# Mavis Requirements Document

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# Table of Contents

## *Mavis analysis software overview*

Mavis a visual analysis tool designed to assist in the determination of magnetic components in core samples.

Mavis gets as input measurement data produced by Ikayaki from SQUID magnetometer measurements on core samples. Ikayaki records sample information and measurement results in IKA files, which Mavis can read. During an measurement sequence the sample is repeatedly measured while its magnetic field is removed in stages. The measurement steps represent sample's magnetic field measured during different demagnetization stages, and from the changes of the magnetic vector from one step to the next one can draw conclusions of the magnetic components that make up the natural remanent magnetization of the sample. Analysis of these components can provide information on the geological past of Earth.

Typical Mavis session will have four primary use cases:

- Opening an IKA file with measurement data
- Choosing steps for a likely component based on data presented by Mavis
- Calculating chosen component and reviewing the result
- Exporting results to a CSV file, and printing out sample data and results

## *User requirements*

## Requirements implemented in version 1.0.0

READ DATA

Priority 1

Program needs to be able to read IKA files for input.

DISPLAY SAMPLE HEADERS Priority 1

Program shall display sample information from an opened IKA file. This information should be editable. The changes shall be saved in the IKA file.

Header information:

- Specimen title (name of the file)
- Site
- Latitude
- Longitude
- Strike
- Dip
- Volume
- Density (derived, not editable)
- Rock type
- Susceptibility
- Q (derived, not editable)
- Comments

DISPLAY SAMPLE DATA

Priority 1

Program shall display recorded measurement data for a sample from the corresponding IKA file.

Data columns to be displayed:

- Step number
- Alternating Field Intensity (AF / mT)
- Declination (D / degrees)
- Inclination (I / degrees)
- Intensity (J / mA/m)
- Relative Magnetic Intensity (J/Jo / ratio)

Angular Standard Deviation (Theta63 / ratio)

Normalized Average X (X / mA/m) (geographic coordinates)

Normalized Average Y (Y / mA/m) (geographic coordinates)

Normalized Average Z (Z / mA/m) (geographic coordinates)

STEREOPLOT

Priority 1

Program shall plot and display a stereoplot from the measurement data.

INTENSITY GRAPH

Priority 1

Program shall plot and display an intensity decay plot from the measurement data.

ZIJDERVELD PLOT

Priority 1

Program shall plot a Zijderveld plot from the measurement data. Program shall display two separate orthogonal graphs, one with axes for North and West (N,W), and one with axes for North and Up (N,U).

Declination should be displayed with closed circles, Inclination with open circles.

Both graphs shall be in the same scale. Unit size should be displayed.

Graphs shall also display lines representing calculated magnetic components.

SELECTING POINTS

Priority 1

User shall be able to specify points belonging to a magnetic component to be calculated.

CALCULATE

Priority 1

Program shall be able to calculate components defined by selected measurement steps. Calculation will give the direction and the statistical significance (maximum angular deviation) of the component.

Calculation attempts to fit a line to selected points. Calculation shall be done according to Principal Component Analysis

Same calculation method is used for the autocalulation function.

Data calculated for components:

- Steps included in component
- Intensity range of component
- Declination of component
- Inclination of component
- Maximum angular deviation for component
- average/median intensity for component
- Longitude of ancient pole position
- Latitude of ancient pole position

See http://www.cs.helsinki.fi/group/mavis/docs/poles.xls for ancient pole position calculation

See http://www.cs.helsinki.fi/group/mavis/docs/testpca.xls for PCA example

ORIGIN

Priority 1

Program shall add a pseudo measurement step for origin to the list of steps from the IKA file. This step can be selected for component calculation like the other steps.

Origin line should have the following values:

- Step number = n+1, where n is the number of measurement steps for the project
- Alternating Field Intensity (AF / mT) = 999
- Declination (D / degrees) = 0
- Inclination (I / degrees) = 0
- Intensity (J / mA/m) = 0
- Relative Magnetic Intensity (J/Jo / ratio) = 0
- Angular Standard Deviation (Theta63 / ratio) = 0,1
- Normalized Average X (X / mA/m) (geographic coordinates) = 0
- Normalized Average Y (Y / mA/m) (geographic coordinates) = 0
- Normalized Average Z (Z / mA/m) (geographic coordinates) = 0

DISPLAY COMPONENTS

Priority 1

Program shall display a list of the calculated magnetic components, with the following data columns:

Data displayed for components:

- Steps included in component
- Intensity range (demagnetization amplitudes) of component
- Declination of component
- Inclination of component
- Maximum angular deviation for component
- Median intensity

Ancient pole position (Longitude)

Ancient pole position (Latitude)

Exluded points in the range of component

Program shall also represent components with lines on the Zijderveld plot.

EXPORT TABULAR

Priority 1

Program shall provide a function to export calculated component data in tabular form for spread-sheet applications. Exporting should be an explicit action on the part of the user.

It shall be possible to add component data to an existing file. There is no need to support overwriting existing file.

See http://www.cs.helsinki.fi/group/mavis/docs/table_mavis.xls for the saved data format

PRINT RESULTS

Priority 1

Program shall provide a function to print out results.

Printout shall include sample data, graphs and calculated components.

Printout shall consist of two parts:

Data page(s) shall list sample details, measurement data, difference vector list, and a list of calculated components. Two first items, sample information and measurement data should contain the same information as the printout for Ikayaki.

Graph page shall include a Stereoplot of measurement steps, an Intensity decay plot, and a joint Zijderveld plot.

The Zijderveld graph shall be printed as a joint Zijderveld plot, with both orthogonal components displayed on the same Zijderveld plot. (Declination with closed circles, Inclination with open.)

Printout shall be in black and white.

See ATTACHMENT 1: printout model

DIFFERENCE VECTORS

Priority 1

Program shall calculate difference vectors between measurement steps. Difference vectors do not need to be displayed within the program, but shall be included in the printout.

ZOOMING

Priority 2

It shall be possible to zoom in and out on Zijderveld plots. Both graphs shall zoom synchronously.

Rationale: Points on the graph tend to be closer together close to origin. Discerning components on the graph is difficult without the ability to zoom them.

## Requirements not implemented

DISABLING POINTS

Priority 2

Program shall provide a facility to disable data points so they aren't included in calculations. This should not change the IKA file.

AUTOCALCULATE

Priority 3

Program shall have a function to automatically try to find separate magnetic components. Autocalculated components will include the maximum number of steps possible within the limits of acceptable error.

ERRORLEVEL

Priority 3

User shall be able to set acceptable angle of error for automatically calculated components. This has no effect on calculation of user-defined components.

EXPORT PDF

Priority 3

Program shall provide a function to export graphs as a PDF file. File should consist of one page containing graphs listed for Graph page in PRINT RESULTS. Page should be black and white with no points or components higlighted.

DIFFERENCE VECTOR PLOT

Priority 3

Printout should contain a stereoplot of difference vectors. The plot need not be displayed in the program, only on the printout.

END VECTORS

Priority 3

Program shall provide a function to calculate End Vectors (EV) using Fisher statistics. Points for EVs are selected like components and results displayed with calculated components.

## *Requirements notes*

## Requirements implemented in version 1.0.0

READ DATA, DISPLAY SAMPLE HEADERS, DISPLAY SAMPLE DATA:

Reading and displaying sample data is functionality easily implemented with existing code from Ikayaki.

STEREOPLOT, INTENSITY GRAPH:

Classes implementing Stereoplot and Intensity plot are part of Ikayaki and can be reused directly.

ZIJDERVELD PLOT:

Zijderveld plot will be a new subclass of AbstractPlot.java.

SELECTING POINTS:

Code reused from Ikayaki to display measurement sequence already handles step selection.

CALCULATE:

The heart of Mavis is component calculation.

PCA sometimes gives results for components that are of the opposite direction to actual. Currently user can correct these components with the ”Antipole” check box, but if a 100% dependable algorithmic way to determine the sign of the component was found, that would be preferable.

Components that include the origin should be calculated specially; the component should be forced to pass the origin. However, the client couldn't give instructions as to how this should be done. Mavis does calculate components passing origin separetely, but the implementation is likely not correct.

DISPLAY COMPONENTS

EXPORT TABULAR

PRINT RESULTS

Print uses two different print panels to separete print to data and graphs.  Pagable and scaling printable document would be preferable.

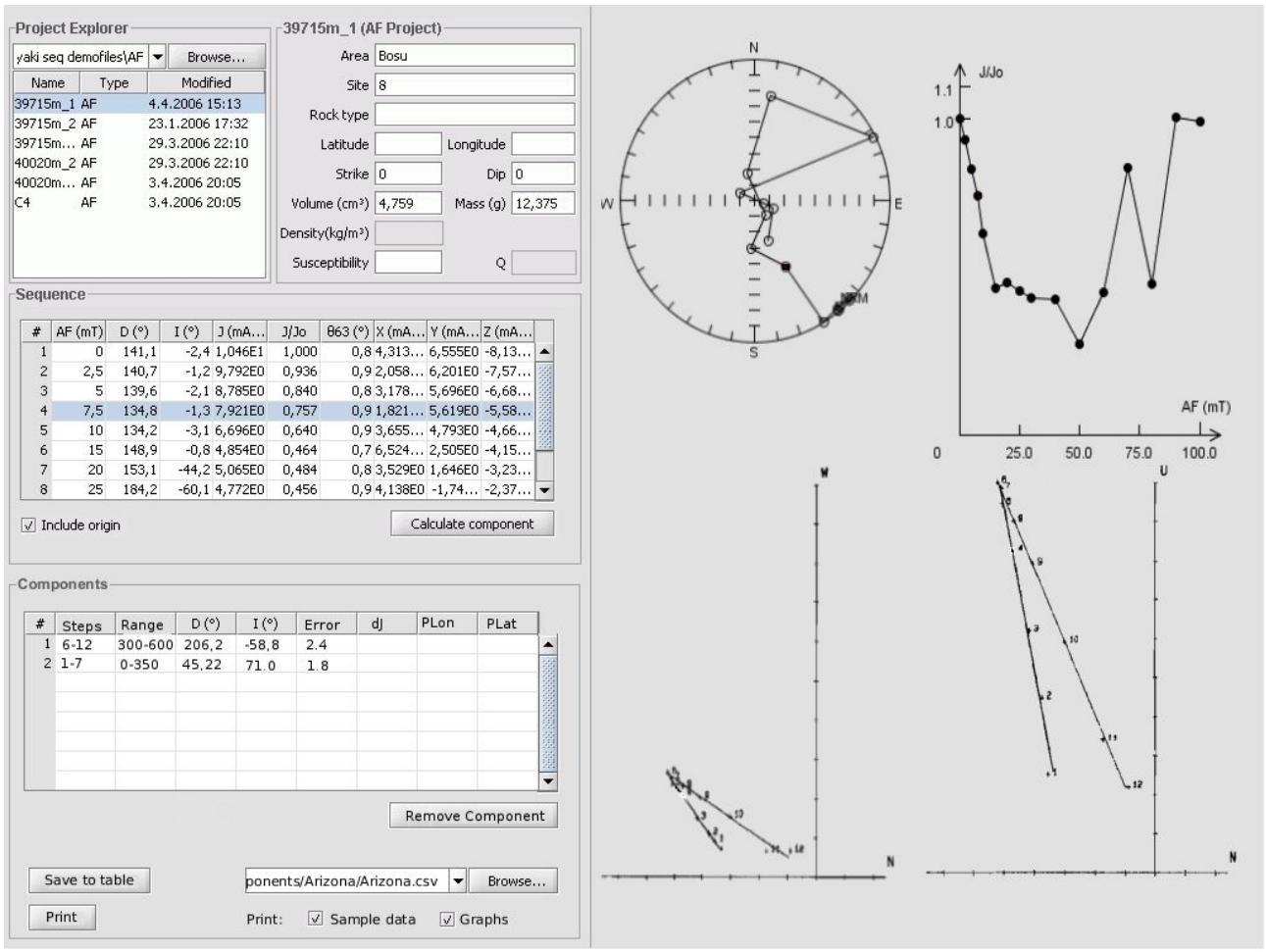
Graph page has space reserved for Difference Vector plot.

DIFFERENCE VECTORS

ZOOMING

Zooming was originally left out of the list of features to be implemented in this version, but was deemed so necessary for usability of the software that we eventually included it.

GUI




GUI has four main components:

AF and meta data about sample

display and manipulation of measurement data

Calculation

calculating and displaying of magnetic components

File Actions

saving components and printing results

Plots

Stero-, intensity, and Zijderveld plots, and operations for the last.

## Requirements not implemented

DISABLING POINTS

This requirement is already satisfied by the ability to freely choose steps. Component details include a list of steps excluded from between start and end steps for the component.

AUTOCALCULATE

ERRORLEVEL

Error level is related to autocalculation feature which was left out as a lower priority item.

EXPORT PDF

Low priority item not calculated.

DIFFERENCE VECTOR PLOT

Error vectros are already calculated, and modification of existing Stereoplot.java might not be a big job.

END VECTORS

Low priority item not implemented.

ATTACHMENT 1: PRINTOUT MODEL (DATA)

# Area, Site : 0660, Karelia Valaam
# Specimen : VG2-2a (AF-project)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Operator / Date | : | Johanna / Aug 25, 2005 | Latitude | : | 61.3 | Sample type | : | hand |
| Mass | : | 28.591 g | Longitude | : | 31.0 | Strike | : | 13.0 |
| Volume | : | 10.720 cm^3 | Susceptibility | : | 17500E-6 SI | Dip | : | 85.0 |
| Density | : | 2667 kg/m^3 | Q | : | 1.52 | Rock type | : | Diabase |

Comments : No comment

| # | AF (mT) | D (°) | I (°) | J (mA/m) | J/Jo | θ63 (°) | X (mA/m) | Y (mA/m) | Z (mA/m) | M (Am2) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 37,4 | 12 | 1.060E3 | 1 | 0,9 | 9.441E2 | 2.566E2 | -4.072E2 | 1.136E-5 |
| 2 | 2,5 | 40,3 | 8,5 | 1.034E3 | 0,98 | 0,9 | 9.086E2 | 1.939E2 | -4.538E2 | 1.108E-5 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

## Difference vectors:

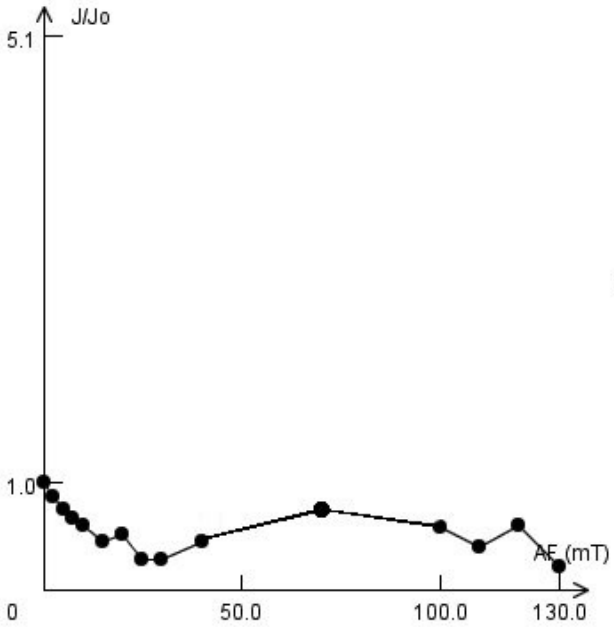
| # | AF (mT) | DE (°) | IE (°) | J (mA/m) |
|---|---|---|---|---|
| 1 | 0 | | | |
| 2 | 2,5 | 5,8 | 12,2 | 5.106E1 |
| | | | | |
| | | | | |
| | | | | |

## Components:

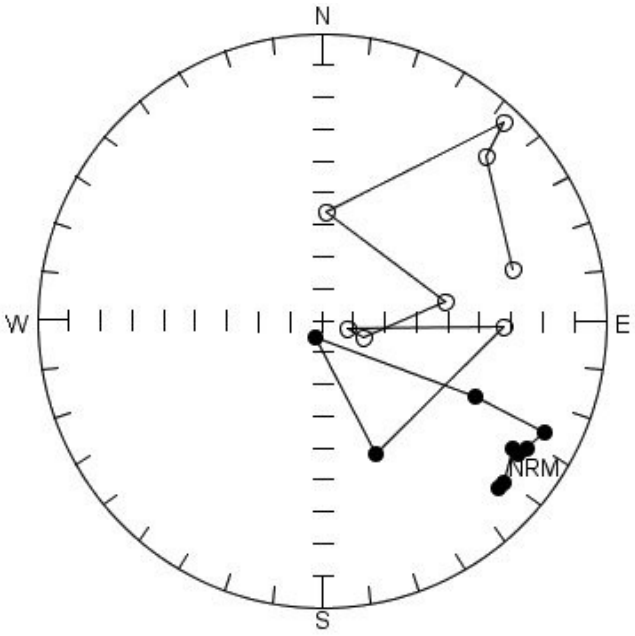
| *#* | *Steps* | *Range* | *D* | *I* | *Error* | *dJ* | *Plon* | *Plat* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2-6 | 2,5-15 | 127 | 14,6 | 4,5 | 3,8 | 47,8 | 121,0 |
| 2 | 9-13 | 30-90 | 113,7 | -20,6 | 13,5 | 2,4 | 45,5 | 110,4 |

PRINTOUT MODEL (GRAPHS)

Intensity Plot




Stereoplot




Zijderveld Plot