GEOS 606 Physical Volcanology

GEOS 606 CRN 74060 3 credits

September 1th – December 17th, 2011
Mondays, Wednesdays and Fridays
MWF 10:30-11:30
Irving 208 and Elvey 101

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Office hours: Tuesday and Wednesday 3:00-5:00 pm

Texbook: Fundamentals of Physical Volcanology, Parfitt & Wilson
Class Homepage: http://classes.images.alaska.edu/geos606

Course Description:
Volcanic Processes shall be discussed in depth, relating the physics behind the processes to the outcrops in the field. In addition to homework and examinations, the student will be required to solve a unique physical problem and present the results to the class during the "micro-meeting" at the end of the semester.

Structure:

41 Class Periods total
39 Lectures total
1 Guest Lecture
1 Day of "micro-meeting"
3 Last lectures cancelled for AGU

Weekly Homework
10 separate assignments each 2% total grade

3 Exams, take-home, open book, closed neighbor
2 mid-terms 15% total grade
1 final 20 % total grade

1 Project 30% total grade

Grading: Standard A-B-C, will not include +/- due to effect on graduate standing (i.e. B- = 2.7)

Syllabus GEOS 606 Physical Volcanology
FALL 2011

September 1 Introduction, Important physical variables and constants
the physical approach, boundary conditions

Part 1: "Introduction to physical processes"

Week 1

05 LABOR DAY, NO CLASS

07 Statics
stress and strain, properties of matter, stress distributions

09 Dynamics -homework 1: statics
how stress effects strain, fracture, propagation of movement
kinematics and kinetics, classic models, internal vs. external processes

Week 2

12 Thermodynamics
the 3 laws, and 3 methods of heat transfer, the phase transition

14 Introduction to Rheology and Flow
laminar vs. turbulent flows, thixotropic and power law fluids

16 Factor Dimensional Analysis -homework 2: thermo
how to brew your own models

Week 3

Part 2: "Intrusive Processes"

19 Introduction
physical and/vs. chemical processes, magma generation, viscosity

21 Stress in and Around Magma Chambers
sampling a magma chamber, physical interactions

23 **How to present your results in Google Earth** -homework 3: FDA
John Bailey Guest Lecture

Week 4

26 Magma Chambers
size and shape, over turn

28 Fracture
how does magma get out of a chamber?

30 Rate of Rise -homework 4: magma
how fast can magma move

October

Week 5

03 Pipe Flow
Simple models, Hagen-Poiselle, Reynolds, Rayleigh, and worse

05 Magmas & Dikes
Phase differences in magma, fracturing, flow

07 Dikes, Lacoliths, and Conduits -EXAM 1: physical properties
real cases, emplacement mechanisms

Week 6

10 **Bubble Formation Growth & Coalescence**
Jessica Larsen tentative guest lecture

12 Conduit mechanics
flow-type transitions, bubbles and density

14 Eruption Mechanisms -homework 5: conduits
mixing, the role of volatiles, pressure, temperature and cyclicity

Part 3: "Extrusive Processes"

Week 7

17 Measuring Subsurface Movement
intro to seismicity, long period tremor, displacement, inflation

19 Fissures, Flows and Fountaining
changes during eruptions

21 Flow Structures
channels, levies, textures, and vesiculation -homework 6: bubbles

Week 8

24 Lava Flows
pahoe hoe to a'a transition, growth of flow fields

26 Lava Domes
endogenous and exogenous growth, brittle ductile transition

28 Flow Monitoring and Measurement
field methods, flux -homework 7: lavas

-project proposals due-

Week 9

31 Mafic Volcanoes
examine the entire primitive volcanic system

November

02 The Role of Viscosity and Hazards
flow dynamics of domes and Merapi-type pyroclastic flows

04 The Role of Temperature -EXAM 2: hawaiian-type
higher silica contents, increase in explosivity

Week 10

07 The Cooling of Lavas
Stefan cooling problem, lakes, flows, domes

09 The Role of External Water
rain, subaqueous to submarine flows

11 Measurement of Temperature -homework 8: cooling
thermocouples, radiometers, FLIR, field methods

Part 4: "Pyroclastic Processes"

Week 11

14 Strombolian Eruptions
ballistics, drag

16 Fragmentation Processes
ash, lapilli, bombs, blocks, and "JCs"

18 Cooling and Energy Transfer in Eruptions -homework 9: fragmentation
cold ash clouds, gas emissions

Week 12

21 Vulcanian, Plinian, and Worse part 1
eruption columns, pf, base surge, fallout

23 Vulcanian, Plinian, and Worse part 2 -homework10: explosions
calderas, secondary processes, rheomorphism

******* Thanksgiving Weekend 24-27 November *******

Week 13

28 Pyroclastic Flow Mechanisms
models, deposits

30 Slope Stability
debris avalanche, volcanic and non-volcanic hazards

December

03 Lahars -FINAL EXAM
volcanic vs. non-volcanic, types of flow, hazards

Week 14

05 Volcano Monitoring
78 Organizations, AVO, seismic, remote sensing, geology

07 Volcanic Hazards
management and mitigation, responsibilities of the science

Student Presentations

09 "Micro-Meeting" 12:00-14:00 (final exams due)
Student Talks/Poster Presentations

Week 15

******* American Geophysical Union Meeting 5-9 December *******
Class cancelled, have a good break!

Homework Format: 3 Questions; 2 analytical (@25%), 1 qualitative (50%)

Exam Format: 10 Questions; 6 analytical (@5%), 3 qualitative (@10%), 1 fda (40%)

Final: 15 Questions; 9 analytical (@4%), 4 qualitative (@5%), 2 fda (@22%)

All assignments are take home, open book, closed neighbor.

Project:

The student will pick a physical problem relating to volcanology which has not been previously solved, and write a <3 page proposal (due October 28) for evaluation.

Suggested Additional Reading:

Part 1:
Clift, Bubbles Drops & Particles
Johnson, Physical Processes in Geology
Kreith and Brohn, Principles of Heat Transfer
Turcotte and Schubert, Geodynamics

Part 2:
Schmincke, Volcanism
Dobran, Volcanic Processes
Bursik & Freundt, From Magma to Tephra

Part 3:
Kilburn & Guest, Active Lavas
Fink, Lava Flows and Domes
USGS Prof. Paper 1350
USGS Prof. Paper 1250
USGS Prof. Paper 1676

Part 4:
Fisher & Schmincke, Pyroclastic Rocks
Sparks, Volcanic Plumes
Calvari et al., Mt. Etna: Volcano Laboratory