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Operating Manual
Model G-846
UniMag II™ Proton Magnetometer

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

The UniMag JITM Portable Proton Magnetometer, Model G-846, is a complete system designed for man carry general field applications requiring simple operation and stable measurements of the total intensity of the earth's magnetic field. UniMag II provides one gamma accuracy with the sensor detached from the unit and connected to the staff and ten gamma absolute accuracy and resolution without the staff. Each measurement is based upon an atomic constant* and is independent of temperature, humidity, and sensor orientation. The integrated simplicity of the UniMag II Proton Magnetometer allows rapid, accurate measurements to be obtained from a single, compact field instrument without the need for external batteries, cables or sensor. UniMag II is a precision instrument and reasonable care should be exercised to avoid damage from unnecessary field abuse.

I-M-P-0-R-T-A-N-T

Read Chapter 3.0 Before Using UniMag II on a Survey

1.2 MAGNETIC ENVIRONMENT

During survey operation, it is important that the earth's magnetic field is not biased or disturbed by allowing unwanted magnetic objects to come close to the sensor. Such objects include jewelry, keys, watches, belt buckles, pocket knives, mechanical pencils, zippers, notebooks, other survey equipment, etc.

NOTE: The special nonmagnetic membrane push button operates with as little as 3 oz of pressure. Therefore, it is important that the operator completely remove his thumb or forefinger from the push button during the instrument cycle.

*Proton Gyromagnetic Ratio: (2.67513 $\pm$ 0.00002) x 104
Radians/Gauss second.

Prior to survey use objects that are suspected to be magnetic may be checked in the following manner:

1. Go to a magnetically clean area away from buildings, roads, automobiles, ac power lines, etc.

2. Place the suspected object far away (15 to 20 ft.) from UniMag II, and take several readings by depressing the black push button - releasing - and waiting for a digital readout to appear.

3. Observe the displayed readings. Each reading should repeat to within 1.0 gammas, i.e., the least significant digit should NOT change by more than one count.

4. Now place the suspected object at the distance from the sensor expected during actual survey operation. Take several more readings and note the measurements.

5. If the measurements made in Step 4 above differ by more than + one count from those measurements made in Step 3, then Eh-e object is magnetic.

IF THE'ARTICLE IS HIGHLY MAGNETIC, OR IF UniMag II IS OPERATED INSIDE OR NEAR A BUILDING OR VEHICLE, NO SIGNAL WILL DEVELOP, GIVING COMPLETELY ERRATIC READINGS AND LOSS OF ± ONE COUNT REPEATABILITY.

UniMag II cannot operate properly in areas that are known sources of radio frequency energy, power line noise (transformers), or in buildings. Also UniMag II may not operate properly if it is placed directly on the ground, due to the magnetic properties of most soils.

UniMag II will indicate a high gradient field by blanking the two least significant digits. This gives a 100 gamma resolution, instead of 1 gamma. To view all five digits, hold the cycle button down while the display is illuminated.

1.3 SPECIFICATIONS

Resolution:	Ten gamma without staff One gamma on staff Hundred gamma in high gradient f ields
Tuning Range:	20 , 000 to 100, 000 gammas (worldwide)
Tuning Mechanism:	Multiposition switch with 24 over- lapping steps
Gradient Tolerance:	2,000 gammas per meter

Sample Rate:	Manual push button, new reading every 3-1/2 seconds
Output:	Five digit, illuminated display directly in gammas
Power Requirements:	12 Vdc, rechargeable battery, sufficient for 2,300 readings
Power Source:	An internally mounted and rechargeable 12 volt, 1.5 amp/hr nonspill gelled electrolyte battery. Charge state or replacement signified by flashing readout display.
AC Battery Charger:	Input: 115 V, 50/60 Hz , 220 volt with adapter Output: 14 Vdc
Temperature Range:	-20' to +50'C, weatherproof Note: Battery capacity decreases with low temperature operation.
Accuracy:	One gamma with sensor detached Ten gamma with sensor attached
Sensor:	Noise cancelling, high signal. May be mounted to console, or used on staff.
Console Size:	3-1/2 x 3-1/2 x 27 in (9 cm x 9 x 68 cm)
Console Weight:	6.6 lbs (3 kg) Includes batteries, sensor and shoulder harness.

1.4 INVENTORY INSPECTION

When received from the manufacturer, the UniMag IITM Proton Magnetometer should include the following items:

1.	UniMag II Console	1	each
2	Sensor	1	each
3.	AC battery charger	1	each
4.	Adjustable shoulder strap	1	each
5	Collapsible Sensor Staff	1	each
6.	Battery	2	each
7.	Operator's Manual	1	each

8.	Applications Manual for Portable Magnetometers	I each
9.	Carrying Case	1 each
10.	220 V to 115 V ac Adapter	1 each
11.	AC Plug Adapters	1 set

2.0 FIELD OPERATION

2.1 INTRODUCTION

UniMag II is completely self-contained, and ready for field survey operation. A few simple procedures should be observed to obtain optimum results, and it is recommended that the operator follow each step as outlined in this chapter to initially become familiar with the operation of the instrument. Refer to Figure 2-1 for identification of UniMag II's controls and indicators.

2.2 CONSOLE OPERATION

PRELIMINARY CONSIDERATIONS: BEFORE USING UniMag II, CHECK FOR:

1. Presence of sensor fluid:

The sensor is located in the forward, cylindrical portion of the instrument. Shake the instrument GENTLY and listen for a sloshing sound. If fluid is not present, or cannot be heard, it is necessary to fill the sensor PRIOR to operation. Note that this procedure will not be required under normal conditions.

a) Hold the UniMag II console vertically with the sensor pointed up. Remove the slotted Fill Plug from the convex end of the sensor as shown in Detail "A" of Figure 2-1. Note that sensor may be removed from its bayonet mounting on the console.

b) Fill the sensor with STRAINED* kerosene or unleaded gasoline completely. Then REMOVE approximately two tablespoons of fluid.

*NOTE: The fluid MUST be strained several times through paper filters, (i.e., paper towels, coffee filters, etc.) . NEVER use kerosene or gasoline directly from a pump or storage can as it may be contaminated with metal particles.

2. Battery pack is fully charged:

To check the battery voltage, simply depress the black push button and observe the readout - if it "flashes" on/off during the display period, the battery pack is NOT fully charged. Refer to Chapter 3.0 for instruction of recharging the battery PRIOR to survey operation.

ONLY THREE SIMPLE STEPS ARE NECESSARY TO CORRECTLY TUNE AND OPERATE UniMag II.

1. Lift the UniMag II console out of the carrying case, and adjust the shoulder strap for a comfortable fit. Typically, the magnetometer is used on the operator's right or left side, with the shoulder strap suspended across the operator's chest from the OPPOSITE shoulder. Keep sensor on console if ten gamma accuracy is sufficient for survey.

2. Adjust the TUNING-KILOGAMMAS knob to a position that correlates with the earth's known magnetic field. The earth's field, in any general location, can be estimated by using the world intensity map at the front of this manual.

3. Depress the black push button and release; observe that the center digit on the readout will flash briefly. This indicates that the measurement cycle has started. Numeric value of digit is MSD (most significant digit) of last reading. Wait two seconds, and observe the two second illuminated display of the earth's total field directly in gammas.

THE INSTRUMENT IS NOW READY FOR FIELD SURVEY OPERATION

NOTE: A true and repeatably correct reading can be made with TUNING-KILOGAMMAS knob set in three or four tuning positions on either side of the "estimated" local magnetic field (i.e. , the tuning is quite broad and noncritical in most cases). Unless high field changes on the order df four or five thousand gammas occur during operation, it will not be necessary to retune the console.

2.3 SENSOR ORIENTATION

In low magnetic latitudes (where the field dips less than 40", or below 40,000 gammas) such as near the magnetic equator where the field is horizontal, it may be necessary to rotate the sensor 90' as in following procedure.

The small dot or line on the sensor is provided to allow proper orientation of the internal sensor axis, which must be placed perpendicular to the earth's field to produce optimum signal. The following procedure is recommended for easy rotation of the sensor.

1 Loosen the black knob on the sensor mount before removing the sensor.

2. Twist the sensor and remove it from the bayonet mounting on the front of the UniMag II console.

3. Turn the sensor 90' so that the white dot or line on the open end is aligned with the side of the console.

4. Reattach the sensor to the bayonet mount after coiling the interconnect cable in a figure 8 pattern approximately 5 inches in length and inserting into the end of the sensor as far as it will go.

NOTE: The sensor should be rotated ONLY in survey areas where the local field intensity is less than 40,000 gammas.

2.4 SURVEY OPERATION

During survey operation and after UniMag II has been tuned to the local field intensity (see Section 2.2), the operator need only depress the black push button and note the reading in a log or field notebook. If a reading is in question (i.e., a sudden shift of several hundred gammas) several readings should be taken with the console held as still as possible

UniMag II SHOULD EXHIBIT ONE COUNT STABILITY, WHICH CAN BE VERIFIED BY REPEATING A MEASUREMENT WITH THE CONSOLE HELD IN THE SAME LOCATION. If one count stability is not possible, then an unwanted ferromagnetic article is present (buried pipe, etc.) or an extremely high magnetic gradient has been encountered.

2.5 INSTRUMENT STORAGE

When not in use, all of the components except the battery should be stored in the carrying case to prevent damage, loss, or possible contact with magnetic particles that could be embedded in the sensor. If extended storage (one week or longer) is anticipated, the battery should be stored in a cool, dry, place (see Chapter 3.0) to minimize self-discharge After any storage time, always recharge the battery.

NOTE: Gelled electrolyte batteries provide an excellent power/weight ratio, but do require special handling considerations. TO PREVENT DAMAGE FROM EXCESSIVE BATTERY DISCHARGE, READ CHAPTER 3.0 COMPLETELY BEFORE USING THE UniMag II MAGNETOMETER ON A SURVEY.

2.6 POSSIBLE SURVEY DIFFICULTIES

The following is a list of possible survey difficulties, probable causes, and recommended corrective action.

Survey Difficulty	Probable Cause	Corrective Action
No reading on display, or digit flash on start	1. Poor battery contact	1. Check for loose connector or broken cable
	2..Dead battery	2.. Recharge battery
Console will not tune	1. Loose tuning knob	1. Tighten set screw
	2. Open signal cable	2. Check signal cable for continuity
	3. High noise area	3. Move to different location
Blinking BAT Display	1. Low battery voltage	1. Recharge battery
Erratic readout or partial display three digits only	1. Sensor located in high noise area	1. Move sensor away from generators, power lines buildings, highways, etc.
	2. Highly magnetic environment	2. Check for magnetic articles (knives, belts, eye glass straps, pen-cils, etc) that are close to or are imbedded in sensor (steel chips, magnetic dirt, etc.). Unit will not make valid readings inside buildings (refer to Section 1.2)

3. No fluid in sensor	3. Shake sensor and listen for fluid. Fill as required (refer to Section 2.2)
4. Sensor not connected or signal cable is broken	4. Check sensor signal cable for damage
5. No polarize power	5. Weak or "dead" battery - replace
6. Intermittent battery contact	6. Check battery cable connections
7. Sensor not properly oriented	7. Align sensor dot to side or top (refer to Section 2.3)
8. Diurnal shift or magnetic storm	8. Wait for several hours - repeat readings when field is stable

3.0 BATTERY MAINTENANCE AND CHARGING

3.1 INTRODUCTION

UniMag II uses a 12 volt , 1.5 amp/hour gelled, lead-acid battery. A special keyed plug is used to connect this battery to the UniMag II circuitry, or to the ac battery charger.

NOTE: Lead-acid batteries REQUIRE careful attention to charging and storage procedures. To avoid unnecessary damage to the battery, READ THIS CHAPTER COMPLETELY BEFORE USING THE UniMag II MAGNETOMETER.

3.2 CHARACTERISTICS OF LEAD-ACID BATTERIES

The battery selected for use in UniMag II represents the best available combination of usable power vs weight and cost. When the battery has been allowed to excessively discharge over an extended period of time, however, the internal electrolyte is reduced to water which is a very poor conductor of electricity. Such a discharged condition increases internal resistance of the battery making recharging difficult at best, and perhaps impossible with the charger supplied with the UniMag. IT IS NECESSARY TO REMOVE THE BATTERY FROM UniMag II WHEN IT WILL NOT BE USED FOR EXTENDED PERIODS. ALWAYS STORE THE BATTERY IN A COOL ENVIRONMENT.

3.3 LOW VOLTAGE INDICATORS

There are two methods of checking the available battery voltage:

1. Cycle the magnetometer by depressing the black push button and observe the readout. If the readout "flashes" on and off (b links) then the battery pack MUST be replaced with a fully-charged one. When the readout flashes, the battery voltage is dropping to approximately 10.25 volts during polarize time. This is not adequate for proper operation.

2. The second method of checking a battery for charge involves use of the ac charger. Connect the battery to be tested to the keyed connector on the ac charger cable. Assuming that the charger has been connected to the ac mains already, the "READY" lamp shall light within one or two minutes if the battery is fully charged. If the lamp stays off, charge the battery fully as instructed in Section 3.6.

3.4 BATTERY STORAGE

Batteries stored on a shelf will self-discharge as a function of temperature as shown in Figure 3-2:

Figure 3-2

Rate Of Self-Discharge vs. Temperature

Storage Temperature OF/OC	Estimated % Loss per day	Percent Capacity Loss in 6 Months
0-/-18'	0.03%	5%
300/-l"	0.07%	13%
600/160	0.13%	23%
80-/27-	0.25%	45%
100'/380	0.50%	90%
120'/49-	1.10%	100% in 90 days
1400/60-	1.60%	100% in 62 days

It is important to remember that water is one of the resulting products of battery discharge. When batteries are stored at low temperatures, therefore, they must be in a fully-charged. condition to prevent water freezing. After delivering its full-rated capacity, a battery will freeze at approximately -6'F (-21'C). If long term storage is anticipated, it is best to leave the battery on the charger for at least 48 hours to ensure full charge. It should also be noted that when shipping the G-846 system, the battery included should be at full charge.

Batteries in long term storage should be occasionally "boost" charged as a function of the long storage temperature (see Figure 3-3 below) using the charger supplied with the UniMag II. Allow 48 hours for boost charging.

Figure 3-3

Months in Storage Prior to Boost Charging

Storage Temperatures	Months in Storage
00 to 30OF (-180 to -IOC)	12
310 to 60OF (-.5* to 160C) --(Optimum)	8
61* to 8OF (16.50 to 27'C) --(Optimum)	4
810 to 100OF (27.5' o 38*C) --(Optimum)--	2

NOTE: Do not store the battery above IOOOF (380C). Maximum operating temperature is 140OF (600C).

3.5 BATTERY INSTALLATION AND REPLACEMENT

The following steps should be followed for the initial installation or replacement of the battery (refer to Figure 2-1 for identification of parts).

1. Unsnap the plastic door locks on the bottom of the UniMag II console. Remove the battery door.

2. Remove the battery. Avoid letting the battery fall out of the console as this could damage the connected wires. For initial installation of a battery ignore this step.

3. Connect a fully-charged battery using the white, keyed, POWER PLUG.

4. Install the battery pack in the bottom of the UniMag II console. Replace the battery door and lock it in place.

CAUTION

The battery contains sulfuric acid which can cause severe burns to ski ' n and eyes and damage to fabrics. In the event the battery leaks and contact is made with the sulfuric acid, immediately flush skin or eyes with water for at least 15 minutes. For eyes, seek immediate medical attention. A good neutralizing solution for sulfuric acid is water and household baking soda.

3.6 BATTERY CHARGING

The small battery charger supplied with UniMag II is compatible with a standard line voltage of 115 volts, 60/50 Hz ac power. An AC POWER adapter is provided with the charger (see Figure 3-1). The charger is a dual rate type; it does not have the capacity to recharge a battery that has been deeply discharged as discussed earlier in this chapter.

To charge a battery plug the charger into ac power and connect it to the battery using the keyed POWER PLUG. Observe the following rules to correctly charge the battery.

1. Daily use of the UniMag II Magnetometer: At the end of each day's use of the magnetometer, it is recommended that the battery be recharged overnight, or for at least 12 hours. If it is necessary to use UniMag II for longer than

one day between charges, the spare (fully charged) battery pack should be installed when the readout display flashes. The discharged battery should then be recharged for a minimum of 24 hours or as long as 48 hours to ensure full capacity charging.

2. Non-daily use of the UniMag II Magnetometer: If it is anticipated that UniMag II is not going to be used for several days or weeks, the battery should be removed and stored in a cool, dry, place (see Figure 3-2) ; this applies to all UniMag II models. The UniMag II console has no ONI OFF switch, therefore a small amount of current will always flow. The small current drain (approximately 50 u amps), is insignificant to normal usage of the magnetometer, but if a partially discharged battery pack is left in the instrument for a long period of time, it is possible that this current drain could eventually cause a deep battery discharge. The charger supplied is not designed to overcome the internal resistance caused by a such deep discharge (refer to paragraph 3.2).

3. The battery charger has two lamps to indicate when the battery is being charged and is "READY" or finished charging.

Careful attention to the above details regarding battery care and charging will allow years of service from the battery.

CAUTION

DO NOT ATTEMPT TO OPERATE CHARGER FROM 220 VOLT POWER WITHOUT USING THE 220 VOLT ADAPTER SUPPLIED, OTHERWISE THE CHARGER WILL BE SERIOUSLY DAMAGED.