Geol 568 Metamorphic Petrology, Fall 2016. Course Outline

Introductory reading prior to course: Spear* Chapters 1 and 2. Ignore section on p. 4 on "high-strain metamorphism".
* F. S. Spear, 1994. Metamorphic Phase Equilibria and Pressure—Temperature—Time Paths. Mineralogical Society of America Monograph. xxii + 799 pp. Washington, D.C.: Mineralogical Society of America.

Session 1. Crystal chemistry and structure
Spear, Chapter 4, p. 73-79. Each student to take a mineral group and present structure, formulae, sites, exchange vectors, end members, and phase relations within the group. E.g., Pyroxenes, Ca-amphiboles, Na-amphiboles, micas.

Session 2. Thermodynamics and Phase Equilibria
Spear, Chapter 6.

- p. 133-138, through to the definition of chemical potential (eqn 6.9) and the Gibbs-Duhem equation (eqn 6.13).
- Note eqn summary on p. 141, with definitions of H and G, and particularly eqn 6.17
- p. 152-158 on chemical activity and thermodynamics of mixtures.
- *Exercise* on H-X, S-X, and G-X diagrams.

Session 3. Phase Rule and Phase Diagrams
Spear, Chapter 8.
p. 241-244 on Conditions of Equilibrium. Note eqns 8.17, 8.23.
p. 244-247 on the Phase Rule (see p. 107 and 163 for definitions of system components and phase components), and Duhems Theorem.
p. 247-252 on Phase Diagrams
p. 252-254 on Schreinemakers Rule
p. 266-271 on binary systems. Note eqn 8.47, and the Clapeyron eqn on p. 270.
Exercise on phase relations: calculating the slopes and positions of reaction lines; Schreinemakers method for distribution of univariant and divariant fields around a univariant point.

Session 4. Pelites
Spear, Chapter 10.
p. 337-358
AKF, AKM, and AFM diagrams
KFASH, KMASH, and KFMASH petrogenetic grids
Progressive metamorphism of pelites, chlorite zone to biotite breakdown
p. 369-73. Fractional crystallization and mineral zoning
Exercise: construction of phase diagrams for metamorphism of pelites along a different PT paths; effects of bulk composition, melting, and phengite substition in white mica.

Session 5. Activity models
Spear, Chapter 7.

p. 175-188 Ideal solutions, ideal activity models
p. 191-198 Non-ideal activity models. Note Margules parameter p. 196.
p. 198-201 Solvi.
Exercise from literature: hornblende, pyroxene, garnet, phengite …

Session 6. Introduction to the electron microprobe
Teaching session on the UCLA probe.

Session 7. Thermobarometry
Spear Chapter 15.
Exercise: recalculation of raw probe data using AX software. Application of GARB and GASP equilibria using published calibrations.

Session 8. Modelling growth profiles
Spear, Chapter 17.

Session 9. Applications of thermobarometry.
Each student to read a published paper applying thermobarometric methods to a thermo-tectonic problem, and present it in class.

Session 10. Mafic rocks / carbonates / ultramafics
Each student to pick a topic and present it in class

Session 12. Melting reactions and anatexis.
Spear, chapter 9.

Session 13. Presentation of term papers on project.
Each student will carry out thermobarometric measurements on a sample of his/her choice, on advice from the instructor: a day of probe time at UCLA will be provided, and the student is expected to consult with the instructor on the choice of thermobarometers and the areas to be analyzed. The results are to be written up as a term-paper, and presented to the group in a meeting at the end of the semester.