

ES322 Geomorphology Midterm Study Guide
Fall 2023 *Draft 1 Oct. 24, 2023*

Exam Format

Tuesday October 31, 2023, NS218. Arrive early, stay late as needed. Early exam start at 1 PM possible.

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 math based, 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 class exercises before taking the exam!!! Review 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
Isostasy
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~~
~~CLOPPT~~
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

Textbook Review Questions:

Chapter 7 Drainage Basins

https://people.wou.edu/~taylors/g322/Bierman_Montgomery_Chap7_Drainage_Basins_Review_Questions.doc

watershed + drainage basin
channel network
perennial vs. ephemeral streams
drainage divide (interfluvium)
headwaters vs. basin outlet
open basin vs. closed basin
tributary network
sediment source vs. sink
sediment discharge vs.
water discharge
sediment routing
hillslope storage
valley bottom storage
tributary junctions
drainage patterns
rectangular
dendritic
trellis
radial
Colluvial vs. alluvial process
Hillslope vs. valley process
Bedrock vs. alluvial valleys
Knickpoints
terraces
Longitudinal profiles

Transverse profiles
Basin Sediment Storage
Floodplains + terraces
Alluvial fans
Colluvial (debris) fans

Key Words from Notes

(Web links provided below)

Introduction

<http://www.wou.edu/las/physci/taylor/g322/intro.pdf>

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
~~isostasy~~
~~isostatic rebound~~
~~crustal uplift / isostasy~~
~~rates of crustal uplift~~
~~rates of crustal denudation~~
Quaternary (when is this?)
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

<http://www.wou.edu/las/physci/taylor/g322/weather.pdf>

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
pH
~~chelation~~
hydration
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 aluminosilicates~~
~~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 ago?)
Pleistocene
Holocene
Relative age dating
Absolute or numerical age dating
Early-middle-late Pleistocene
Age of material vs. age of surface
coastal wave-cut terrace
soil correlation
~~law of superposition~~
~~law of geomorphic position~~
Rates 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~~
~~joules~~
~~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_et_al_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 physiography
Soil mantled slopes

Sandstone terrain vs. igneous
intrusives
Folding + rotation
Uplift rates = 0.1-0.3 mm / yr
Erosion rate = 0.05-0.3 mm/yr

Oregon Coast Field Trip

https://people.wou.edu/~taylors/g322/ES322_Oregon_Coast_Field_Guide_Fall2023.pdf

coast
beach
tectonics / Cascadia Subduction
waves
tides
tsunami
storm surge
longshore drift
pocket beach
marine terrace
wave-cut notch
wave-cut terrace
emergent coasts
submergent coasts
erosional coasts
depositional coasts
headlands
sea cliff
sea stacks
sea arches
wave-cut platform
uplifted coasts
sea level change
global sea level rise /fall
global climate cycles
interglacial / glacial
PNW tectonic setting
convergent
subductions
neotectonic uplift
relative sea level change
uplift vs. SL change
subsidence vs. SL change
global warming
density currents
thermal expansion of water
re-leveling surveys
tide-gage surveys
tectonic vs. sea level changes
seasonal wave activity in OR
winter vs. summer beaches
rock headlands

pocket beaches
littoral cell
estuaries
Oregon Coast Range Uplift
Oregon rotation / tilt history

Fluvial / Rivers

<http://www.wou.edu/las/physci/taylor/g322/fluvial2.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
 $Q=VA$
 $V=L/T$
 $A=wd$
 $P=2d + w$
~~velocity profiles~~
discharge calculations
~~manning equation~~
~~energy expenditure~~
~~roughness coefficient~~
velocity-depth relations
slope-discharge 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.