Vibrating Sample Magnetometer (VSM)

[Princeton Applied Research]—Room 294 (*VSM*)

Sensitivity 2 x 10^{-8} A m^2
Applied fields from 0 T to 1.7 T
Temperature: room temperature
2 to ~30 min/sample for hysteresis loops (8 cm^3)
See *IRM Quarterly*, Fall 1993, Vol. 3, No. 3
See *IRM Quarterly*, Spring 1994, Vol. 4, No. 1 (magnetic quantities and units)

The VSM consists of an electromagnet assembly, a magnet power supply rack, a control electronics rack, and a computer. The system presently only operates at room temperature.

Contents:

Please note that the system software is currently in development and updates to the following documentation may lag changes to the program.

I. SAMPLE PREPARATION

1) Samples must fit between the pole pieces of the magnet. Standard paleomag cores will not fit, and must be trimmed or subsampled first. Trimming can be done on the rock saws in the basement of Pillsbury Hall (Geology and Geophysics Department Building). Chips can be removed with a rock hammer. Samples can be crushed in the pneumatic press in the prep lab and/or in a mortar and pestle. Unconsolidated samples should be packed in the small plastic P1 boxes or in a gelcap/straw.

2) If you plan on taking advantage of the IRM database, be sure the specimen information (including mass) is entered into the database.

3) Select a sample holder from the right-side table drawer that best suits your sample. Affix your sample to the rod (with tape or vacuum grease).

4) Fit the sample between the pole pieces of the magnet, and slide the sample holder onto the vertical shaft. Tape it in place for insurance.

II. COMPUTER SETUP

1) If this is the first time you have used the system, create a directory for your data:
   a) Click on the ClassicVSM icon on the desktop.
   b) Click on the Data(D:) drive.
   c) Click on 'User', then 'Guest'
   d) Select from the toolbar 'File' -> 'New' -> 'Folder'
   e) Edit the folder name to be whatever you want.

2) To start the software, click on the 'VSM_Basic' icon on the desktop. The program will launch and give you instructions for setting up the instrument (also see below).

III. INSTRUMENT SETUP

1) Turn on the magnet main power -- the left-most switch on the box labeled "PrecisionBipolar Magnet Controller."

2) Turn on the Teslameter:
   a) Set the toggle switch to On (right side of the Teslameter panel in the electronics rack). [This allows the computer to measure the field at the Hall probe between the pole pieces of the magnet.]
   b) Check that the left-hand knob in the panel is set to "measure," and the right-hand knob is set to "computer control".

3) Turn on the Vibration Control:
   a) Set the toggle switch to On (right side of the Vibration Control panel in the electronics rack).
   b) When the sample is in place, set the Vibration toggle switch to On (middle of the Vibration Control panel).

4) Turn on the Lock-In Amplifier:
   a) Set the toggle switch to On (right side of the Lock-In Amplifier panel in the electronics rack).
   b) Press the Remote Enable button so that its red light comes on (middle of the Lock-In Amplifier panel). [This allows the computer to control signal detection.]

IV. RUNNING THE CONTROL PROGRAM

1) When the system electronics are set up (see above), click the "Ready to Go" button on the main screen.

2) Click the "Get specimen from database" button and select the specimen you want to measure.

3) Choose the experiment you would like to run:

Loop: this will allow you to run a hysteresis loop, with or without the additional measurement and calculation of Hcr.

a) Enter a sample description if desired. Press 'Continue.'

b) The next panel allows you to set the experiment parameters:
   i) Set the *maximum applied field* in Tesla
   ii) *Measure Hcr:* select Yes or No (Note that this will *not* execute a complete backfield curve).
   iii) *Start from Jrs?:* selecting Yes will begin by saturating the sample in the maximum applied field and then resetting the field to zero. Measurements will begin at Jrs (H = 0) and continue as the field ramps back up to Hmax.
   iv) *Field increment*: select *Log* for computer determined logarithmically-spaced increments or *Linear* to assign a constant field increment of your choice.

c) Set up amplifier. Wait for the message box to display: "Self setup mode. When amp is setup, Press Amp SetupOK Button." Then:
   i) Turn off Remote Enable button
   ii) Change the Sensitivity setting so Output signal is maximized, but <10 V.
   iii) Select a Time Constant (0.01, 0.1, 1, or 3 sec). This is the averaging time for each measurement.
   iv) Adjust the Phase to achieve *maximum* Output signal. This may be easiest to do by shifting 90º out of phase (press the +90º button), and then

adjusting the phase up and down until you get the *minimum* Output signal. When finished, press the +90º button 3 times to get back to where you started. The final phase should be somewhere around +30º.

v) Turn the Remote Enable back on.

d) Center the sample. Use the three translation screws near the head of the VSM so that you get a minimum signal when adjusting the X direction (side-to-side), and maximum readings when adjusting the Y direction (front-to-back) and the Z direction (up-and-down).

e) The program will now allow you to re-adjust the Amplifier settings if desired (see step [c] above; for example if the centering procedure resulted in a significantly higher output signal). If you are satisfied, press 'Start Loop Measurement.'

f) When the measurements are finished, select 'Save Data to Files.' The program will prompt you for a file name. Enter whatever file name you desire, but note that any file extension will be ignored by the program; it will force an extension of .hys for loop data and .bkf for any backfield or Hcr measurements. The raw data will be written to file(s) and will also be uploaded into the IRM database.

Note that if you select 'Cancel' from the file dialog box, you will NOT be able to get back there. You will essentially lose the data and have to re-measure.

Backfield Measurements: This option will allow you to specify parameters for measuring a backfield curve and/or measure the S-ratio (a 100 mT or 300 mT backfield remanence divided by saturation remanence).

a) Enter a sample description if desired. Press 'Continue.'

b) The next panel allows you to set the experiment parameters:

i) Select *Default Fields* or *User Fields*. If User Fields is selected, you can set the Saturating Field, Maximum Backfield, and field Increment (linear only).

ii) *Measure S:* select Yes or No to measure S-ratio.

iii) *Measure Backfield:* select Yes or No.

iv) *Field increment*: (for Backfield only) select Log for computer determined logarithmic or Linear to assign a constant field increment of your choice.

c) Set up amplifier and center sample (if necessary) as described above under **Loop**.

d) When measurements are finished, save data as described above.

V. CHANGING SAMPLES

1) Set the Vibration toggle switch to Off (middle of the Vibration Control panel).

2) Remove the sample rod from the vertical shaft and change your sample.

3) Replace the sample rod on the vertical shaft, again using masking tape for insurance.

4) Set the Vibration toggle switch to On (middle of the Vibration Control panel).

5) Go to section IV above to measure another loop.

VI. INSTRUMENT SHUT DOWN

1) Set the Vibration toggle switch to Off (middle of the Vibration Control panel).

2) Remove the sample holder from the vertical shaft, remove your sample, and put the sample holder back in the drawer.

3) Turn off the Magnet (far left switch on Precision Bipolar Magnet Controller) *after checking to make sure the field is set to zero and the magnet current is zero. Do not turn magnet off if current is not zero.*

5) Turn off the Teslameter:
   a) Set the toggle switch to Off (right side of the Teslameter panel in the electronics rack).

6) Turn off the Vibration Control.

7) Turn off the Lock-In Amplifier:
   a) Set the toggle switch to Off (right side of the Lock-In Amplifier panel in the electronics rack).

8) Exit software.