Operation Manual for

BSS-02B Magnetic Susceptibility Sonde

Bartington®
Instruments

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1. About this Manual

This manual provides the information necessary to help customers operate the BSS-02B Magnetic Susceptibility Sonde from Bartington Instruments. It should be read in conjunction with the product brochure (DS0064) which can be found found on the product page of the Bartington Instruments at: www.bartington.com.

1.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:

WARNING: Indicates a situation in which serious bodily injury or death could result if the warning is ignored.

Caution: Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.

Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

Note: A note provides useful supporting information and sometimes suggests how to make better use of your purchase.

2. Safe Use

WARNING: These products are not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.

3. Introduction

The BSS-02B magnetic susceptibility sonde is used for prospecting for magnetic minerals and stratigraphic correlation. The operating frequency is chosen to be sufficiently low to avoid interference from rock conductivities, and the circuitry is temperature compensated to minimise thermally induced drift. The detector features a single focused coil arrangement to achieve a single response to strata. Larger diameter holes than those for which it is calibrated can be logged where the angle of the borehole assures de-centralisation. Correction factors for this and for linearity error correction are given in the technical specification in the product brochure.

A typical range of magnetic susceptibility together with rock types is given in the Appendix.

4. Magnetic Susceptibility Measurements Using the BSS-02B System

4.1. Measurements of Interest

Measurements of interest are always positive and arise from either paramagnetic or mostly ferro or ferrimagnetic geological materials. Apparent (false-negative) paramagnetic values will arise only in strongly conductive media.

> **Note:** For this reason the tool should not be used in the presence of ferrous or conductive cladding.

The conductivity of normally encountered borehole fluids will not be sufficiently high to produce this effect.

4.2. Dimensional Systems

The BSS-02B is calibrated in the cgs system. To convert to SI units, multiply the cgs value by 4π. For example:

> 1×10^{-5} cgs ≡ 1.26×10^{-4} SI

> **Note:** This refers to volume susceptibility, which is dimensionless.

4.3. Calibration Sample

An acetal block with three equispaced ferrites around its circumference is supplied with each tool as a calibration sample. Best practice is to check the calibration prior to and following a logging sequence. Thermal (ferrimagnetic) drift of the sample together with geometrical errors suggest that an error band of 10% should apply to the calibration check. The calibration of the tool with time and temperature is assumed to be superior to the calibration check sample.

See also Groundwater Effects.

4.4. Digital and Pulse Rate Interface

A six-wire interface is provided. The power supply connects to a live and a common return line. Digital communication is via a three wire, 24-bit serial port, and pulse rate is output via a single wire.

4.5. Principles of Operation

4.5.1. Magnetic State of a Specimen

The magnetic state of a specimen is generally described by the following equation:

$B = \mu_0(H+M)$ ... (1)

where:

B is the flux density of the specimen in Tesla

μ_0 is the permeability of free space. This is a constant $(4\pi x 10^{-7})$

H is the applied field strength in AT/m

M is the magnetisation of the specimen in Tesla.

Dividing through by H we get:

$\mu_r = \mu_0 + \mu_0\kappa$ ... (2)

where:

μ_r is the relative permeability of the specimen (dimensionless)

κ is the magnetic susceptibility of the specimen (dimensionless).

Rewriting, we get:

$\mu_0\kappa = \mu_r - \mu_0$ ... (3)

4.5.2. Measurement of Magnetic Susceptibility

The BSS-02B instrument measures magnetic susceptibility in the following way.

A wound inductor is the principle frequency-determining component of a very high thermal stability oscillator. When the inductor is surrounded only by air, the value of μ_0 determines the frequency of oscillation. When the inductor is placed within the influence of the specimen to be measured, the value of μ_r determines the frequency of oscillation. Electronic circuitry digitises the μ_0 and μ_r dependant frequency values with a resolution of better than one part in a million, and computes the value of magnetic susceptibility.

The value of μ_0 is constant but the variable of interest, κ, is small by comparison. For this reason any thermally induced electronics drift is compensated out during the calibration of the tool.

Any residual thermally induced baseline drift needs to be eliminated by obtaining a new 'air' or μ_0 value prior to logging. A residual value of circa 1000 units, corresponding to air value, accommodates drift and negative excursions.

Calibration is traceable to water (κ = -0.72 x 10^{-6} cgs) via standards held by Bartington Instruments and measured using an MS2 meter and MS2B sensor.

Immunity to errors arising due to resistivity ρ can be demonstrated by reference to 'skin depth' S, which is the depth of penetration of alternating magnetic flux for which the flux is attenuated to 1/e = (0.37) where:

$S = \sqrt{2\rho/\omega\mu}$ where ω is the operating frequency in radians/second.

For example, if we choose the extreme case of pure, solid graphite as the conducting medium ($\kappa \approx 0$, $\mu_r \approx 1.0$, and a very low resistivity of $\rho = 1.4 \times 10^{-5}\Omega$m), we get:

$S = \sqrt{2 \times 1.4 \times 10^{-5} / 2\pi \times 1.36 \times 10^{3} \times 4\pi \times 10^{-7} \times 1} = 0.05$m

or double the FWHM (full width at half maximum) depth for this tool. This would depress any (artificial) value for κ but the next, much higher ρ value would be for sulfides where measurements of κ should be virtually uninfluenced by ρ.

4.6 Groundwater Effects

4.6.1. Capacitive

Note: If the application will involve the probe being immersed in water, then to simulate the capacitive effect, the calibration sample should be grounded during calibration via hand contact. This will depress the measured value by approximately -15 x 10^{-5}cgs.

4.6.2. Pressure

Note: For deep water-filled boreholes, allowance should be made for pressure-induced baseline drift (see the product brochure).

5. Servicing the BSS-02B Sonde

The BSS-02B is not field serviceable. In the event of a malfunction, contact Bartington Instruments.

6. Storage & Transport

Your sensor is a precision electronic instrument and should be treated as such.

Caution: Do not exceed the environmental ratings stated in the product brochure.

Caution: Do not expose this instrument to strong magnetic fields while being stored.

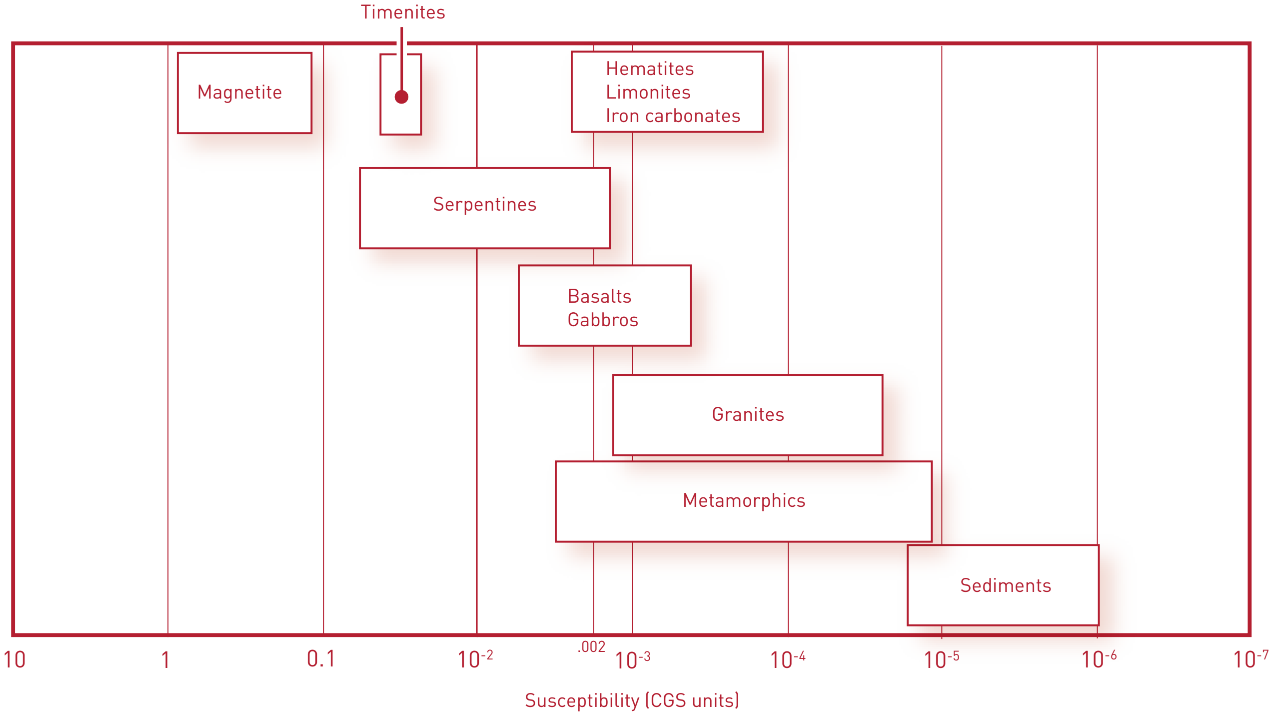
Caution: Avoid exposing this instrument to shocks or continuous vibration.

Note: The sensor should be stored and transported in the original shipment packaging, or that of similar protective standard.

7. End of Life Disposal

This instrument complies fully with RoHS (Reduction of Hazardous Substances) legislation. However, electronic equipment should never be disposed of in municipal waste. Contact Bartington Instruments to arrange the return of products for disposal. Where returning the instruments is not possible you should check local regulations for disposal of electronic products.

Appendix: Magnetic Susceptibility of Common Rocks



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