GEOL5140: Advanced Igneous Petrology
Syllabus

This is a three-credit course that will examine a variety of petrologic and petrographic tools useful for unraveling the petrogenesis of igneous rock suites. The course will cover geochemical modeling, but will concentrate on what can be learned from phase equilibria and application of modern petrographic techniques. Ideally, these results would be combined with more standard geochemical modeling techniques to place quantitative constraints on petrologic processes. Each week the class will consist of three one-hour lectures and a two-hour lab/problem session. These sessions will be scheduled at the beginning of the semester so as to accommodate everyone's schedule

Course Outline

- I Introduction
  - A. Magmatic Introduction
    1. Introduction
    2. Crystal Fractionation
    3. Assimilation/Contamination
    4. Magma Mixing/Hybridization
    5. Liquid Immiscibility
    6. Partial Melting
  - B. Magma Types
  - C. Liquid Vs Bulk Rock Compositions
- II Thermodynamics
  - A. Introduction
  - B. Fundamental Laws of Thermodynamics
    1. zeroth law: the meaning of temperature
    2. first law: energy conservation
    3. second law: definition of entropy
    4. third law: the shut down point
  - C. Thermodynamic Potential Functions
  - D. Equilibrium
  - E. Summary of Basic Thermodynamic Relations
- III Phase Equilibria
  - A. Thermodynamics of Solutions
    1. fundamental thermodynamics
  - B. Phase Diagrams
    1. mechanical mixtures
       a. congruent melting
          1) uinary
          2) binary
          3) ternary
       b. incongruent melting
          1) binary
          2) ternary
          3) with immiscibility
    2. solutions
       a. binary
          1) complete solution
          2) partial solution
       b. ternary

1) complete solution
2) partial solution

c. quaternary

C. P-T Diagrams
1. construction
2. theory of use
3. limitations
4. examples

D. Application Examples

IV Geochemical Modeling

A. Major Element Systematics
1. overview
2. iron oxidation
3. variation diagrams
4. Pearce element diagrams
5. least squares
6. pseudoternary projections
7. isostructural projections

B. Trace Element Systematics
1. introduction
2. partitioning behavior
3. spider diagrams
4. crystal fractionation

C. Rare Earth Systematics
1. introduction
2. partition coefficients
3. REE diagrams
4. REE modeling

V Petrographic Techniques

A. Crystal Nucleation

B. Crystal Growth

C. Crystal Size Distributions
1. theory
2. applications

D. Modern Petrographic Techniques
1. Nomarski differential interference contrast imaging
2. laser interferometry
3. cathodoluminescence
4. back-scattered electron imaging
5. x-ray mapping
6. CSD