Study Guide for Earth Sciences 089G Final Examination

This study guide includes only lecture material following that tested on the midterm test. If you study this material in detail and can memorize and understand it to a high degree, you should be very well prepared for the final examination. Once you have reviewed these lectures it would be advisable for you to go over the general points indicated below and try to recount (in writing) the details surrounding each point—i.e. think of each point as a question and try to answer it.

This does not mean that only the latter portion of the course content will be tested, only that the latter portion will constitute the majority of the material to be tested.

It is strongly recommended that you also review your notes for the previous (Jan. 9- Feb. 8) lectures to ensure that your knowledge of this material is sound. You should especially concentrate on any topics covered before the midterm which relate directly to, or form the foundation for, material covered in the lectures outlined below.

Mother Nature's Chisel: Processes of weathering and erosion

Importance of erosion, and particularly differential erosion in the production of various landforms.

Definitions of "Erosion" and "Weathering" and the differences between them.

General types of weathering.

Various types of mechanical weathering processes. How/why do they work?

Various types of chemical weathering processes and reactions. Know what basically happens in each reaction—you don't need to worry about memorizing precise reactions, but do know the main reactants (what you start with), and products (what you end up with), e.g. dissolution results in the transformation of solid mineral crystals into free ions in (aqueous) solution.

Be aware of the significance of each of these processes in breaking down various rock and mineral types, e.g. hydrolysis is a significant process involved in the transformation of K feldspars and other aluminosilicates into clay minerals.

Remember, only a few minerals will dissolve directly in water.

Relationship between mechanical and chemical weathering and how the former aids the latter.

Definition of "Joint".

Understand potential reasons for differential weathering in relatively homogenous rock.

Various agents of weathering.

Physical and chemical properties and corresponding erosive effects of different media/agents.

Why is liquid water, in particular, such an effective erosive agent?

Solution enhanced joints—how formed?

Differential chemical weathering due to differing rock/mineral solubilities.

Definition of “Plucking”.

Combined effects of turbulent media (i.e. liquid water, wind) plus suspended particles on abrasion.

Definition of “Deflation”.

Role of deflation in producing desert pavements.

Glacial ice and its role in erosion.

Gravity, definition of “Mass wasting” and landslides.

Stolen land: Famous erosional landforms

Definition of “Karst”.

Types of karst landforms.

Limestone and Karst: Why are karst landforms developed primarily in carbonate rocks?

Understand and be able to explain the probable sequence of events that led to the formation of the limestone karst mountains of southern China.

Definitions of “Mesa” and “Butte”, and “Plateau”.

“Mesa and Butte topography” and the Colorado Plateau.

Reasons for uplift of the Colorado Plateau and the production of Mesa and Butte topography.

Effects of general aridity and lack of vegetation on erosion.

Understand the formation of “Badland topography”.

Understand differential erosion with respect to the production of exposed and elevated “Volcanic necks” and “Exfoliation domes”.

Understand differential erosion with respect to the formation of “Hoodoos” and “Natural arches”.

Clay: From weathering product to art medium

Understand the various uses of the term "Clay"; i.e. clay minerals, clay sized particles, clay mud.

Definition and means of production of "Ceramics".

Be aware of the general composition and general molecular structure of clays, but don't get bogged down in the details.

Understand the plasticity of clays from the standpoint of their microstructure.

The definitions of "Primary" and "Secondary clays" and the major differences between them.

Definition of "Clay body".

Definition and purpose of use of "Grog".

Major categories of clay bodies

Characteristics, uses and processes of formation of "Earthenware", "Stoneware" and "Porcelain".

Air drying ("Greenware") phase and associated tranformations in the clay body.

Kiln drying phase and associated transformation in the clay body.

Total dehydration and the formation of "Mullite"; structural effect of the growth of mullite crystals.

Definition of "Vitrification"; vitrification of the clay body and associated effects.

Importance of firing temperatures in terms of the vitrification temperatures of the various clays used.

Definitions of "Glaze" and "Glazing" and the purpose of the latter.

Importance of, and types of materials used as "Fluxes".

Rivers: The geological and cultural significance of rivers

Importance of rivers and streams in the hydrological cycle and sedimentation processes.

Definition of "Channel".

Definitions of "Runoff", "Rills", "Tributaries".

Definitions and significance of "Base level" and "Downcutting".

Defintions of "Gradient", "Headwaters", "Tailwaters", "River mouth".

Definitions of “Bedload” and “Suspended load”.

General changes in load characteristics along the length of a stream.

Characteristics and occurrences of “Laminar flow” and “Turbulent flow” within a stream.

Variation in predominant flow type and flow rate in headwaters vs. tailwaters as well as characteristic load types.

Significance of river valleys and their relationship to stream channels.

Variable morphology of valleys and channel course in headwaters vs. tailwaters.

Definition of “Thalweg”.

Direction of deflection of “Thalweg” and resultant lateral variability in water velocity and pressure within a meandering river.

Lateral (cross-channel) flow of water as a result of pressure gradient and effect on the morphology of the channel (not symmetrical in cross-section).

Effect of variable flow velocity and pressure on erosion and deposition activities occurring within a meandering stream and lateral migration of the stream flow course.

Definition and means of formation of an “Oxbow Lake”.

Significance of river floods and “Floodplains”.

Understand why large amounts of formerly suspended sediments are deposited on the floodplain following a flood as well as why coarser sediments are deposited closer to the stream channel while finer sediments are deposited farther away.

Definition, composition, and significance of “Levees”.

Definition of a “Yazoo tributary”: a would-be tributary which flows parallel to the main river channel (does not join) due to the fact that it can not break through the levees which bound the main channel laterally.

Significance of floodplains for agricultural purposes, and sustained agriculture.

Minerals and Paint: The use of minerals as pigments

Physical explanation for colour of pigments.

Some mineral pigments such as graphite are soft enough to be applied directly to paper or canvas, but most are much harder than these materials and therefore must be applied in powdered form.

Early use of ochre as pigments, and corresponding minerals for yellow ochre and red ochre.

You don't need to remember the precise chemical formulae of these ochre minerals, but know that they are iron oxide and iron oxyhydroxide minerals.

Significance of pigment use and blending by the Ancient Egyptians.

The significance of the evaporite mineral Natron and its multiple uses in Ancient Egypt.

Various uses and mineral source of "Vermilion".

Significance of Lapis Lazuli and Dioptase as pigments (once again, you needn't remember the chemical formulae).

Cerrusite and its cosmetic use as well as associated harmful effects.

Components of paints; definition of "Binder"; nature of pigment-binder mixture.

Pigments currently used (more or less in their natural form), vs. those which may occur in nature but which are now produced through combination of the necessary elements under controlled conditions.

Different varieties of binding media and corresponding names for the resultant paints.

The Geology of Ancient Monuments: When human hands meet stone

Significance of Ancient Egyptian burial customs.

Advances in the complexity of structures built to accommodate the tombs of Pharaohs and other members of the nobility throughout time.

Possible symbolic significance of Pyramids of Giza Plateau.

Nature of building materials used in the construction of Pyramids and other structures and the interpreted means of construction.

Sources of materials used in construction of the Great Pyramids.

Possible significance, origin and age of the Sphinx.

Significance of the "Dream Stele".

Geological origin and environment of Easter Island.

Composition and character of the guardian statues (Moai) of Easter Island.

Cultural significance of Moai and Ahu.

Sources of Moai and topknots; nature of geological material comprising topknots.

Nature of tools used in carving the Moai.

Other materials used in the creation of Moai.

Reasons for demise of native Easter Island culture.

Metal Madness: The geology of metallic mineral deposits

Understand why the earliest metals used by humans were most likely native (i.e. naturally occurring elemental) metals.

Understand why most metals do not occur in a native form.

Understand the need to extract metals from ore minerals for large-scale use of metals to be a possibility.

Significance of sulphides and oxides of metals as ore minerals.

General physical and chemical properties of metals.

Characteristics of "Fusible metals", "Precious metals", "Base metals".

Relation of chemical properties and reactivity to economic value of metals.

Historical significance of the term "base metal".

Realize low concentration of metals in the Earth's crust compared to silicon and oxygen (Aluminum most common metal—relatively light).

Many metals of significant use to society occur in only trace quantities in the Earth's crust.

Metals are not uniformly distributed throughout crust, but are concentrated by various geological processes.

Concept of "Enrichment" of metals.

Definitions of "Ore" and "Ore body".
(Economic) considerations in identifying "ores" and in determining the feasibility of mining and extraction of the desired metals.

The various igneous and hydrothermal processes of metal enrichment in natural deposits.

The various (siliciclastic and chemical) sedimentary processes of metal concentration.

Formation of Skarn metal deposits through contact metamorphic processes.

Heavy Metal Thunder: Early history of metal use in human culture

Note association of major developments in human technology with geological materials: i.e. Stone, Chalcolithic, Bronze and Iron ages.

Note major change in stone tool technology from the Paleolithic to Neolithic periods.

First metals used by humans were most likely native metals. Lacking a means of extraction, other sources of metals (combined with other elements in minerals) would not have been useful as such.

Native metals such as gold and copper were probably the first metals used by humans, particularly for the manufacture of jewelry and other ornamental objects.

Placer gold was used extensively in some cultures at least 6000 years BP.

Definition of "Chalcolthic" or "Copper Age".

Significance of the use of ductile and malleable native metals in the production of highly useful tools such as needles (metals were far superior to other materials for the manufacture of tools of this nature).

Reasons for lack of practical use of early Copper "cutting" tools—primarily used for ornamental purposes only by high-status individuals.

Limited early use of silver and natural iron-nickel alloys due to extreme rarity of occurrence.

Significance and nature of change in metal structure involved in "Annealing".

Development of early smelting methods (of Copper) during the Chalcolithic age.

Significance of Malachite in copper smelting.

Hypothesized origins of the smelting process and related discoveries.

Importance of the use of a kiln, flux, and charcoal for successful smelting, as opposed to an open campfire.

Move to sulphide minerals and the discovery of metal alloys (i.e. arsenic bronze).

Advantages of alloys.

Early uses of arsenic bronze followed by typical (tin-copper alloy) bronzes (initiation of the Bronze age).

Origins of the Iron Age and iron smelting processes.

Reasons for the difficulty of early iron smelting.

Characteristics of an “Iron bloom”.

Definition of “Slag”.

Discovery of means of removing slag and purifying the iron.

Problems with the use of pure elemental iron as tools or building materials.

Understand the major advancements in iron working technology which allowed iron to be used extensively for these purposes.

Coal and Petroleum: Fuel, Fad and Fashion

The nature of the origins of coal and the original ancient depositional environments that coal deposits represent.

Definitions of, and differences between “Peat”, “Lignite”, “Bituminous Coal” and “Anthracite” and the post-depostional conditions which they represent.

Significance of the use of coal (historically and to date) as a major source of fuel for heating, power generation etc.

Definition and uses of “Coke”.

Significance of organic by-products from processed coal in the production of several modern products.

Nature and origins of “Petroleum”, “Oil” and “Natural Gas”.

Significance of the process of “(thermal) Cracking” or “Pyrolysis” and the “Oil window” for production and geological occurrence of crude oil and natural gas.

Definition and significance of “Petroleum trap”, “Reservoir”, “Caprock”, “Structural trap”, “Stratigraphic trap”.

Major types of petroleum traps: Understand how these work and how a knowledge of these might be useful for oil exploration purposes.

Extraction and recovery of oil from reservoirs.

Geological environments and materials necessary for the formation of oil and gas.

Understand how various components of crude oil are extracted through evaporation of the crude oil followed by and condensation of fractions under different temperature conditions in a distillation tower.

Be aware of the various uses of petroleum and petroleum by-products.

Be able to define “Plastics” and “Polymer”.

Be able to identify various useful properties of plastics and also try to understand why they are highly versatile materials which are amenable to so many different applications.

Nacre: the natural beauty of mother of pearl

Definition and characteristics of “Mother of Pearl” and “Nacre”.

Sources of nacre and mother of pearl within the animal kingdom.

Generalized mollusc anatomy and portion responsible for secretion of shell.

Other functions of the mantle.

Mineralogical composition and structural divisions of a typical mollusc shell.

Definition, compositon and function of “Periostracum”.

Microstructure of “Prismatic and “Nacreous layers”.

Composition and mineralogy of nacre.

Optical significance of regularly spaced “stepped” layers of nacre.

Lustre of nacre and importance of internal light transmission and reflection.

Definition of “Orient”. Significance of “Constuctive” and “Destructive interference” of reflected light waves.

Other optical qualities of nacre; prism effect, dispersion, diffraction etc.

Traditional ornamental uses of mother of pearl.

“Ammolite”: nature, composition and source of material.

Optical qualities of Ammolite; use as a gemstone; special mounting technique.

Pearls: Irritants, iridescence and industry

Pearl oysters vs. Edible (true) oysters. Understand why edible oysters do not produce pearls of value.

Types of molluscs capable of producing pearls.

Largest known pearl characteristics.

Pearl formation and varieties (i.e. “Blister pearls”, “Free pearls”).

Tissue responsible for secretion of nacre.

Typical stimuli for natural pearl formation.

Necessary conditions for the formation of natural free pearls.

Reason for different pearl colours.

Characteristics of “Baroque pearls”.

Occurrence of “Fossil pearls” in some Cenozoic bivalves.

Development and advantages of the cultured pearl industry (“Perliculture”) over natural pearl production.

Procedure for culturing pearls in captive stocks of pearl oysters.

Success rate of perliculture.

Molluscs other than pearl oysters in which perliculture is used.

Characteristics and means of production of “Mabé pearls”.

Typical uses of Mabé pearls.

Other blister pearl techniques.

The Dinosaur: Dragon or Doofus?

Reasons for the cultural popularity of dinosaurs.

Possible association of dinosaurs with dragon myths.

Origins of reptiles and dinosaurs; know the major difference(s) between reptiles and amphibians.

Reptile classification: note that dinosaurs and most modern reptiles were/are diapsids.

Dinosaurs are part of the “Archosaur” group or group of “ruling lizards”.

“Thecodonts” were the direct ancestors of dinosaurs.

Physiological importance of an upright (non-sprawling) posture in dinosaur development and success.

Dinosaur classification: two major groups (orders).

Major difference in the anatomy of "Saurischians" vs. "Ornithischians".

Nature and approximate age (part of geological period) of the earliest dinosaur fossils.

Saurischian types: definitions of "Theropods" (all carnivorous) and "Sauropods" (all herbivorous) and some well-known examples of both types.

Different types of Ornithischians (all herbivorous).

Association of dinosaurs with nests containing eggs with dinosaur embryos (good parents?).

Oviraptor: A misnomer for this dinosaur?

Various myths surrounding dinosaurs and the current state of knowledge regarding these issues.

Theropod (i.e. *T. rex*) posture and maximum speed of locomotion—high levels of dinosaur activity suggested.

Similarities between dinosaur skin structure and bird skin structure. Dissimilarities between dinosaur skin and modern lizard skin.

Brain size and possible intelligence of some dinosaurs.

"Pterosaurs" were a different group (order) of Archosaurs—not dinosaurs.

Possible reasons and evidence for dinosaur endothermy or homeothermy: Know the meanings of: "Ectothermy", "Endothermy", and "Homeothermy".

Possible reasons for strong colouration of dinosaurs, particularly in forms that had feather-like plumage.

Geological time span of dinosaur reign and success of dinosaurs as a group.

Volcanoes, Frankenstein, and The Scream

Non-uniform distribution of volcanoes over the Earth's surface.

Primary association with plate tectonic processes and plate boundaries. Intraplate volcanism also occurs though is less common.

Properties of magma and physical differences between magmas of mafic and felsic composition.

Volcanism at divergent plate boundaries—formation of pillow basalts in submarine (mid-ocean ridge) settings. Importance of decompression melting.

Volcanism at convergent plate boundaries as a result of subduction and dehydration melting. Production of relatively felsic magmas.

Definition of an “Island Arc”.

Island Arc volcanism—Arc is generally concave (in plan view) toward the nearby continent mimicking the arcuate shape of the associated subduction zone.

Modern examples of Island Arcs.

Common composition of Island Arc magmas.

Definition of a “Contiental Volcanic Arc”.

Common composition of Continental Arc magmas.

Modern examples of Contiental Arcs.

Type and means of formation of intraplate volcanoes.

Composition of intraplate volcano magmas.

Possible stages of volcanism associated with variations in magma volume.

Common types of Volcanoes.

Nature and eruption style of “Shield Volcanoes”

Nature and eruption style of “Stratovolcanoes” or “Composite Volcanoes” or “Composite Cones”.

Structure and compostion of stratovolcanoes.

Understand “Angle of repose”.

Nature and eruption style of “Cinder Cones”

<u>Relative</u> comparison of size (height, width, volume) of the three main volcano types.

Note highest volume and highest (from base to top) mountains in the world are Shield volcanoes.

Association of violent volcanism primarily with subduction zones.

Understand why gas and magma pressure builds up within stratovolcanoes until there is a catastrophic release of energy.

Definitions of “Glowing Pyroclastic Flows” or “Glowing Avalanches” and “Lahars”.

Definition of “Caldera” and reasons why calderas form.

Atmospheric effects of violent volcanic activity.

Climatic significance of “Particulates” and “Aerosols”.

Historic examples of climatic effects associated with major eruptions.

Eruption at Toba 75,000 years ago—largest magnitude eruption event in last 2 million years. Local and more widespread evidence of eruption.

Widespread effects of eruption of Toba

Possible significance of eruption of Toba to Human evolution: “Toba Catastrophe Theory”.

Effects of particulates and aerosols on the Earth’s “Albedo”—general reflectivity.

Climatic effects of the eruption of Tambora; relation to creation of “Frankenstein”.

Eruption of Krakatau and probable atmospheric effects which inspired “The Scream”.

Physical explanation for red sunsets and redder skies overall following a major volcanic eruption.

Other possible accounts of the atmospheric effects of eruption of Krakatau in art and literature of the time.