Protolith to Schist: Triangles, GBT, and PerpleX

Lab 6: Pelitic AFM Mineral Assemblages

Basis for the lab:
*prelab and diagrams from C. Tom Foster; lab itself similar to one by Lukas Baumgartner in his 1998 Metamorphic Petrology class

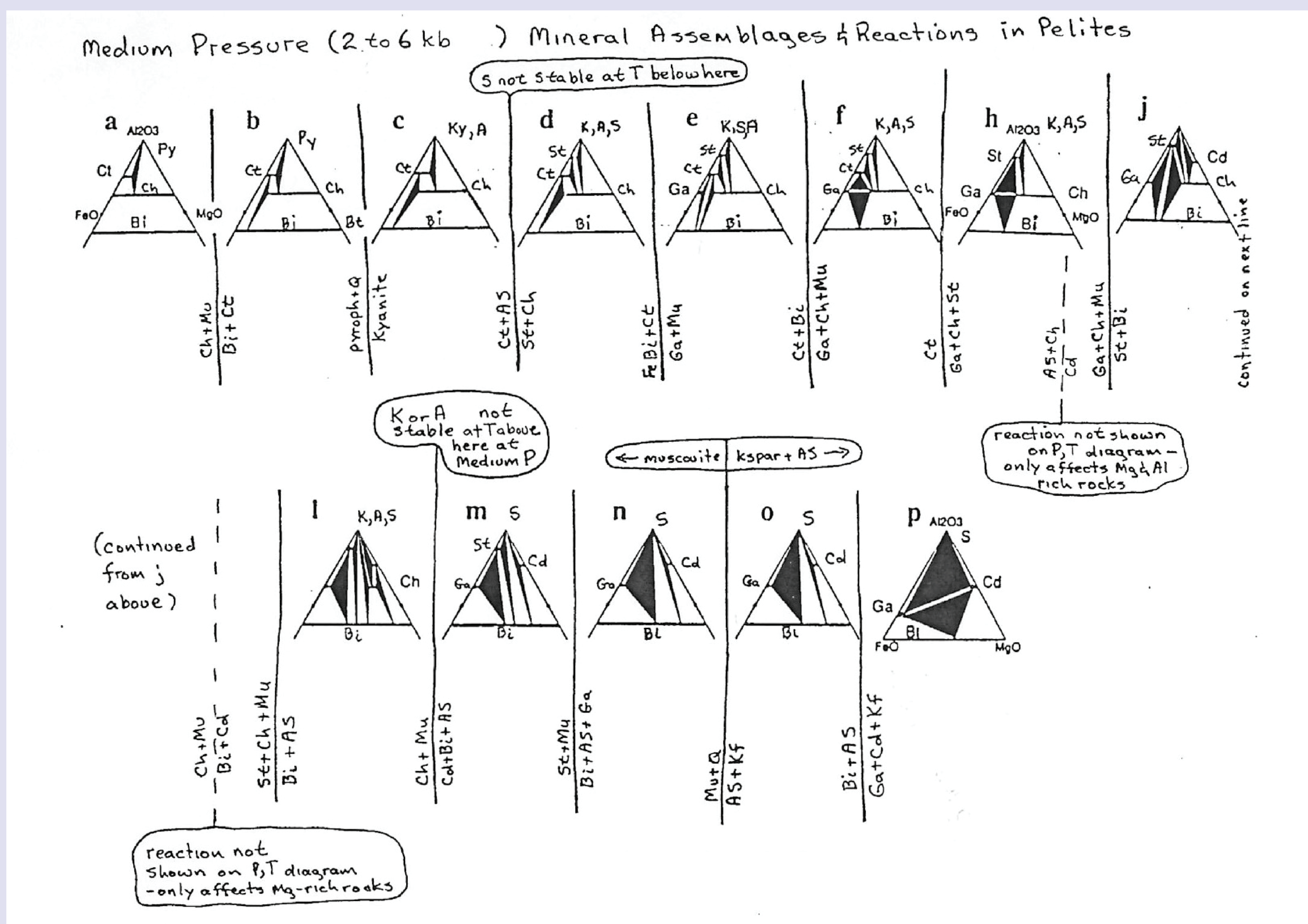
Skills / knowledge needed by the students:
*petrographic identification of common greenschist and amphibolite grade peltitic minerals from mineralogy
*metamorphic AFM diagrams covered in the metamorphic chemistry plot lecture

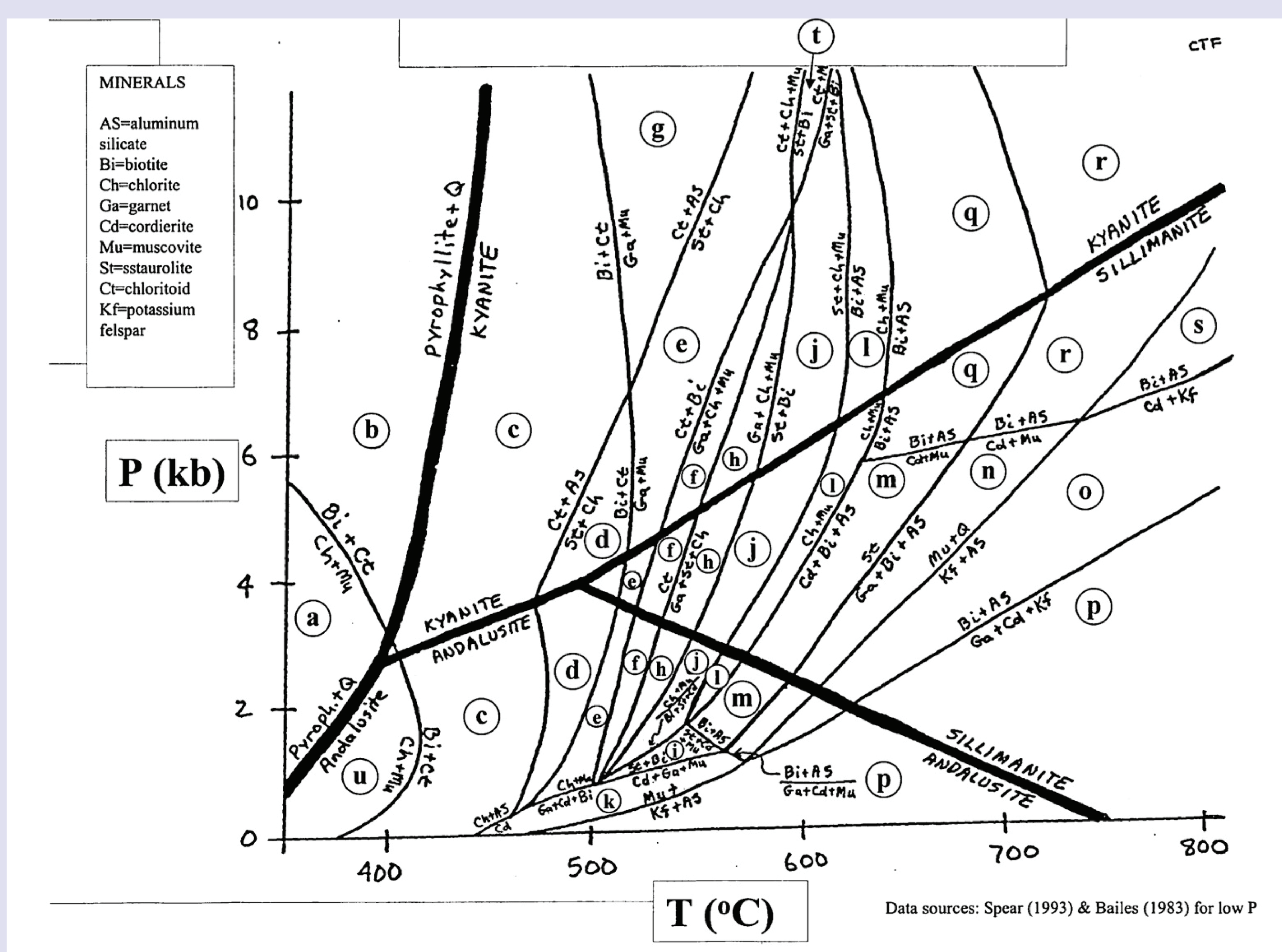
Goals:
*for students to understand that metamorphic mineral assemblages are highly dependent on bulk composition
*reinforce petrographic skills at identifying metamorphic minerals
*reinforce ability to read and use metamorphic AFM diagrams and petrogenic grids

Layout of assignment:
*prelab:
-short excercise in using the AFM diagrams in order to determine appropriate field on the petrogenic grid
-students are given 4+ mineral assemblages, informed that the rocks are from the same road outcrop and should have formed at the same P&T, and asked to determine the correct field on the Spear (1993) and Bailey (1983) diagram
*lab:
-petrographically examine a suite of 10 thin sections from gun club road outcrop in the Dutchess County Barrowian sequence
-determine what minerals are present (modes & textural relationships not needed at this point)
-using the metamorphic AFM diagrams provided (below), determine the possible range of PT areas for each thin section
-once you have examined all 10 thin sections, use all of the data to determine the appropriate AFM trianlge(s) for the region
*reflection:
-compare & contrast which minerals were more or less helpful in narrowing down the PT range
-what assumptions are critical in completing this assignment?

Sucesses & Pitfalls:
*I find several students struggle with the prelab every time I use it, but tend to understand the concept once I walk through it once or twice
*the students varied quite a bit in how long it took them to examine all 10 thin sections to determine the mineral assemblages
*I've used two different sets with this lab, but I only have the bulk chemistry and mineral compositions for the Dutchess County set; the Adula set has a wider diversity of metamorphic minerals, though
*I probably should redraft the Foster figures...

Options:
*If you are not moving on to lab 7 & 8, then using a sequence of thin sections without accompanying chemistry would work fine





Lab 7: Geothermobarometry with GBT

Basis for the lab:
*C. Tom Foster lab for his 2004(?) Metamorphic Petrology class

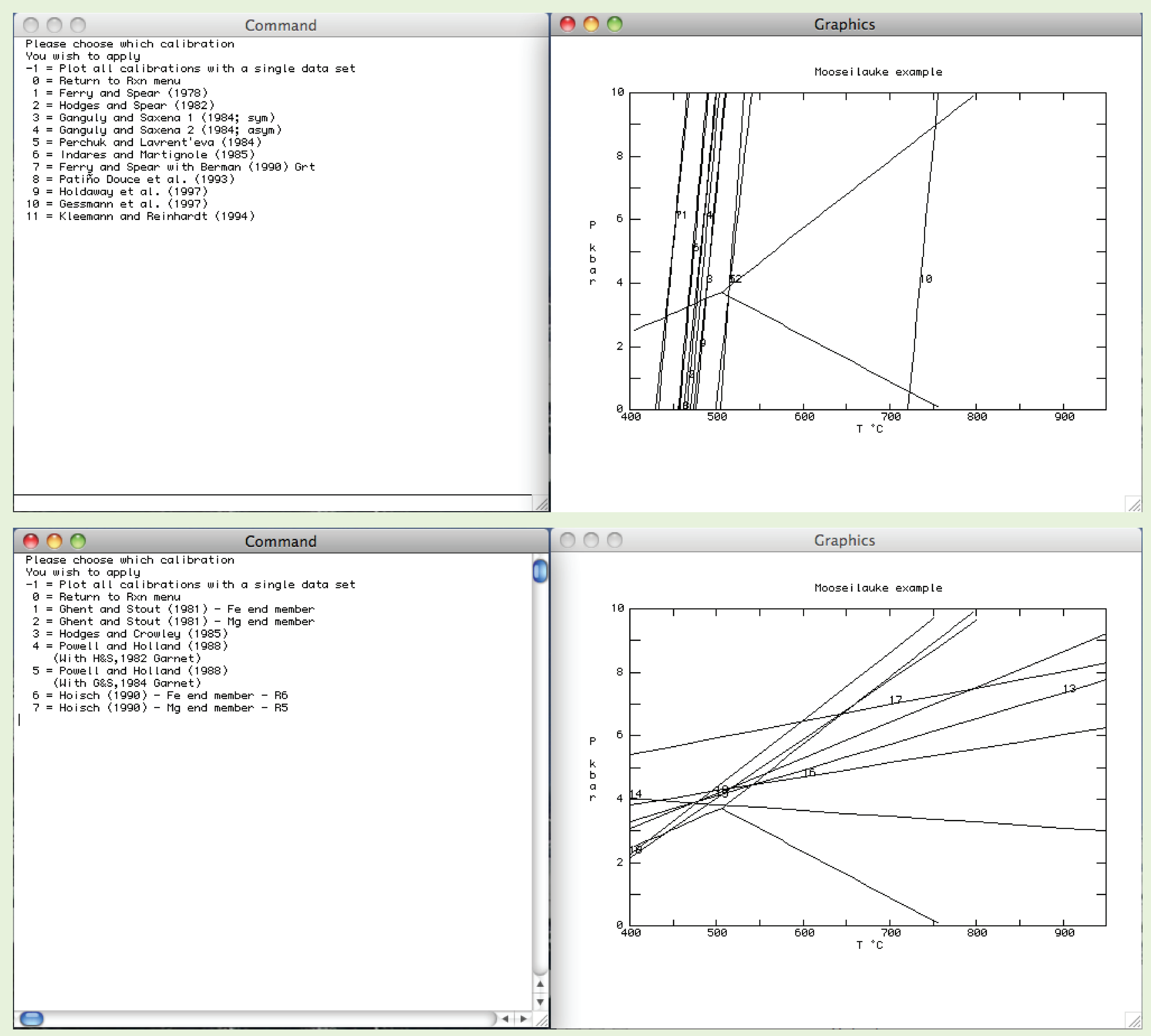
Skills / knowledge needed by the students:
*lab 6 to compare & contrast Thompson diagrams with this method
*basic thermodynamics will help the discussion and is covered in both mineralogy and petrology lectures

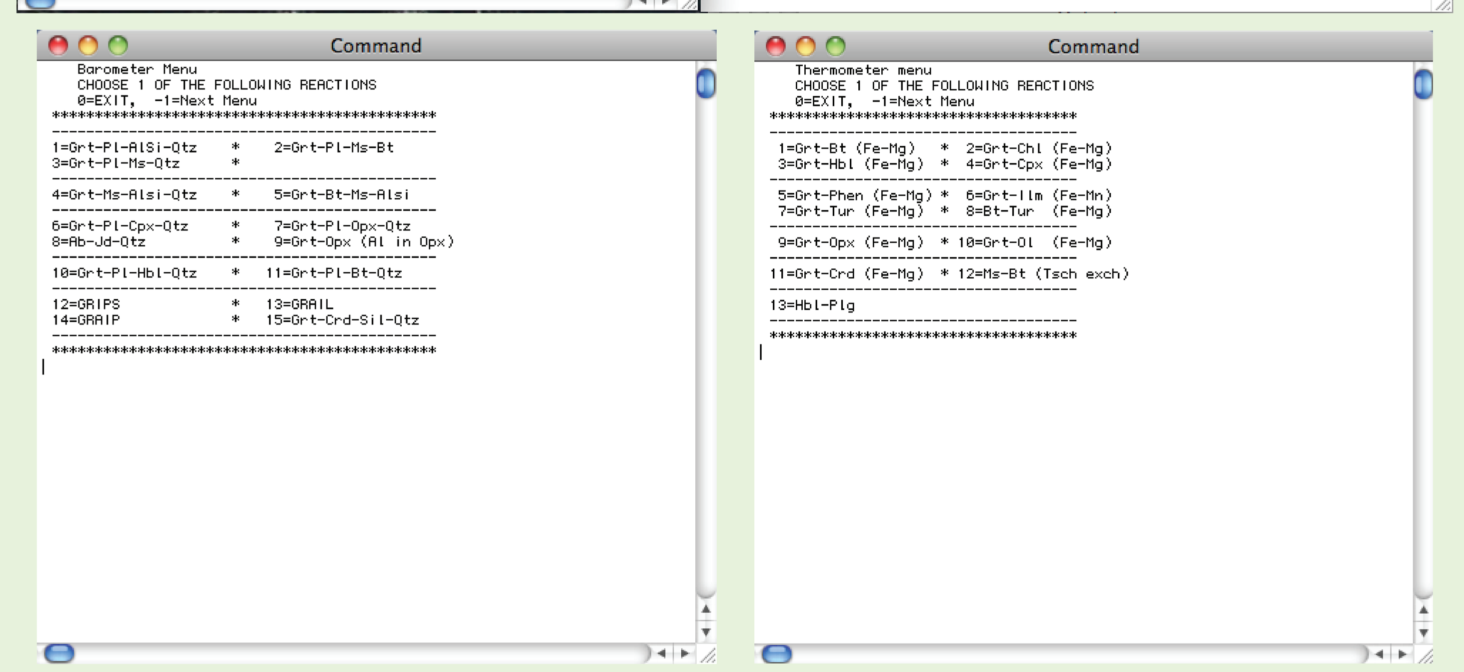
Goals:
*students should understand the wide diversity of results that can occur when applying geothermobarometry
*comprehension of a Journal of Petrology-level paper about geothermobarometry and be able to discuss the assumptions, interpretations, and conclusions intelligently
*compare and contrast using mineral assemblages vs. geothermobarometry to determine approximate PT conditions

Layout of assignment:
*prelab:
-ask the students to define a few terms used within the lab (e.g. solution model, internally consistent)
*lab:
-using GBT, the students are asked to apply a variety of thermometers and barometers to determine PT conditions
*first set of data is taken from the Hodges & Spear (1982) Moosilauke dataset (it comes with GBT) and involves a wider range of thermometers & barometers for a pelite close to the aluminosilicate triple point
*second set of data provided by GBT (the SC-160 file) that is a gar + cpx + horn + pl + qtz + kfs + rt + ilm rock
*third set of data is from the same Dutchess County Barrowian sequence as for lab 6
-students are asked to go through a sequence of actions for dataset one & two to learn more about what is possible with GBT and what the range of results for a single set of inputed data might be
-based on their experiences with dataset one & two, students are asked to choose appropriate thermometers, barometers, and calibrations to determine a PT estimate for dataset three

Sucesses & Pitfalls:
*GBT only runs on Macs, so you will either need to have access to a Mac computer lab or a number of your students will have to have Apple laptops
*the class read a thermobarometry-heavy paper several days after this lab and had a rich discussion about whether or not the thermobarometry had been properly applied & sources of error within the study
*because GBT was originally written for OS 8, I give the students step-by-step directions to deal with the program and that usually solves most of the "geesh, this runs very very strangely" complaints

Options:
*this obviously could be run with another geothermobarometry program, but GBT is very simple to use
*the lab could easily be run without the third dataset





Lab 8: Pseudosections with Perple_X

Basis for the lab:
*Dave Hirsch's Perple_X lab
-http://serc.carleton.edu/NAGTWorkshops/petrology/teaching_examples/44110.html
*C. T. Foster did a similar lab using Gibbs in his 2004(?) Metamorphic Petrology class

Skills / knowledge needed by the students:
*lab 6 on Thompson diagrams and lab 7 on geothermobarometry are needed for comparison
*petrographic determination of mineralogy needed from lab 6
*basic thermodynamics, solution models, metamorphic reactions -- all covered in lecture
*helps if they at least know what UNIX is, but not necessary

Goals:
*for students to understand the benefits and pitfalls of pseudosection use
*comprehension of a Journal of Petrology-level paper about pseudosections and be able to discuss the assumptions, interpretations, and conclusions intelligently
*understand how petrologists may use a combination of Thompson diagrams, geothermobarometry, and pseudosections in "real" research
*more student independence

Modifications to the original Hirsch lab:
*I run the assignment as is except that the final segment (labeled "Advanced Perplex Assignment" by Hirsch), where I assign each student a different bulk composition from the Dutchess County sequence
*students then compare the pseudosections they produced with the observed mineralogy, the Thompson diagram region they chose, and the GBT results from lab 7

Sucesses & Pitfalls:
*this lab is LONG and it is easy to get hung up somewhere along the line, so I encourage them to work through the majority of the lab in my presence to troubleshoot
*Perple_X comes in a number of different varieties -- though Dave's version is not the most recent, he made several adjustments to the command line prompts that make it easier to run
*the diagrams usually result in a chaotic overlap of labels (see below) that have to be cleaned up by the user
*if you load Dave's version and then want to use a more recent version for research purposes, some hacking experience is recommended
*Fortran libraries need to be up-to-date on the machine running the program
*non-UNIX users may simply find this too complicated to troubleshoot for their students
*reading a pseudosection paper later that week resulted in a strong discussion with several very good points brought up by the students
*one student chose to use pseudosection modeling as the core of his senior thesis project after this lab
*Jamie Connolly (the "creator" of Perple_X) is easy to contact via email and is usually extremely helpful in dealing with random run errors; there is also a Yahoo group specifically for Perple_X issues (http://tech.groups.yahoo.com/group/Perple_X/?yguid=284821277)

Options:
*have the students skip tasks 1-6 that involve calculating T-X, Thompson diagrams, etc. in PerpleX and only assign the pseudosection tasks (7&8)
*use a different pseudosection program (e.g. Theriak-Domino, Gibbs) -- the compare & contrast between Thomspon diagrams, geothermobarometry, and pseudosections is the critical point, not the specific program
*this is the lab I drop if I lose time to snow / rain / tornados / all-campus lectures