GEOS 3010 Minerals and Rocks

Exam 3 Info:

Part 1: Multiple choice, T/F, fill-in, matching (20-25 questions)
Part 2: Short answer and calculations/graph problems

The exam will cover lecture and homework activities related to Igneous Rocks (including Chapters 8 and 9 of the M&RCP) and Sedimentary Rocks (Chapters 10, 11, and 11a of the M&RCP). Concentrate your study efforts on the material covered and discussed in lecture – you should be familiar with the material from the readings that we did not discuss in class, but you do not need to know this in detail (example: sedimentary structures in Chapter 10). Specific important concepts are listed below.

The problems will be similar to things we did on the homework assignments. Review your homework and be sure you understand how to do the problems! Bring a calculator to the exam.

Topics to be covered – be able to:

ROCKS

- Define a rock
- Define petrology, petrography, and petrogenesis
- Explain the general processes that form the 3 main classes of rocks (ig, met, sed)
- Explain in a general way how rock features (textures, structures, and mineral assemblages) relate to the processes of rock formation, and how processes of rock formation relate to tectonic setting
- Know which rock types (ig, met, sed) are most abundant in the earth's mantle, continental crust, and oceanic crust

IGNEOUS ROCKS AND ROCK-FORMING PROCESSES

Igneous Rock Classification and General Characteristics

- Know how igneous rocks are classified based on texture and composition (mineral assemblage)
- Describe common igneous rock textures (aphanitic, porphyritic, phaneritic, glassy, vesicular) and relate these to environment of formation (intrusive vs. extrusive)
- Know the basic classification scheme for igneous rocks (e.g. granite, rhyolite, diorite, andesite, gabbro, basalt, peridotite, obsidian, pumice)
- For these rocks (above), know their essential minerals, whether they are mafic, intermediate, or felsic in composition, and whether they are intrusive or extrusive
- Define Bowen's Reaction Series (BRS), know the participating minerals and their general order of crystallization

Igneous Rock Petrogenesis

- Explain general processes involved in igneous rock formation (magma genesis, transport, modification, and crystallization)

- Define magma and know its general characteristics; explain how magma properties vary with composition
- Define fractionation and understand why it is important in explaining the diversity of igneous rocks on earth
- Explain the origin of magma, including the role of BRS in partial melting, possible source rocks for magma, the role of the geothermal gradient, decompression melting, flux melting, and crustal anatexis
- Explain the two main mechanisms of magma transport (dike, diapir)
- Explain the processes of magma modification, including magma mixing, assimilation, and fractional crystallization
- Know the difference between equilibrium and fractional crystallization, and explain each process

Igneous Structures

- Describe the major types of intrusive igneous structures (batholith, stock, pluton, dike, sill, laccolith, vein, xenolith); know which of these are discordant and concordant
- Explain the major controls on effusive versus explosive volcanic activity (role of viscosity, gas content, and magma composition)
- Describe common effusive (lava flow and dome) and explosive (tephra, pyroclastic fall, pyroclastic flow) volcanic products
- Describe hydroclastic eruptions and their products
- Describe the major styles of effusive (flood basalt, shield volcano, pillow lava) and explosive (cinder cone, stratovolcano, caldera) volcanic activity; relate activity to magma type and tectonic setting

Igneous Rocks and Plate Tectonics

- Explain igneous rock-forming processes in each of the major tectonic settings (mid-ocean ridge, continental rift, ocean island arc, continental volcanic arc, continental collision, and hot spot)
- Relate packages of igneous rocks to their tectonic setting

SEDIMENTARY ROCKS AND ROCK-FORMING PROCESSES

The Production of Sediment

- Define weathering and explain the two main types of weathering
- Explain what occurs to rocks during physical weathering, and give examples of physical weathering processes
- Explain what occurs during the major types of chemical weathering (oxidation, hydrolysis, and dissolution) and give examples of these reactions
- Explain why chemical weathering occurs
- Explain the Goldich stability series and how it is related to BRS
- Describe the main products of both physical and chemical weathering

Clay Minerals and Soil

- Define clay and clay mineral (relate clay minerals to phyllosilicates)

- Explain the TO(T) structure of common clay mineral groups (kaolinite, mica, and chlorite)
- Relate the mineralogical, textural, and chemical properties of clay minerals to their physical properties
- Relate clay properties to their beneficial uses (ex: CEC) and hazards (ex: swelling soils)
- Define soil and explain how soil formation and type is related to climate

The Formation of Sedimentary Rocks

- Explain the general requirements for the formation of sedimentary rocks (sediment source, weathering, depositional basin, diagenesis)
- Explain what occurs to sediment during diagenesis
- Describe the main categories of sedimentary rocks (clastic and chemical)
- Know the major types of sedimentary rocks (conglomerate, breccia, sandstone, mudstone, limestone, dolomite, chert, evaporite)
- Know the TAO classification scheme for sedimentary rocks, explain the general origin of each rock type, and be able to relate rock types (above) to each category
- Define depositional environment and explain how processes in the common types of depositional environments (ex: beach, fluvial, glacial, submarine) relate to textural and compositional features in sedimentary rocks
- Define basin and relate sedimentary basins to tectonic settings

Siliciclastic Rocks

- Know the main components in siliciclastic rocks
- Explain the phi scale, grain size, and sorting; relate these to textural maturity and relate textural maturity to depositional environments
- Explain basic sandstone classification (arenite vs wacke); know sandstone mineralogy and explain why proportions of Q-F-L relate to tectonic setting
- Describe conglomerates and mudstones, and relate their formation to depositional environment
- Explain how types of siliciclastic rocks form in different depositional settings within long and short systems

Carbonates

- Explain the origin of carbonate sediment
- Describe the major components in carbonate rocks (micrite, sparite, types of allochems, and biolithic elements)
- Describe the two main schemes for carbonate rock classification
- Explain how carbonate components and features relate to major types of carbonate depositional settings
- Describe how carbonate and siliciclastic depositional systems differ

Problems

- Read and interpret graphs of element concentration during crystallization of igneous rocks

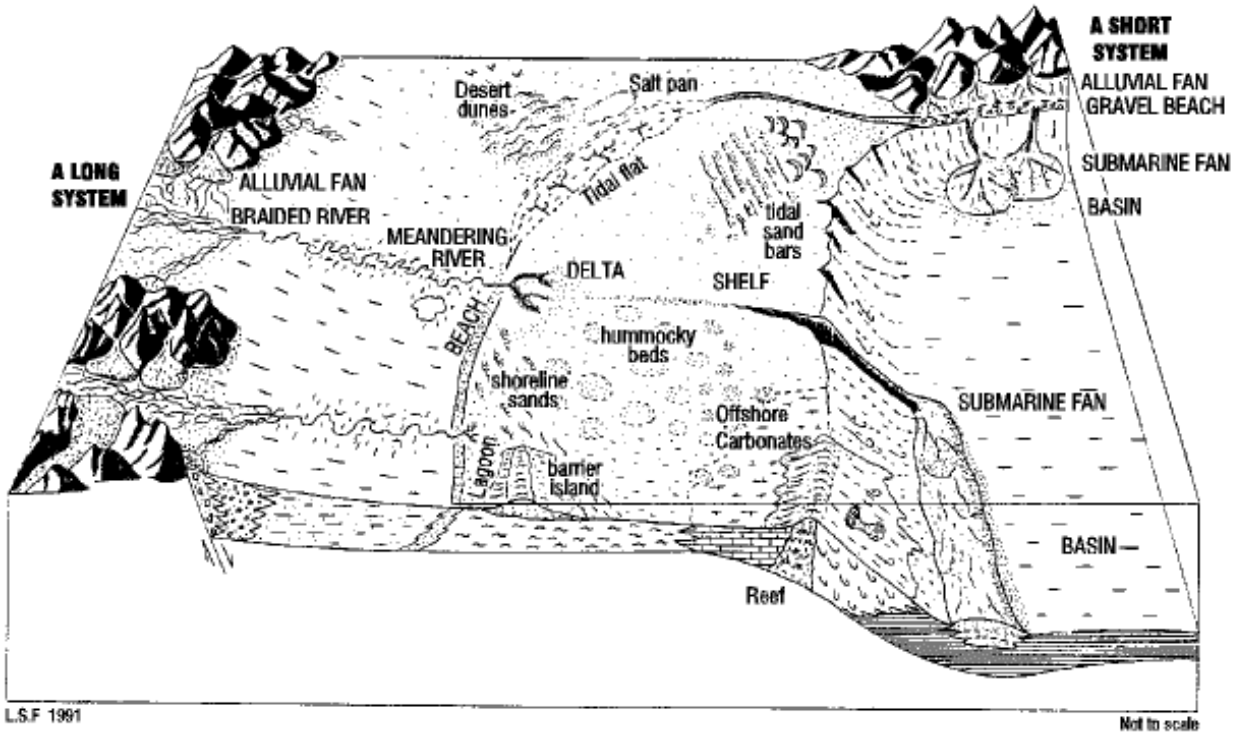
- Determine magma and crystal compositions, and temperatures during both fractional and equilibrium crystallization from binary T-X diagrams
- Calculate and plot sandstone compositions on a Q-F-L ternary diagram
- Interpret sandstone provenance and tectonic setting using Q-F-L proportions

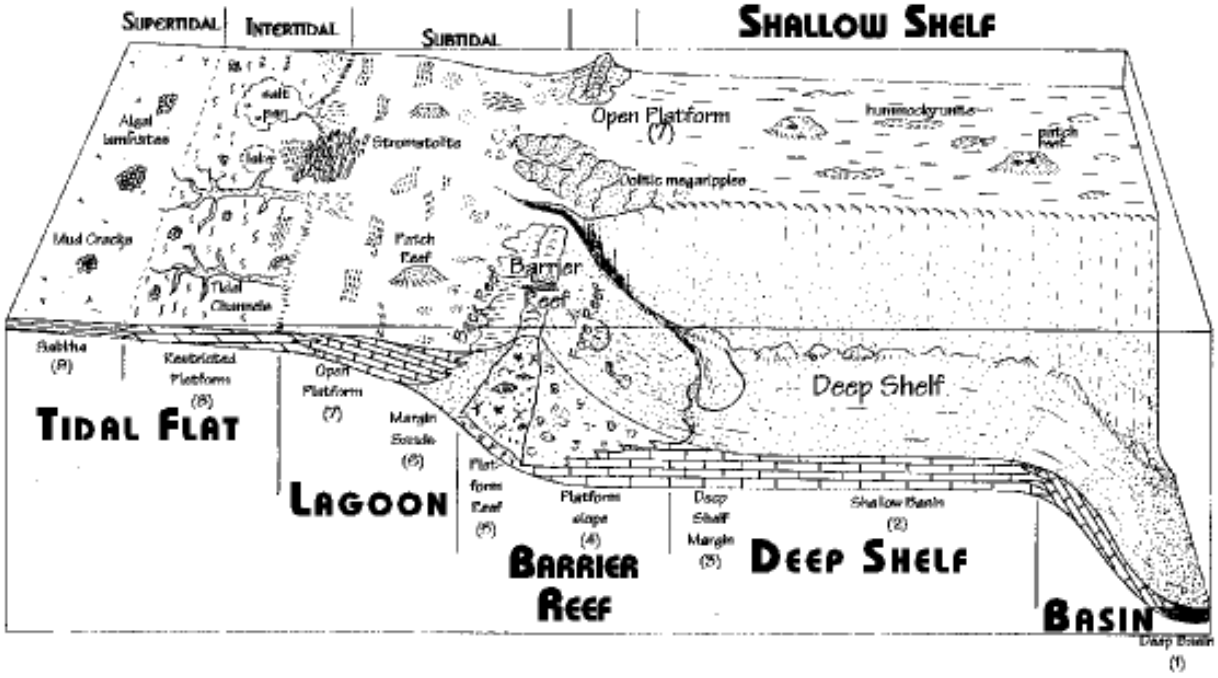
Exam Review "Homework"

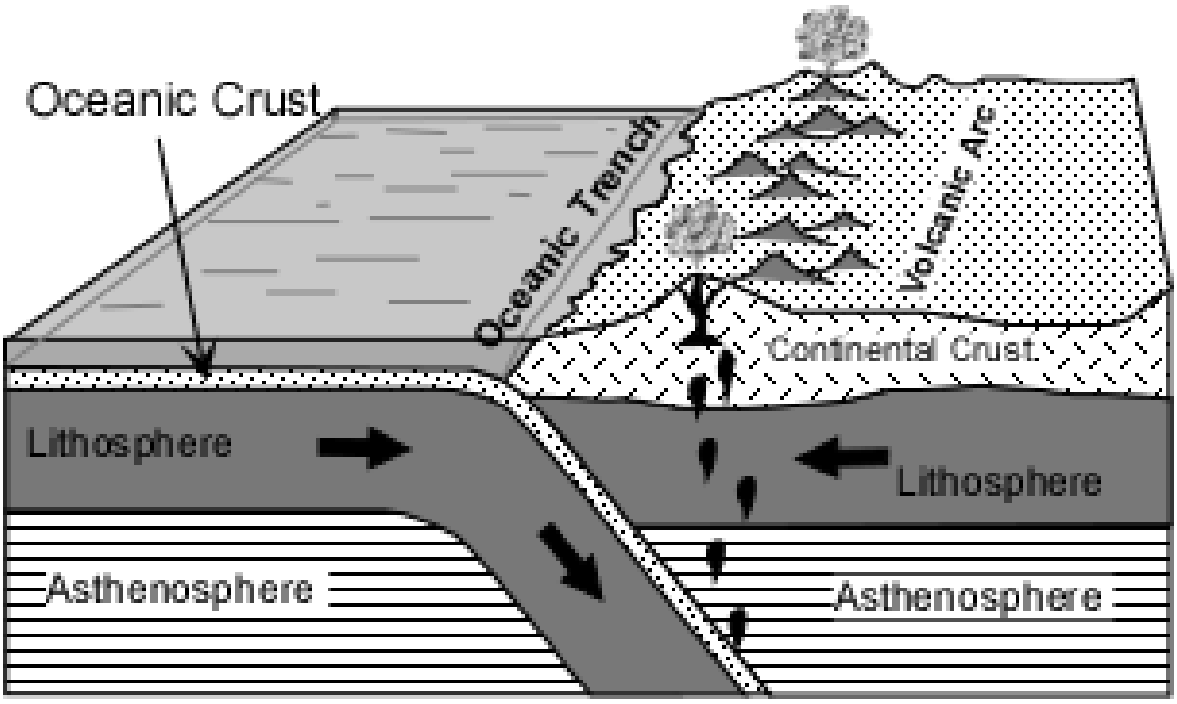
On the attached diagrams, explain the processes involved in forming igneous and sedimentary rocks. Specifically:

1. Pg. 6 has diagrams of siliclastic and carbonate depositional systems. For each numbered location, describe the depositional environment in terms of high, low, or mixed energy. Speculate as to what sort of sedimentary rocks would form in this environment, and what the textural (grain size, sorting, rounding) and compositional characteristics of these rocks would be (mature/immature).

2. Pg. 7 has diagrams of two tectonic locations where igneous rocks typically form. For each numbered location, describe the processes that are occurring (partial melting – be specific as to the type of melting). Also describe the composition and texture of igneous rocks that typically form in these locations (as appropriate – not all locations form rocks).


A LONG SYSTEM
ALLUVIAL FAN
BRAIDED RIVER
MEANDERING RIVER
Desert dunes
Salt pan
Tidal flat
DELTA
BEACH
hummocky beds
shoreline sands
Lagoon
barrier island
Offshore Carbonates
Reef
tidal sand bars
SHELF
A SHORT SYSTEM
ALLUVIAL FAN
GRAVEL BEACH
SUBMARINE FAN
BASIN
SUBMARINE FAN
BASIN
L.S.F 1991
Not to scale


SUPERTIDAL
INTERTIDAL
SUBTIDAL
SHALLOW SHELF
Algal laminites
salt pan
lake
Stromatolite
Open Platform
(7)
hummocky ripples
oolitic megaripples
Mud Cracks
Tidal Channels
Patch Reef
Barrier Reef
Sabkha (9)
Restricted Platform (8)
Open Platform (7)
Margin Sands (6)
Deep Shelf
TIDAL FLAT
LAGOON
Platform Reef (5)
Platform slope (4)
Deep Shelf Margin (3)
Shallow Basin (2)
BARRIER REEF
DEEP SHELF
BASIN
Deep Basin (1)



Ocean - Continent Convergence