ESS 298D: SPRING 2011

PLANETARY SURFACE PROCESSES IN THE SOLAR SYSTEM

Instructors: An Yin and David Jewitt

Class time: Spring Quarter, 2011; lecture from **2:30 PM to 4:00 PM on Tuesday and Thursday** in **GEOLOGY 3645**.

Class format: Full lectures are given when introducing new topics. Subsequent lectures may consist of 40-50 minutes "lead lectures" by instructors and 40-30 minutes of student presentations on related subjects based on recently published papers.

Grading: Grades are based on (1) a short final exam on the basic concepts from the class (20%), (2) a presentation on any subject covered by the class (40%), (3) a term paper (no longer than 10 pages including references and figures) based on the class presentation, which may either summarize recent literature on a topic covered by the class or integrate the class materials with student's own research project (40%).

Class objectives: (1) To introduce physical and chemical processes shaping the morphology and evolution of the solid surfaces of the planets and smaller solar-system bodies. (2) To illustrate the fundamental mechanisms controlling the planetary surface processes.

I. Fundamentals of the Solar System

Lecture 1 March 29: Introduction to planetary and satellite systems:

(1) Formation of the planetary system.
(2) Formation of satellite systems.
(**Jewitt**)

Lecture 2 March 31: Introduction to Surface Processes

(1) thermophysics of rotating body;
(2) radiation forces
(3) scattering properties, phase functions, albedos, color, radar roughness)
(**Jewitt**)

.....

Lecture 3 April 05: Introduction to landscape evolution by Terrestrial example:

(1) landscape as a combined product of internal and external processes;
(2) evolution of landscape as a result of feedbacks between internally and externally processes.
(**Yin**) **(DJ gone)**

Lecture 4 April 07 : Introduction to techniques for examining planetary surface processes:

(1) crustal composition and evolution of rocky planets;
(2) crustal composition of icy satellites;
(3) compositions of small bodies.
(4) determination of planetary landscape using high-resolution satellite images, stereoscopic images, and digital-elevation models);
(5) crater counting methods for dating surface features
(**Yin**).

.....

Lecture 5 April 12: Basic principles of planetary tectonics:

(1) modes of planetary tectonics (stagnant-lid mode vs. plate-tectonics mode) and their dynamic controls;
(2) the style of crustal deformation on planetary surfaces: flow vs. fractures;
(3) fundamentals of rock deformation (relationship between stress and fracture orientations; power law rheology)
(**Yin**)

Lecture 6 April 14: Basic principles continued (**Yin**)

.....

Lecture 7 April 19: Planetary tectonics - Venus and Mars (**Yin**)

Lecture 8 April 21: Properties and evolution of small bodies: the ideas
(1) Size, Dohnanyi, truncation
(2) Ice stability, distribution, phase transitions
(3) Color as composition proxy, ultra-red matter, organics
(4) Shapes, binarity (**Jewitt)**

.....

Lecture 9 April 26: **Properties and evolution of small bodies: the reality**
(1) Amorphous ice - data
(2) Asteroid collisional processes
(3) Surface morphology, cratering in zero-g
(4) Distributions of ice and organics (**Jewitt)**

Lecture 10 April 28: *Planetary volcanism:* (1) composition of magma; (2) types of volcanic eruption; (3) fundamentals of physical volcanology
(**Yin**)

.....

Lecture 11 May 03: volcanic land forms and distribution of volcanic rocks in the solar system
(**Yin**)

Lecture 12 May 05: **Space weathering (processes and evidence):**
(1) sputtering as a loss process and atmospheric source;
(2) gardening and loss processes
(**Jewitt**)

.....

Lecture 13 May 10: **Comets**
(1) Comet sublimation, dust mantle formation & destruction
(2) dust transport, deposits, loss
(**Jewitt**)

Lecture 14 May 12: Comets
(1) real nuclei - feedback cycles
(2) surfaces in the reservoir populations
(**Jewitt**)

.....

Lecture 15 May 17: Geological expression of cratering processes:
(1) crustal-thickness modification and its expression in gravity;
(2) regolith formation;
(3) crustal and mantle melting related to large impacts
(**Yin**)

Lecture 16 May 19: Cratering on icy crust and development of palimpsests on icy satellites (Europa, Ganymede etc.)
(**Yin**)

.....

Lecture 17 May 24:
Cratering as a geological process:
(1) classification of craters;
(2) physics of impact cratering (experimental and theoretical basis)

Crater counts and planetary geochronology;
(1) influence of astronomical evolution (solar system and beyond)
(**Jewitt**)

Lecture 18 May 26: Landforms induced by flowing water (fluvial landforms), gravity, wind (dunes and Yadong landforms) and glacier movement (landslides)
(**Yin**)

.....

Lecture 19 May 31: Student presentations

Lecture 20 June 02: Student presentations

.....

Week 11 (June 6-10): the final week; final exam on Tuesday 6th while the term paper is due on Thursday.

SOURCE BOOKS

No single book fits the class mission although several books are relevant and will be useful:

• J. Melosh (1989) Impact Cratering: A Geologic Process (Oxford Monographs on Geology and Geophysics). OUP.

• W. Hubbard (1984) Planetary Interiors. Van Nostrand Reinhold International.

• Selected chapters in the Annual Reviews of Earth and Planetary Science series.

• Selected chapters from dePater and Lissauer (2001), Planetary Science, CUP

The lecturers of this course might be well-placed to write the ultimate book on this subject.