Chapter 1

Chapter 8 - Problems

1.1 Problems

Problem 1

a) Use the program **curie.py** to calculate the Curie temperature of the data contained in the two data files *curie_example.dat* and *curie_example2.dat* in the Chapter_8 directory of the Datafiles folder (see Problems to Chapter 5 for downloading instructions). This program is designed to run on the command line, but can be run within an IPython notebook by using the -sav option. To run a command line function from within an Python notebook, just put an exclamation point before the command. So, to see how any of the PmagPy programs work from within the Python notebook, type !ProgramName -h in a code block. Try this with **curie.py**.

b) The way **curie.py** works is to use a triangular sliding window and average over a range of temperature steps. Then it calculates the first and second derivatives of the data and uses the maximum curvature (maximum in the second derivative) to estimate the Curie Temperature. It can be tricky to get the "right" temperature, especially if there are two inflections and/or the data are noisy. Therefore, the program will scan through a range of smoothing intervals. You can truncate the interval over which you want to look using the -t option and set the smoothing interval desired with the -w option. The program has a default smoothing window width of 3°, which is usually too small to get an accurate Curie Temperature. The first data file is not very noisy and the second is noisier. Note that you MUST use the

-sav option within the Python notebook or the program will hang.

First look at each data file using the defaults. To view the images from within the notebook you will need to import the Image module from Python.display (from Python.display import Image) and then use the Image(filename='IMAGE_NAME') command to display the image. Now choose the optimal smoothing interval (the smallest interval necessary to isolate the correct peak in the second derivative). Finally, repeat this, but truncate the data set to between 400° to 600°.

What is the Curie Temperature of the two specimens?

Problem 2

Rock magnetic parameters have been used extensively to study the Chinese sequences of loess. Data from one such study (Hunt et al., 1995) is saved in the file loess_rockmag.dat in the Chapter_8 directory of the Datafiles folder. The data columns are: stratigraphic position in meters below reference horizon, total mass normalized magnetic susceptibility (κ_{total}) in $(\mu\mathrm{m})^3\mathrm{kg}^{-1}$, and sIRM in $(\mathrm{mAm})^2\mathrm{kg}^{-1}$. The paramagnetic susceptibility (κ_p) for the section was relatively constant at about 60 $\mathrm{nm}^3\mathrm{kg}^{-1}$.

Make plots of total susceptibility, ferromagnetic susceptibility ($\kappa_f = \kappa_{total} - \kappa_p$), sIRM and the ratio κ_f/sIRM/ versus stratigraphic position. The reference horizon was the top of the modern soil, S_0.

Magnetic susceptibility is closely linked to lithology, with peaks associated with soil horizons. The triplet of peaks between about 20 and 27 meters are three units in soil S_1, which spans the interval 75 ka to 128 ka. The material in between S_0 and S_1 is the top-most loess horizon L_1. The interval below S_1 is L_2.

The explanation for the high magnetic susceptibility in the soils has been that there is magnetic enhancement caused by growth of superparamagnetic magnetite in the soil horizons. Susceptibility, sIRM and their ratio have all been used as magnetic proxies of past climate changes (mainly rainfall/year). But, only one of them represents best the concentration of the superparamagnetic particle fraction created from iron silicates by rainfall. Which of the profiles you plotted would be the best proxy for the superparamagnetic fraction and why?

Table 1.1: Data for beach project.

Specimen	χ (10^{-5} SI)	Mass (gm)
# 1	0.05	9.92
# 2	0.2	10.00
# 3	0.4	11.03
# 4	1.94	11.29
# 5	3.3	11.31

Problem 3

The sand on Scripps beach accumulates in the summer when gentle waves drop their load high up on the beach and erodes in the winter when high energy waves strip the sand away, leaving bare rock. Sand accumulation and preservation therefore depends critically on density. The sand can be crudely divided into a light colored fraction, composed of quartz, plagioclase, and feldspar and a darker fraction, composed of magnetite, pyroxene, amphibole, and biotite. Wave action on the beach separates the sand into light and dark stripes with the darker sand being deposited at points when the water velocity slows down (over ripples or around stones, for example). Average density measurements would help sedimentologists predict which beaches are more resistant to erosion during winter storms, but accurate density measurements are time consuming.

As part of a class project, students investigated whether magnetic susceptibility could be used as a proxy for density because it is much quicker and easier to measure. Students collected five test samples of sand ranging from light (#1) to dark (#5). They dried and weighed out sand into 7 cc plastic boxes. The specimens were measured on a Bartington susceptibility meter with units of 10^{-5} SI, assuming a 10cc specimen. a) Convert the susceptibility in Table 1.1 (also in *beach_sand.dat* in the Chapter_8 Datafiles folder) into mass normalized units in m^{3}kg^{-1}. Make plots of susceptibility against color (specimen number) and density. b) Is there a relationship? Pose a plausible hypothesis that explains your observations. How would you test it?