Data and File Format

PaleoMag uses five different kinds of files, all of which are stored as text files: .SAM, .LSQ, .STEP, sample data files, and means files. With version 3.1, Univ. of Wyoming "APP" format (ascii Ogg format), 2G's binary (.DAT) format, and a raw AGICO Spinner data format (.JRA) are supported as well as the original CIT format; the .STEP file is now dropped. The first four of these filetypes must be together in a single folder; only the .SAM and sample data files must be present (**PaleoMag** will create the others). The .SAM file gives locality information and a list of the samples in the locality. Editting this file can allow the user to combine data from several different localities. The .LSQ file has the least-squares fits made for this locality. The .STEP file need not concern most users; it contains a summary of the demag steps used in the locality and can be regenerated at any time using the Remake .Step command. Each sample data file contains all the measurements and orientations of a single core. The means file need not be in any locality folder and can contain mean directions from several different localities.

With the creation of version 2.0 of **PaleoMag** files opened with **PaleoMag** have their creator ID changed to **PaleoMag**; thus once you have examined a locality with **PaleoMag**, you can open any sample in the locality for examination merely by double-clicking on the sample's data file. The data fork of these files in unaffected and continues to be readable with any text editor and most word processors. Two strings have been added to the resource fork to permit **PaleoMag** to distinguish the five types of files; one indicated the file type, and the other has the name of the .SAM file. If you change the name of the .SAM file you must either open the locality by openning the .SAM file; opening any other file in the locality will produce a file not found error. Because these strings must be present for **PaleoMag** to open files with a "Pmag" creator id, do not ever assign plain text files transfered from another computer the "Pmag" creator id!

.SAM file format

The data format used by **PaleoMag** is an ascii text file with fixed formats that has been in use in the paleomagnetics laboratory at Caltech. A sample illustrates the format of the .SAM file (note that the top two lines are column numbers):

```
0000000001111111111222222222233333333334444444445555555556
1234567890123456789012345678901234567890123456789012345678890
CIT
East Rotated Block (East end of block east of West End Wash)
 36.2 245.3  14.0              42.2  45.8
erb1.0a              12.3aa
erb2.0a              23.4ab
```

The first line is a 2003 addition specifying the data format and is either CIT, 2G, APP, or JRA. If absent, the data is assumed to be in CIT format. After that is a comment line; the fields of the third line are the locality's latitude (first 5 characters) in °N, locality longitude (next 5 after a space) in °E, and the magnetic declination (next 5 after a space) in °E of N. Two fields can follow the magnetic declination: the azimuth and plunge of a fold axis (both are 5 characters after a space). The following two fields (underlined) can be added by **PaleoMag** and will usually be blank before using the code. These are the average strike and dip of the beds at the locality (used for the tilt-corrected reference directions; see "Equal Area Options..." under the Edit menu, above), both a space and 5 characters. All following lines are the filenames of samples from this locality with the stratigraphic level (8 characters and underlined, indicating that it is added by **PaleoMag** to the standard CIT format) and the site id (optional), which is two letters (case-dependant). For some formats (esp. JRA) the bedding strike and dip

Sample Data file format

The sample format is illustrated by the following fragment:

```
0000000001111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
erb  1.0A    Sample just above tuff
  113.0 291.0  63.0  43.0  46.0   1.0
NRM     41.2  49.7  91.4  41.0 3.44E-05   5.5 184.1 -13.1  0.0289  0.0270  0.0468
TT 150  46.7  41.3  84.3  33.7 1.79E-05   7.5 189.4 -20.9  0.0188  0.0130  0.0228
TT 225  55.6  36.8  84.5  25.5 1.44E-05   4.0 197.8 -23.3  0.0193  0.0252  0.0171
```

In the first line the first four characters are the locality id, the next 9 the sample id, and the remainder (to 255) is a sample comment.

In the second line, the first character is ignored, the next 6 comprise the stratigraphic level (usually in meters). The remaining fields are all the same format: first character ignored (should be a blank space) and then 5 characters used. These are the core strike, core dip, bedding strike, bedding dip, and core volume or mass. Conventions are discussed below. CIT format can include fold axis and plunge, which at present is unused.

The following lines are in the order the demagnetizations were carried out. The first 2 characters (3 for NRM only) is the demag type (AF for alternating field, TT for thermal, CH for chemical, etc.), the next 4 (3 for NRM) is the demag level (°C for thermal, mT for alternating field, etc.), the next 6 (first blank for all the following fields) for geographic ("*in situ*") declination of the sample's magnetic vector, next 6 for geographic inclination, next 6 for stratigraphic declination, next 6 for stratigraphic inclination, next 9 for normalized intensity (emu/cm^3; multiply by the core volume/mass to get the actual measured core intensity), next 6 for measurement error angle, next 6 for core plate declination, next 6 for core plate inclination, and the final three fields of 8 each are the standard deviations of the measurement in the core's x, y, and z coordinates in 10^5 emu. **NB in 2003, it appears the CIT format is actually using three final fields of 9 characters, not 8.**

Presently only the sample id line, the second line, and the first ten fields (to core inclination but excepting the error angle) of the demag lines are used in **PaleoMag**. Except for the stratigraphic level, info on the second line is only displayed in the info window or used in the "Headers..." command. A possibility exists that future versions will plot Zijder plots with the measurement uncertainties.

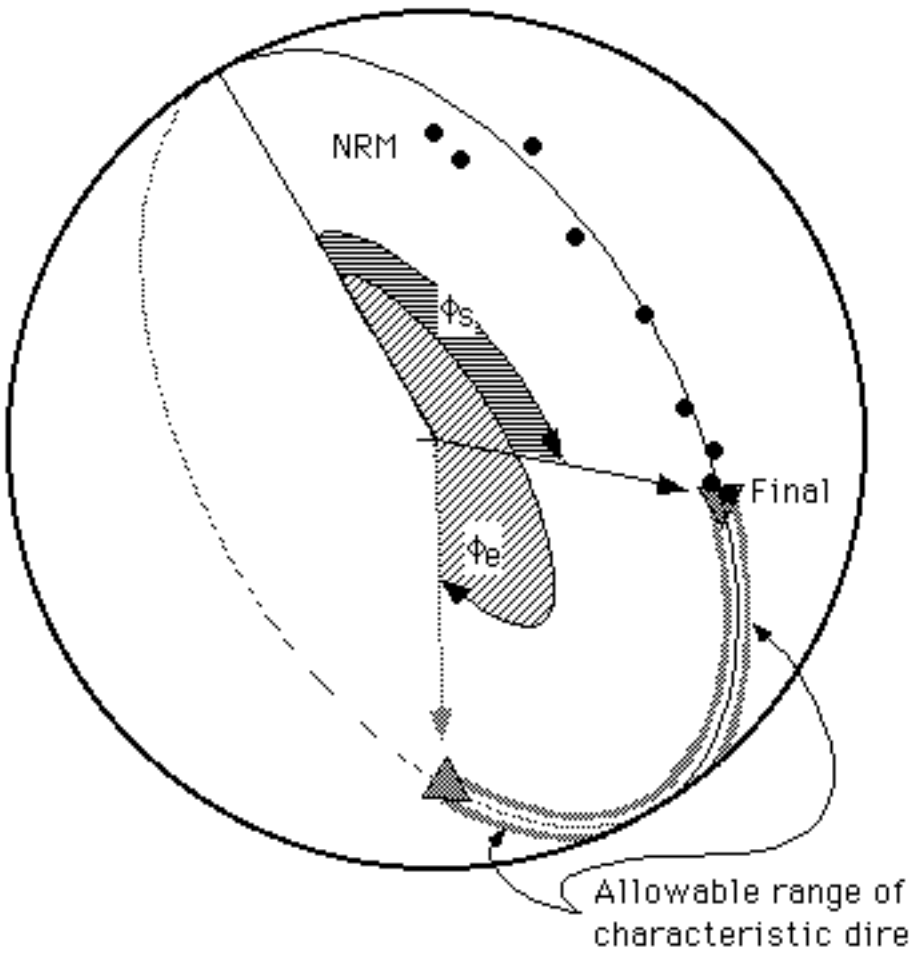
.LSQ file format

The least squares file has a similar format:

```
000000000111111111122222222223333333333444444444455555555556666666666777777777888888888
123456789012345678901234567890123456789012345678901234567890123456789023456789
acg  1.0A     L  prx  14.1  -9.6  14.6  13.6 F-K     6   0.8
acg  2.0A     L  prx  24.4  13.6  19.7  37.8 F-IK    5   3.9
acg  2.0A     P  pox 104.4  76.6  99.7  64.8 F-IK    5   3.9   20.0  150.0  45.8
175.8
```

The first 14 characters comprise the full sample id. It is followed by the fit type (L for line, P for plane, C for circle), 2 blanks, and the user-entered 3 letter id code. After a blank, there is the geographic declination and inclination and the stratigraphic (tilt-corrected) declination and inclination. After a blank comes the summary of the points used in the least-squares fit; measurements used are identified by letter (same as in the Data List window--A through Z then a through z for the first 52 measurements) up to 7 characters, then the number of

points used and the maximum angular deviation (*MAD*) of the least squares fit. For plane fits made with v.2.2 and beyond, the rake within the plane of the farthest point (Φs) and the of antipode of the beginning point (Φe) are given in the next 28 characters; these values bound the arc within the plane where the second (characteristic) direction can lie (both geographic and stratigraphic). Positive values are down and away from the strike of the plane (90° counterclockwise from the down-dip direction). This information is used by the "Combine lines and planes" option with the "use arc constraints" option for Fisher statistics.



For example, in the figure above (an equal-area plot), the measured directions did not yield a clean estimate of the characteristic direction, but that characteristic direction does not lie between the NRM and final directions. Thus it should lie between the final point and the antipode of the NRM (marked as "allowable range" in the figure).

Means file format

The locality means file lacks an analog on the IBM-PC version of the CIT paleomag system (other files are extensions of the PC versions, with the exception of the .STEP file). Unlike the other files, it can be shared between localities. Each locality mean, saved using the "Save Means..." command, fills 3 consecutive lines:

```
0000000001111111111222222222233333333334444444445555555566
1234567890123456789012345678901234567890123456789012345678901
acg  HLLGprx  23 196.3  -6.6  14.18  14.18   0.00   5.5   5.5
acg  HLLTprx  23 197.6 -32.3  14.01  14.01   0.00   5.6   5.6
acg   36.2  245.3 test-3 Hemisphere
acg  BLLGprx  23 198.5  -7.2   9.07  14.59  90.10  -7.6  -3.5
acg  BLLTprx  23 193.3 -32.0   9.08  14.75 110.49  -7.6  -3.4
acg   36.2  245.3 test-3 Bingham
acg  NLLGprx  23 198.5  -7.2   8.28  12.75  90.10  -9.1  -4.5
acg  NLLTprx  23 193.3 -32.0   8.45  12.97 110.49  -8.8  -4.4
acg   36.2  245.3 test-3 Watson
```

The first line has the geographic (in-situ) mean information, the second has the stratigraphic (tilt-corrected)

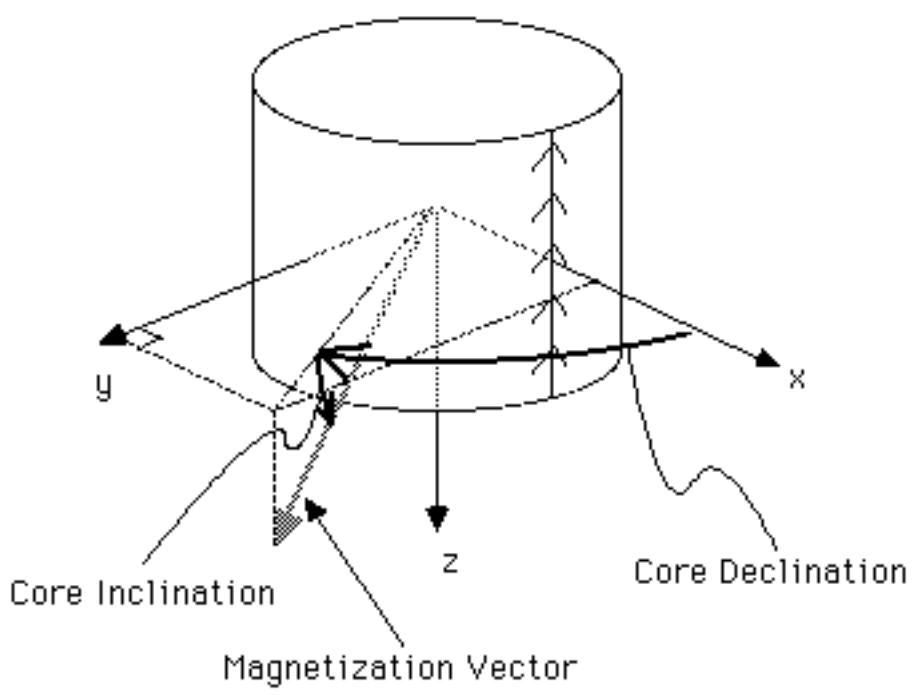
information, and the third has locality information. The first two lines have a common format: locality id (4 characters), space, 4 single letter id characters (statistic type, data type, population type, and geographic or tilt corrected data), a user input 3 letter id, the number of data points used, declination, inclination, α_{95}'s (1 and 2; same for Fisher statistics), oval azimuth, and κ's (1 and 2; same for Fisher; meaningless for non-parametric statistics). The statistic types are true Fisher (F), hemisphere Fisher (H), Bingham (B), and non-parametric (N). Data types are from least-square fits ("L") and locality-equal area plots ("E"). Population types are lines (bipolar data; "L"), planes (girdle data, "P"), and mixed lines and planes ("M"). The third line repeats the locality name, its latitude and longitude, and the user comment for this mean.

Addition for 3.1d26 and up: Comment lines (starting with #!) will be ignored. Color and symbol preferences are stored in the means file in lines with "#!Prefs" at the start.

Direction and orientation conventions

Conventions: All magnetization declinations (and azimuths and strikes) are degrees east of **true north**, all inclinations are in degrees, positive down. Bedding strike and strike of a fold axis are all relative to **magnetic north**. [NOTE that this differs from older documentation, but this is how PaleoMag has always worked]. Sample coordinates x, y, and z are a right-handed coordinate system with the positive x-axis extending from the core center out through the "scritch" (the top line of the core) and the positive z-axis parallel to the core axis and down into the outcrop. For the CIT conventions, core strike and dip are actually the strike and dip of the plane orthogonal to the core (the core plate). For bedding, if we define the z axis as perpendicular to bedding and positive (stratigraphically) downward, the positive x axis as going updip, and insist on a right-handed coordinate system, then the strike direction is the azimuth of the positive y direction (to the right as you face up-dip) for both bedding and core coordinates and the dip is the plunge of the negative x axis. In this system beds striking N30°W, overturned and dipping 75° to the southwest would have a strike and dip of 330° and 105°. A core drilled upward parallel to a line plunging 55° toward S25°E would have a core plate strike and dip of 25° and 125°; the core drilled in the opposite direction would have a strike and dip of 205° and 55°.

Core declination is measured in degrees clockwise from the x axis when viewed from the negative z direction (see figure below).; core inclination is positive from the x-y plane toward the positive z-axis.



Error angles reflect the uncertainty of the magnetization vector as reflected in the difference between the directions determined from the core in up to 8 different orientations in the magnetometer.

APP Format (3.1 only)

A sample fragment of the Wyoming ascii format, which includes all locality data in a single file:

```
0000000001111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
erb  EastRotBlck  36.2 245.3  14.0 35 35  19  542    0.0       1
erb    1.000    113.0  27.0 201.0  46.0  43.0  1P   23   38    2
erb    1.000  NRM  0  41.2  49.7  91.4  41.0  3.44E-5   0.0    3
erb    1.000  TT 150  46.7  41.3  84.3  33.7  1.79E-5 000.0    4
erb    1.000  TT 225  55.6  36.8  84.5  25.5  1.44E-5 000.0    5
```

The first line has the **locality information** (like in the .SAM file), with a three letter locality ID, a short name for the locality (columns 6-16), latitude (columns 18-22), longitude (east positive, columns 24-28), magnetic declination (columns 30-34), and then a host of unused information (number of lines to reserve for pilot and regular samples, number of samples, total number of lines; rightmost number is the line number (columns 61-64)).

The succeeding lines will repeat for each sample in the file, one sample header line and then lines for each measurement. The **sample header line** has the sample name (locality name (usually) in columns 1-4 and sample number in 5-12 with a letter ID in column 13), the stratigraphic level (columns 15-21), the core plunge (columns 23-27) and azimuth (columns 29-33), the bedding dip (column 35-39) and dip direction (41-45), core volume (or mass) as an integer (columns 47-48) and whether this is a pilot sample ("P" in column 49, unused here), followed by unused values of the last line of this sample, the first line of the next sample, and this line's number. A **sample measurement line** has the sample name again, the demag type (columns 15-17) and level (columns 18-20), the geographic magnetic declination (columns 22-26) and inclination (columns 28-32), the stratigraphic declination (columns 34-38) and inclination (columns 40-44), the intensity per unit volume (columns 47-53), an unknown value, and the line number. As with the CIT format, bedding dip direction and core azimuth are relative to magnetic north; magnetic declinations are relative to geographic north.

JRA format (3.1 only)

The ".JRA" files used by the AGICO Spinner instruments are displayed in the CIT file format when using PaleoMag. But unlike the CIT and Wyoming APP formats, there are no site or locality comments in the file. A sample .JRA file fragment looks like:

```
0000000001111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
AGD1a     NRM      -1.99 -0.86  4.22  -4 108  56   0   0   0   0
AGD2a     NRM      -0.95 -2.99  3.53  -4  96  62   0   0   0   0
AGD3a     NRM      -1.99 -1.39  2.91  -4  81  61   0   0   0   0
AGD4a     NRM      -1.09 -1.62  4.83  -4  92  70   0   0   0   0
AGD1a     AF50     -1.73 -0.62  3.26  -4 108  56   0   0   0   0
AGD2a     AF50     -0.40 -2.40  2.24  -4  96  62   0   0   0   0
AGD3a     AF50     -1.40 -1.60  1.24  -4  81  61   0   0   0   0
AGD4a     AF50     -0.86 -0.95  2.65  -4  92  70   0   0   0   0
```

The columns are: sample name (1-10), demag step (11-18), magnetization's x-coordinate (19-24), y-coordinate (25-30), z-coordinate (31-36) in the core's coordinates, power of ten to multiply the magnetizations by (e.g., 10^{-4} here) (37-40), the core azimuth (in the up-plunge direction, 180° from the usual

reading in the field) (41-44), and core plunge (hade) (45-48), bedding dip direction (49-52), bedding dip (53-56), fold bearing (57-60), and fold plunge (61-64).

Because sometimes the bedding strike and dip are not in the .JRA file (as in the above example), we have implemented a pop-up window that asks the user for the bedding strike and dip (in right-hand coordinates). Do not enter the bedding dip direction, but the azimuthal strike. This window opens ONLY when a sample window is opened for a sample lacking the bedding information.

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Please send mail to cjones@terra.colorado.edu if you encounter any problems or have suggestions.

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