# ES322 Geomorphology Mid-Term Study Guide Fall 2020

# **Exam Format**

Two-Part Exam, Monday November 2, 2020, online via Moodle. Exam will be open over a 3 hour window between 8 AM and 10 PM. Once you begin the exam, you will have 3 hours to complete it in one block of time from beginning to end during the availability period.

Part 1 - Closed Book, short answer essay – terms and definitions, draw sketches, long answer essay – "compare and contrast", "discuss", "explain".

Part 2, Open Book, lab-style problem solving, you will be able to use all of your class resources to solve mathbased, lab-style problems.

## **Study Tips**

- go through the web site, look at the figures and slide shows, compare to notes
- use study guide in combination with notes
- go back through the in class / lab exercises, make sure you can work the math / units
- spend a couple days studying, the exam will be essay and there is much material.
- don't wait until the last minute!

- carefully go through the notes, some of the material we briefly discussed, but did not spend much time on in class... but the notes will give you the detail

-finish all your lab exercises before taking the exam!!! Lab questions will appear.

-Exam format: Part 1. Closed book short answer / essay. Part 2. Open-book lab-style problem solving.

#### **Recommendation:**

Review Montgomery and Bierman "Key Concepts in Geomorphology" Text Chapters (posted on Moodle class site); focus on following key words and concepts:

# Chapter 1 Introduction

Lithosphere-Biosphere-Atmosphere-Hydrosphere **Plate Tectonics** Isostacy Convergent-Divergent-**Transform Plate Boundaries** Continental / Oceanic Crust **Crustal Density** Asthenosphere Landforms/Topography **Geomorphic Processes** Earth Materials Age / Dating Spatial vs. Temporal Scale Force-Mass-Density-Velocity-Acceleration

## Chapter 3 Weathering/Soils

Regolith Saprolite Soil Forming Factors = Cl O R P T Pedogenesis Exfoliation Freeze-Thaw **Thermal Expansion** Grus **Fire Spallation** Honeycomb weathering (tafoni) Ion Exchange Hydrolysis Solution Oxidation Reduction Goldrich Weathering Series vs. **Bowen's Reaction Series** (weathering index of minerals) Mobile Cations (Ca, K, Na, Mg, Fe, Al)

Carbonation hydration Carbonic acid Humic acid Clay formation Leaching Soil Profiles /Development Soil horizons Leaching – eluviation Accumulation – illuviation O-A-B-C-R Horizons B horizon (iron, clay, CaCO3) Soil texture: sand-silt-clay-loam Differential weathering Tafoni Spheroidal weathering

# Chapter 5 Hillslopes

Mass Wasting Toe slope Weathering limited Transport limited Colluvium Alluvium Saprolite Till Normal stress Shear stress Friction Cohesion Angle of repose Creep Flow Falls-topples Slides Slumps Debris flow Earth flow Shallow vs. deep slides Factor of safety Shear strength Shear stress Root strength

## Chapter 6 River Channels

Channel flow baseflow ephemeral perennial

fluvial alluvial riparian discharge streampower stream gradient alluvial vs. bedrock channel Sediment Transport Suspended Dissolved Bedload Large woody debris meandering vs. braided river point bar cut bank levee oxbow lake floodplain terrace scroll bars channel bed aggradation vs. degradation

Key Words from Notes (Web links provided below) Introduction

Intro to Landscape Analysis Landforms Materials Process Age Active Channel Floodplain Valley Bottom Hillslope Sediment Transport Bedload Suspended load Dissolved load Flotsam Force Mass Velocity Acceleration Energy Geothermal Solar gravity Time Temporal vs. Spatial Scaling landscape construction tectonics landscape destruction weathering erosion denudation driving mechanisms climate / solar energy tectonics / internal gravity process rates Earth Systems process-response models Systems mass and energy flux equilibrium concept driving force vs. resisting framework force energy kinetic energy potential energy

work climate controls insolation precipitation temperature gravity controls tectonic controls resisting framework lithology rock structure resistant vs. non-resistant lithologies geomorphic thresholds extrinsic vs. intrinsic critical angle Constructional landforms destructional landforms exogenic processes endogenic processes isostacy isostatic rebound crustal uplift / isostacy rates of crustal uplift rates of crustal denudation Quaternary (when is this time?) Pleistocene (ages? When is this) Holocene (ages? When is this) Time unit abbreviations: Ma, m.y., ka, t.y., Ga, b.y.

Weathering and Soils

nysci/taylor/g322/weather.pdf http://www.wou.edu/la mass transfer weathering sediment / grain size "sediment" vs. rock erosion denudation bedrock regolith residuum colluvium alluvium diamicton eolian glacial till drift lacustrine deltal pedogenesis - soil development

O,A,B,C, R porosity clay clay size clay minerals joints faults permeability physical weathering frost wedging unloading sheeting exfoliation thermal expansion organic activity root wedging salt wedging water molecule volume expansion hydrolysis clay expansion thermal expansion chemical weathering <del>рН</del> chelation hvdration oxidation ion exchange solution parent material aspect soil horizonation eluviation illuviation soil color / color index soil profiles (A, B, C) soil percolation soil translocation weathering rinds relative dating iron accumulation phyllosilicates / clays hydrous alumino silicates bowen's reaction series temp-pressure reactions soil forming factors: Cl,O,R,P,T climate, parent, organic time, slope/relief/aspect

#### *Geomorphic and Landscape Age Dating*

Quaternary (when / how long<br/>ago?)PleistoceneHoloceneRelative age datingAbsolute or numerical age<br/>datingEarly-middle-late PleistoceneAge of material vs. age of<br/>surfacecoastal wave cut terrace<br/>soil correlation<br/>law of superposition<br/>law of geomorphic positionRates of Erosion / Deposition

#### Topographic map Principles http://www.wou.edu/las/physci/taylor/g322/topomaps.pdf

topographic maps north arrow magnetic declination map scale fractional scale graphical scale longitude latitude township-range-section equator prime meridian parallels angular measurement 7.5 min quadrangle contour interval index contour law of V's / streams

Geomorphic Mapping Criteria (\*\*see new notes on web site) Landform-Material Process -Age hollow side slope channel floodplain dune terrace levee sediment texture diamicton lacustrine eolian colluvial-alluvial glacial

Mass Wasting Video http://www.wou.edu/las/physci/taylor/g322/masswast.pdf

mass wasting angle of repose slope angle hillslope rock debris earth fall topple slide slump flow slope gradient slope angle: degrees vs. percent head scar creep solifluction avalanche landslide classification

Mass Wasting / Hillslope Process http://www.wou.edu/las/physci/taylor/g322/masswast.pdf

potential energy kinetic energy force stress ioules newtons shear force normal force shear stress normal stress shear strength slope stability internal friction pore pressure cohesion safety factor coulomb equation mass wasting angle of repose

slope angle hillslope rock debris earth fall topple slide slump flow slope gradient angle: degrees vs. percent head scar creep solifluction avalanche landslide classification

Oregon Coast Range Landslide Controls (Roering et al., 2005) https://people.wou.edu/~taylors/g322/Roering\_e tal\_2005\_deep\_seated\_landslides\_OCR.pdf

Deep-seated bedrock landslides vs. shallow debris flow

Landslide controls Slope morphology Channel incision Geologic structure (dip, fractures) Lithology (sandstone vs. siltstone)

Tyee Formation (age, outcrop distribution, environment of deposition)

Landslide dams / lakes

Mountain uplift + denudation + landslide controls

OCR – landscape pysiography Soil mantled slopes Sandstone terrain vs. igneous instrusives Folding + rotation Uplift rates = 0.1-0.3 mm / yr Erosion rate = 0.05-0.3 mm/yr *Fluvial / Rivers* http://www.wou.edu/las/physci/taylor/g322/fluv ial2.pdf

Hydrologic Cycle / Water Budget Discharge precipitation infiltration channel area wetted perimeter hydraulic radius gradient runoff rain splash sheet erosion rill erosion gully erosion channel flow stream erosion shear abrasion (tools) corrosion Q=VA V = L/TA=wd P=2d + wvelocity profiles discharge calculations manning equation energy expenditure roughness coefficient velocity-depth relations slope-discarge relations stream power calculation depth-velocity relations width-velocity relations sediment load stream competence stream capacity vegetative effect on sed. load dissolved load suspended load bed load saltation flotation load bernoulli principle "fluid lift force" turbulent flow laminar flow channel morphology

straight meandering braided width/depth ratio vs. channel bank grain size relations gradient vs. stream type sed. load vs. stream type meanders point bar cut bank levee floodplain terrace oxbow lake oxbow cutoff process pool-riffle sequences overbank sedimentation bankfull discharge vs. flood discharge meander scrolls centrifugal force braid gravel bars river base level local base level regional base level graded profile Fluvial System Factors slope base level climate discharge velocity sed. supply sed. load aggradation conditions degradation conditions river entrenchment **knickpoints** knickpoint retreat terraces / incision rates terrace tread terrace scarp paleohydrology slackwater deposits

# **Quantitative Skills**

Unit algebra / basic problem solving skills

Process Rate Calculations

Basic map reading / landform identification from a topographic map.

Map scaling, determining fractional scales

Given a rate of weathering and "soil erosion", calculate the equivalent rate of crustal denudation and rock erosion

Calculate long term and short term erosion rates at the watershed scale

Interpret degree of weathering from soil and rock characteristics;

Interpret relative ages from weathering data

From a topographic map, calculate hillslope gradient (in degrees, in percent, in ratio form)

Draw a topographic profile from a topographic map.

Plot soil texture data on a triangular diagram, determine soil classification, calculate soil texture parameters Apply landscape analysis concepts to air photos (landform, material, age, process)

Interpret geomorphic information from soil survey maps / data

Identification of basic landforms and geomorphic process by examining aerial imagery

calculate the slope of stream channel or hillslope from a topographic map (in degrees and percent)

Calculate long term geologic rates of erosion by volume and mass.

View photographs of landforms, and identify objects in terms of landform, material, process of formation.

# Key Concepts and essay questions

Give examples of resistant vs. non-resistant lithologies, and how they respond to erosion and landscape evolution.

List and discuss the driving mechanisms for geologic / geomorphic processes.

Give example rates of crustal uplift and crustal erosion

What are the necessary elements for the collection and analysis of air photos.

What is the significance of "clay" at the Earth's surface

What factors effect rates of weathering? What are the physical and chemical weathering processes? What is the difference between soil and sediment? How are soils formed? How are they identified? What are the soil forming factors, and how are they used as a dating tool in geomorphology?

What are the range of processes, landforms, and surficial materials found at the Earth's surface? in western Oregon? Can you make some general sketches showing these geomorphic elements?

How does the landscape evolve over time? How does this relate to systems theory? Thresholds theory? What are the typical ranges of rates and processes of erosion and deposition found at the Earth's surface? Discuss the controls of bedrock lithology on landslide style and susceptibility in the Oregon Coast Range? Draw and discuss the mass wasting classification system.

Identify mass wasting processes from air photos and field photographs.

Discuss the mass wasting classification system, describe materials and processes, draw sketches to illustrate each.

List, identify and describe the basic erosional and depositional landforms associated with river channels. List, identify and describe the factors that control the occurrence of landslides and mass wasting.