GEOS 606 Physical Volcanology

GEOS 606 CRN 77573 3 credits

September 6th – December 13th, 2013
Mondays, Wednesdays and Fridays
MWF 11:40:12:45
Elvey 214 and Elvey 101

Dr. Jonathan Dehn office: WRRB 108G, lab Elvey 101
phone: 474-6499 322-0676
email: jdehnavo@gmail.com

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 lectures cancelled for AGU

Weekly Homework ~ 3 QUESTIONS.
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 2013

September 06 Introduction, Important physical variables and constants
the physical approach, boundary conditions

Part 1: "Introduction to physical processes"

Week 1

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

11 Dynamics
how stress effects strain, fracture, propagation of movement
kinematics and kinetics, classic models, internal vs. external processes

11 Statics and Dynamics -homework 1: statics
Stress and strain, how these interact

Week 2

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

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

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

Week 3

Part 2: "Intrusive Processes"

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

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

27 Magma Chambers -homework 3: FDA
size and shape, over turn

Week 4

30 Magma Chambers
size and shape, over turn

October

02 Fracture
how does magma get out of a chamber?

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

Week 5

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

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

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

Week 6

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

16 Conduit mechanics
flow-type transitions, bubbles and density

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

Part 3: "Extrusive Processes"

Week 7

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

23 Fissures, Flows and Fountaining
changes during eruptions

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

Week 8

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

30 Lava Domes
endogenous and exogenous growth, brittle ductile transition

November

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

-project proposals due-

Week 9

04 Mafic Volcanoes
examine the entire primitive volcanic system

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

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

Week 10

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

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

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

Part 4: "Pyroclastic Processes"

Week 11

18 Strombolian Eruptions
ballistics, drag

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

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

Week 12

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

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

****** *Thanksgiving Weekend 28-30 November* ******

Week 13

December

02 Pyroclastic Flow Mechanisms
models, deposits

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

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

Week 14

**** ***American Geophysical Union Meeting 9-13 December*** ****
Class cancelled, have a good break!

Week 15

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

17 Volcanic Hazards
management and mitigation, responsibilities of the science

Student Presentations

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

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