. The value consists of the numeric and directional parts.
EASTING	GPS easting in UTM coordinate on which this measurement took place. The value consists of the numeric only.
NORTHING	GPS northing in UTM coordinate on which this measurement took place. The value consists of the numeric only.

Recall Displays

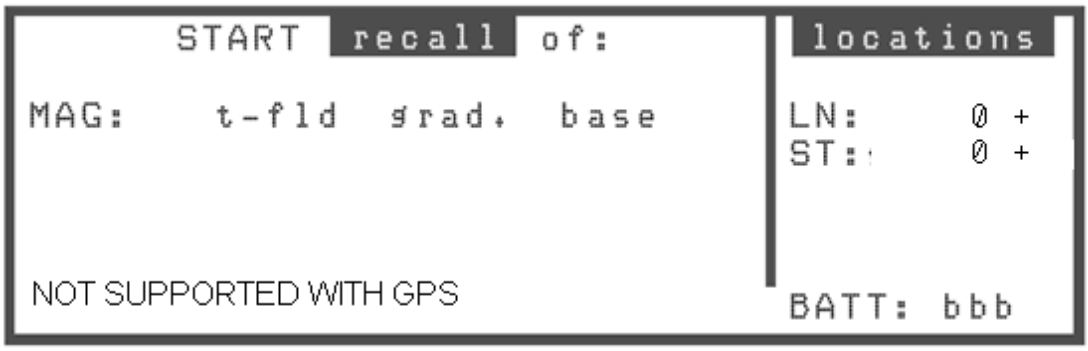
The “RECALL” function is useful to view the collected and stored data. But the RECALL function is disabled when GPS enabled.

Recall Setup display

	This display allows you to select the type, location or time and date of the data when GPS is disabled. This display is accessed by pressing the “RECALL” key.



The RECALL SETUP display with GPS disabled



The RECALL SETUP display with GPS enabled

Display Item	Description
MAG	The mode of the data collected. Either one of Total Field, Gradient or Base Station.
LN	The line number whose data is to be recalled, consisting of the numeric and directional parts.
ST	The station number is the starting location for the recall, consisting of the numeric and directional parts.
TM	The starting time of the recall. This parameter is only present when the Base Station is selected.
DT	The data of the data to be recalled. This parameter is only present when the Base Station is selected.

Warning: GPS must be disabled in order to recall t-fld and grad. data.

Not only the Time and Date, but the Line and Station numbers must also be correct to successfully recall Base Station data.

RECALL DATA display

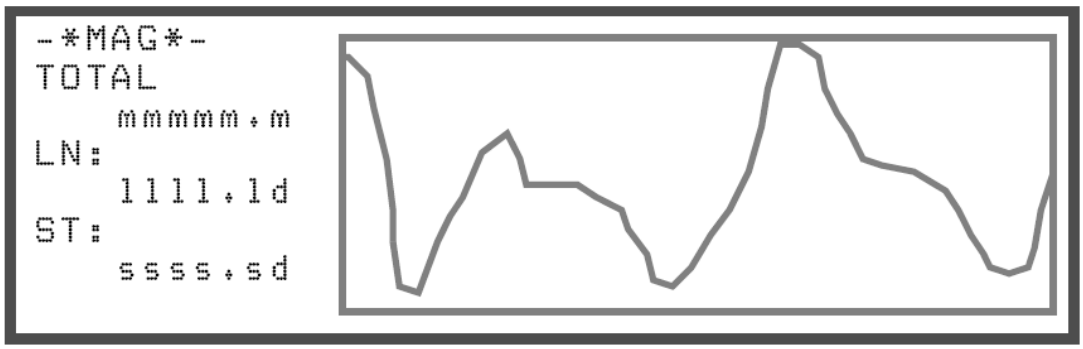
Note: Only Data collected and saved with GPS disabled can be recalled, but only in *graphic* form and with GPS disabled. Up to 178 readings can be shown at one time. The display window can be moved sideways (called *panning*) in steps of one half of its width (i.e. up to 89 readings) to view adjacent data with the aid of the

"+" or "-"keys. It is also possible to adjust the vertical scale and bring any point to the vertical center of the window.

Exact values can be read off the numerical section at the left hand side of the display.

The Total Field display is shown and explained. The Gradient display differs in title only. The Base Station display shows Time and Date instead of Line and Station. Note that there are *two* pages of data for the gradiometer.

These displays are accessible with the "START" key when in the RECALL SETUP display.

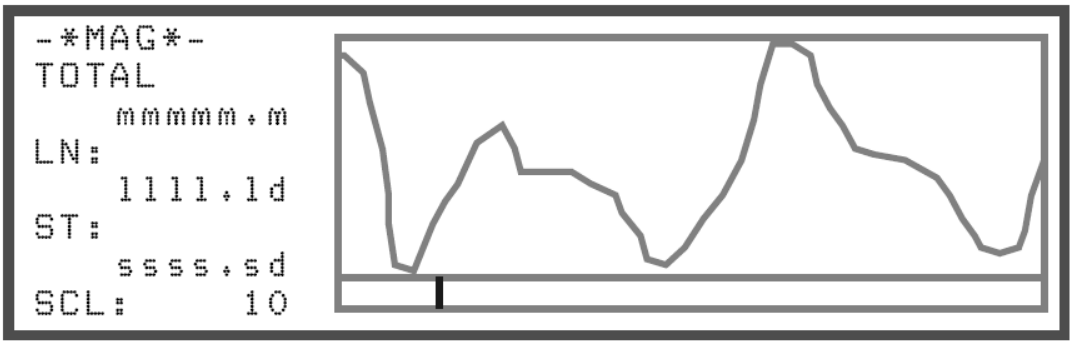


The RECALL DATA display

Display Item	Description
TOTAL	The title of the display indicating the data shown by the graph. The numeric value indicated by MMMMM.M is the respective total-field value, at the indicated line and station number.
LN	The line number along which this measurement took place, consisting of the numeric and directional parts.
ST	The station number to which the respective magnetic data applies, consisting of the numeric and directional parts, at the *cursor* position.

Modifying the display window

The graph can be altered by changing the vertical scale or by centering any point vertically in the window. A smaller window can be opened up using the "ENTER" key to allow changes. The changes take effect after you press "ENTER".



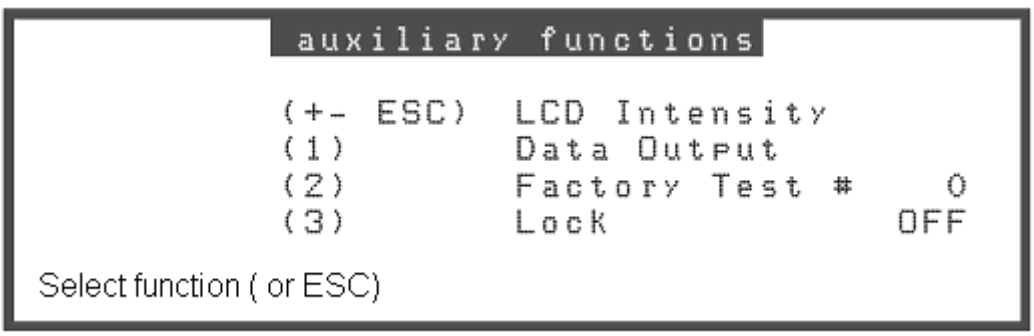
The RECALL Display ready for customizing

Display Item	Description
SCL	Shown after the “ENTER” key is pressed. It indicates the vertical full scale. Scrolling using the +/- keys allows the full scale values of 1, 10, 100, 1000, 10000 nT.
▌	This is the cursor, which is normally at the left edge of the window. It can be moved with the aid of the ← and → cursor keys. Numerical data at the left hand side of the display represents the data at the cursor position.

Pressing the “0” key adjusts the display such that the point at the cursor position becomes the center value of the graph.

Auxiliary Functions display

The Auxiliary Functions display is accessible by pressing the “AUX/LCD” key. It provides additional functions which are not directly accessible from the keyboard. You will need to press the appropriate key to get to the function.



The auxiliary functions display

Key Pressed	Action under Auxiliary functions
	These keys allow you to adjust the intensity of the LCD screen for better viewing under a variety of lighting conditions.
	This option allows you to access the Data Output menu to transfer information to you computer or printer.
	This function is reserved for production and service tests. It has no functions for you to use.
	The lock option allows you to lock the ENVI PRO setup parameters so that they are not accidentally changed. To make any changes, you will have to toggle this option first.

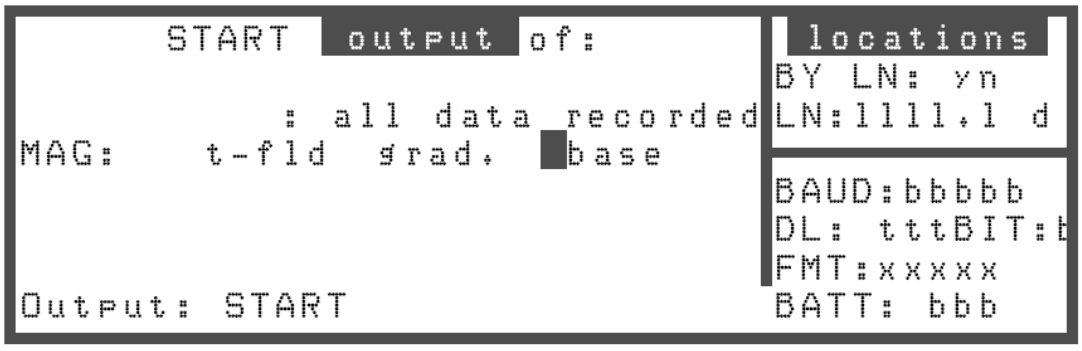
Data Output Display

This display allows the selection of:

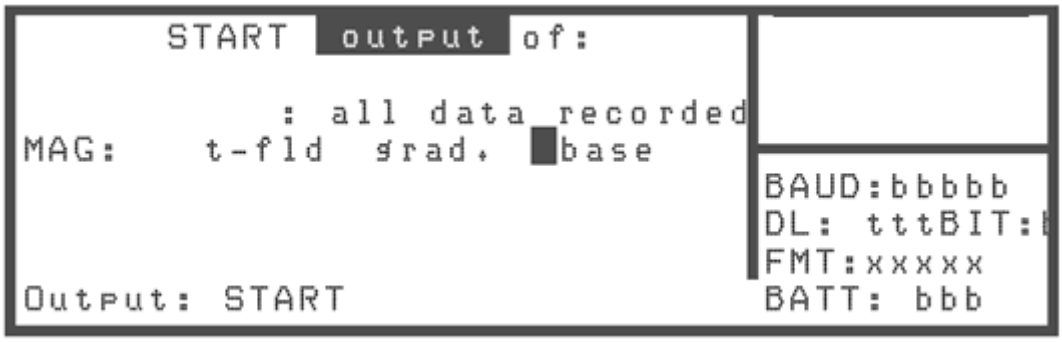
- Communication parameters between the ENVI console and the output device such as a computer or printer.
- The data format of the output
- And possibly the Line number, if a line by line data dump is desired.

Data can be dumped in its entirety at once, or selectively on a mode basis.

This display is accessible from the AUXILIARY FUNCTIONS display. Depending on if GPS is enabled or not, the display is different.



The data output display with GPS disabled



The data output display with GPS enabled

Parameter	Description	Default
: all data recorded	With the cursor placed after the colon, all the data in the instrument would be dumped sequentially into one, possibly very large, file.	
MAG	Lists the modes available for the ENV-MAG. As shown, only the gradiometer data would be dumped as indicated by the cursor position.	
BY LN	yes/no Directs the instrument to dump the data on a line by line basis, in addition to a method by method basis. This is usually left at no.	No
LN	The line number whose data has to be dumped, consisting of the numeric and directional parts.	
BAUD	The Baud rate of communication with the output device. The following choices are available by scrolling: 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 Baud.	9600
DL	A delay which may be added after each carriage return/linefeed (CR/LF) to accommodate slow peripherals such as some printers. The range is 0 to 999 ms. This value is normally left at 0 for dump to computers. The proper setting has to be established experimentally for other equipment. Problems usually are indicated by the loss of a few characters.	0

BIT	The number of data bits. The default value is 8 bits, which usually works properly. The proper setting has to be established experimentally. For example, on some printers, 7 or 8 bits results in either normal or italic print.	8
FMT	The output data format.	

Data output formats

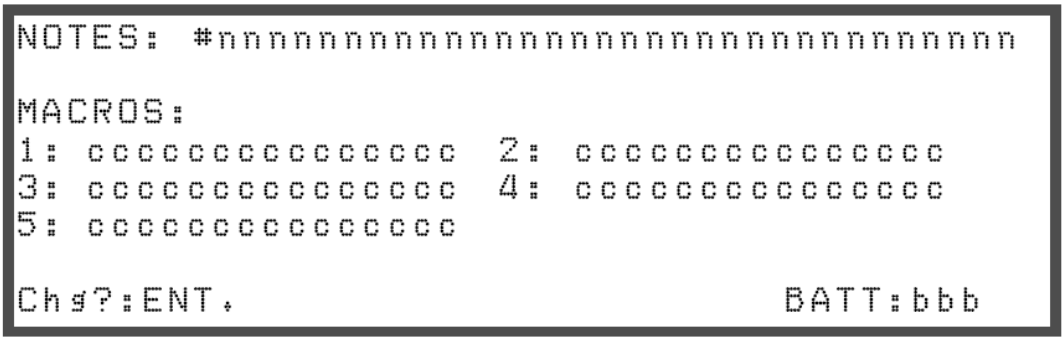
The following table shows the available output formats for dumping the data to a computer or printer.

Data output format	Description
XYZ	XYZ is the simplest format. It contains no heading or comments. The individual data items are separated by a single space character. X and Y represent the Cartesian coordinates (N and E are positive while S and W are negative). Z is one or more items of magnetic data. There is one set of data per printed line, including the time of the measurement. CAUTION: Due to the lack of header information, you should label the files clearly.
XYZ+	XYZ+ is identical to XYZ but a header and user entered NOTES are added.
XYZ++	XYZ++ is identical to XYZ+ but the data is now placed into columns.
PRN	PRN is a format used with software for the Scintrex MP-3/4 Magnetometer.
NOTES	NOTES outputs a report of all user entered NOTES, cross-referenced with the Line and Station number, or GPS coordinate value.

NOTES display

The notes display is useful for the entry of comments, which are stored with the data at the particular Line and Station number.

Macros (pre-recorded messages) provide a quick entry for repetitive notes which can be entered while measuring. This display is accessible with the “NOTE” key.



The NOTES display

Parameter	Description
NOTES	Alpha-numeric characters, including “+”, “.” and “-“ up to 32 characters. A note can be saved as one of five macros in a separate memory for re-use.
MACROS 1: … 5:	MACROS are pre-recorded messages of up to 15 characters. These are used to speed up note entry. It is most advantageous to enter frequently encountered items, such as *road, fence,* and so on.

Information / GPS Setup Display

This display screen is used for the entry of ancillary information and GPS setup. You can also see how much free memory is available. This screen is accessed from the main display by pressing the “INFO” key. Fig. 1 shows the default display or with GPS disabled. In order to enable or disable GPS, move the cursor to GPS and press “+” or “-“, a pop-up window comes out as shown in Fig. 2. By selecting 2 or 3 to enable GPS and configure it to either Lat/Lon or UTM coordinate. At this point, the real time clock (RTM) is synchronizing with GPS time, as shown in Fig. 3. Fig. 4 and 5 show the INFO screen with GPS lat/lon and UTM coordinate, respectively.

Fig. 1 The default INFO display

Fig. 2 GPS setup display

Fig. 3 RTC synchronizing display

Fig. 4 The INFO display with GPS enabled (LAT/LON)

Fig. 5 The INFO display with GPS enable (UTM)

Parameter	Description
Vx.x	The version number of the ENVI PRO internal software.
TIME	The current time of day.
DATE	The present data.
GPS	Enable or disable of GPS. Configure GPS to LAT/LON coordinate or UTM coordinate.
GPS INTERVAL	This is the GPS reading intervals when taking measurement.
SER.*	This is usually the serial number of the instrument. No use is made of this number by the instrument, therefore it also could represent the users inventory number. Up to 8 digits are accepted.
JOB *	This may be the survey project number. Up to 6 digits are accepted.
OPERATOR	This is the operator's name or number.
MEMF	The percentage of free memory available for further use.
HDOP	This is the qualities of GPS reading.
SAT.	This is the number of satellites.
LON.	This is the GPS longitude value.
LAT.	This is the GPS latitude value.
EAST.	This is the GPS UTM easting value.
NORT.	This is the GPS UTM northing value.

Warning: The TIME and DATE *must* match between the base-station and the portable magnetometer(s) for the base-station style of correction to work properly.

Chapter 6 Setting Up the ENVI MAG

This chapter describes the process of how to:

- Initialize the ENVI PRO for first time operation
- Program it for the different modes of operation
- Enter line and station numbers

Step by step procedures are given in Chapter 7 on how to perform:

- A total-field survey in the WALKMAG mode
- A gradiometer survey in the stop-and-go mode
- Base-station operation

First Time Operation

A special procedure has to be followed to get the ENVI-PRO software set up properly. This procedure is called a *cold boot.* This assures that all setup parameters are initialized properly and that the memory is cleared.

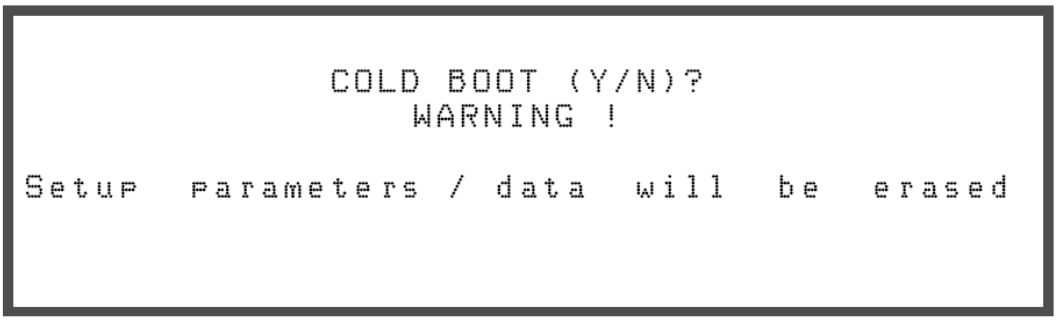
Warning: First time operation procedures (cold boot) have to be carried out every time the instrument has had its battery disconnected for more than 10 minutes. You may also need to cold boot if the screen stays blank or is scrambled.

Cold Boot

To perform a cold boot, proceed as follows:

Press the “ON/OFF” key repeatedly and listen carefully to the beeper. Stop pressing this key after the display goes blank, or after the unit stops beeping. This is to ensure that the ENVI PRO is truly in the OFF state.

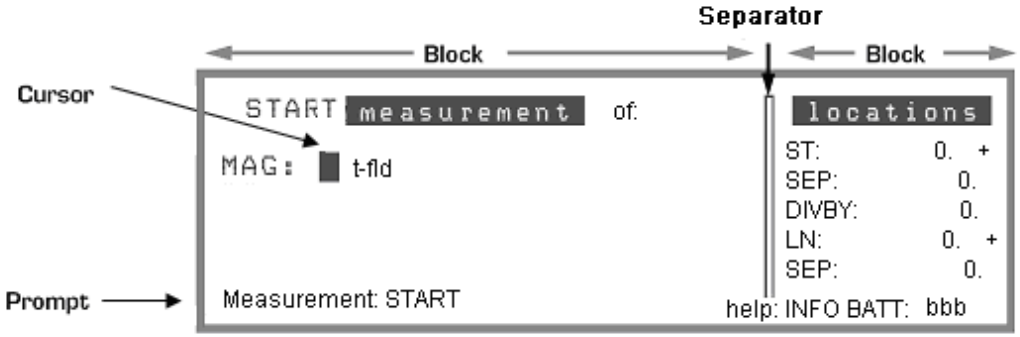
Press and hold the “AUX/LCD” key. Then press the “ON” key. Release both keys after the beep. The following message should appear:



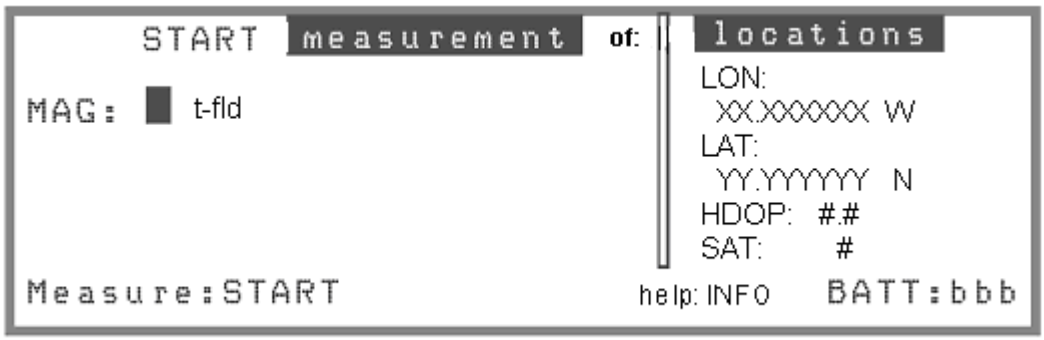
Press the “9/YZ” key containing “Y” for *yes* to confirm the cold boot operation.

You are now ready to setup your ENVI PRO for surveying.

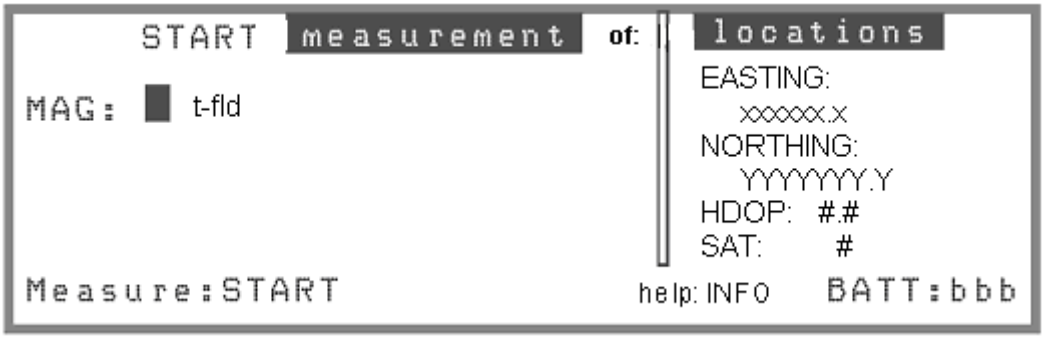
Configuration Menu



Main operating displays for all modes with GPS disabled



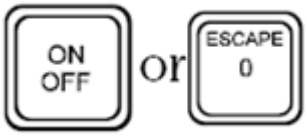
Main operating displays for all modes with GPS Lat/Lon



Main operating displays for all modes with GPS UTM

HOW TO:

Access the Main Operating Display



The Main Operating display can be called up by simply pressing the “ON” key *or* by pressing the “ESCAPE” key one or more times.

Access Display Sub-Panels/Blocks

Some display screens have sub-panels or blocks that are separated by a vertical and/or horizontal line. These represent different logical sub-groups of information. To move the cursor into another block you will have to press the “NEXT” key.

Access the Parameter Fields

To access a particular parameter field, move the cursor by repeatedly pressing either of the cursor (←→) keys until the cursor is on the desired field.

Change Parameters

There are two types of parameters – those that are selected from a *list* and those that you must *fill-in* a value. The proper method for changing a particular item is indicated by the *prompt* at the left-hand, bottom corner of the display.

Changing the parameters requires you to either:

▲ Select from a list when the prompt is Chg?+-, by pressing either the “+” or “-“ keys.

OR

▲ Fill in the parameter fields via the keypad when the prompt is Chg?ENT, by first pressing the “ENTER” key. You will then need to follow the procedures as described for “Enter” in the next item.

Select and Enter

To simplify the detailed descriptions that will be presented next, the key-words **Select** and **Enter** will be used to represent a series of actions that you will be required to do. These are defined as follows:

Select

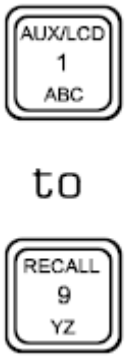
When the prompt Chg?:+- appears in the bottom left corner of the display, you have a *pre-defined* list of values to choose from. You will be required to make a selection as follows:

Press either the “+” or “-“ key to scroll through two or more parameters.

Enter

When the prompt Chg?:ENT. Appears in the bottom left corner, the parameter field requires you to enter a specific value. The enter values, you will be required to do the following:

Step	Press	Action
1		This opens the field for data entry as indicated by a new prompt (>) at the start of the field.

2		Key in the desired value. If the field requires a *numeric* input, just Press the appropriate keys in sequence. If the field requires *alphanumeric* input, you may need to Press the same key several times to get the proper character to appear (similar to spelling on a telephone keypad). If you enter an incorrect value, use the "CLEAR" key to delete the incorrect character(s).
3		Pressing the "ENTER" key again stores the value in memory and the prompt (>) disappears.

Line and Station Setup

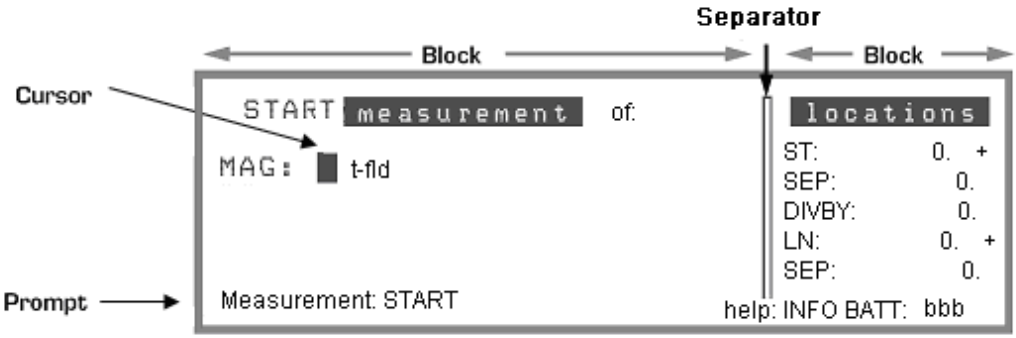
Except for the Search mode magnetometer configuration, you will need to enter into the ENVI PRO the information about your survey grid. This includes:

- Your starting points on each line
- How far apart each line is
- How far apart each station on the survey line is

Note: In considering the co-ordinate system shorthand you will be using for a survey grid, you should be aware that the units of measure are not important, as no calculations are made by the console with respect to distance. Consequently, you can use single digits to represent values that may actually be in hundreds.

To show you the steps required to set the line station values, the following example will:

- Set the Line Number (LN) to Line 16 East (sometimes marked on the grid survey pickets as 16+00E) with a Line separation (SEP) of 2
- Set the Station Number (ST) to 50 North (sometimes marked on the grid survey pickets as 50+00N), with a Station separation (SEP) of *minus* 10. The *minus* indicates that the walking direction is to the south.



Press the “NEXT” key to move the cursor to the right hand block/subpage of the display. If the cursor is already in the locations block, go on to the next step.

Entering the Starting Station

Move the cursor to ST:

Enter 50

Move the cursor one step forward

Enter n (for north)

Move the cursor to SEP:

Enter -10

Note: The “-“ causes the station number to *decrement.* This indicates that you will be traveling south and that stations are spaced 10 units apart.

Entering the Starting Line

Move the cursor to LN:

Enter 16

Move the cursor one step forward.

Enter e (for east)

Move the cursor to SEP:

Enter 2 (This indicates that you will be surveying successive lines 2 units apart and you will be moving in a easterly direction)

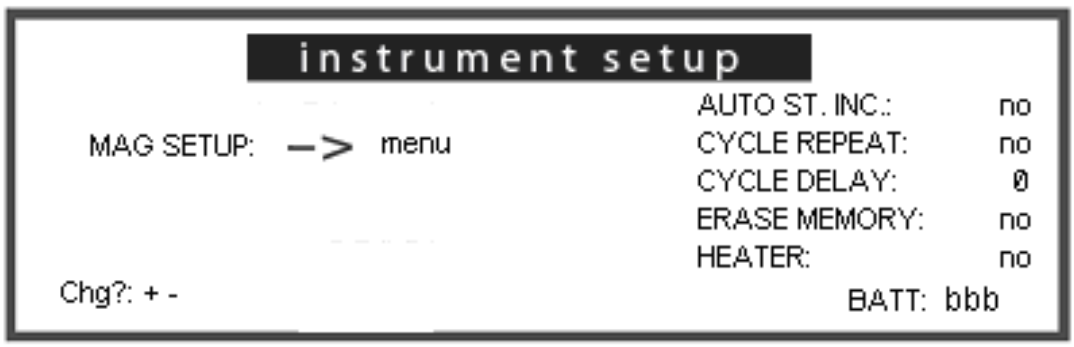
To set your required starting point and separations, just substitute your specific values in the previous steps. Also, keep in mind that entering *negative* values for the separation parameters causes the respective line or station values to *decrement.*

Instrument Setup

The following setup prepares the instrument for a total-field or gradient survey in the WALKMAG or WALKGRAD modes respectively. This mode uses the cycle repeat feature of the measurement. A cycle delay can also be entered, so that the repetition rate is adjusted while walking uphill or downhill.

From the MAIN OPERATING display proceed as follows:

Press the “SETUP” key. The INSTRUMENT SETUP display appears:



Move the cursor to AUTO ST. INC: (automatic station increment).

Select No (Since the ENVI PRO is reading continuously, you want the station value to change only when you reach a station – not with every reading.

Move the cursor to CYCLE REPEAT:

Select Yes (You want the instrument to continuously take readings at the rate specified by the DURATION parameter)

Move the cursor to CYCLE DELAY:

Enter 250 (This value is in milliseconds, and pauses the reading cycling by 250 ms. This is useful when you are traversing uneven ground where your speed may vary. You should enter what ever is appropriate for the type of terrain you are traversing).

Ignore ERASE MEMORY:

Move the cursor to HEATER:

Select No (Unless you are doing a winter survey and the ambient temperature is below -15° C)

Press ‘ESCAPE” to return to the MAIN OPERATING display.

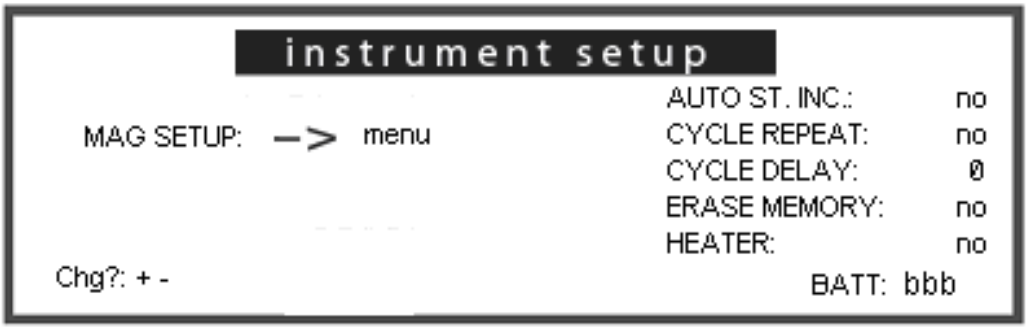
Sample Total-Field Setup (Walkmag or Walkgrad)

The following steps prepare the ENVI PRO for:

- A total-field survey in the WALKMAG or WALKGRAD modes
- With a 0.5 second reading period (though 1 or 2 seconds can also be used)
- Automatic tuning
- Manual station increment

From the MAIN OPERATING display proceed as follows:

Press the “SETUP” key and the INSTRUMENT SETUP display appears:

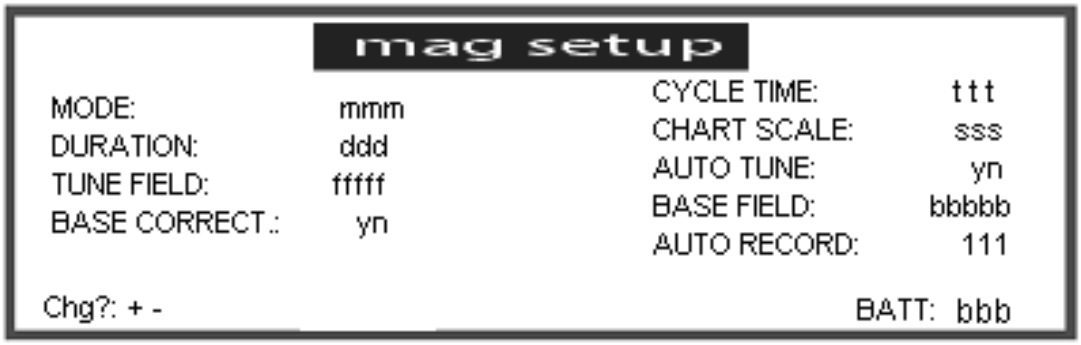


Carry out steps 2 through 9 for setting up the instrument on page 6—14, if you have not already done so.

Move the cursor to MAG SETUP.

Press “ENTER” and the MAG SETUP display appears:

Mag Setup Display with GPS Disabled



Mag Setup Display with GPS Enabled

Move the cursor to MODE:

Select t-fld or grad from the following list:

Off ,t-fld,grad,base

Move the cursor to DURATION:

Select 0.5 sec from the following list:

0.5 sec, 1 sec, 2 sec

Move the cursor to TUNE FIELD:

Enter the ambient magnetic field value of your survey area.

Ignore BASE CORRECT:

Ignore TIE CORRECT (GPS disabled):

Move the cursor to CYCLE TIME:

Enter 0 (This parameter is used in the base-station mode only and should be 0 for all other modes)

Move the cursor to CHART SCALE:

Select 10 from the following list: 1, 10, 100, 1000, 10000 (This is the range in nT scale)

Move the cursor to AUTO TUNE:

Select yes (This assumes that you will encounter large variations in the ambient field, without strong gradients. If you encounter strong cultural electrical noise or large variations in the ambient field, with very strong gradients, you may want to turn the automatic tuning off)

Move the cursor to BASE FIELD:

Enter the ambient magnetic field value, if known, of your survey area.

Move the cursor to AUTO RECORD:

Select no

Ignore TIE-MODE (GPS disabled):

Press “ESCAPE” to return to the MAIN OPERATING display.

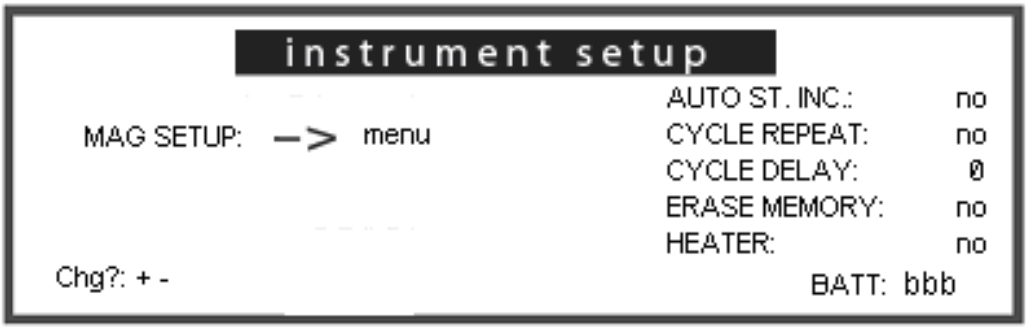
Sample Stop-and-Go Gradiometer Setup

The following steps prepare the ENVI PRO for a:

- Gradient survey
- In the Stop-in-Go mode
- With a 2 second reading period
- And fixed tuning in the fully manual mode

From the MAIN OPERATING display proceed as follows:

Press the “SETUP” key and the INSTRUMENT SETUP display appears:



Follow the instructions for the INSTRUMENT SETUP on page 6—14, but substitute the following:

Move the cursor CYCLE REPEAT:

Select no

Move the cursor to CYCLE DELAY:

Enter 0

Move the cursor to MAG SETUP:

Press “ENTER”. The MAG SETUP display now appears.

Move the cursor to MODE:

Select grad from the following list: off, t-fld, grad, base

Move the cursor to DURATION:

Select 2 sec from the following list: 0.5 sec, 1 sec, 2 sec

Move the cursor to TUNE FIELD:

Enter the ambient magnetic field value of the survey area.

Ignore BASE CORRECT:

Ignore TIE CORRECT (GPS disabled):

Select No (Please refer to “Remote operation” for more information on this feature)

Move the cursor to CYCLE TIME:

Enter 0

Move the cursor to CHART SCALE:

Select 10 from the following list: 1, 10, 100, 1000, 10000. (This is the range in nT full scale)

Move the cursor to AUTO TUNE:

Select no

Move the cursor to BASE FIELD:

Enter the ambient magnetic field value of the survey area, if known.

Move the cursor to AUTO RECORD:

Select no

Ignore TIE-MODE:

Press “ESCAPE” to return to the MAIN OPERATING display.

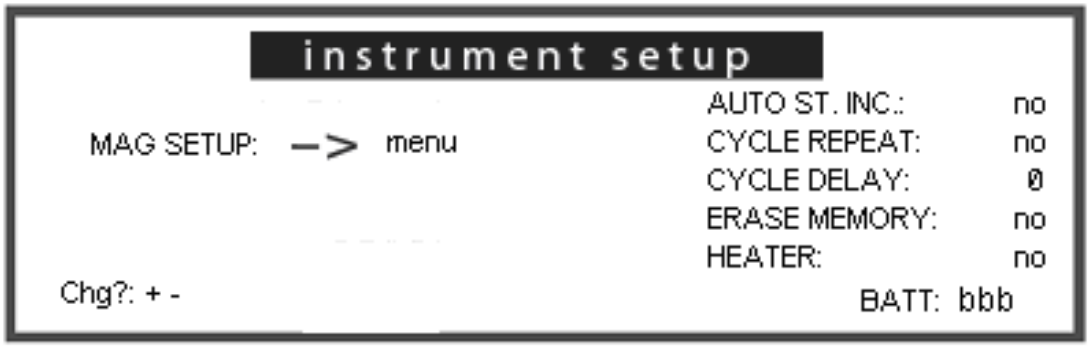
Sample Base-Station Setup

The following steps prepare the ENVI PRO as a:

- Magnetic base-station
- With a 2 second reading period
- And fixed tuning

From the MAIN OPERATING display proceed as follows:

Press the “SETUP” key and the INSTRUMENT SETUP display appears:



Follow the instructions for the INSTRUMENT SETUP, but substitute the following:

Move the cursor CYCLE REPEAT:

Select no

Move the cursor to CYCLE DELAY:

Enter 0

Move the cursor to MAG SETUP:

Press “ENTER”. The MAG SETUP display now appears.

Move the cursor to MODE:

Select base from the following list: off, t-fld, grad, base

Move the cursor to DURATION:

Select 2 sec from the following list: 0.5 sec, 1 sec, 2 sec

Move the cursor to TUNE FIELD:

Enter the ambient magnetic field value of the survey area.

Ignore BASE CORRECT:

Ignore TIE CORRECT (GPS disabled):

Select no (please refer to “Remote operation” for more information on this feature)

Move the cursor to CYCLE TIME:

Enter 0

Move the cursor to CHART SCALE:

Select 10 from the following list: 1, 10, 100, 1000, 10000. (This is the range in nT full scale)

Move the cursor to AUTO TUNE:

Select no

Move the cursor to BASE FIELD:

Enter the ambient magnetic field value of the survey area, if known.

Move the cursor to AUTO RECORD:

Select no

Ignore TIE-MODE (GPS disabled):

Press “ESCAPE” to return to the MAIN OPERATING display.

Information Display

The steps described below are used to set:

- The date
- Time
- Job number
- Serial number
- Operator identification
- GPS

From the MAIN OPERATING display proceed as follows:

Press the “INFO” key and the INFORMATION display appears:

NOTE: if GPS is used, TIME and DATE can not be entered manually. GPS is able to automatically setup the GMT time and date.

Move the cursor to TIME:

Enter the current *hour*

Move the cursor one step →

Enter the current *minute*

Move the cursor one step →

Enter the current *seconds* or set to zero

Move the cursor to DATE:

Enter the current *year*

Move the cursor one step →

Enter the current *month* (numeric entry 1 to 12)

Move the cursor one step →

Enter current *day* (numeric entry 1 to 31)

Move the cursor to GPS:

Press “+” or “-“, then select “2” or “3” to select GPS coordinate.

At this point, GPS is enabled and time, data and GPS information show automatically

Move the cursor to GPS INTERVAL:

Enter GPS reading intervals

Move the cursor to SER.*:

Enter the instrument serial number or other

permanent identification

Move the cursor to JOB *:

Enter a *job number* or other unique identifier for the survey

Move the cursor to OPERATOR:

Note Entry

This section describes the steps needed to:

- Enter unique text to be recorded with the present measurement
- Or how to enter text to be used as macros for use as quick-entry notes

Identical keystrokes are also used to enter the operator's name in the previous paragraph.

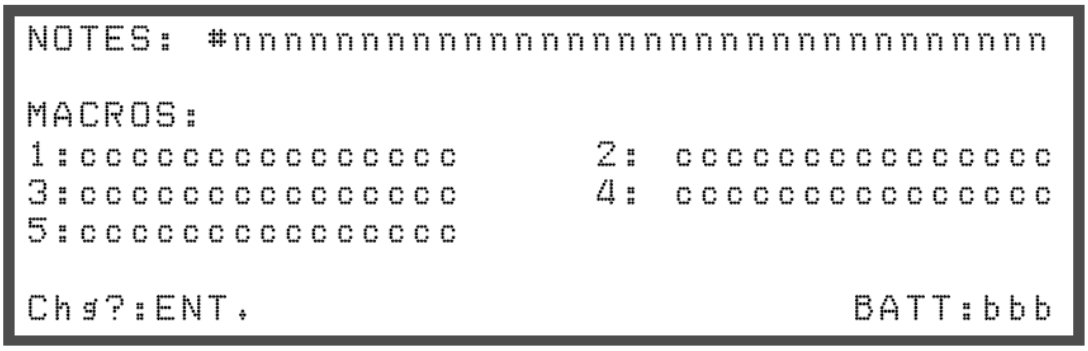
Notes, or macros, may contain all letters and number sas well as +, ., -. Entry procedures are similar to the Enter procedure for entering numbers only, as discussed in the previous sections. The Number keys now offer also three letters, which can be accessed by subsequent keystrokes, such as 1 A B C 1…

The "CLEAR" key allows deletion of erroneous entries, whereas the "NEXT" key allows spaces between words. New macros can be entered by simply over-writing the previous ones.

The following steps enter the macro "fence 1" as Note 1. Other macros would be entered similarly, except that they would be saved with Note 2, Note 3, etc.

From the MAIN OPERATING display proceed as follows:

Press "NOTE" and the NOTE display appears:



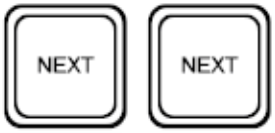
Press the “ENTER” key.

Press the “2” key repeatedly until f appears.

Press the “NEXT” key. If the following character is on a different key, there is no need to Press the “NEXT” key.

Press the “2” key again until e appears.

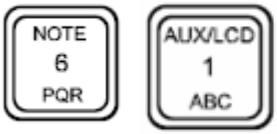
Continue entering in the same way until “fence” is completed.



Press the “NEXT” key twice.

Press the “1” key.

Press “ENTER”.



Press the “NOTE” key, followed by the “1” key. You should now see fence 1 appear further down, under MACRO: 1.

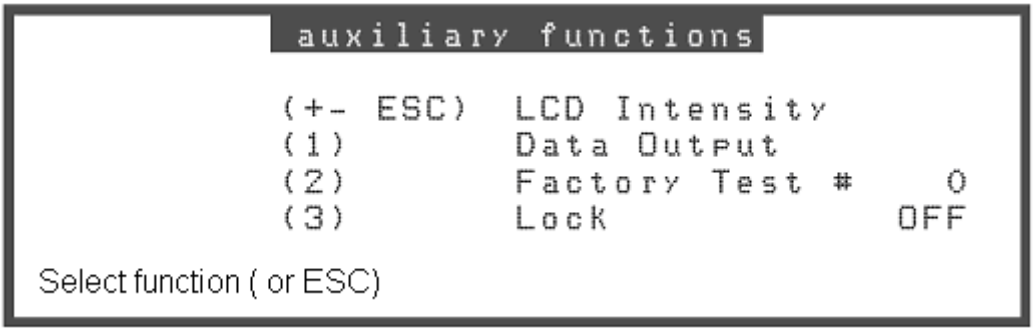
Unique notes, belonging to one reading only, are entered in the same way, with the exception that the final step is omitted. The note will then be recorded along with the data. The note entry field is then cleared.

Display Intensity Control

The display intensity gets pre-set at each cold boot and seldom needs to be adjusted. If it does, proceed as follows:

From the MAIN OPERATING display:

Press the “AUX/LCD” key, and the AUXILIARY FUNCTION display appears.



Press the “+” or “-“ key to adjust the intensity of the display to your satisfaction.

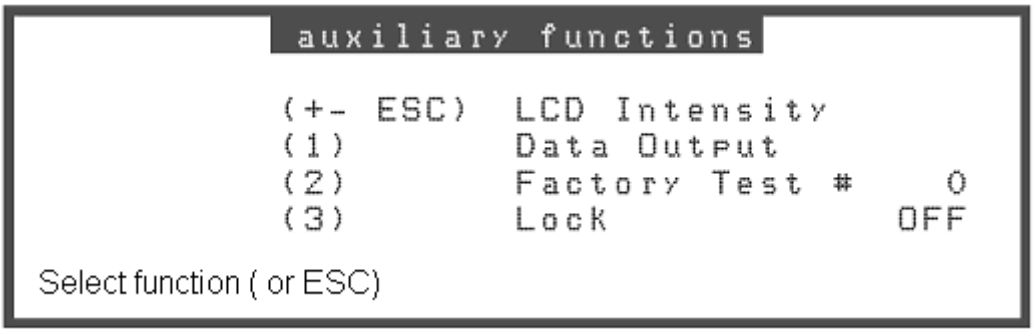
Press “ESCAPE” twice to return to the MAIN OPERATING display.

Parameter Lock

The ENVI PRO instrument setup and mag setup parameters can be locked to prevent accidental change. To do so, proceed as follows:

From the MAIN OPERATING display:

Press the “AUX/LCD” key to get the AUXILIARY FUNCTIONS display.



Press the “3” key to toggle the locking feature ON.

Do your work….

To unlock the instrument repeat steps 1 and 2, except that now the locking is toggled to OFF.

Press “ESCAPE” to return to the MAIN OPERATING display.

Chapter 7 Operating the ENVI PRO

The information in this chapter is not intended to be a complete tutorial on magnetic surveying, rather it highlights the unique features of the ENVI PRO. Chapter 11 – Applications of this manual covers the subject in more detail. This chapter will cover the following:

- Guidelines for obtaining accurate, meaningful measurements
- Tips on field procedures with the ENVI PRO
- A sample WALKMAG (automatic) mode of survey (basic mode)
- A sample Stop-and-Go (semi-automatic) mode of survey (advanced)
- Base-station magnetometer operation (advanced)
- Search-mode magnetic surveys
- Data correction procedures using the base-station, tie-line or loop survey modes
- Operating the ENVI PRO under the control of another host computer (remote operation)

Accurate and Meaningful Measurements

The quality of your measurements are greatly affected by the sensor orientation, magnetic gradients and any other source of noise near the sensor. Accurate, meaningful measurements can only be made by observing some simple guidelines as discussed in the following sections.

Orientation

Optimum performance can be achieved with proton magnetometers when the axis of the sensor coils (not the sensor itself) are aligned perpendicular with the Earth's magnetic field. Proper orientation is of utmost importance at the magnetic equator, where the field is horizontal. In polar regions, the field is vertical and orientation is not as critical.

The sensors have orientation marks. Care should be taken when assembling the gradiometer sensor to align both sensors with each other, such that the whole assembly can be oriented in both the vertical and horizontal modes.

If the sensor is properly oriented, the sensor coil axis points east-west. This also occurs if the sensor is mis-oriented by 180 degrees; that is the N mark points to the south etc. This means that a properly oriented sensor, when mounted fixed onto the Back Plate, is suitable for surveying while walking up or down a survey line.

Effects of gradient

Many small items carried by the operator in addition to the magnetometer may be magnetic and therefore upset, locally, the magnetic field to be measured. Such items are notebooks, pencils, cigarette lighters, eye-glasses, dentures etc., just to mention a few.

The higher the magnetic gradient is at the sensor, the poorer the proton precession magnetometers operate, since the precession signal decays more rapidly. With an abrupt signal decay at very high gradients, measurements are impossible to obtain.

Also, the closer a sensor is to a highly magnetic object, the higher the gradient the higher the gradient that will be present at the sensor.

Display page 2 of the Numeric Data display (page 5—12) shows a bar graph indicating the decay and the average signal amplitude. It is good practice to get familiar with this feature as it is a useful tool in diagnosing difficulties.
Take the MEMF: nn% out from the display

Other sources of noise

Other sources of noise can be objects (such as belt-buckles, branches, etc.) striking the sensor, staff, or console while walking. These can introduce microphonic noise that typically appears as spikes in your data. It is a good practice to secure the sensor cable as much as possible to prevent this microphonic noise.

On the staff

Detectability of anomalies depends on its magnetic moment, the size and the distance from the sensor. The stop-and-go mode of operation, with the sensor on top of four staff sections, is usually used for large low intensity anomalies. Small anomalies are easiest detected using the search mode, with the staff held upside down, with the sensor near the ground.

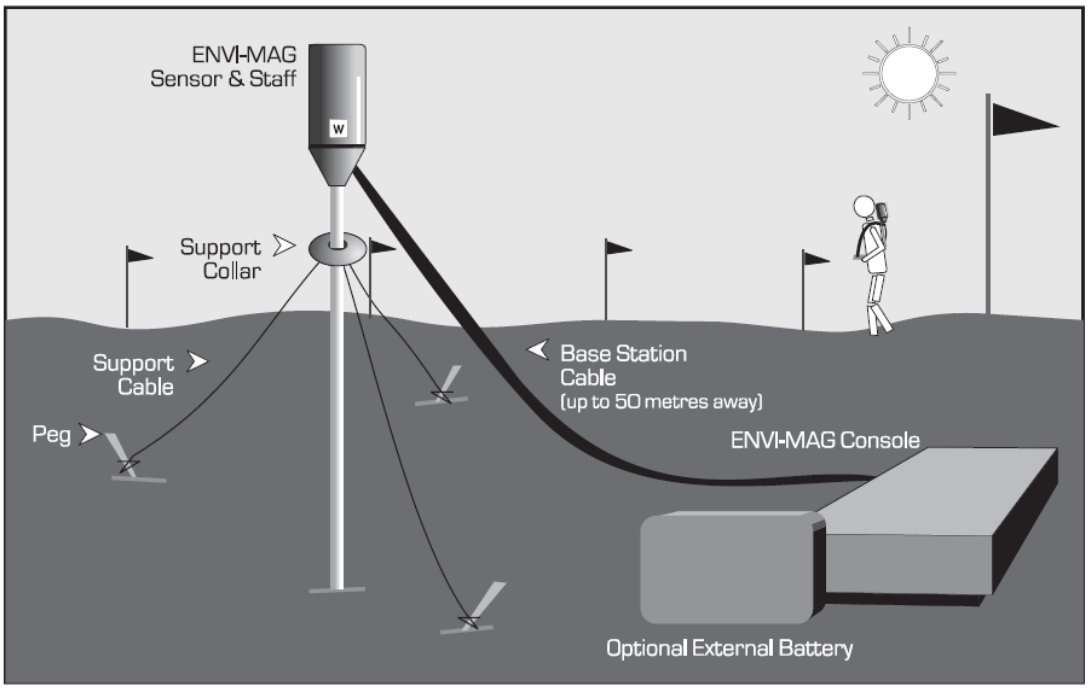
Note: The sensor has to be oriented for each reading.

Base-station

The Base-station is normally installed as close to the actual survey area as practical to minimize spatial differences in the magnetic field.

The base-station sensor is supported by the staff and secured with the aid of three cords and tent pegs as shown in the figure below. In some situations, it may be more convenient to lash the sensor to a tree. You can also use the standard total-field sensor (page 3—3) instead of the base-station sensor (page 3—3) to operate in the base-station mode, depending upon your particular circumstances.

Note: The long sensor cable is particularly susceptible to interference. You should ensure that the sensor cable is kept away from other cables and electrical equipment, especially electrical generators.



Typical base-station sensor setup

Repeated Surveys Lines

If it is necessary to repeat a set of measurements on a survey line, you should take certain precautions to ensure data handling is done in the most effective manner. The ENVI recalls or outputs repeated data sequentially by time at the same locations, resulting in unsightly (or unintelligible) recall displays. You will also have to substantially edit your data files to properly use them with your software.

Hint: It is recommended that you assign a minor increment to the survey line number prior to re-surveying to avoid problems. For example, if you are about to re-survey line 40N, enter the line number as 40.1N instead.

Magnetometer Operation

Walkmag Total-Field/Gradiometer Automatic Mode

The following sets of instructions will lead you step by step through the first three survey lines of an imaginary total-field survey looking for buried drums. This should give you a better understanding of what you will be required to do when doing your ENVI survey.

- It is assumed that the lines are marked and pegged intervals of 10 units
- The most suitable configuration for such a survey is with the sensor mounted (and properly oriented) onto the back place or optional backpack
- Ensure that the sensor orientation is such that when you are walking along the survey line, the N mark on the sensor is facing magnetic North (or South)

Typical configuration

Press the “ON” key to turn the instrument on.

This is described fully in “Configuration menu” on page 6—5.

Check your setup

Set up Line and Station Number and Separations as shown in the example under “Line and Station Setup”.

Do the setup shown under “Sample total-field setup (WALKMAG or WALKGRAD).

Start survey

Proceed to your first location.

Press the “START”key.

Proceed immediately with your desired pace toward the West.

Press the “NEXT” key when the *sensor* passes the first station peg. If you trigger the station marker at the time that you yourself pass the station, rather than the sensor, you will likely introduce a herring-bone pattern into the survey data. Observe how the Station Number decrements.

Repeat the previous step at each peg.

At Station 50 W, Press “STOP” right after you have pressed “NEXT”.

If you wish to inspect your data graphically (before you press “ESCAPE”), you will need to press the “NUM/GRA” key. This will show you up to the last 178 readings on the line.

Press the “ESCAPE” key.

Move the cursor to ST: SEP:

Enter 10

Move the cursor to LN:

Press the “+” (plus) key. The Line number increments to 18.

Proceed to Line 18N, Station 5W.

Press the “START” key.

Press the “NUM/GRA” key to enter the graphics display mode.

Proceed *immediately* walking to the East.

At each peg, Press the “NEXT” key.

At Station 50E, Press “STOP” right after you have pressed “NEXT”.

Press the “ESCAPE” key.

Change the ST: SEP: to -10.

Move the cursor to LN:

Press the “+” (plus) key. The Line number increments to 20.

Proceed to Line 20N, Station 50E.

Press “START”, and proceed walking to the West again, etc. The beep indicates the start of the first reading which belongs to Station 50E.

Hint: Walk gently without swinging your shoulders unnecessarily to prevent excessive rotation of the sensor or agitation of the sensor fluid, otherwise this will lead to noisy data.

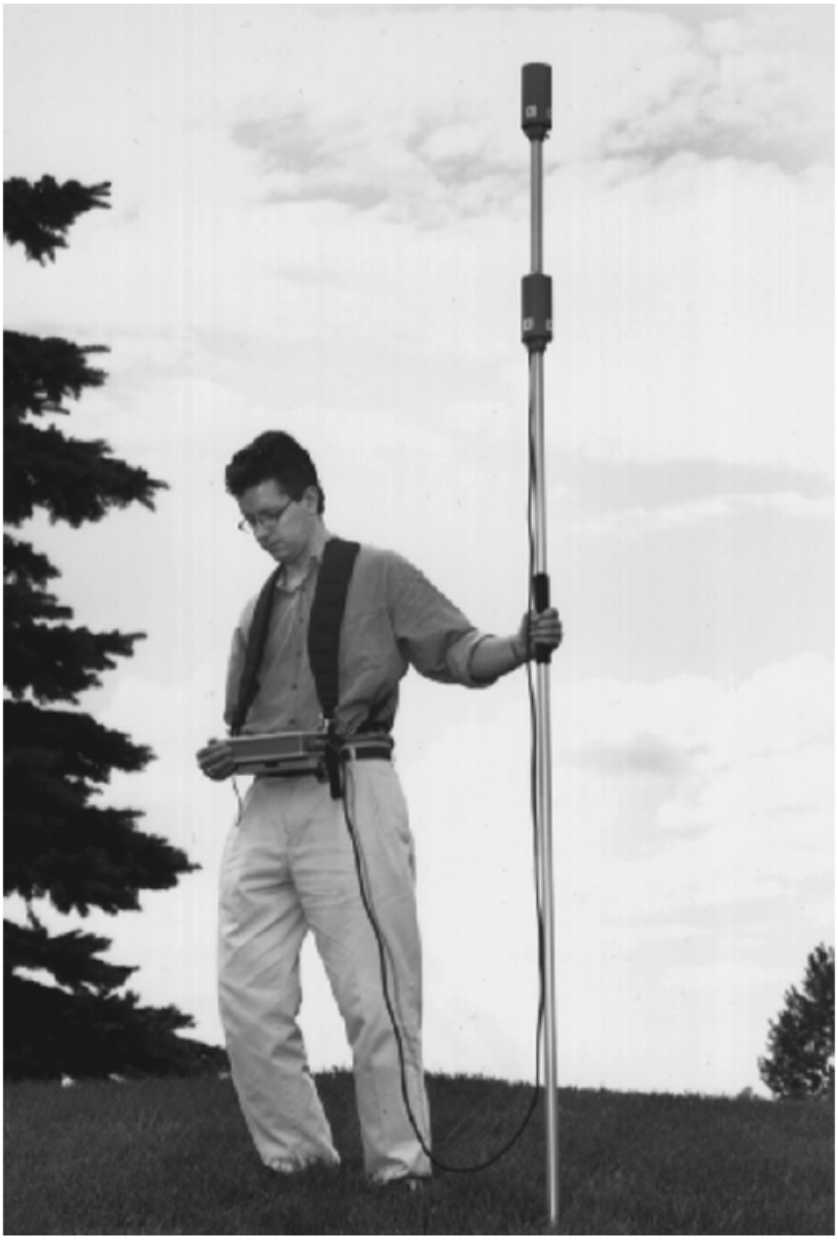
WALKGRAD Gradiometer Survey

A walking type of gradiometer survey is done in the same manner as that WALKMAG, with the following exceptions:

Manual Mode – Total-Field/Gradiometer (Semi-Automatic)

These instructions lead you through the steps for the first three survey lines of an imaginary gradiometer survey. A fully manual procedure (using the advanced mode) is explained first, followed by some suggestions on how to make it semi-automatic. It is assumed that:

- The lines are marked and pegged at 10 units of interval
- The sensor is carried on the staff. This gives the highest precision by eliminating the possibility of a small magnetic signature caused by the ENVI MAG console. *The sensor has to be oriented for each reading and should be held as steady as possible.*



Typical gradiometer configuration

Press the “ON” key to turn the instrument on.

This is described fully in “Configuration menu” on page 6—2.

Check your setup

Set up Line and Station Number and Separations as shown in the example under “Line and Station Setup”.

Do the setup as shown under “Instrument Setup” on page 6—7, except set the CYCLE REPEAT: as no and CYCLE DELAY: as 0.

Do the setup as shown under “Sample stop-and-go gradiometer setup on page 6—11.

Hint:

To operate as a total-field magnetometer in the Stop-and-Go mode, make the following change in the mag setup: screen, MODE: T-FLD.

Enter a Note as shown under “Note entry” on page 6-19.

Start Survey

Proceed to your first location.

Hold the sensor steady and Press the “START” key to take a reading.

Inspect the data.

Re-adjust the LOCAL FIELD in the mag setup if necessary to the current total-field value.

Press the “RECORD” key to save the data.

Press “ESCAPE”, optionally followed by “OFF”.

Proceed to the next station to the West.

Move the cursor to ST:

Press the “+” key. Verify that the Station has decremented to 40W.

Take a reading and record the data.

Continue along the line and take a reading at each station.

At 10W, before you press the “START” key, Press the “NOTE” key and then the “1” key to enter the note “fence 1”. You may also enter your Macro or

any unique note after the measurement, but before you Press the “RECORD” key.

After completing 50W, proceed to 50W on Line 18N.

At the MAIN OPERATING display move the cursor to ST: SEP:

Enter 10.

Move the cursor to LN:

Press the “+” key to increment the line number to 18N.

Take a reading and proceed along line 18N toward the East.

At 10W again, before you press the “RECORD” key, Press the “NOTE” key, and then the “1” key.

After you have finished the line, move to Line 20N and proceed to 50E.

At the MAIN OPERATING display move the cursor to ST: SEP:

Enter -10.

Move the cursor to LN:

Press the “+” key to increment the line number to 20N.

Proceed with Line 20N.

Automating your measurements

There are two items which can be automated after each measurement:

- Data recording
- Altering of the Station Number can take place automatically

Warning: Please note that *repeat measurements* will alter the Station Number and possibly disrupt the correlation between location and data.

To enable both features do the following:

In the Instrument setup, move the cursor to AUTO ST. INC.: Select YES.

In the mag setup, move the cursor to AUTO RECORD: Select YES.

Base Station Operation

Base-station operation is a simple matter of setting up the equipment and getting it operational. A single base-station can be used with a multiple of mobile (portable, airborne) instruments. The base-station sensor(s) should have the same location for multi-day projects.

A chart recorder may be used for a continuous analog output, though the on-line graphics capability may make this unnecessary. See “Data Output Connector” on page 4—2 for more information on this.

The magnetic base-station operation uses the standard base-station sensor with the 50m cable. However, the total-field sensor can also be used for convenience. You will be asked whether you are using a long (50m base-station) or shore (total-field) cable.

After all the equipment has been set up and connected, proceed as described to set up the instrument (or at least to verify proper settings as shown in the “Sample base-station setup” on page 6—14).

Warning: It is of **utmost importance** that **date** and **time** coincide on all instruments to successfully correct the mobile data. But if GPS is used, GPS will synchronize the time on all instruments.

Proper correction also requires a *base field* value, which has to be entered into **all** magnetometers before the base-station correction takes place. This usually is one of the first readings of the base-station taken on the first day of an extended survey. This value **must not** be changed while in the same area.

Check your setup

Set up Line and Station Number to the actual location of the base-station. This is recommended to avoid later confusion.

Do the setup as shown under “instrument setup”, except set: CYCLE REPEAT: as no.

Do the setup as shown under “Sample base-station setup”.

Start operation

Press the “START” key, read the console message and act accordingly.

After two or three readings, Press the “STOP” key.

Press the “ESCAPE” key.

Bring up the MAG SETUP display by pressing the “SETUP” key, then moving the cursor to mag setup and pressing the “ENTER” key.

Enter the measured total-field value as TUN FIELD: and also as the BASEFIELD:

Enter the same Base Field value into all mobile units.

Press the “ESCAPE” key and resume the measurement.

Press the “NUM/GRA” key to show the graph.

Press the “+” or “-“ key to change the sensitivity of the graph. The new full-scale value is shown briefly on the message line at the bottom of the display. You can also press the “0” key to center the graph vertically.

Note:

Data scrolled off the screen may be inspected using the RECALL feature. This, however, requires interruption of the data acquisition cycle. A change in the graph sensitivity does not affect the recorder sensitivity.

Survey Data Correction Procedures

The purpose of data corrections is to remove diurnal and micro-pulsation effects of the Earth’s magnetic field from the magnetic data and atmospheric effects and transmitter power variations form the VLF total-field data. This gives you the cleanest data possible for interpretation. However, these procedures may not be necessary, if your goal is only target identification (anomaly hunting).

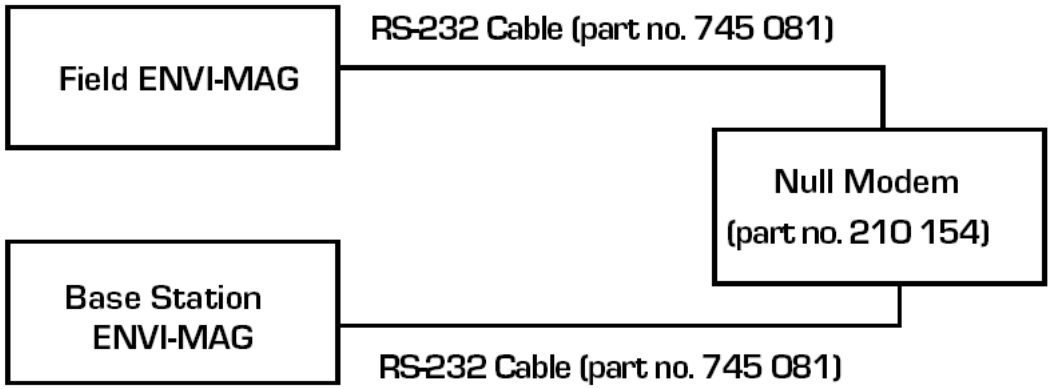
Using Base-Station Data

You can only use base-station data when you have selected one of the advanced (5-7) survey configurations. This procedure describes the correction when using an ENVI PRO only. The correction with difference instruments must be done independently on a computer.

Warning: The base-station correction physically modifies the data of the mobile units, but does not alter the base-station’s data. The correction must only be done once. If the raw mobile unit’s data are required, then it must be dumped prior to correction. Please make certain that the BASE FIELD value in the field unit is correct before proceeding.

To correct your data, proceed as follows:

Connect the units as shown.



Connections for the Base-station correction

Proceed, on both units, to the mag setup: display.

Scroll, on both, to BASE CORRECT.:

Select yes.

You will now see a warning message on the right side of the display of the field unit indicating that the raw data in the field ENVI MAG will not be preserved.

Press the “START” key on both. Either one can be started first.

You will be asked to confirm the start of the data correction by pressing either the “Y” or “N” key.

When finished, Press the “ESCAPE” key.

Tie-Point (TIE-PT) Mode

This type of correction procedure uses data from repeated stations during the course of the survey to correct for the variations in the earth's magnetic field or VLF field strength.

It should be noted however that this correction method is not as accurate or precise as the Base-station Correction method. A technical paper on the subject "Magnetic Correction Techniques" is available from Scintrex.

Note: Both Looping and Line-Type methods can be applied to either a WALKMAG or a Stop-and-Go type of survey. However, for the Line type, the tie-line itself must be done in the Stop-and-Go mode.

Loop type – collecting data

This is the default mode available when you select any of the basic configurations (1-3) from the configuration menu. To select the LOOP mode, calla up the mag setup: display and:

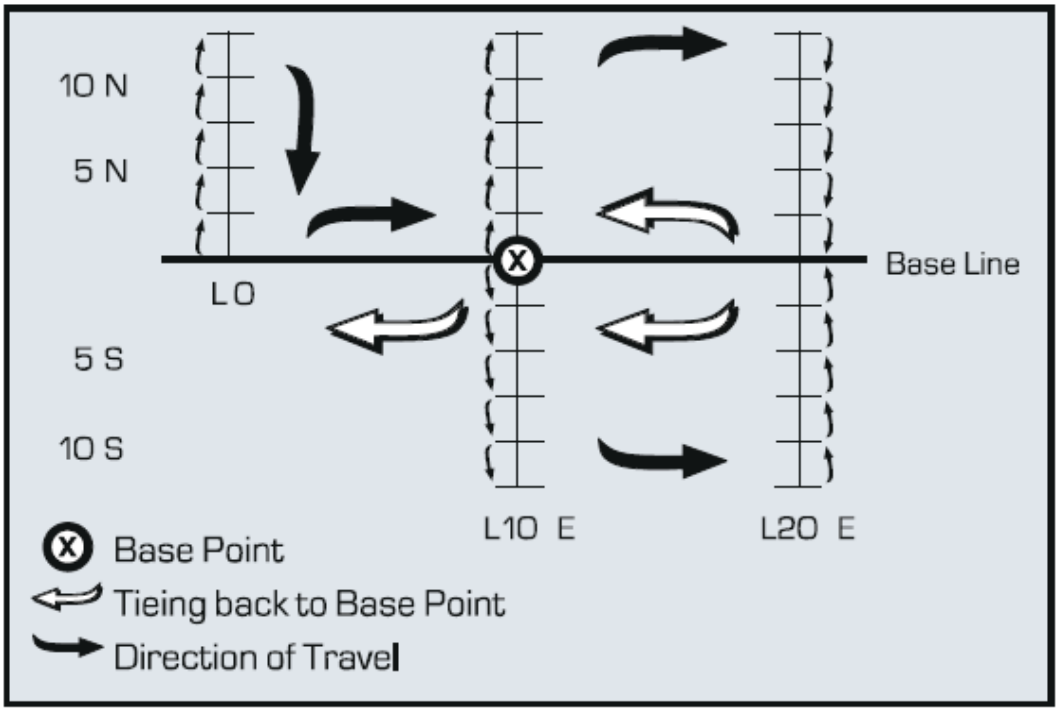
Move the cursor to TIE-MODE:

Select LOOP

Pick a location in your survey area that you can conveniently come back to during the course of your survey.

At your designated tie-point location, press the "TIE-PT" key instead of the "START" key.

Proceed with your normal survey, but return to your designated tie-point on a regular basis. Always take readings using the "TIE-PT" key instead of the start key at this location. This is illustrated in the following diagram:



Looping method for collecting correction data

Line type – collecting data

This mode is only available when using the advanced configuration (5-7). See "Advanced mode configuration displays".

During a traverse along the tie-line, the Station numbers are kept constant, but the Line numbers are changed.

It is assumed that the instrument has been fully setup in advance for other functions. A few setup items have to be changed:

Call up the instrument setup display.

Move the cursor to AUTO STN. INC:

Select NO.

Call up the mag setup: display.

Move the cursor to TIE-MODE:

Select LINE.

Return to the MAIN OPERATING display.

Move the cursor to STN: in the Locations block on the right side.

Enter the Station number at the Tie-Line.

Move the cursor to LN:

Enter the Line number at the start of the Tie-Line.

Press the “TIE-PT” key to take a measurement and record it.

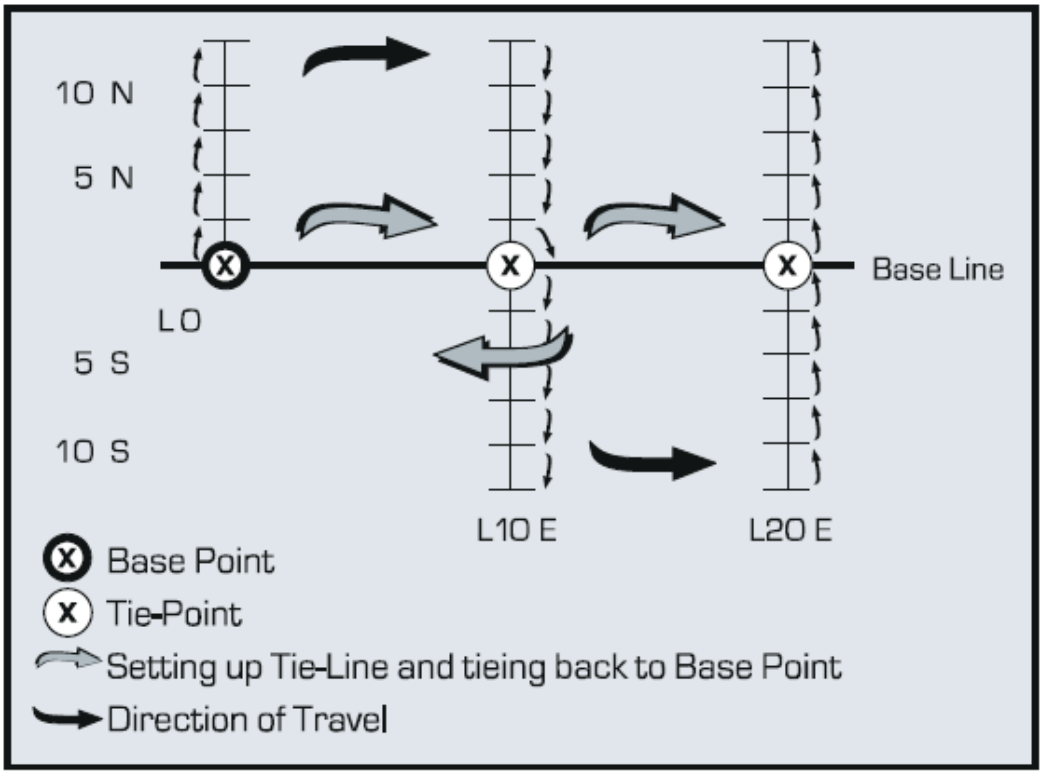
Proceed to the next line.

Move the cursor to LN:

Press the “+” or “-“ key, as needed, to change the Line number.

Repeat steps 12-15 to complete collecting the tie-line data.

Proceed with your normal survey as illustrated in the following diagram:



Tie-line method for collecting correction data

Note: If you need more than one day to complete your survey in the Line-type mode, please make sure that you collect *all* your Tie-points as the first data that you store in memory, i.e. before you survey any lines. This ensures that they will not be erased when clearing memory to make room for the next days data.

Tie-Point Correction Procedure

The Tie-point correction is performed as follows:

Move the cursor to TIE:

Press the “ENTER” key.

You will now see a warning message on the right side of the display indicating that the data will be altered.

Press the key containing “Y” for yes or “N” to abort.

When finished, Press the “ESCAPE” key.

Chapter 8 Data Output

Note: For data dump please use Windows Hyperterminal S/W, or Scintrex RS232 Data logger Ver. 1.0.

There are many different types of computers and printers on the market. Consequently, only general instructions on how to dump the data will be given.

The RS-232 cable (p/n 745081) is the link between the ENVI PRO data output connector and the serial port of the computer or printer.

Warning: The null modem (Scintrex p/n 210154), as used for the base-station correction, must not be used here.

Output Formats

The data can be dumped in several different formats. These formats, for each mode, are discussed here with sample data shown for each. The data is normally fully left justified but are shifted here (for typographical reasons) somewhat to the right. The maximum line length is 80 characters.

XYZ

The XYZ format is the *recommended format* to be used in conjunction with the ENVI-MAP processing program.

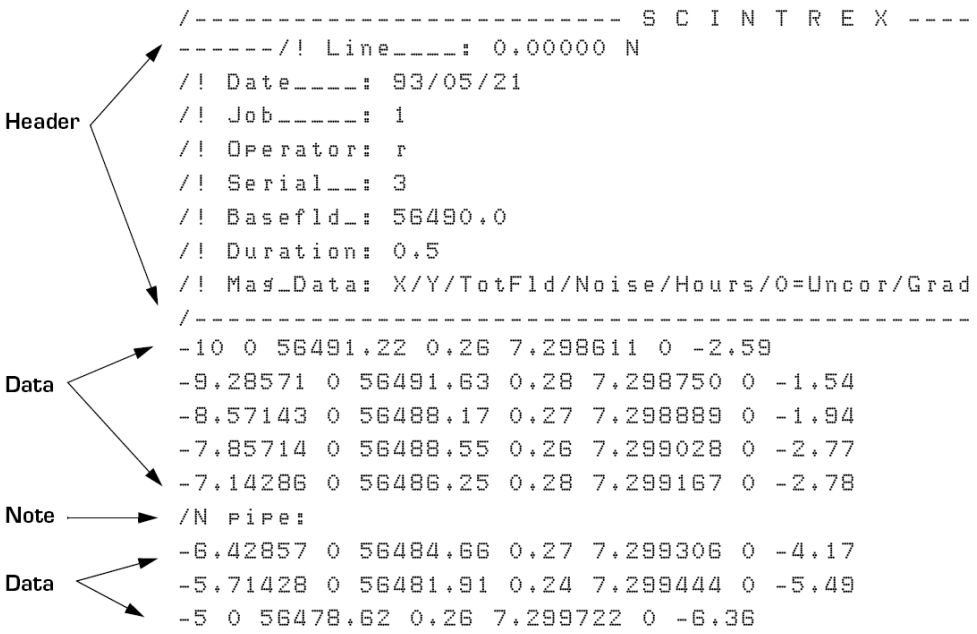
The XYZ format does *not* have a header section *nor* does it contain NOTES.

A short sample of the format follows:

```
-10 0 56491.22 0.26 7.298611 0 -2.59
-9.28571 0 56491.63 0.28 7.298750 0 -1.54
-8.57143 0 56488.17 0.27 7.298889 0 -1.94
-7.85714 0 56488.55 0.26 7.299028 0 -2.77
-7.14286 0 56486.25 0.28 7.299167 0 -2.78
-6.42857 0 56484.66 0.27 7.299306 0 -4.17
-5.71428 0 56481.91 0.24 7.299444 0 -5.49
-5 0 56478.62 0.26 7.299722 0 -6.36
```

XYZ+

The XYZ+ format has a header section and contains user entered Notes, but it is otherwise identical to XYZ.



XYZ++

Note: This is the default format for the basic mode (configurations 1-3), however, you will not. have any Notes entries in this mode

The XYZ++ format also has a header section and user entered Notes. The distinguishing feature is that the data is placed into columns.

```
/--------------------------- S C I N T R E X ----
------/! Line____: 0.00000 N
/! Date____: 93/05/21
/! Job_____: 1
/! Operator: r
/! Serial__: 3
/! Basefld_: 56490.0
/! Duration: 0.5
/! Mag_Data: X/Y/TotFld/Noise/Hours/0=Uncor/Grad
/-------------------------------------------------
-10        0   56491.22   0.26   7.298611   0    -2.59
-9.28571   0   56491.63   0.28   7.298750   0    -1.54
-8.57143   0   56488.17   0.27   7.298889   0    -1.94
-7.85714   0   56488.55   0.26   7.299028   0    -2.77
-7.14286   0   56486.25   0.28   7.299167   0    -2.78
/N pipe:
-6.42857   0   56484.66   0.27   7.299306   0    -4.17
-5.71428   0   56481.91   0.24   7.299444   0    -5.49
-5         0   56478.62   0.26   7.299722   0    -6.36
```

The following is the XYZ++ format when GPS is enabled in UTM coordinate.

```
/-------------------------   S C I N T R E X   ----------------------------
/! Revision:  1.0
/! Date____:       09/04/30
/! Job_____:       1
/! Operator:
/! Serial__:   0
/! GPS_Intl:   3
/! UTM_ZONE: 17
/! Basefld_:   0
/! Duration:   2.0
/! Mag_Data:        East/North/TotFld/Noise/Hours/0=Uncor
/-------------------------------------------------------------------------
 620403.23  4849673.90    54555.7  0.19  13.903333  0
     *           *        54555.4  0.08  13.903889  0
     *           *        54555.9  0.07  13.904444  0
 620400.16  4849673.84    54555.3  0.07  13.905278  0
```

```
    *           *      54556.2  0.06  13.905833  0
    *           *      54555.2  0.06  13.906389  0
620398.23 4849678.89   54556.9  0.07  13.907222  0
    *           *      54553.9  0.06  13.908056  0
    *           *      54553.4  0.06  13.908611  0
620395.69 4849683.51   54556.7  0.06  13.909167  0
    *           *      54555.9  0.06  13.909722  0
    *           *      54556.3  0.06  13.910278  0
```

PRN

The PRN format is compatible with software written for the Scintrex MP-3/4 magnetometer.

```
/---------------------------- S C I N T R E X -----
-----//! Line____: 0.00000 N
/! Date____: 93/05/21
/! Job_____: 1
/! Operator: r
/! Serial__: 3
/! Basefld_: 56490.0
/! Duration: 0.5
/! Mag_Data: Station/Dir/TotFld/Noise/Grad/Time/
*=Uncor/Notes
/-----------------------------------------------
           10 W56491.22 0.26  -2.59    07:17:55  *
9.28571 W     56491.63   0.28  -1.54    07:17:55  *
8.57143 W     56488.17   0.27  -1.94    07:17:56   *
7.85714 W     56488.55   0.26  -2.77    07:17:56  *
7.14286 W     56486.25   0.28  -2.78    07:17:57  *
pipe
6.42857 W     56484.66   0.27  -4.17    07:17:57  *
5.71428 W     56481.91   0.24  -5.49    07:17:58  *
              5 W56478.620.26 -6.36    07:17:59  *
```

Notes

The NOTES output format just retrieves your manually entered NOTES and macros. In the output, it shows them with their respective line and station values.

For example, from the data in the PRN file you would see the following:

/Y: Line 0.00000 N / X: Stn 7.14286 W/ pipe

Operation Mode

From the MAIN OPERATING display:

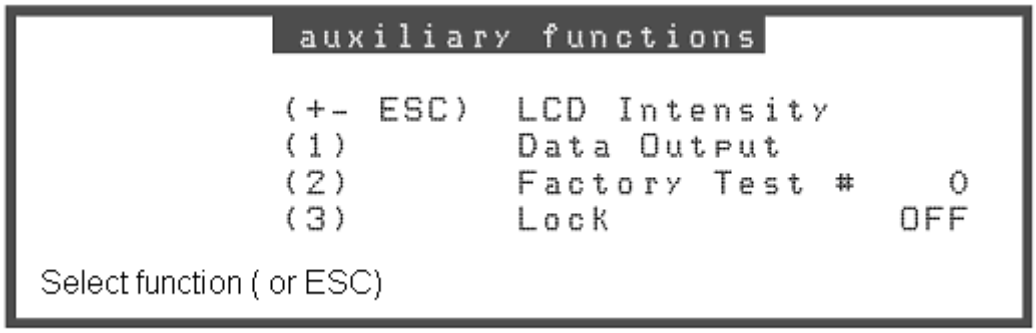
Connect the ENVI PRO to the serial port of your computer, using the RS-232 cable (Scintrex p/n 745081)

Start your communications program in order to receive data.

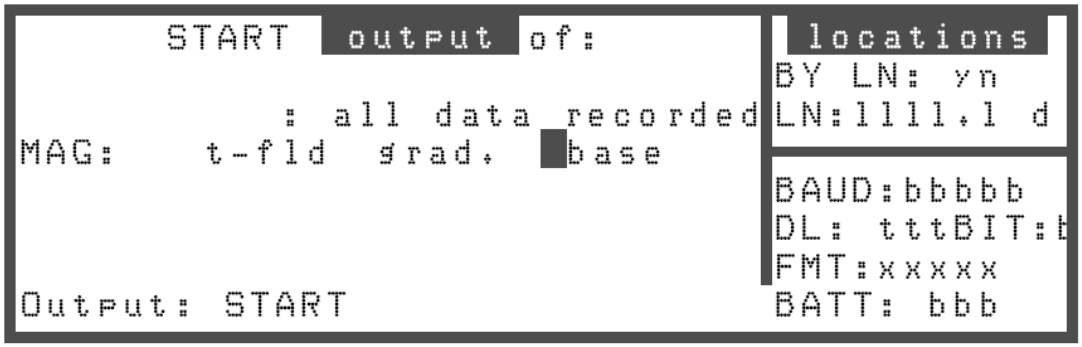
Output Setup

From the Main operating display of the ENVI PRO:

Press the AUX/LCD key



Press the 1 key to get the START output of: display.



At the START output of: display proceed as shown:

Press the NEXT key until the cursor rests within the lower *right* sub-page, i.e. the communications block.

Move the cursor to BAUD:

Select your desired baud rate.

Note: The baud rate on the ENVI PRO *must match* the baud rate on the output device for successful communication.

Leave DL: at 0 and BIT: 8

Move the cursor to FMT:

Select the desired output data format (see Output formats)

Warning: If some characters are lost during the dump, (an occurrence in particular to some printers), it may be necessary to set the delay DL: to a value between 0 and 999. The actual value has to be established experimentally. BIT: may need to be changed to 7 to get the proper character font.

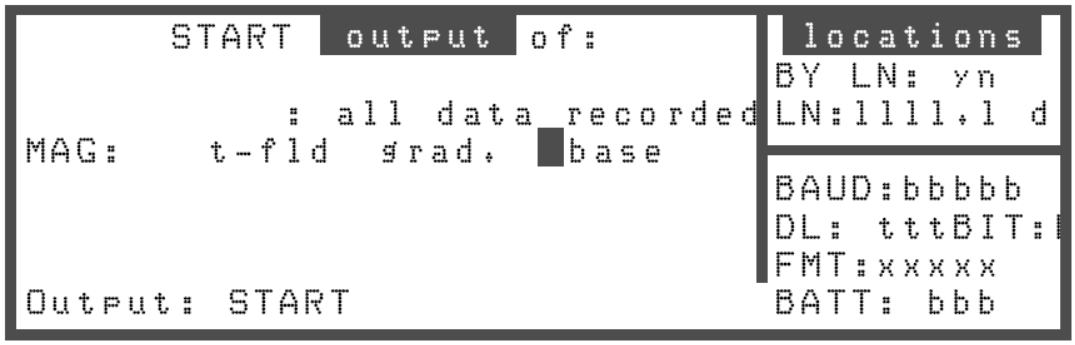
Dumping Data

Data can be dumped in three different ways:

- All data – regardless of method; one *big* sequential dump
- By method or sub-method, i.e. total-field, gradient or base
- On a line by line basis

All data

At the START output of: display proceed as follows:



Press the NEXT key until the cursor rests within the *left* sub-page.

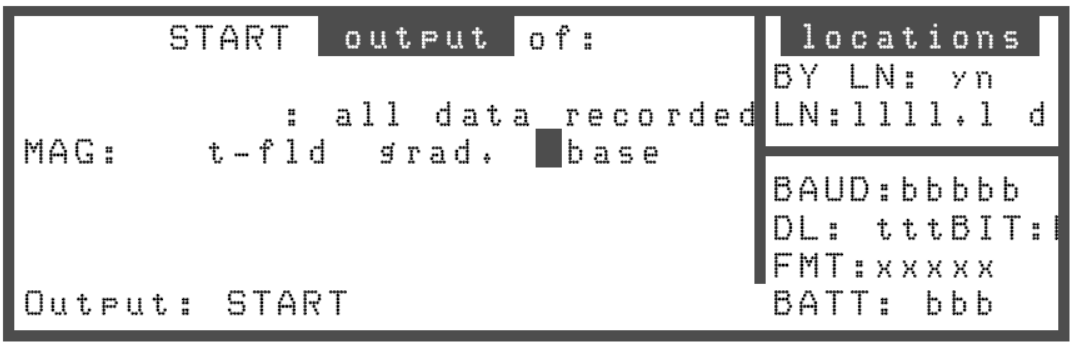
Move the cursor to: all data recorded

Press the START key.

Options: Press the STOP key to temporarily suspend dumping. Press the ESCAPE key to *abort* the dump.

Specific data

At the START output of: display proceed as shown:



Press the NEXT key until the cursor rests within the *left* sub-page.

Move the cursor to one of the three data types: MAG: T-FLD, GRAD, BASE

Press the START key.

Options: Press the STOP key to temporarily suspend dumping. Press the ESCAPE key to *abort* the dump.

Line by Line

At the START output of: display proceed as shown:

Note: Data recorded when GPS enabled can not be dumped based on line number.

Press the NEXT key until the cursor rests within the *right* sub-page. i.e. the locations block.

Move the cursor to BY LINE:

Select YES to activate this function.

Move the cursor to LN:

Enter the desired Line number and direction.

Press the NEXT key until the cursor rests with the *left* sub-page.

Move the cursor to one of: MAG: T-FLD, GRAD, BASE

Press the START key.

Options: Press the STOP key to temporarily suspend dumping. Press the ESCAPE key to *abort* the dump.

Repeat steps 5 to 8 as required.

Press the ESCAPE key to return to the Main operating display.

Erasing data from memory

After you have successfully dumped your data to a computer and have verified that it is all there, you should free up the ENVI-PRO's memory to prepare for your next survey. This is accomplished by activating the ERASE MEMORY option. This removes only the data from memory, but preserves the rest of your configuration parameters. To clear everything you would have to do a cold boot.

Hint:

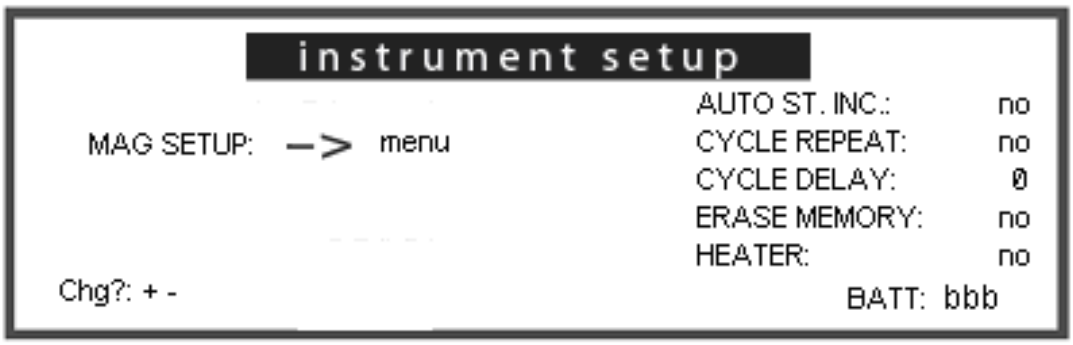
If you are using the TIE-PT mode of diurnal correction with the Line option, there is a special provision for not clearing the TIE-PT data. This allows multi-day surveys to be corrected to the same set of control values. However, this also requires you to collect *all* of the TIE-PT data before you start surveying the rest of the grid.

Operation mode

From the Main operating display:

Press the SETUP key.

The INSTRUMENT SETUP display now appears:



Move the cursor to ERASE MEMORY:

Select YES

You will now see a prompt on the bottom line:

Mem. Erase! 1: DATA 2: TIE+DATA

Options:

1: DATA – This will only clear the current days data and leave any TIE-PT data in the memory for the next day's use.

2: TIE+DATA – This will clear all of the data,

including the TIE-PT data.

You will be asked to confirm that you actually want to erase all the data from memory by pressing the Y key. You will then see the *Block memory free* increment on the prompt line as it is cleared.

Chapter 9 Maintenance and Repair

Battery Charging

The ENVI PRO uses lead-acid batteries. These are a reliable power source when properly maintained. They can provide power through a few hundred charge/discharge cycles. However, the main source of trouble with these batteries is *deep discharge*. This occurs when the battery is fully discharged and left discharged for an extended period.

To prevent deep discharge in the ENVI PRO, electronic circuitry monitors the battery voltage and shuts the instrument down when the battery has reached it's lower operating level. It should then be recharged as soon as possible. However, the instrument draws a small current even when turned off. If the ENVI PRO is left in a discharged state, for even a few days, you will need to replace the deep-discharged battery with a new one (Scintrex p/n 400078 or 400080).

Warning: The small current drain just mentioned above is the reason why the battery MUST BE DISCONNECTED FOR SHIPMENT AND STORAGE. Batteries also self discharge slowly, therefore they must be recharged periodically, e.g. every 3 months, even when in storage. Finally, batteries should also be stored at room temperature, or as close to it as possible.

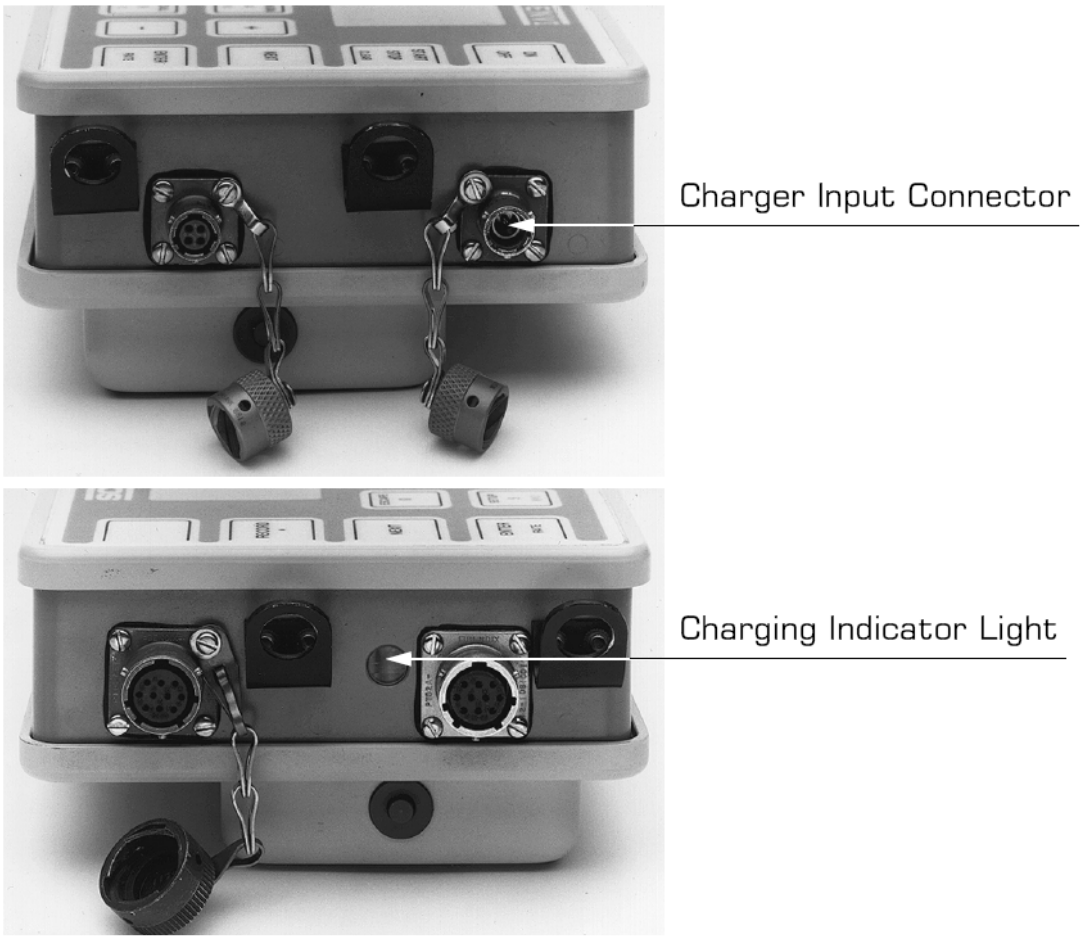
Up to two batteries can be charged at the same time. If high capacity batteries are charged, such as those used in the External Heavy Duty Battery Pack, it is important that the charging begin right after work and continue overnight.

Optimum charging takes place at room temperature. Provision is made to compensate for variation in temperature in the 0° to 40° Celsius temperature range. The battery and console should also be at the same temperature.

To charge the batteries proceed as follows:

One Battery

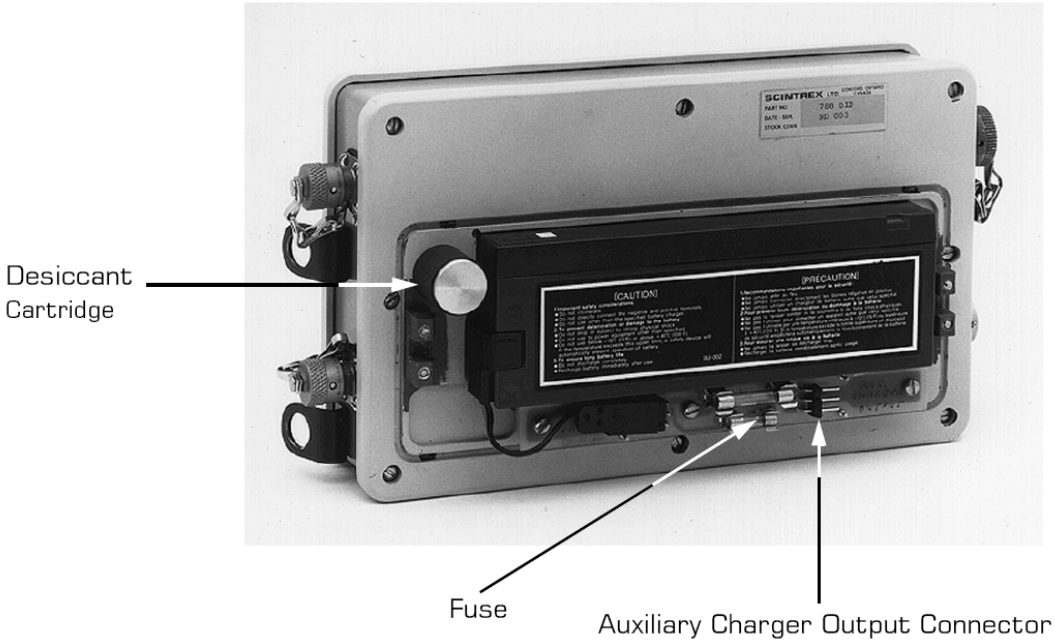
1. Connect the charger to the power outlet. Adjustment for different line voltages are made automatically.
2. Connect the charger to the charger input connector.
3. Flip the switch on the charge to ON.
4. Observe the charging light at the left hand side of the ENVI PRO console. It will be ON while charging at a high rate and turn OFF when the battery is nearly charged.



Charger port and charging light

Two Batteries

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the knurled screws on each side of the battery cover and lift off the over.
3. Connect the spare battery to the AUX. CHARGER OUTPUT connector. Either side of the plug may be on top.
4. Connect the charger to the power outlet. Adjustments for different line voltages are made automatically.
5. Connect the charger to the charger input connector.
6. Flip the switch on the charge to ON.
7. Observe the charging light at the left hand side of the ENVI PRO console. It will be ON while charging at a high rate and turn OFF when the battery is nearly charged.



Location of the auxiliary charger output connector, fuse and desiccant cartridge

Periodic Maintenance

Cleaning the Sensors

There is only minimal periodic maintenance required: the cleaning of the sensors. Due to their proximity to the sensor coils, magnetic dust particles on the sensor housing may upset the magnetic field. This would result in erroneous absolute values. Therefore, it is good practice to wash the sensor(s) periodically with soap and water.

Desiccant Exchange

Small amounts of moisture may possibly enter the ENVI PRO console, even though it is fully sealed. A cartridge filled with a drying agent (desiccant) is located under the battery cover. The desiccant should be dried out periodically as required. A spare cartridge is supplied as part of the Minor Spare Parts Kit.

To dry out the cartridge:

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the screws at both sides of the battery cover.
3. Lift off the cover.
4. Pull out the cylindrical plug while gently turning.
5. Place the cartridge in front of a heat source for about one hour. A hair direr is a good source of dry heat.
6. Clean the mating surfaces on the cartridge and the access hole.
7. Replace the cartridge.
8. Replace the battery cover.

Fuse Replacement

There is one fuse located inside the battery cover and another one is under the metal cover of the External Heavy Duty Battery Pack.

Two fuse holders are provided under the battery cover of the ENVI PRO as shown on page 9—3. One is for a 1.5A quick, standard North American fuse (Scintrex p/n 512018). The other fuse holder is for a 5 x 20mm European fuse.

Warning: ONLY *one* fuse may be in place at any given time.

The fuse in the External Battery Pack (Scintrex p/n 512049) is a standard 5A automotive fuse.

Console Disassembly/Assembly

Warning: Disassembly of the console is strongly discouraged due to its complexity, but should disassembly of the console be required proceed as follows:

1. Place the console, face down, onto a flat smooth surface.
2. Unscrew the screws on both sides of the battery cover.
3. Lift off the cover.
4. Remove the battery.
5. Unscrew the eight screws.
6. Lift off the rear panel carefully.
7. Watch for the wires.
8. Place the panel above the instrument on the surface.
9. Turn the console over.
10. Lift off the front panel carefully.
11. Place it to the left of the console.
12. Take care of the cable.
13. Clean all connecting surfaces before re-assembly, including the O-rings under the eight screws.
14. Make sure that the wires coming from the power connector located at the bottom left hand side of the display module are placed side by side and that all other wiring is placed such as not to get pinched.
15. Repeat steps 1 to 12 in reverse order to assemble the console again.
16. If available, apply a small amount of oil or grease to the O-rings.
17. Tighten up the screws with a medium-sized slotted screwdriver. Do not over tighten.

Cable Repair

The cable connectors should be periodically checked to ensure that they are not filled with dirt. An electronic contact cleaner spray can be used to flush the connectors.

Cables may occasionally need repair as conductors eventually break due to flexing. Some connectors are sealed with a silicon compound to prevent the entry of water and dirt. The sealing material can be removed after the cable clamp has been unscrewed to gain access to the pins. It is a good practice to seal the connector again when repaired. The proper connections are indicated in the following table:

Cable	Wire Colour	Connector Pin
Total Field (780547 & 780550)	Shield/Bare	K
	White	G
Gradiometer (788028)	Shield/Bare	A
	Green	C
	Red	G
	White	H
	Black	K
Base Station (788029)	Shield/Bare	A
	White	G
	Black	K
External Power (788029)	Red	Outside
	Black	Center

Trouble Shooting

Problem	Possible Causes	Possible Solutions
On/Off key does not respond (no beep)	Battery not connected	Install battery
	Battery discharged	Charge battery
	Fuse blown	Disconnect sensor. Check and replace fuse in the battery compartment or in the External battery pack depending on which one you are using.
Instrument shuts off immediately	Low battery	Charge battery
Fuse blows after the start of a reading	Short circuit in sensor cable	Repair sensor cable
Display is very slow	Display is too cold	Turn on the LCD heater, using the AUX/LCD button to access option, if the ambient temperature is below minus 15°C.
Display is invisible	Incorrect LCD intensity setting	1. If no data is in the instrument, perform a cold boot. 2. Adjust LCD intensity using AUX/LCD button to access option. 3. Turn on the heater if below minus 15°C.
Reading noise is high	No sensor(s) attached	Connect the sensor(s).
	Tuning is incorrect	1. Properly set the

		manual tuning. 2. Use Auto-tuning.
	Sensor cable is improperly connected	Connect properly.
	Sensor cable is broken	Repair sensor cable.
	Improper sensor orientation	Make sure hat either the N or S mark on the sensor points to magnetic North.
	High gradient	1. Monitor the Numeric Page 2 display chart. 2. Readings may be impossible.
	External interference (e.g. power line)	Readings may be impossible.
	No fluid in the sensor (shake & listen for sloshing sound)	Contact Scintrex Customer Service.
Data does not dump	RS-232 cable not connected	Connect cable.
	Computer not communicating	1. Run the computer communications program. 2. Check that you are using the correct serial port on your computer.
	Baud rate incompatible	Set baud rates on the compute rand ENVI console to be identical.
	No such data in instrument	1. Make sure that you are asking for data that you have measured, i.e. asking for base or grad when t-fld recorded. 2. Select: dump all records.
	No matching line number	Set proper line number or disable line by line dump.
Base-station correction does not work	Base unit and mobile unit not properly interconnected	Interconnect units via Null Modem.
	No matching date or time	Correction must be made externally on a computer.
Cannot recall data	No respective line or station (or time, if base-station)	Set recall parameters to match survey parameters, i.e. LN< SEP, STN, SEP may be out a digit.

Chapter 10 Reference Information

Envi Pro Technical Specifications

Total field range:	23,000 to 100,000 nT
Total field absolute accuracy:	± 1 nT
Sensitivity:	0.1 nT at 2 second reading time, reduced at other reading times.
Supplied GPS Accuracy:	2.4m (CEP) and 6m (2DRMS) SBAS ± 1m (autonomous), <1m (WAAS) Connects to most external GPS receivers with NMEA & PPS output
Sensor spacing: (Gradiometer)	0.5 meter
Tuning:	Fully solid state. Manual or automatic; keyboard selectable.
Reading period:	0.5 sec 1 sec 2 sec
Cycle time: (Base Station)	Internal: The minimum is determined by the reading period, max. 9999 s, in 1 s intervals. External: Any, as long as it exceeds the reading period and is initiated by a command at the RS-232 interface.
Cycle delay:	The minimum is determined by the reading (WALKMAG) period; max. 8 s, in 1 ms intervals.
Display:	8 lines by 40 characters, 64 x 240 dots. Super-twist LCD display with heater.
Keyboard:	17 keys, membrane type. Main mode is Function Key; secondary mode is Alpha-numeric.
Note Entry:	32 characters and 5 user pre-defined MACROs of 15 characters each, for quick-entry.
Audio:	Beeper to acknowledge key-press, start of reading to act as a pacer.
Clock:	Real time clock with date and time. 1 second resolution and +/- second stability over 12 hours.
Data Memory:	**Mode** **Readings**

Base Station	500,000
Total Field	84,000
Gradiometer	67,000

Data presentation:	Present and three previous readings in numerical form. Up to 178 readings in graphic form. Display shirts ¾ screen when full.
Data output interference:	RS-232 interface, 600 to 57600 Baud, 7 or 8 data bits, 1 start, 1 stop bit, no parity format. Selectable carriage return delay (0-999 ms) to accommodate slow peripherals. Handshaking is done by X-On/X-Off.
Data output format:	Data dump of all acquired data in memory or on a mode by mode and line by line basis in XYZ or printer listing format. Separate dump for “Notes”.
Analog Output:	0 to 999 mV full scale output voltage with keyboard selectable range of 1, 10, 100, 1000 or 10000 nT full scale.
Data Recall:	On the LCD display in graphic format. Based on time for the base station, on line and station basis for other modes. Bi-directional scan.
Power Consumption:	2.9 Ah Lead-acid battery (Camcorder type). 12 V at 0.65 A for magnetometer. 1.2 A for gradiometer. Approximate battery life is 40000 readings as a WALKMAG at 25°C.
Power Supply:	External 12V input for base station operation.
Battery charger:	110 V – 230 V 50/80 Hz
Environmental Range:	-40° to 60° C Humidity 0 – 100% Fully sealed. Easy to exchange desiccant cartridge.

Dimensions & Weight

Console:	250 mm x 152 mm x 55 mm 300 mm x 152 mm x 82 mm overall 2.45 kg
Magnetic sensors:	70 mm diameter x 140 mm 70 mm diameter x 175 mm overall, total field 70 mm diameter x 675 mm overall, gradiometer 1.0 kg total field ; 1.15 kg gradiometer

Staff:	25 mm diameter x 2 m in 4 sections. 0.8 kg

Warranty & Repair

Warranty

All Scintrex equipment, with the exception of consumable items, is warranted against defects in materials and workmanship for a period of one year from the date of shipment from our plant. Should any defects become evident under normal use during the warranty period, Scintrex will make the necessary repairs free of charge.

This warranty does not cover damage due to misuse or accident and may be voided if the instrument console is opened or tampered with by persons not authorized by Scintrex.

Repair

When to ship the unit

Please do not ship your instrument for repair until you have communicated the nature of the problem to our Customer Service Department by e-mail, telephone, facsimile or correspondence. Our Customer Service Department may suggest certain simple tests or steps for you to do which may solve your problem without the time and expense incurred in shipping the instrument back to Scintrex for repair. If the problem cannot be resolved remotely, our personnel will request that you then send the instrument to our plant for the necessary repairs.

Description of the problem

When you describe the problem, please include the following information:

- The symptoms of the problem
- How the problem started
- If the problem is constant, intermittent or repeatable
- If constant, under what conditions does it occur
- Any printouts demonstrating the problem

Shipping Instructions

No instrument will be accepted for repair unless it is shipped *prepaid*. After repair, it will be returned *collect*, unless other arrangements have been made with Scintrex. Please mention the instrument's serial number in all communications regarding equipment leased or purchased from Scintrex.

Warning: Please do not ship the instrument with the batteries installed. **FURTHER DAMAGE MAY RESULT**

Instruments should be shipped to:

Scintrex Limited
222 Snidercroft Road
Concord, Ontario, Canada
L4K 2K1

Telephone: (905) 669-2280
Fax: (905) 669-9899
e-mail: service@scintrexltd.com

Three sets of customs documents must be included:

- One set inside of the package
- One set attached and sealed to the outside of the package
- One set attached to the air waybill

Scintrex instruments are manufactured in Canada, consequently there is no customer duty payable in Canada. It is advisable to state on the customs documents the follows:

- “Canadian Goods Returned to Canada for Repair”
- Name of the equipment
- Value
- Serial Number
- Reason for return
- Packaging and weight

Chapter 11 Applications for the ENVI PRO

Magnetic Surveying Overview

Introduction

These application notes review some of the numerous environmental applications for which the ENVI PRO is designed. The first chapter will give a general overview of the purpose and scope of a magnetometer survey. In the second chapter, we shall discuss the planning of a magnetometer survey carried out with the ENVI PRO, Environmental Magnetometer/Gradiometer, within a specific environmental application. The third and last chapter will be devoted to applications in the field. These applications will illustrate field results as well as the corresponding structures or objects creating the magnetic anomalies.

Basic magnetic theory

What is being measured?

In a simple way, the Earth can be described as a large magnet with the north pole pointing south (that is why the needle on your compass points north because it is attracted by a magnetic pole of opposite sign). Figure B-1 on page B1-2 illustrates the magnetic field of the Earth. The Earth's field at any given point on the Earth is vector, in that it has a preferred orientation (direction) and an amplitude (intensity). The inclination and declination describe the local orientation of the Earth's magnetic field vector.

The orientation and intensity of the Earth's field is quite well known. The map of the Earth's magnetic intensity is shown in Figure B-4. You will need to refer to this figure occasionally, in order to set the base-field parameters on the ENVI PRO. The magnetic field intensity is usually expressed in gammas or nanoTeslas. NanoTesla is the preferred SI nomenclature, however, a nT equals a gamma. The values of the Earth's magnetic field that you will typically observe should vary from 25,000 nT to 70,000 nT.

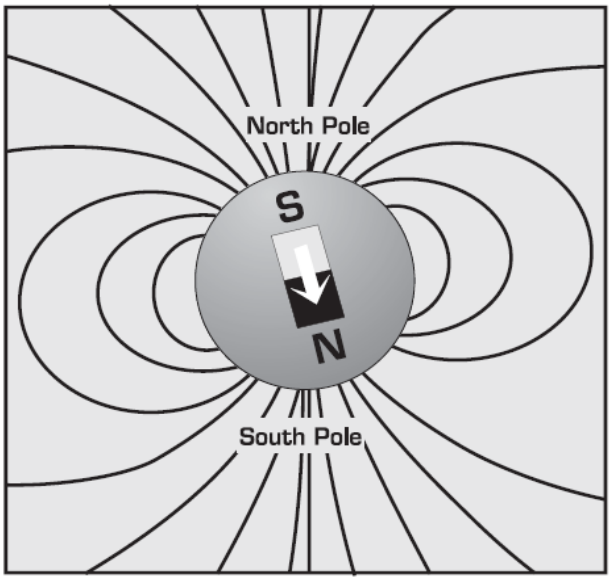
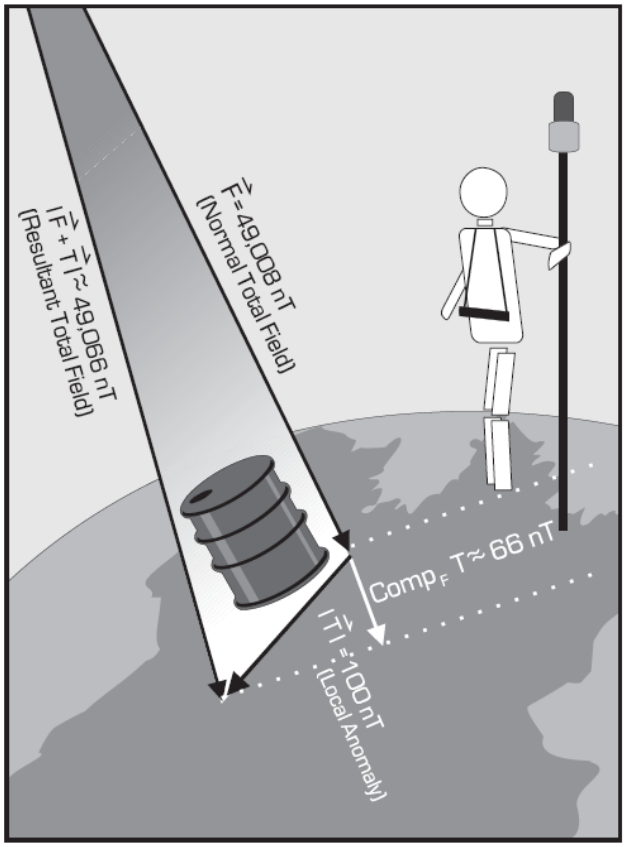


Figure B-1 The magnetic field of the Earth.

The ENVI PRO is a total-field magnetometer, and optionally a gradiometer, using the proton-precession technique to measure the scalar amplitude of the magnetic field vector. This is explained with the aid of the diagram shown in Figure B-2. The predominant magnetic field is that of the Earth's (shown by the vector $\vec{F}$ in the figure). A local magnetic disturbance has its own magnetic field (represented by the vector $\vec{M}$ in the figure). This local vector adds to the Earth's field vector to produce the total-field vector $\vec{T}$. What the ENVI PRO in the total-field mode measures, is the projected amplitude of the total-field T in the direction of the dominant Earth's field $\vec{F}$. This is displayed as the intensity in nanoTeslas by the instrument.

Note: No directional information concerning the field of the local magnetic disturbances can be inferred from a total-field intensity measurement.

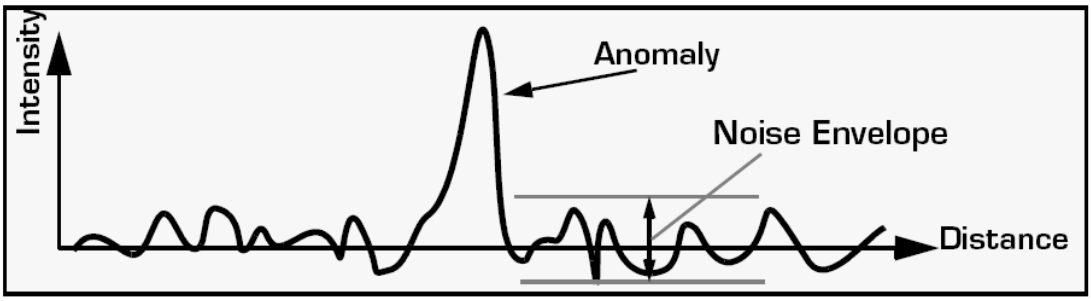
With the ENVI PRO, you can measure not only the total-field intensity, but also the vertical gradient (or rate of change) of the total field (if you have purchased the gradiometer option). The vertical gradient, as previously mentioned, is the rate of change of the total field with vertical distance. This measurement is accomplished by simultaneously reading the total magnetic field at two different elevations, and recording the difference. The usefulness of both these parameters will be explained in the next Chapter.



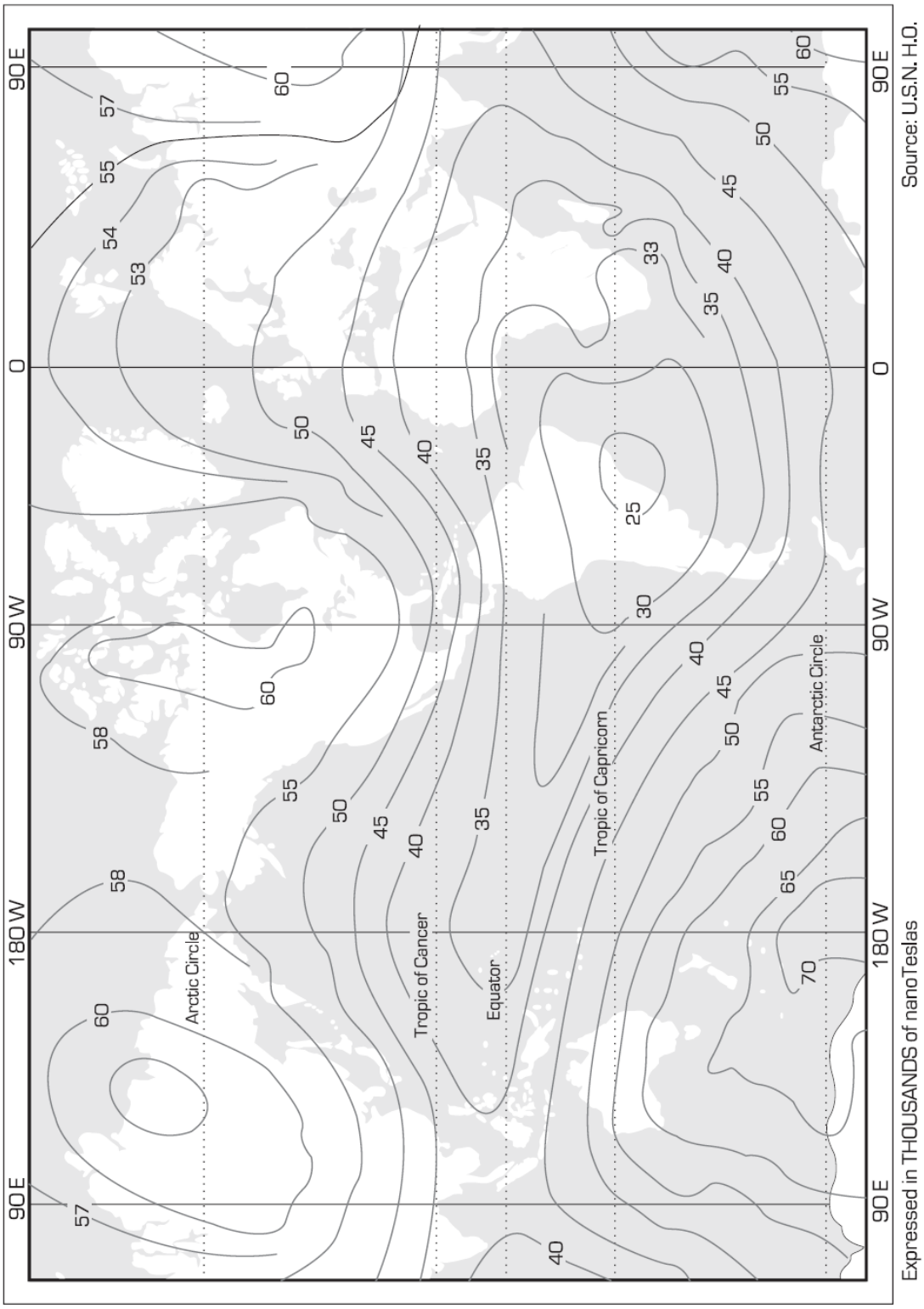
The Earth's magnetic field interacting with a magnetizable body

Anomalies

An anomaly is created when the Earth's magnetic field is disturbed by an object that can be magnetized. The resultant anomaly can also be viewed in terms of vectors as previously described. When this is measured and plotted against the measuring location, you may see a profile of values as illustrated above, showing a local disturbance of 10 nT. It is very important to note that the vector of the local disturbance can be in *any* direction. This is always the case with buried drums.



Typical anomalous signature

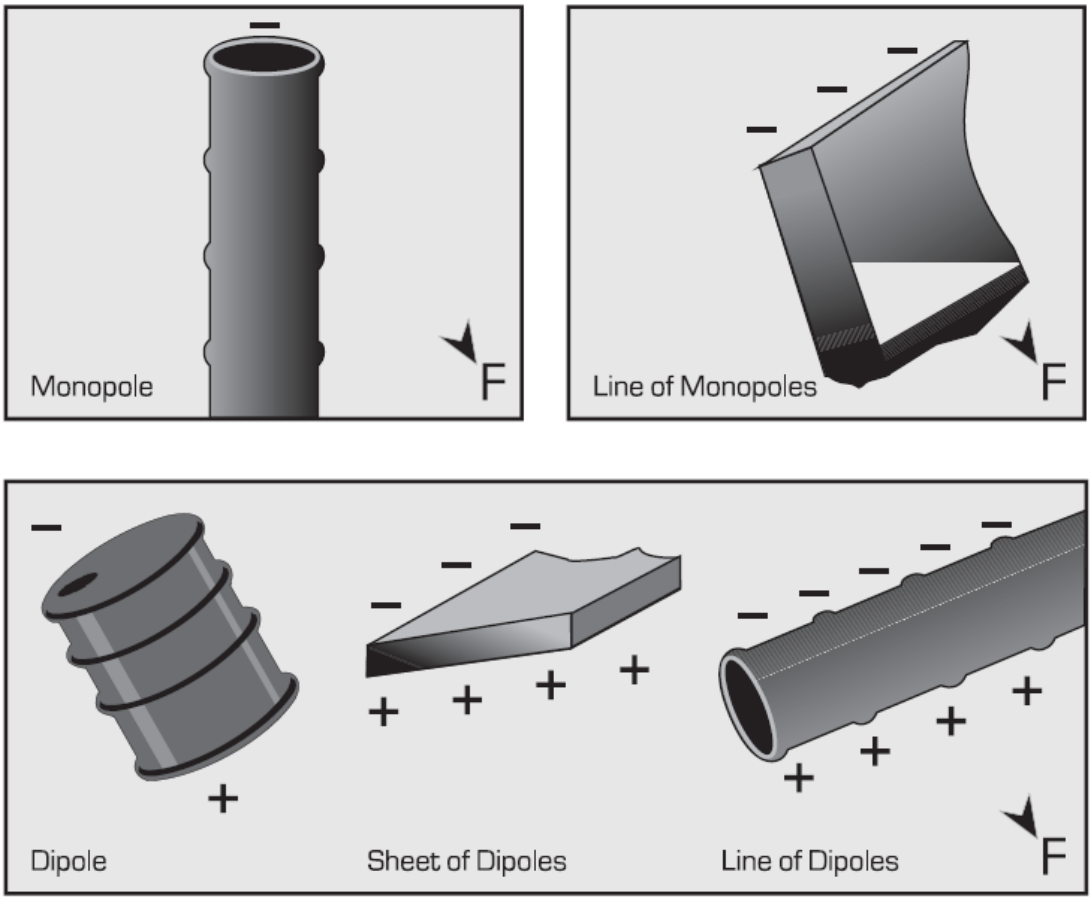


The intensity of the Earth's magnetic field

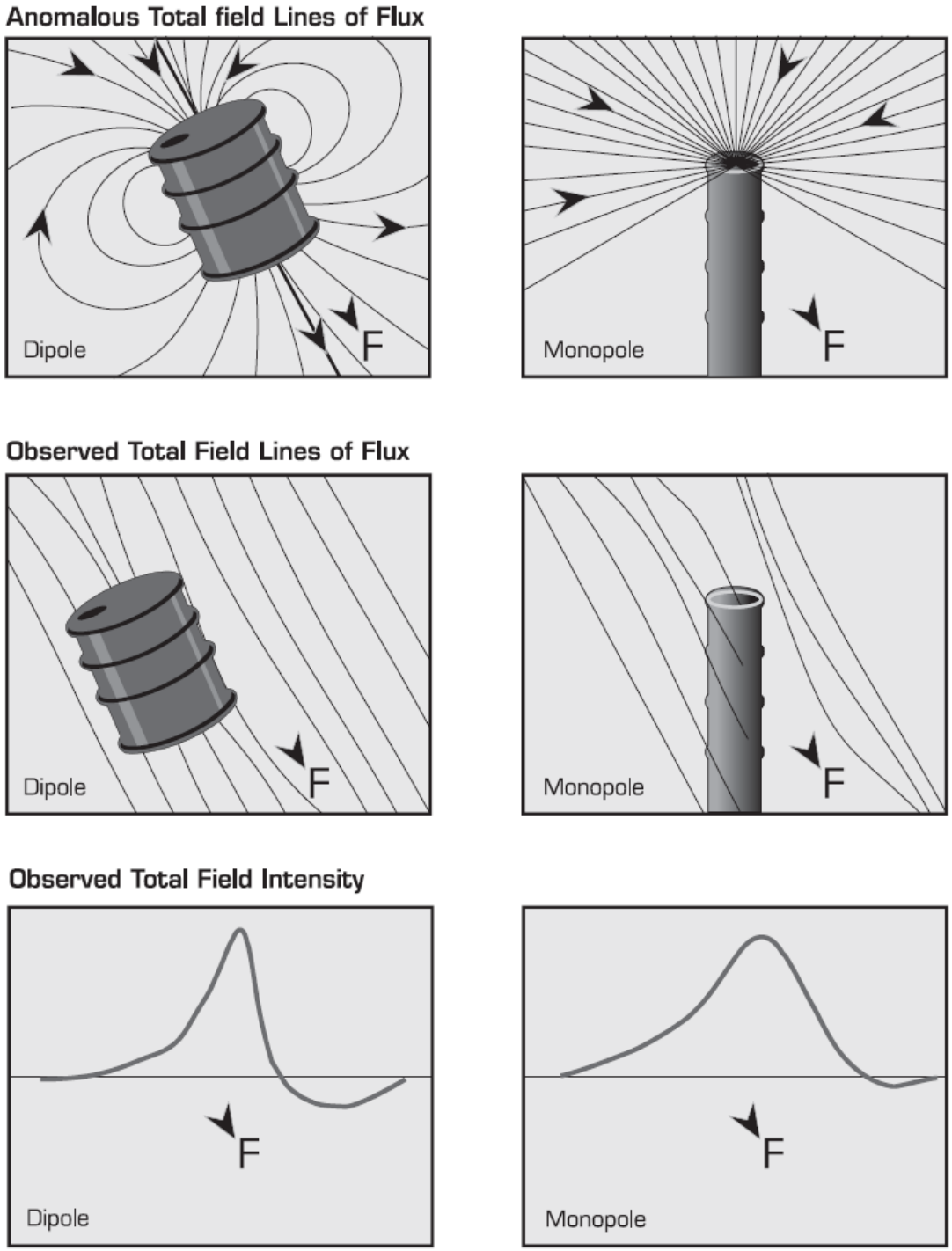
Shape

The shape of a magnetizable body also determines the shape of the magnetic anomaly that you can measure. Compact bodies give rise to one shape of anomaly, while long thin bodies or flat, sheet-like bodies give rise to others. These different

magnetizable bodies can be represented as simple assemblages of magnetic monopoles or dipoles. The figure on page 11—6 illustrates the magnetic field lines around typical dipole and monopole bodies, and the resulting total field with the Earth's magnetic field added. A confined body is illustrated on the left whereas a long and infinite body is illustrated on the right. The fall-off rates for a dipole or line of dipoles would vary as a cub power ($1/r^3$), while that of a monopole or line of monopoles would fall-off as a square power ($1/r^2$).



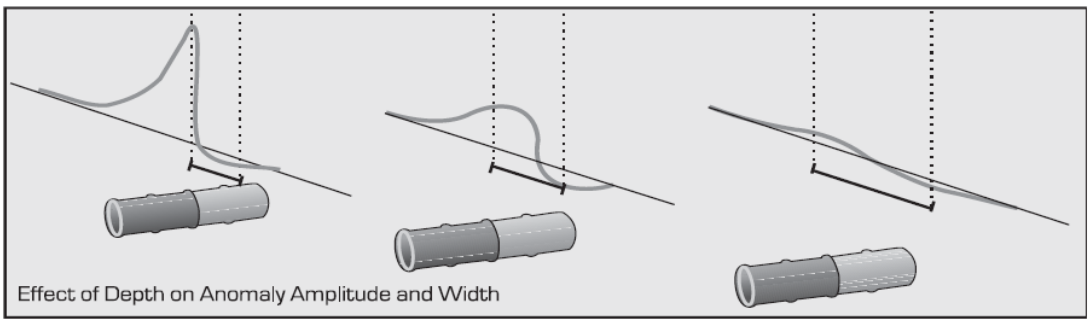
Typical targets



Typical dipole and monopole signatures (after Breiner, 1973)

Amplitude

As you have just seen, the shape of the anomaly is determined by the geometry of the causative body with respect to the direction of the Earth's magnetic field. The amplitude, on the other hand, is controlled by a combination of the susceptibility, permanent magnetization and the distance from the body that you are observing the response. The more magnetizable the object is the stronger and narrower the peak on the profile will be. The deeper the object, the weaker and broader the peak on the profile will be. This is illustrated in the following figure.



Variation of profile according to depth and magnetization

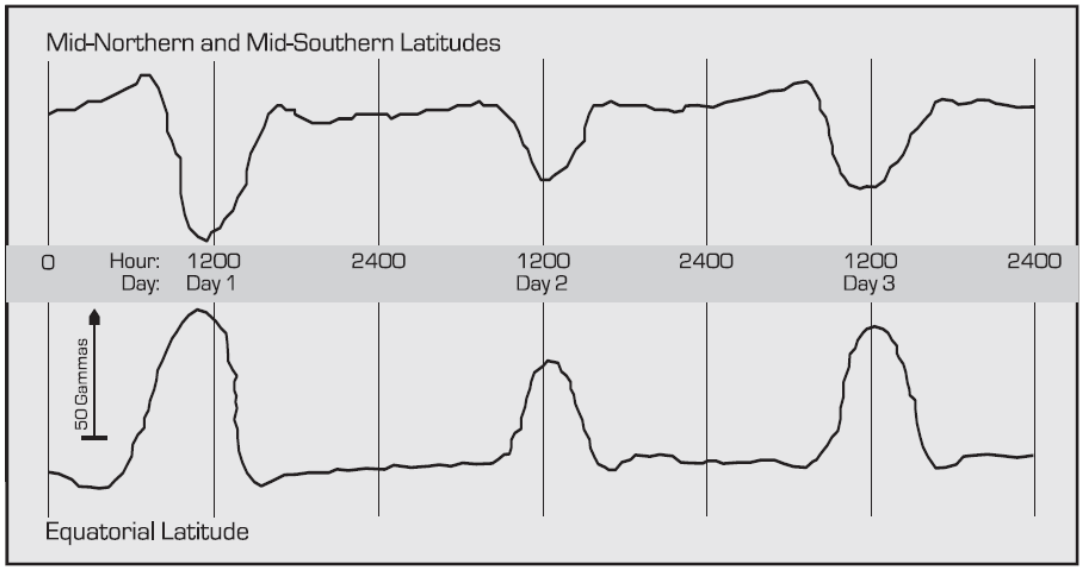
The variation with depth of the amplitude of the local disturbance vector is a function of the distance between the sensor and the target. This variation with depth is called the fall-off rate. The intensity of the local disturbance varies from one model to another.

Variations in the Earth's magnetic field

The Earth's magnetic filed *varies* with time, i.e. it is not constant. As the Earth rotates, the outer layers of the ionosphere interact with the solar wind to cause minor fluctuations in the magnetic field. Depending upon the duration and intensity of these fluctuations, they are given different names.

Diurnal variation

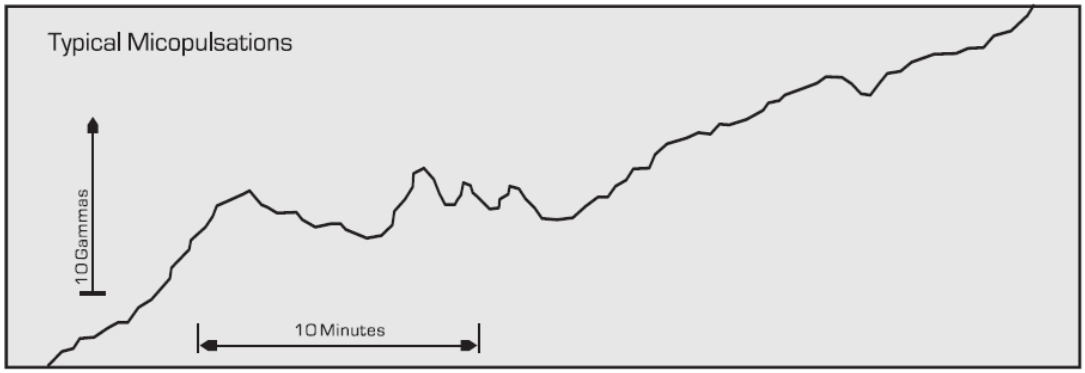
Fluctuations with a period lasting about one day are called diurnal variations. These can be considered much like tides that ebb and flow during the course of a day. However, they are not predictive and usually not a problem when conducting magnetic surveys. This diurnal drift can cause a variation of the order of 50 nT/Hour. The following figure illustrates a typical diurnal variation of the total field.



Typical diurnal variation (after Breiner, 1973)

Micro-pulsations

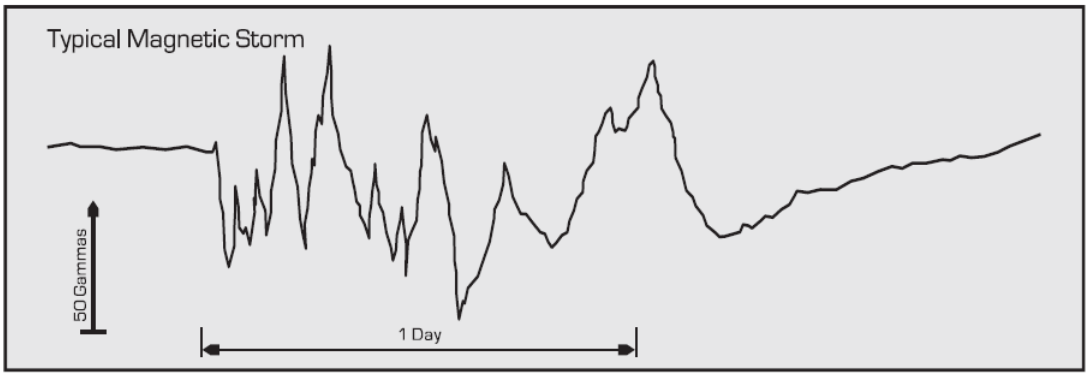
Erratic, short-term blips or spikes in the magnetic field are called micro-pulsations. These can range in intensity from a few through to tens or even hundreds of nanoTeslas in intensity, as can be seen in the next figure. These can present a problem when you are surveying in that they may appear similar to anomalies caused by buried objects.



Typical micro-pulsations (after Breiner, 1973)

Magnetic storms

When the timing and duration of micro-pulsations becomes severe it is then called a magnetic storm. Typical micro-pulsations last a few hours whereas magnetic storms can last for days. The next figure illustrates a hypothetical magnetic storm. Needless to say, it is not recommended to conduct a total-field survey during a magnetic storm, as you may not be able to remove all of the rapidly changing variations in the magnetic field, giving rise to perhaps false anomalies.



Typical magnetic storm (after Breiner, 1973)

You can obtain magnetic activity forecasts (much like weather forecasts) from several agencies worldwide, through an international network of centers called the IUWDS (International Ursigrams and World Days Services). There exist regional warning centers (RWC's) that provide geomagnetic activity information to the scientific and user communities within their own region. Please note that not all of these centers provide the same services and forecasts. However, all of them have access to all information provided by other centers.

The following table gives a list of contact information for each of these regions. In Canada geomagnetic forecasts are available through the Geophysics Division of the Geological Survey of Canada, while in the United States this information is available from NOAA. This information will greatly help you in planning your magnetometer survey. (Please note that this information was correct at the time of publication of this manual but is subject to change).

Regional Warning Centers for geomagnetic forecasts

Location	Telephone	Fax	e-mail
Australia	61-2-921-38000	61-2-921-38060	asfc@jps.gov.au
Belgium	32-0-237-30276	32-0-237-30224	Pierre.cugnon@oma.be
Canada	1-613-837-4241	1-613-824-9803	forecast@geolbab.nrcan.gc.ca
China	255-1968	28-1261	jlwang@bepc2.ihepc.ac.cn
Czech Republic	42-276-2548	42-276-2528	ion@cspgig11.bitnet
India	91-11-572-1436	91-11-575-2678	soltech@crl.go.jp
Japan	81-29-265-9719	81-29-265-9721	soltech@crl.go.jp
Poland	403-766	121-273	cbkpan@plearn.bitnet
Russia			geophys@sovamsu.sovusa.com
Sweden	46-46-2862120	46-46-129879	henrik@jrfl.lu.se
U.S.A.	1-303-497-3171	1-303-497-3137	sesc@sel.noaa.gov

Removing magnetic variations

Depending upon the requirements of your site survey, you may choose to remove, or not to, these variations in time of the magnetic field from your collected magnetic data.

There are three ways in which you can remove these variations:

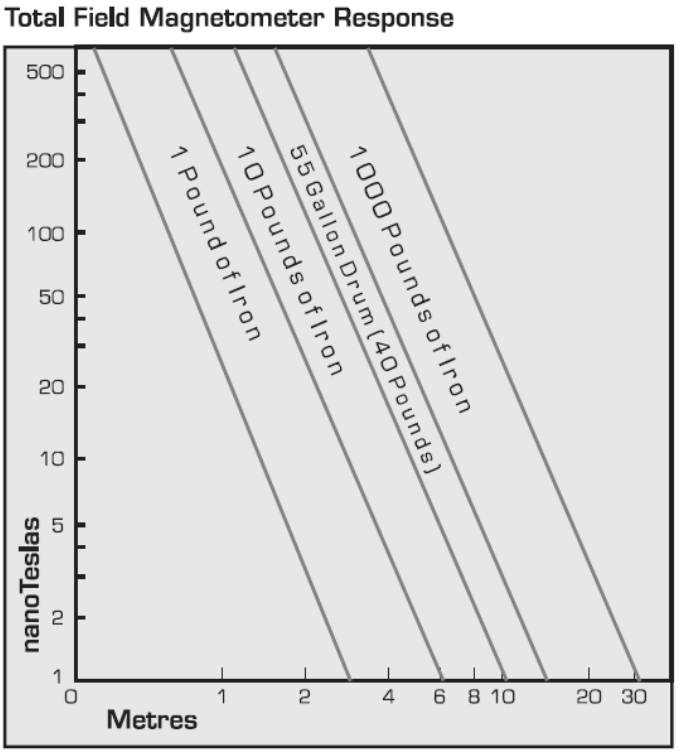
1. Use a base station magnetometer to record all the changes in time and then use this data to remove the change from the readings in the field magnetometer. This is the most accurate way of doing it, but also it is more expensive, as two complete instruments are required.
2. Use a tie-point method while doing the total field survey. This assumes that the field is changing slowly and evenly between the first time you measured the value at the station and the next time you check-in to that station again. This method is not as accurate as using a base-station, but if the field is not changing rapidly, it is quite adequate to locate an anomaly. This technique may be the most cost-effective as it only requires one magnetometer.
3. Perform a vertical gradient survey. Since you are measuring the rate of change between two sensors, any changes in the background field will apply to both sensors and you will not see any of these noise effects. This technique is quite effective for near-surface anomalies. Though only one instrument is required, you will need to have the gradiometer options installed on it. Further, you will need to staff-mount the sensors while doing this type of survey in the continuous WALKMAG mode – depending upon the site, this may not be as convenient as the back-pack mounted total-field WALKMAG survey mode.

The difference correction methods such as the base-station and tie-line methods are explained extensively in the next section “Survey Planning” of this manual. Most environmental applications do not require the use of a base station, as the grids are

relatively small and can be covered in a very short time. In this case tie-point *line* or *loop* methods are adequate.

Magnetic targets

What do drums, pipelines and sheet metal look like “magnetically”? Westphalen and Rice (1992) have shown that a single 55 (U.S.) gallon steel drum buried at a depth of 3 meters (10 feet) will give rise to an anomaly of 10nT. Also, Bensen et al., 1982 have calculated that the total field response in nT for different target distance and mass. This is shown in the form of a chart:



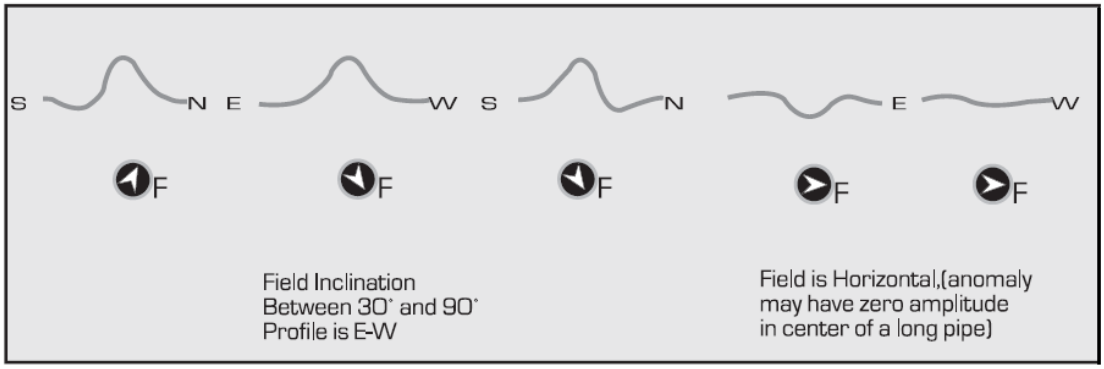
Total field response for different target distance and mass (after Benson et al., 1982)

The above information should give you a feel for the amplitude of the anomaly to expect in typical environmental applications. But it can be slightly misleading. These values are for the magnetic intensity that is induced in the material by the Earth’s magnetic field. Unfortunately all man-made metallic objects carry with them a magnetic memory of their orientation when they were created. Unfortunately, this can lead to complications.

Induced and Remnant magnetism

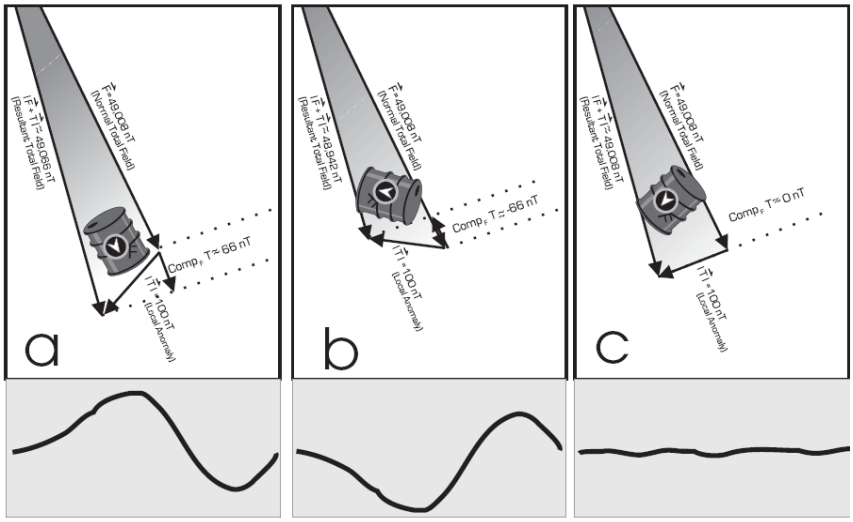
The local disturbance caused by a buried drum, a pipeline or a sheet can be represented as a vector. The disturbance can also be further decomposed into two components: an induced and a permanent (or *remnant*) component. The ability of a ferrous object to be magnetized is termed its susceptibility. The intensity of the induced magnetization is directly related to the ambient field by the susceptibility, and is therefore the induced part of the disturbance. Susceptibilities are measured in cgs units.

The remnant magnetic component of a magnetized body is a function of the orientation of the magnetic field at the time the object was cooled below 550°C. This temperature is called the Curie Point. While the metal, of which the drum, pipeline or sheet metal were made of, was at a temperature above the Curie Point, the magnetic dipoles were aligned in a random fashion. As the temperature of the metal approaches the Curie Point, these dipoles tend to align themselves in the direction of the dominant magnetic field (usually the Earth's) at that point in time. In some mineral applications and most environmental applications, the remnant component predominates. This component can have any orientation and intensity. Therefore the resulting total-field vector $\vec{T}$ can have any orientation and intensity, which can have serious consequences on your magnetometer survey. Remember that it is the projected vector $\mathbf{COMP_F}$, that is measured by the magnetometer. Consider for instance the examples illustrated in the following figure (Figure B-12). You can see that depending upon the orientation of your traverse and the direction of magnetization of the body, you will get a completely different shape of profile for the same body at the same depth!



Effects of orientation and magnetization on anomaly shape

Another example is shown below. This simplifies the previous example by keeping the orientation of the traverse line and the depth of the body constant, i.e. the measuring geometry. The only parameter that is varying is the direction of the permanent magnetization.



Orientation and anomaly amplitude – a) Positive b) Negative and c) Null anomalies

In case a), the projection is in the same direction as the undisturbed total field, resulting in a positive anomaly. In case b), the direction is opposite to the undisturbed total field, resulting in a negative anomaly. In case c), however, the direction happens to be perpendicular to the undisturbed total field, resulting in no anomaly at all.

Case c) is the most interesting because even though an anomaly exists, it cannot be measured. You may want to keep this in mind when carrying out a magnetometer survey for buried drums, pipelines or metal sheets.

These are only simplified examples. Some situations, for instance a collection of drums, each having it's own orientation and intensity for the local disturbance vector, will possibly exhibit a very complex anomaly vector. When this is added to the Earth's magnetic field and then measured only as the scalar amplitude, the results may not be exactly as expected.

Survey Planning

Introduction

There are very specific criteria that need to be considered when carrying out a magnetometer or gradiometer survey for environmental applications:

- the estimated depth at which the targets are and their nature (buried drums, steel pipes or sheet metal),
- the precision and accuracy required of the surveys,
- the orientation of the target, i.e. is it elongated? This needs to be considered for objects having a linear surface expression, such as pipes and sheets of metal.

Sampling intervals

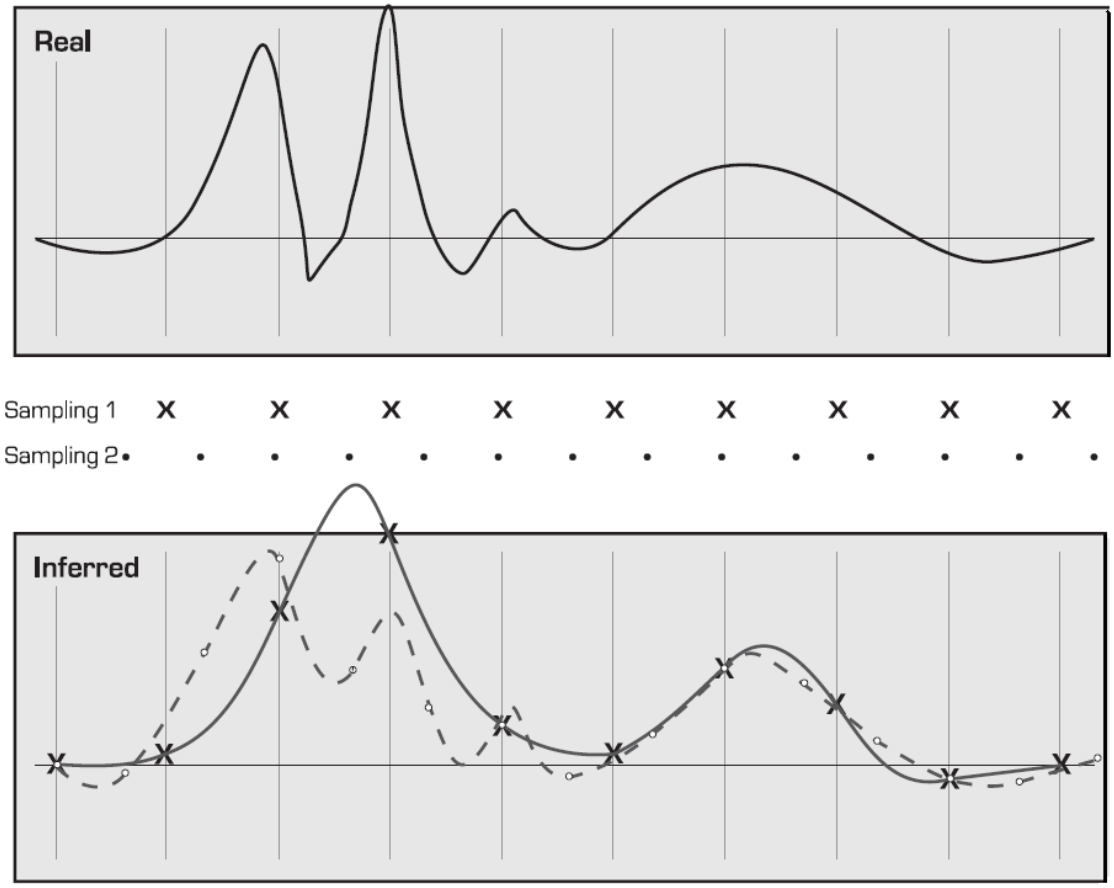
Objects disposed of and/or buried by man are usually not at great depths; within the first ten meters of the surface. The anomalies created by such buried drums, pipelines or sheets of metal can produce relatively intense and narrow anomaly profiles. However, as mentioned in the previous chapter, the deeper the target, the broader the anomaly will be. Further, the anomaly will become less intense when the magnetized body is at greater depths. Larger targets will have broader anomalies and more intensely magnetized bodies will have larger amplitudes.

These relationships of body size, depth and magnetization all have a direct consequence on the station and line spacing, i.e. the density of the survey grid. For instance, if an anomalous peak is only 2 meters in width or length and data points are taken only every five meters in a square grid pattern, there is a very good chance that the peak will be missed altogether!

Line and Station spacing vs. Anomaly width

To be certain that you have detected an anomaly, you need a minimum of two data points to define it. In order to get at least two data points to position an anomaly along the survey line, the station spacing should be less than half the

expected width of the target. In order to determine the strike length of a body, the same holds true for the line spacing—it should be less than half the expected length of the target, in order to have at least two survey lines crossing the target. This detectability threshold of twice the sample spacing is sometimes referred to as the Nyquist frequency in more advanced magnetic data processing. The following figure illustrates these points.



Sampling interval and anomaly resolution

Precision and Accuracy of Surveys

Once you have determined the line and station spacing, you should also take into consideration the sources of noise (both natural or man-made), as well as the best tuning method. Once you have made a decision regarding the accuracy and precision of the data you require, then you can consider the method of surveying best suited to give those results.

Noise

The most commonly encountered sources of noise in the data are the time-based (diurnal) variations we had discussed in “Variations in the Earth’s magnetic field” on page B1-7. These are natural variations and can be removed using either basestation corrections, tie-line corrections or by measuring the vertical gradient of the magnetic field. The procedures to carry out these correction methods will be discussed in the next chapter.

Of the man-made sources of noise, or cultural noise, the most prevalent are electromagnetic and electrical fields. These sources, if strong enough, can seriously hamper any magnetometer survey. Therefore, surveying directly under power lines, since they will disturb the magnetic field you are trying to measure, can be problematic. Other sources of cultural noise in typical waste dumps are the many buried ferrous objects near the surface. Some of these objects, such as tin cans, bed springs, appliances, etc., can introduce unwanted magnetic spikes in the overall results.

As previously mentioned, you may want to remove the natural time-based variations from your data. You may choose to perform these corrections in the tieline mode or base-station mode or perform a gradiometer survey. However, each of these methods has a cost associated with it. The tie-line method is less accurate than the base-station, especially if a long period of time has elapsed between tiepoints. The base-station method, on the other hand, requires the use of two magnetometers and this may not be a feasible alternative in certain cases. The gradiometer approach is intermediate in cost, as only one unit is required, but you are compromising your ability to detect deep and subtle anomalies, since you are only measuring the rate of change of the field.

Tuning

Sensor tuning is used to maximize the precession signal while minimizing the effects of interfering electrical signals, such as power line harmonic frequencies at 50 and 60 Hz.

The automatic sensor tuning function will free you from having to pay close attention to the tuning details. However, this may lead to some potential trouble. In areas where there are very large local anomalies with strong gradients or electrical interference, the ENVI PRO may lock onto those signals.

Automatic tuning is quite useful for mineral exploration surveys. This is primarily due to the fact that these surveys are usually away from major electrical noise sources and encounter large variations (in excess of ±1000 nT) of the magnetic field over large distances.

Fixed tuning is recommended where small field variations are encountered or where there is a greater possibility of strong electrical interference.
Fixed tuning is also recommended for base-station applications or for exploration surveys where there are only low-intensity variations in the magnetic responses. Environmental surveys are also prime candidates for fixed tuning since they are usually conducted in areas of large cultural noise — electrical or large magnetic gradients (due to the close proximity of the magnetic sources).

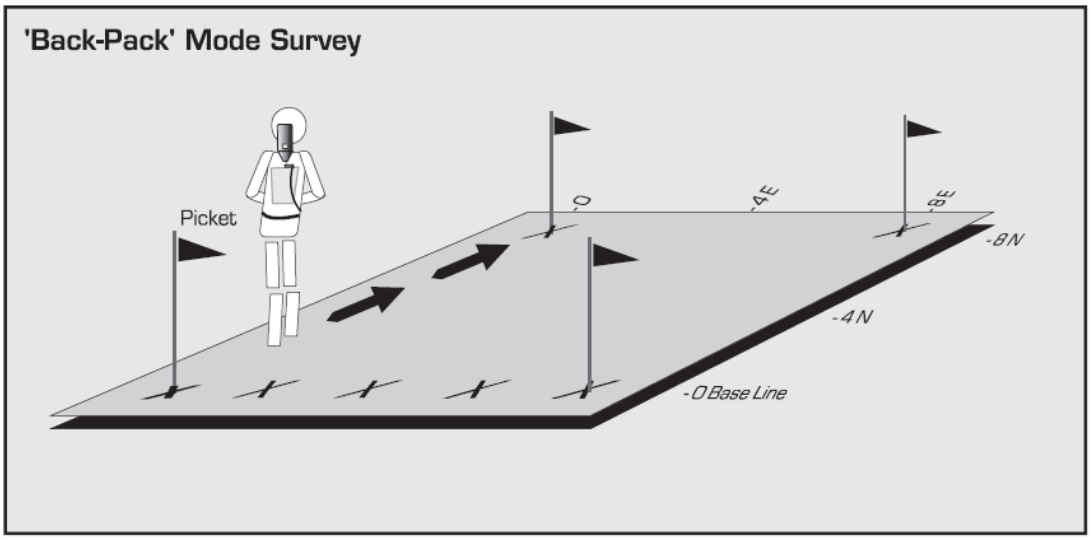
Survey mode

Once you have determined the degree to which you need noise removed from the data, you will need to select the appropriate survey mode.

WALKMAG

The most commonly used mode of operation in environmental applications is the WALKMAG mode. With the ENVI PRO, the operator can take almost continuous readings (at sampling rates of up to every 0.5 seconds) in this mode. For a walking pace of 3 km (2 miles) per hour, data will be collected at approximately every half a

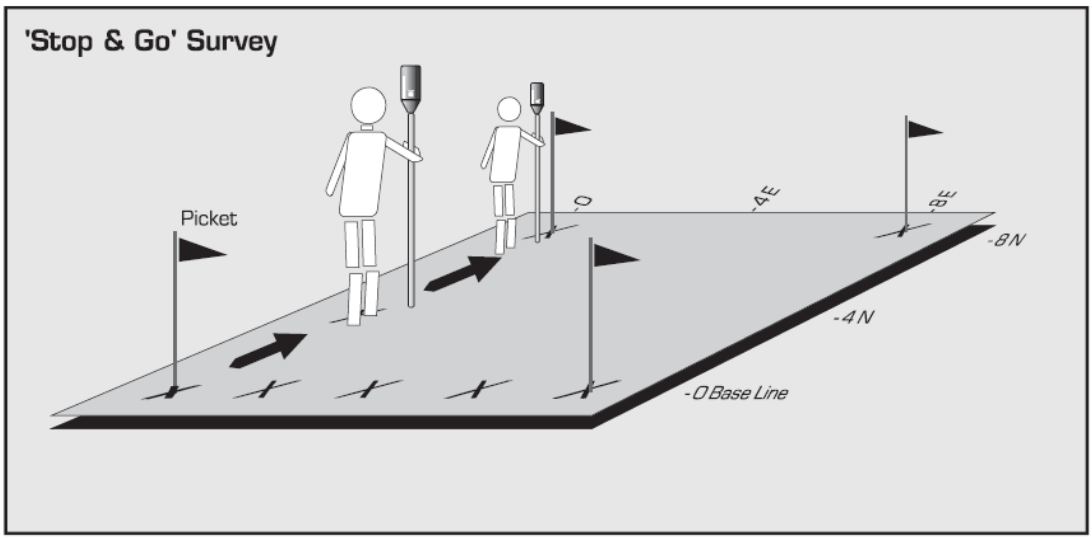
meter (or about every two feet). This tight spacing of data is necessary for the very shallow targets that are usually encountered in environmental applications. The next figure illustrates the set-up for a WALK-MAG survey



Set-up for a WALKMAG survey

Stop-And-Go

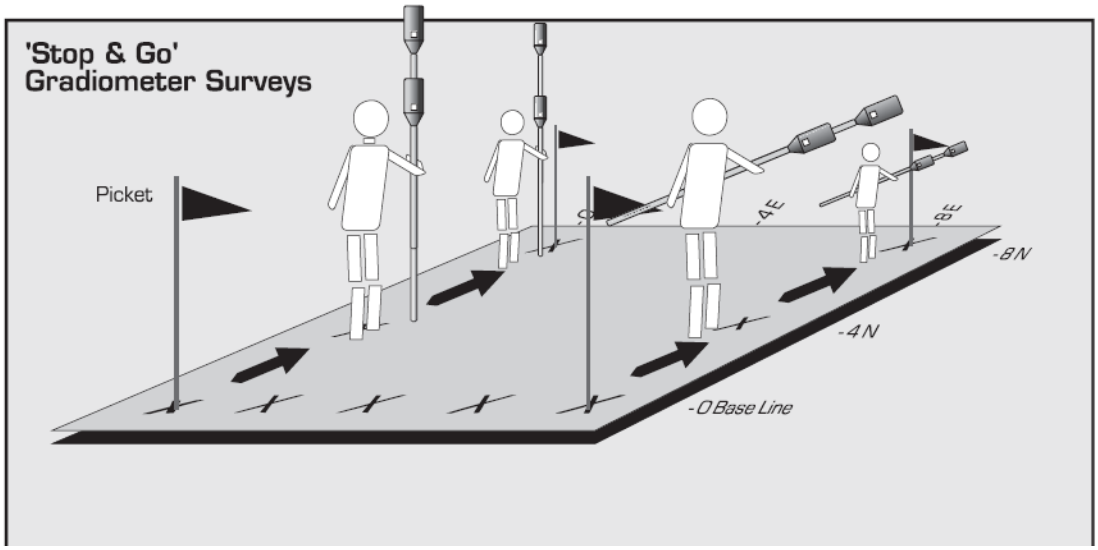
For larger and deeper targets; at depths below 30 meters (100 feet), such as those more often encountered in mineral exploration applications, it is preferable to operate in the *stop-and-go* mode with automatic station incrementing. Data for this case would be taken typically at a 15 meter (50 feet) station spacing – remember, you need at least two points to define an anomaly, which is why the station spacing is half that of the expected depth. This is illustrated in the following figure, which shows the set-up of a stop-and-go survey.



Set-up for a Stop-and-Go survey

Gradiometer

You can also perform the survey using the gradiometer mode. The gradiometer survey is carried out using two vertically spaced sensors; usually one meter (3 feet). The magnetic field reading is taken for each sensor and the difference is divided by the distance. The measure value of a gradiometer survey is expressed as nanoTeslas per meter (nT/m). This mode has the advantages of being totally independent of time-based variations, since it measure a *difference* in magnetic fields. However, especially for environmental applications, it is more sensitive to near-surface objects, which can be a disadvantage. The following figure illustrates the set-up for a gradiometer survey.



Set-up for a gradiometer survey in the Stop-and-Go mode

Field Observations

Finally, to help in the interpretation of the final data, it is very important to *note* all possible sources of noise, i.e. *cultural* features, encountered during your survey. When you are examining the data after it has been plotted, the ability to correlate *known* noise sources with the anomalies on your map greatly aids in the proper identification of the *buried* targets.

Grid layout and orientation

The underlying principle behind the layout of a survey grid is that the survey lines should cross linear bodies at or close to 90 degrees. For very long and narrow structures, such as are encountered in mineral exploration applications, the survey lines are laid out along perpendicular to the strike, therefore optimizing the coverage of each line.

Long structures or bodies which are aligned in a parallel fashion are not usually encountered in environmental applications (except pipelines), the direction of the targets are most often random. Consequently, most environmental grids are laid out in square pattern.

Survey procedures and a sample survey

Introduction

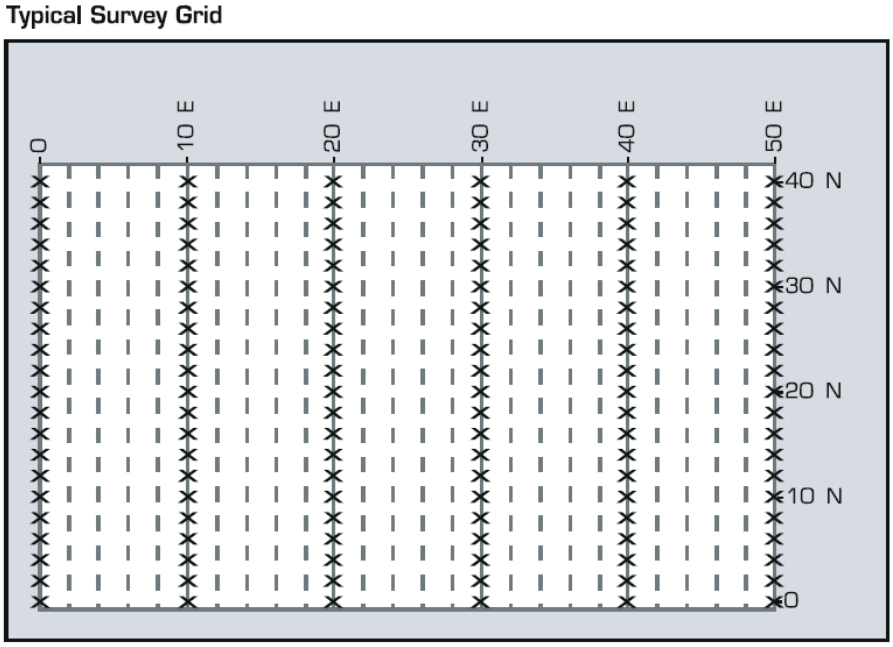
Once you have considered all the factors as to the type of magnetometer survey required, then you are ready to design and lay out a grid to cover the area of interest. This section will cover some aspects of laying out a grid and actually conducting a survey. Finally, a brief discussion of an actual survey undertaken of the Columbia test site at the University of Waterloo in Ontario, Canada, will be presented.

Survey do's and don'ts

Laying out the grid

A survey grid usually consists of a base line and one or several tie lines. The base line serves as a zero reference line for the grid, and the tie lines serve to correct the skewness of the survey lines. From the base line are drawn survey lines perpendicular to the base line.

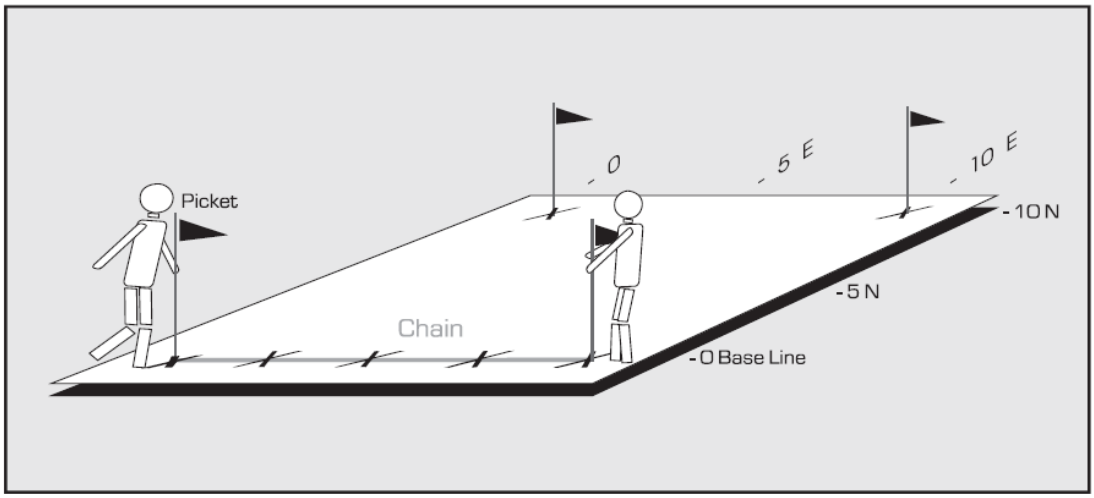
With a square survey grid, the station separation on each line is identical to the line separation. Therefore, every data point collected is on a corner of a square. Typical environmental grids consist of survey lines spaced every meter or two, with data points every meter. The following figure illustrates a typical survey grid, with base lines at 0 and 40 and survey lines every two meters.



Typical survey grid for environmental applications

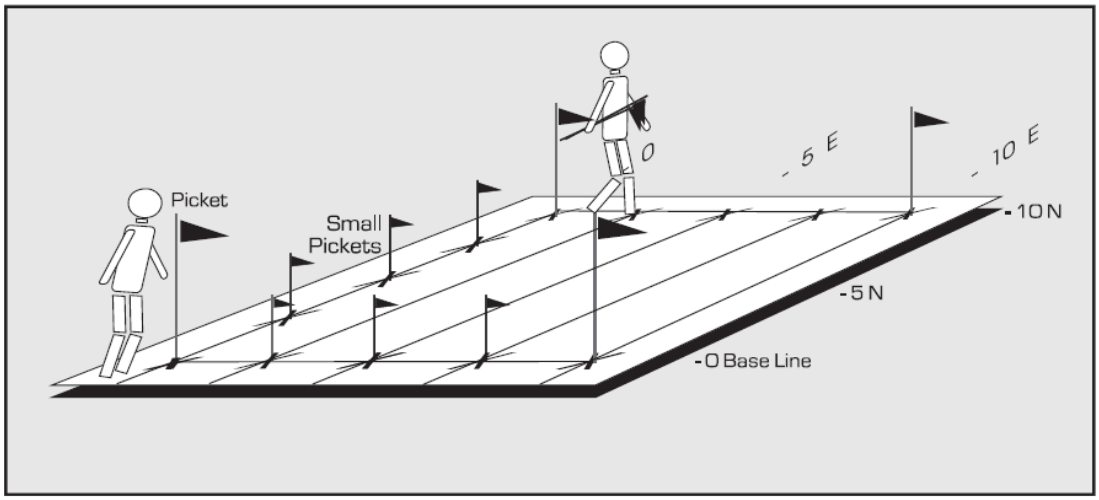
A typical sequence to lay out a grid is as follows:

1. First you must lay in the base line; this is done using a chain (50 or 100 meter measuring tape). Major intervals such as 5 or 10 meter lines can be marked with pickets or flags for a more prominent visual reference.
2. Then mark each survey line with wooden stakes driven into the ground. The heads of the stakes should preferably be marked with fluorescent paint. The base line implementation is illustrated in the following figure.



Base line implementation

3. Once the survey lines are marked on the base line, then you should lay in the survey lines, using wooden stakes or flagging tape to mark your survey stations. For typical environmental applications, the stations may be at every 10 meters. You may also choose not to mark every survey line, but only survey lines every 5 meters. The position of the intermediary survey lines would be approximated by the operator. This is illustrated below.



Typical flagged survey line

These survey stations will serve as reference points to locate your data points on the survey grid and eventually to locate data points on a scaled map of your data. This map will in turn be used for your interpretation of the data.

As illustrated above, survey lines and stations are usually labeled in the manner **NN D**, where **NN** represents the major digits of the distance and **D** represents the direction of the line. For example, a typical environmental grid with survey lines oriented in a north-south directions located every meter and with marked stations every 10 meters would have survey lines labeled 1E, 2E, 3E, etc. and stations along these survey lines labeled 10N, 20N, 30N,...etc.

Multiple grids

As is often the case, you may want to survey several grids in the course of a single day without having to dump the data after each grid. The ENVI PRO does not store any information about which grid a particular set of lines belong to. If identical line numbers are present on different grids, we strongly recommend that you enter a different line number for the second identical line. You can systematically shift the line by either adding a digit in the least significant location or offsetting the line by adding a large value, such as 1000. For instance, if you have two lines 100E, one on grid A and one on grid B, the second line 100E on grid B could be entered as either Line 101E or 1100E instead, to avoid confusion when processing the data.

Diurnal corrections vs. Survey pattern

The type of data correction procedure you will be using, also influences the *survey pattern*, i.e. sequence of lines and stations occupied. The base-station and gradiometer methods let you cover the grid in any sequence you wish. The tie-line and loop methods, on the other hand, require fixed patterns to be effective.

Base-station corrections

In some specific situations you may choose to use a second magnetometer as a base-station, which will measure the magnetic field for time-based variations at specific time intervals—every 20 seconds, for instance. As its name implies, this base-station magnetometer is located at a fixed location.

The magnetometers *must* be synchronized to the same time to allow for proper corrections when removing the time-based variations. If the two magnetometers are not properly synchronized, you may end up effectively adding noise to the corrected survey data. This synchronization should be done at the beginning of every survey day.

Once the magnetometers are synchronized and the base-station started, then the survey can be carried out. The base station is taking measurements independently of the survey magnetometer. Therefore, the survey can proceed without any undue time constraints, nor are you required to follow a specific line and station pattern to cover the grid. We shall see in the next section that this is not always the case for tie-point corrections methods.

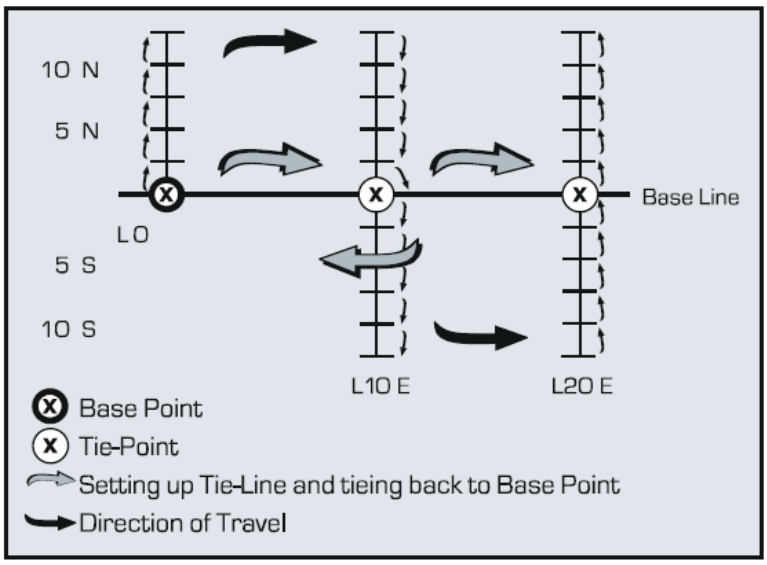
Tie-point Line and Loop mode corrections

If you want to remove the time-based variations, but only have one magnetometer, you could choose to carry out either a tie-line survey in line or loop mode. If you a fairly small area to survey, i.e. can be done quickly, then the loop method is adequate. For larger grids, the line mode is recommended. However, it should ne noted that neither of these methods are as accurate or precise as the base-station correction. A technical paper on this subject (Magnetic Correction Techniques) is available from SCINTREX.

The tie-point line method uses data collected along the base line (or rarely, tie-lines) as reference points to correct for the diurnal drift of magnetic data. The following figure illustrates a typical tie-point line method survey.

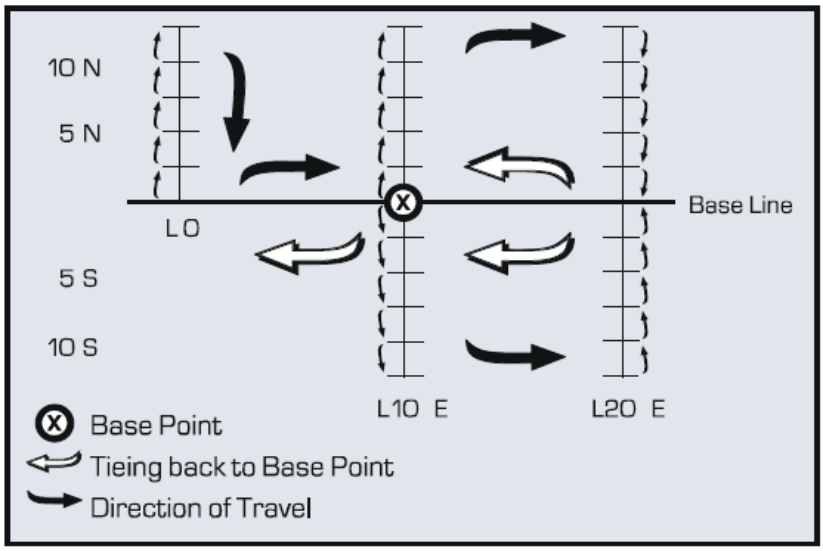
The basic sequence is to survey the base-line as quickly as possible, taking readings at every line that crosses the base-line. This data is entered into a special memory section when recorded with the “TIE-PT” key. You then proceed to survey the grid on a systematic basis. As you proceed along the grid, you will then be occasionally taking readings at known stations (those collected with the “TIE-PT”). This repeating of measurements at certain stations is then used by the correcting procedures (performed after the survey) to remove any diurnal variations detected.

If you will be surveying a large grid, that may take more than one day (or more than one instrument’s memory capacity), then you *must* record all of your tie-line data *before* any other grid survey data is collected. This ensures that the data from the second and subsequent days (or second memory full) are reduced to the *same* set of correction values.



Typical tie-point method in line survey

The tie-point loop method requires a *single* reference point to be resurveyed many times to correct for diurnal drift. The sequence of collecting data for this method is illustrated in the following figure. You may note that the more lines you have to survey, the longer it will take for you to get to the reference station to get the control reading. Compare this to the tie-point line method shown in the previous figure.



Typical tie-point method in loop mode survey

Search mode

Another useful survey mode for the rapid detection of near-surface ferrous objects is the search mode. This mode is a variation of the base-station mode with the data being displayed on the instrument screen as it is collected. This can be very useful for metal ordnance detection. A detailed explanation of using this mode is explained in the operations manual.

Note taking

Recording field information, i.e. *notes*, is very important for the subsequent interpretation of the magnetic survey results.

Typical cultural features that should be noted are: fences, power lines, surface debris, roads and buildings. These features should be noted when they are in close proximity to the point at which you are taking a reading.,You are then relating the disturbance in the magnetometer data with a specific cultural feature. If this is not done, and you don't happen to remember what was present at the specific location, you run the risk of having the cultural feature mistaken for a real anomaly.

The taking of notes is done quite easily with the ENVI PRO using the "NOTE" key. You can pre-enter a choice of five cultural noise sources (macros) that you are most likely to encounter during the survey. The complete description of setting up this feature can be found in the instrument section.

Surveying in the WALKMAG mode

There are some very interesting features about the ENVI PRO. First and foremost, it is a true WALKMAG type magnetometer, with near continuous readings (every 0.5 seconds). This allows you to produce a continuous profile of your magnetic data collected along the survey line. The WALKMAG mode of operation is best performed with the sensor mounted on the back-pack. The WALKMAG feature also allows you to update the major station locations. This updating is performed manually when you

cross the stations separated by the distance increment—each 10-metre station for instance.

Sensor mounting and orientation

It is important that the sensor bottle be placed upright or very close to an upright position on the back frame. Secure the sensor cable as much as possible because you are using quite a sensitive instrument. If the cable is not secure, it can create microphonic noise that typically presents itself as spikes in the data.

Furthermore, (for your own comfort and convenience) the sensor cable extending from the sensor bottle to the instrument should not be left dangling, because you could trip over it. Either tape the extra cable in a knot or hold it in your hand.

Avoid shaking the sensor bottle while surveying, as this will also introduce instrumental noise which is impossible to remove.

Sensor orientation

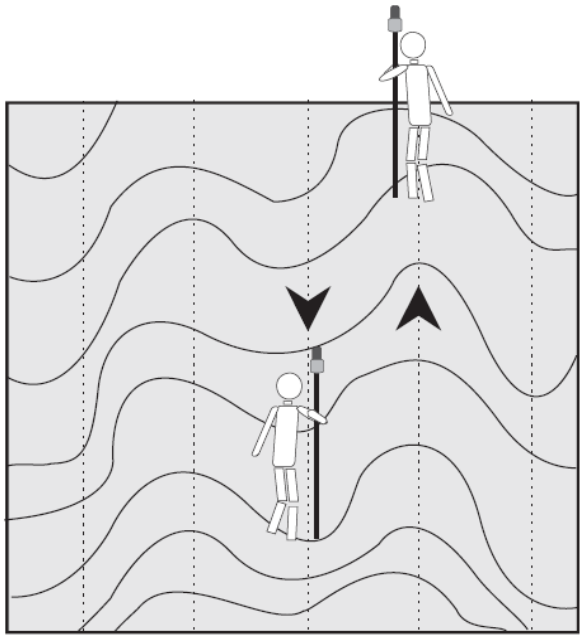
It is also very important to maintain a constant orientation of the sensor while you are measuring and walking from station to station. In other words, do not sway to and fro while walking during a WALKMAG survey.

Rough terrain

You may find that in certain circumstances, such as sloped terrain where progress is much slower than on flat terrain, it is quite difficult to maintain the same station density — as you slow down, more data is being collected over the same amount of lateral coverage as on level terrain. To even out this coverage, you can specify a longer cycling time (greater than the 0.5 seconds you have chosen, for example). Alternatively, you can introduce an additional delay in the cycle time, (the “CYCLE DELAY” feature), prolonging the time interval between readings and allowing you to maintain a more even coverage of your grid.

Station lag and Herring-boning

The measurement that you make with the ENVI PRO does not take place immediately due to the cycle time of the instrument, which is at best 0.5 seconds. Consider also, that during a WALKMAG survey you, the operator, are continuously moving. Is there going to be a problem when you change directions? With some other instruments, this inherent lag in the data would create very distinct herring-bone patterns in the contoured data, as illustrated in the following figure.



Typical herring bone patterns in contoured data

This pattern is present to some degree in all surveys with continuous data collection, where the sensors and instruments are not exactly *spatially* coincident. To minimize any problems, the internal software in the ENVI PRO automatically tries to correct this lagging phenomenon.

Surveying in the Stop-and-Go mode

You can also acquire data in the stop-and-go mode with automatic station increments. This mode is most commonly used in mineral exploration surveys, where the targets are usually larger and deeper than in environmental applications.

Again certain points should be mentioned about this type of survey:

- It is important that the sensor cable does not dangle for the same reasons as mentioned for the WALKMAG mode
- The sensor staff should be held at arm's length when taking a measurement
- It is very important that the sensor be maintained in a constant and proper orientation for each line

Magnetic cleanliness

Certain precautions must be observed before taking readings with a magnetometer. You, as an operator, should be devoid of any metallic objects on your person, such as belt buckles, rock picks, steel-toe boots and compasses. These metallic objects will interfere with the normal reading taken by the magnetometer and produce spurious data.

Monitoring your data

Once data have been collected either on a single line or the entire grid, you can review the data on the console's display screen. This will allow you to visually locate anomalies, as well as, determine the intensity of the anomalies. This is done using the ENVI PRO's graphic display capabilities of the magnetometer data.

You can also visually monitor the magnetic activity at your base station with this feature. These features are well explained in the operations manual and you should refer to this section on page 5—8 for further details.

Post-survey procedures

Clean-up site if required

Once the data is collected, it is a good procedure to remove all stakes and markings left behind, therefore avoiding further damaging the environment.

Data correction

The survey data collected should be corrected at the end of the survey day or the end of the grid. The procedures to perform data correction are explained at length in the instrument operation section starting on page 7—13. However, there are some points that are useful to mention at this stage.

Data correction is done automatically while the survey is carried out in the tieline mode. However, when using a base station the survey data is corrected with the data from the base station.

Warning: Once the data has been corrected with the base station, the raw uncorrected survey data can no longer be retrieved.

Data transfer

It is a good procedure at the end of each survey day to transfer the data acquired during the day. You can keep the equivalent of two days' data for a typical environmental survey in the magnetometers' memory, but it is not considered good procedure. The instructions to transfer (or dump) the data are explained in the operations manual.

The data can either be dumped on a line-by-line basis or as an entire data set. You would normally perform a line-by-line dump, if you intended to produce individual profiles. Alternatively, you would do an entire data dump, if you intended to produce a contour map.

Processing data

Once the data is dumped, you can perform many procedures to enhance the

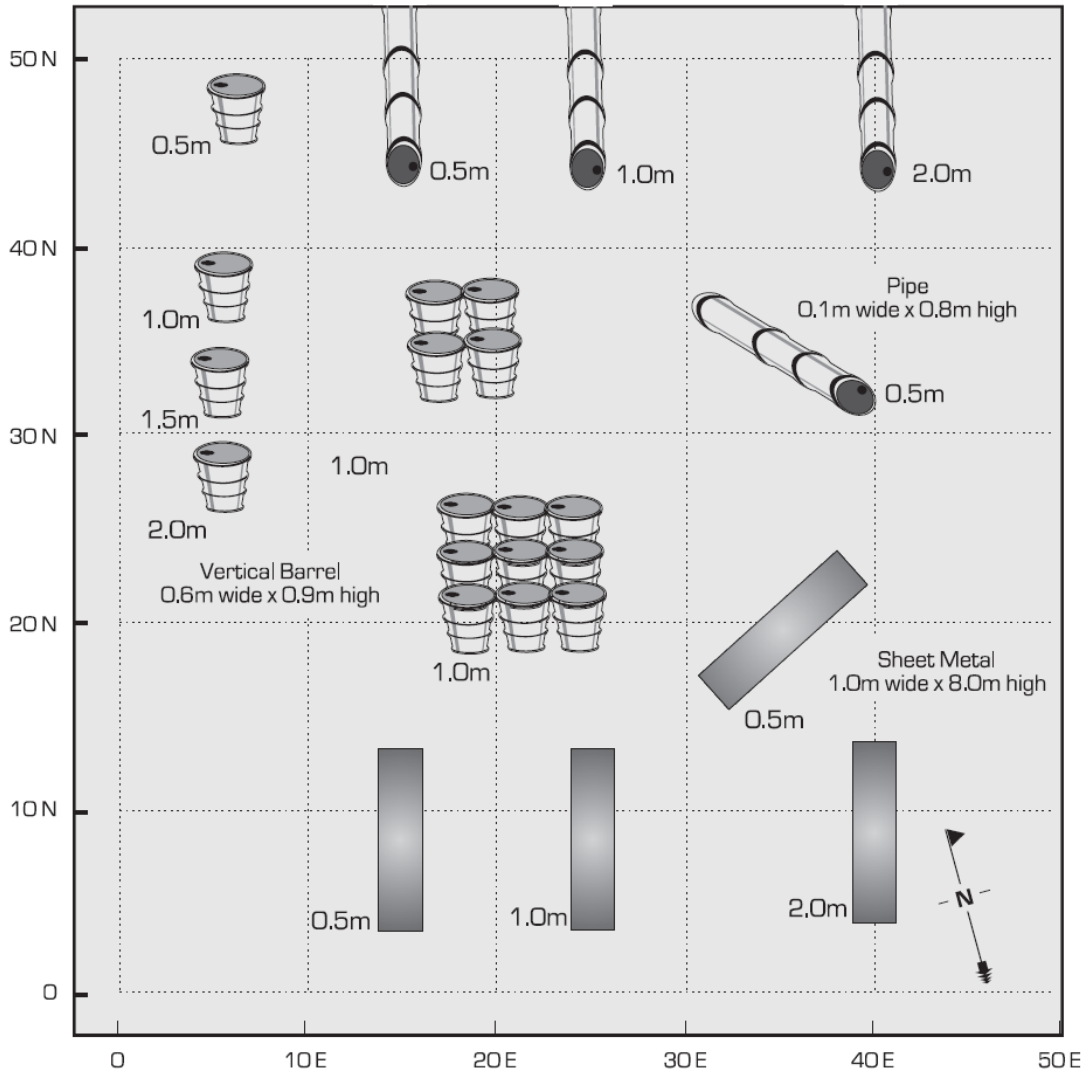
presentation of the data. Data can be presented as contour maps or as profiles of the measured values. In the case of multiple grids it is recommended that processing be done for each grid separately. You will have to manually edit your data file into separate data files for each grid.

Field example

Columbia test site — Waterloo, Ontario

The Columbia test site is located on the grounds of the University of Waterloo, in Waterloo, Ontario, Canada. Three different types of targets are buried at this site: 45 gallon steel drums, pipes and sheets of metal. These targets are buried at different depths and in different groupings. A sketch map of the Columbia test site is shown in the following figure.

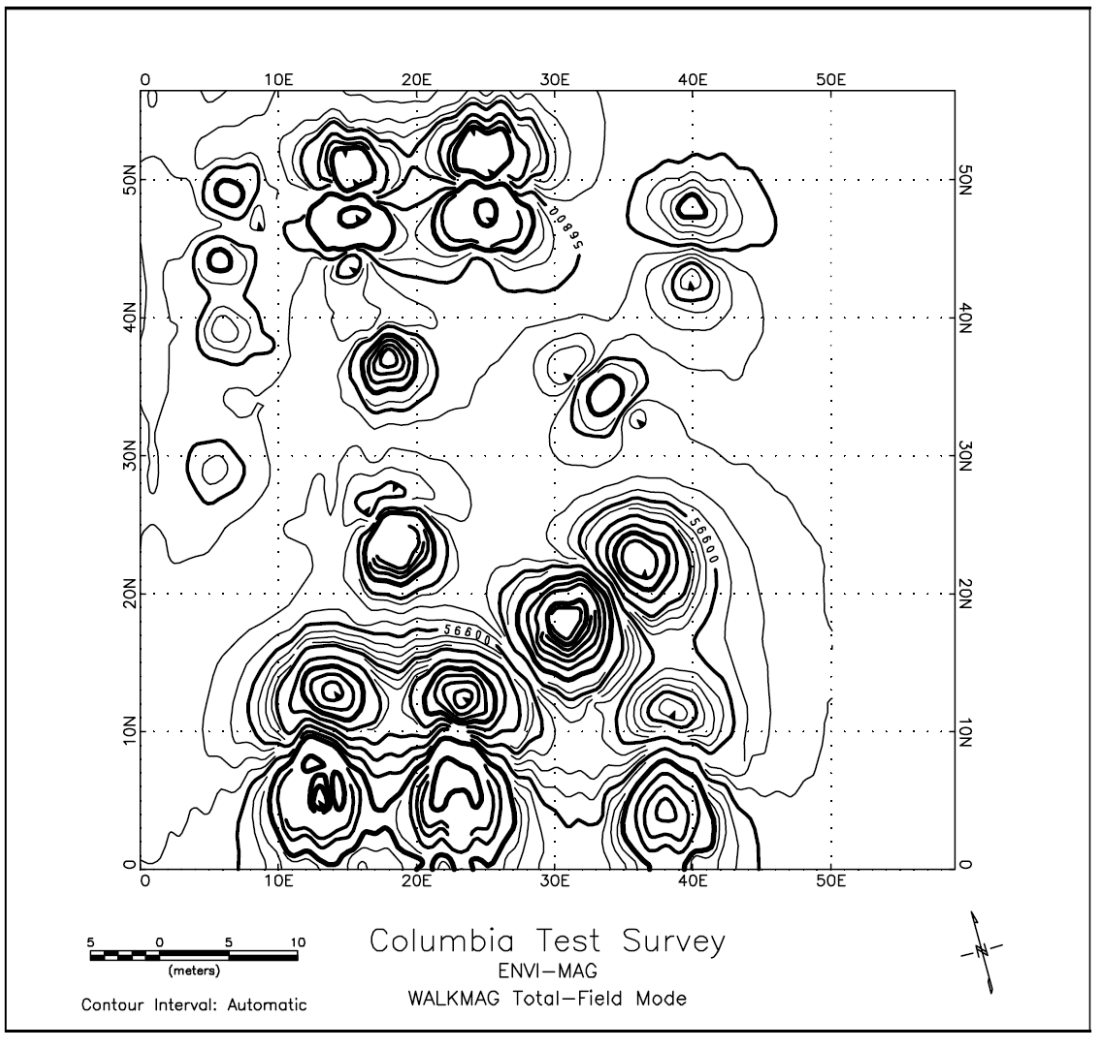
Columbia Test-Site: Plotted next to the hazards are their burial depths.



Columbia test-site

Grid layout

The shallow burial depths of the targets, between 0.5m and 2.0m, required a tight grid spacing be chosen. Ideally a square grid with a line spacing of one (1) meter should be used for this type of site. This was the case. For the same reason, the WALK-MAG mode with readings taken every 0.5 seconds and stations updated every 10 meters was used for this type of site.



Columbia test site total-field contoured data

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