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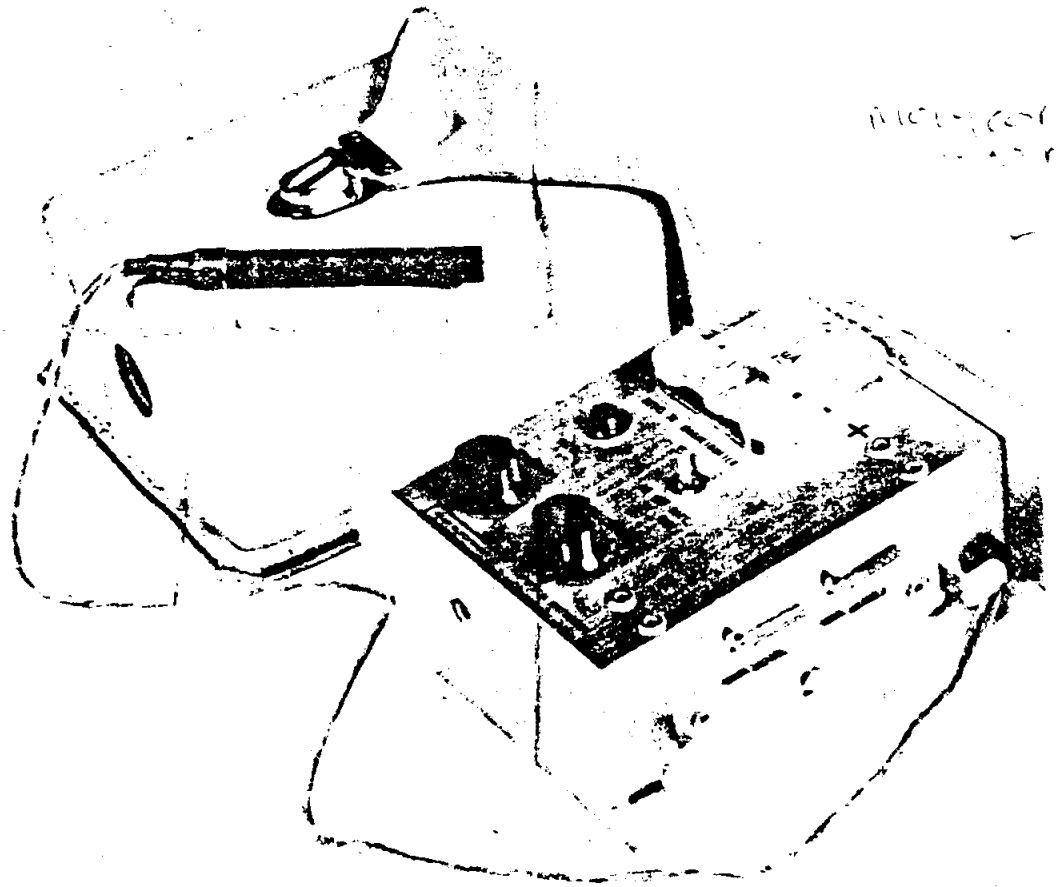
CALEX

CALIFORNIA ELECTRONIC MFG. CO., INC.
P.O. Box 555, Alamo, California 94507

MODEL 70
FLUXGATE MAGNETOMETER



INTRODUCTION:

The Model 70 Fluxgate Magnetometer has been designed specifically as a field instrument for qualitative measurements. The unit is small, lightweight and rugged. It uses a battery for power (Mallory TR 169).

This instrument allows many geologic samples to be checked in the field to identify north and south magnetic poles, and thereby determine normal or reverse magnetic polarity. Measurement of the relative intensity of the remnant magnetism of the sample may also be made with this instrument.

The measurement of the natural remnant magnetism (NRM) at the outcrop allows field checking of the magnetic properties of a sample prior to extensive field work. This represents a significant savings in time and effort. The directions of NRM can be measured to better than ±20°. It is possible through use of the Model 70 to recognize time boundaries by tracing reverse-normal polarity transitions in the field. The temperature to which rocks have been subjected can be estimated in the field. Stratigraphic correlations may also be made in the field.

MODEL 70 MAGNETOMETER OPERATING INSTRUCTIONS

DESCRIPTION:

The Model 70 is completely solid state using only silicon semiconductors. The fluxgate element is 3/8" in diameter and approximately 3" long. The element is connected to the instrument by a flexible cable approximately one meter long. The rugged aluminum case is designed to protect the meter face and adjusting knobs. When the fluxgate element is stored, it is also protected by its case. The leather carrying case is provided with a loop so that the instrument can be carried on the belt. A Monopod for holding the fluxgate element while making measurements is also provided.

CONTROLS:

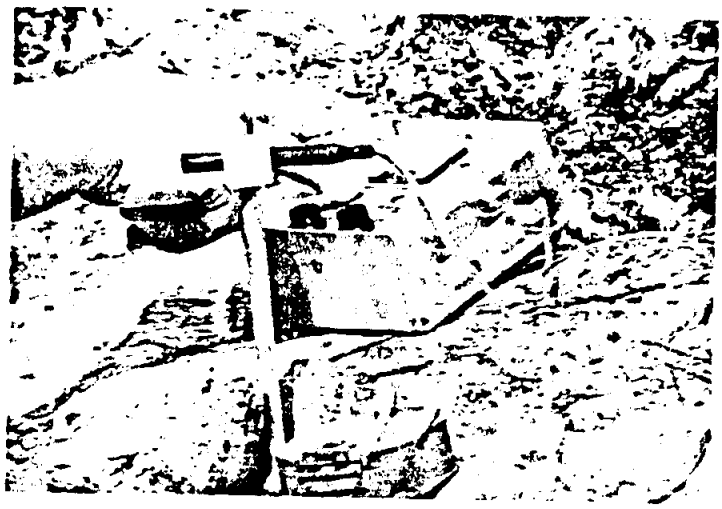
The face of the instrument has four controls and a meter. The functions of the meter and these controls are as follows:

"ON-OFF-BATTERY TEST" SWITCH: The switch, which is normally kept in the "off" position during transportation or between measurements, controls the power to the instrument and provides a means whereby the battery voltage level may be checked. By moving the switch momentarily to the right, the battery voltage may be checked on the meter face. In this position the meter should read between 40 and 50 on the right hand side of the scale. If the meter reads to the left, this indicates that the battery has been placed in the instrument backwards and should be reversed. If the reading is below 40, the battery voltage is low and the battery should be replaced. A low battery will adversely affect the stability and sensitivity of the instrument. It is therefore recommended that a fresh spare battery be carried on field trips.

"OSCILLATOR" KNOB: This control adjusts the frequency of excitation of the fluxgate element sensing head. Its normal position is approximately 1/4 turn in the clockwise direction from the fully counter-clockwise position. It should not need adjustment. Adjustment is provided, however, to allow for small changes in components with aging and also to allow for any frequency changes that would occur due to large temperature shifts during field operation. The only time this adjustment need be touched is when sufficient sensitivity cannot be achieved with the sensitivity control along.

"SENSITIVITY" KNOB: This control determines the sensitivity of the fluxgate element head. It is used to adjust the calibration level. The lowest sensitivity would be in the full counter-clockwise position, and the maximum sensitivity in the full clockwise position. If a calibrated laboratory sample is brought into the field, the sensitivity adjustment can be set to obtain an exact meter deflection for a known magnetic intensity. In this manner rather precise magnetic intensity measurements may be made in the field.

"CALIBRATION" BUTTON: The calibration button switch is designed to provide a fixed excitation of the fluxgate detecting circuit, thereby creating a basis for measurement of relative intensity of the NRM. A meter deflection equal to a magnetic field of approximately 50 gammas is produced by depressing the button. This allows a calibration of the meter from O center to 50 to the right. It is also possible to calibrate the instrument for 100 divisions being equal to 50 gammas. This can be done by increasing the sensitivity adjustment (turning it clockwise) and starting the microammeter needle at −50 and adjusting the sensitivity knob so that the depression of the calibrate button results in a full scale deflection to +50. This would provide a 50 gamma full + and − scale calibration, or 25 gamma using O to +50.



INITIAL OPERATION:

Your Model 70 Magnetometer has been shipped to you with the battery separate to prevent possible damage during shipment (a recommended procedure for future shipment). To open, remove the four screws that attach the instrument to the protective cover. With the battery installed, the battery switch handle should be pushed to the right "Battery Test." The meter needle should swing to the right to indicate proper polarity.

FIELD MEASUREMENTS:

GENERAL: Your instrument has been provided with a monopod for field use. The sensing head can be held in the monopod and then rotated to null the meter. In this configuration the instrument can be rotated for final nulling of the meter. Caution should be exercised when inserting the head in the monopod and the monopod in the ground. Do not exert any pressure on the sensing element itself.

It is generally recommended that the instrument be kept in the "off" condition until you actually make your measurements. You should adjust the null and sensitivity just prior to taking actual sample measurements. This is done in order to achieve maximum battery life and to minimize the possibility of excessive drifts in either the null or the calibration of the instrument.

Samples to be measured may be first oriented and marked in geographic coordinates and then removed from the outcrop. Blocks weighing between 5 and 10 kg are ideal, but measurements can also be made on samples of only a few hundred grams. One must exercise care in the selection of field samples to insure that there are no local anomalies such as those caused by lightning strikes. These strikes would have altered the direction or intensity of the original remnant magnetization.

PREPARATION: Prior to field use the instrument should first be checked for proper operation as described in the operating instructions. After the battery has been checked and a rough calibration made, the instrument is now ready for making measurements. Besides the monopod, the only additional equipment you will need is a field compass and tools for marking and obtaining samples from the outcrop. Because local disturbances such as lightning strikes can cause drastic changes in the apparent NRM, you will also need equipment for locating anomaly free areas. You can insure against local anomalies by making a series of multiple measurements in the surrounding area or by using a gradiometer or a pair of compasses attached to a rod approximately one meter long as described by Doell & Cox in U.S. Geological Survey Bulletin 1203-A (1965).

HEAD ORIENTATION AND INSTRUMENT CALIBRATION: After the head and the instrument have been securely positioned where the measurements are to be made, the sensitivity control should be adjusted to the approximate setting desired. The head then should be rotated to an approximate east-west orientation and adjusted to produce an approximately zero meter reading. This rough nulling of the meter by rotating the head is further improved by rotating the instrument and using the meter magnet to null the head. For the most sensitive settings it will be convenient to use your field compass or a small bar magnet for final nulling. The compass or magnet is placed near the head and rotated carefully until a null is achieved.

Now that the instrument has been nulled with the approximate sensitivity setting desired, the unit is ready for calibration. Depressing the calibrate button will cause a 50 gamma deflection of the meter to the right of +

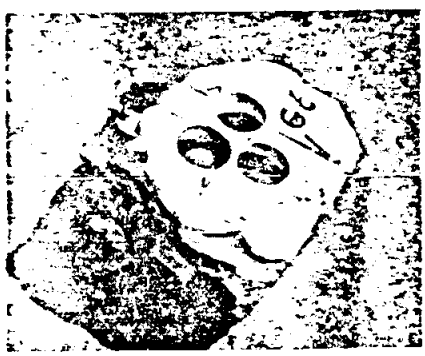
FIELD USE OF THE MODEL 70 MAGNETOMETER

direction (clockwise rotation). Adjust the sensitivity control to get the desired calibration (meter deflection) for the samples to be tested. After the sensitivity control has been adjusted it may be necessary to readjust the head or compass to achieve a null. This process is repeated as often as necessary depending on the desired accuracy and sensitivity. Usually no more than two adjustments are required. In actual use the operator becomes more proficient with time and use, and these adjustments are completed in a matter of seconds.

More exact calibration can be achieved by using a laboratory sample which has itself been precisely calibrated prior to the field trip.

To check that the instrument is working properly and to simulate a field measurement, the instrument should be placed in an approximate East-West orientation lengthwise on a non-magnetic surface (such as a wood bench). Both the sensitivity and oscillator control should be set at approximately 1/4 turn from the full counter clockwise position, then the instrument turned "on." The head then should be oriented to provide approximately 0 meter reading, keeping the head at least 1 ft. from the meter case so that the magnetic field of the meter will not saturate the head. When the needle is near the center of the instrument dial, the instrument itself can be rotated slightly using the magnetic field of the meter to null the field at the head.

Gradually increase the sensitivity (by turning the sensitivity knob clockwise) while maintaining the meter reading near zero by re-orienting the head until the calibrate button causes a full scale meter reading when depressed. This indicates that the instrument is working properly. To check the instrument polarity, bring the north seeking end of a compass needle up to the end of the sensing head (the end without the cable). This should cause a clockwise deflection of the needle to the + side. If the instrument does not respond properly, recheck the calibration and head orientation. With these checks made, your instrument is now functioning properly, calibrated and ready for use.



OBTAINING SAMPLES: Before removal from the outcrop, samples should be marked for location and orientation. A convenient method for marking the samples is a small amount of plaster of paris applied to the piece to be removed, smoothed, leveled and allowed to harden. Once hard, the plaster is easily marked and written upon providing a good record when additional laboratory measurements may be required. This method also provides a good starting surface for a core drill.

Other techniques may be used in obtaining samples. The sample may be removed from the outcrop first, the sample and area brushed clear of dust and chips, then the sample replaced and marked. Successful data can also be obtained by simply marking the sample with a felt pen and then removing the sample from the outcrop.

When the plaster of paris is not used to provide a horizontal reference, the sample should be marked with a horizontal line drawn on at least two surfaces and in all cases should be marked with a north arrow.

MAKING MEASUREMENTS: Just prior to making the actual measurement, the instrument should again be turned on and the calibration checked. This should be a standard operating procedure.

The sample can now be brought up to the head carefully, to avoid contact. Movement of the head would cause a null shift. A direct reading along a premarked orientation line can be made in this manner.

To measure the direction of the NRM vector, the sample should be rotated until the meter shows a maximum "+" deflection, and this position on the sample should be marked. The sample should then be rotated and the position of the maximum "−" deflection marked. A line drawn between these two marks defines the direction of the NRM vector. During rotation the sample should be kept in line with the long axis of the head and at a constant distance from it.

The declination "D" and the Inclination "I" of the vector then may be estimated visually with reference to the horizontal reference lines.

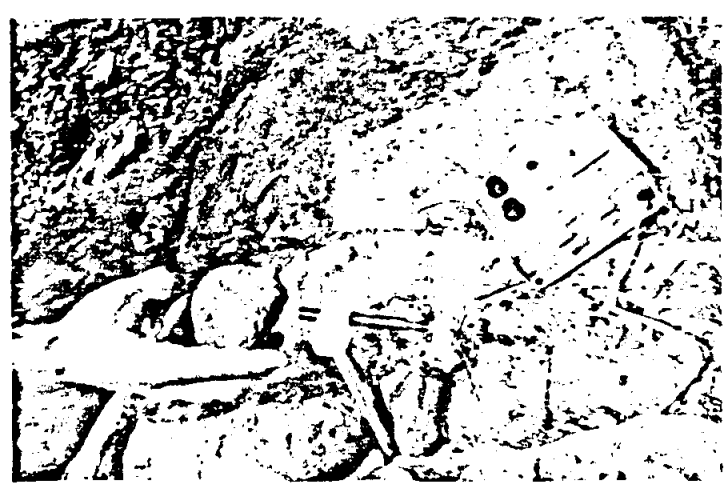
FLUXGATE ELEMENT (HEAD) AND INSTRUMENT PLACEMENT: The location of where the measurements are to be taken must be determined by evaluating the relative merits of the factors of terrain, time and weather

against the basic objectives of the field trip. A fundamental decision to be made is whether the instrument will be brought to the outcrop, or sample of the outcrop brought to the instrument at a "base" or roadside location for the actual measurements. In either case, the techniques for positioning the head and instrument are essentially the same except that passing vehicles will cause meter deflections.

Locate a general area most convenient for the taking of measurements that will be stable and free from magnetic interference or physical disturbance. The area may be a wooden table in a laboratory or a rugged outcrop location. At this time it is a good practice to remove from your person any magnetic materials that might move during measurements, i.e. wristwatch, keys, etc.

The first basic requirement in placement is that the head must be located at least one foot from the instrument to prevent saturation of the head by the magnetic field of the meter. The second requirement is that both the instrument and the head be stable so that wind, body movement or the pushing of the calibrate button will not change their physical position. Any movement will cause a meter shift and appear as a measurement error.

NOTE: Care should be exercised when placing the head in the monopod to prevent excessive pressure on the head. Although the head is sufficiently rugged for normal field use, it is somewhat fragile and will break under stress or shock. You will notice in each photograph showing placement of rotation of the head that the monopod is grasped by the spike. It is advisable to force the monopod into the ground prior to inserting the head.



We gratefully acknowledge the editorial assistance of the following in preparing these instructions: DR. F. J. VINE, Department of Geology, Princeton University; DR. E. E. LARSON, Department of Geological Science, University of Colorado; DR. D. F. HEINRICHS, Department of Oceanography, Oregon State University; DR. R. T. SHUEY, Geology Department, University of Utah.

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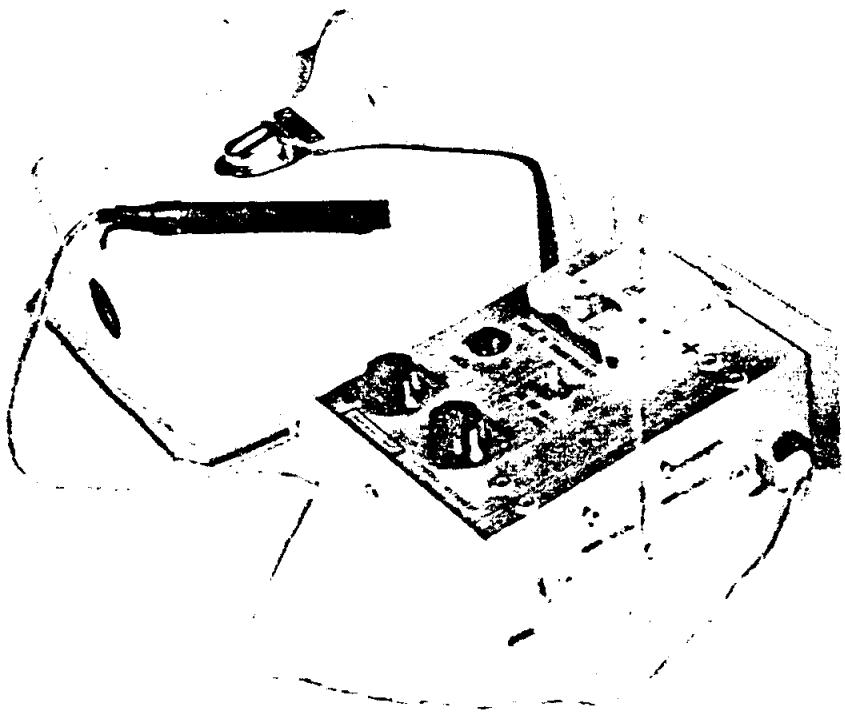

MODEL 70 FLUXGATE MAGNETOMETER

features

Small size • Light weight • Battery operated • Wide operating temperature range • Field carrying case • Built-in calibration • All components conservately rated for maximum reliability • All silicon solid state design

applications

1. Strategic correlation. 2. Dating by the polarity method. 3. Checking field free space. 4. Rough comparative testing of magnetic intensity. 5. Inspecting "non-magnetic" materials for magnetic impurities. 6. Structural interpretation of deformed igneous rocks.

specifications

Sensitivity:	Approx. 25 to 2,500 gammas full scale (continuously adjustable)
Calibration:	50 gammas
Dimensions:	4" x 2" x 5"
Weight:	1¾ pounds including case and battery
Battery:	Mercury 12.6 Volt
	Mallory TR-169 or equivalent
Price:	$495.00 F.O.B. Factory

GEOPHYSICAL INSTRUMENT DIVISION