Unit #2 ES 100 lecture outline and related internet links.
Introduction to Earth Science and Chapters 4,5 and 6

For this unit read chapters 4, 5 and 6. Start with the chapter summaries. Learn the key terms and answer the review questions at the end of each chapter. The readings are required before class. The lectures and films augment and clarify the readings. The ends of chapter questions are in order of the material presented in the text. The CD Rom at the back of the book has additional material to help you.

Films:
Please view the Earth Revealed videos before class.

15. Weathering and Soils (unit#2)
The Cleopatra's Needle obelisk in New York City's Central Park is severely weathered after only 75 years, whereas the dry climate of Egypt has preserved similar structures in that country for millennia. This program shows how weather, climate, chemicals, temperature, and type of substrate factor into rock and soil erosion. Environmental connections are also considered.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. What happened to Cleopatra's Needle?
2. Why does rock material change when exposed to surface conditions?
3. Discuss mechanical weathering.
4. Describe exfoliation, and the fracturing of rock due to pressure release.
5. What is ice wedging?
6. How much does water expand when it freezes?
7. Discuss chemical weathering.
8. How do mechanical and chemical weathering work together to disintegrate rock?
9. What are the principle agents of chemical weathering?
10. How does rain water become acidic?
11. How do climate and temperature affect the rate of weathering?
12. Discuss chemical weathering, mineral stability, and how they relate to the order of crystallization.
13. Discuss the formation of acid rain and its impact on surface materials.
14. Discuss the formation of soils and soil horizons.
15. What circumstances led to the Dust Bowl of the 1930's?
16. How do irrigation practices affect the long term health of soils?
17. What have you seen blowing away from the equipment in every scene during the last 10 minutes of this episode?
18. Why is soil one of our most important natural resources.

16. Mass Wasting (unit #2)
Anyone undertaking a building project must understand mass wasting — the downslope movement of earth under the influence of gravity. Various factors in mass wasting, including the rock's effective strength and pore spaces, are discussed, as are different types of mass wasting such as creep, slump, and landslides. Images of an actual landslide illustrate the phenomenon.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. What is mass wasting?
2. Why does mass wasting occur everywhere?
3. How do human activities help trigger mass wasting events?
4. Describe how the angle of a slope affects mass wasting.
5. Describe how water in the ground contributes to mass wasting.
6. What is creep, and what causes it to occur?
7. What is slump?
8. Discuss landslides at Portuguese Bend.
9. How has road building contributed to the problems?
10. Why are many Portuguese Bend landowners unable to move?
11. What are some of the things residents are doing to protect their homes?
12. Discuss mudflows and debris flows.
13. Describe rock slides.
14. What factors do engineering geologists look at when studying slope stability?
15. How do heavy rains contribute to mud and debris flows?
16. How does human activity contribute to mass wasting processes?

19. Running Water I: Rivers, Erosion and Deposition (Unit#2)
Rivers are the most common land feature on Earth and play a vital role in the sculpting of land. This program shows landscapes formed by rivers, the various types of rivers, the basic parts of a river, and how characteristics of rivers — their slope, channel, and discharge — erode and build the surrounding terrain. Aspects of flooding are also discussed.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. What 3 things do all streams do?
2. What is one important factor in how rivers shape the land?
3. What factors can cause a river's velocity to increase?
4. What is discharge?
5. What are the 3 erosional processes of rivers?
6. What factors affect sediment transport?
7. What are river bars?
8. Describe a meander point bar and cut bank.
9. How often do most streams flood?
10. What is a floodplain, and what does a river store there?
11. How do streams work to maintain equilibrium?
12. What happens at "Red Eye Crossing" when water levels fluctuate?
13. What geologic factors contribute to the evolution of river systems?

20. Running Water II: Landform Evolution (Unit#2)
The Colorado River is a powerful geologic agent — powerful enough to have carved the Grand Canyon. This program focuses on how such carving takes place over time, looking at erosion and deposition processes as they relate to river characteristics and type of rock. The evolution of rivers is covered, along with efforts to prevent harmful consequences to humans.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. What happens as a river deepens its channel?
2. What is base level, and what happens to a stream as it approaches base level?
3. Describe the youthful stage of stream development.
4. Describe the mature stage of stream development.
5. Describe the old age stage of stream development and the formation of peneplains.
6. Discuss the interplay between tectonics and erosion.
7. Describe the process of rejuvenation.
8. What are stream terraces and how are they formed?
9. What are incised meanders and how are they formed?
10. Why do deltas form at the mouths of rivers?
11. How much sediment is added to the Mississippi delta every day?
12. What will it take to keep the Mississippi in its present channel?
13. How does sediment transport affect attempts to control the flow of the Mississippi?
14. What is the ultimate fate of any river control project?
15. Why are the processes which shape the land so poorly understood?

21. Groundwater (Unit#2)
Approximately three-quarters of Earth's surface is covered by water. But most fresh water comes from underground. Topics of this program include aquifers, rock porosity and permeability, artesian wells, the water table, cave formation, sinkholes, and how groundwater may become contaminated.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. Why is groundwater such an important natural resource?
2. What is the source of most groundwater?
3. Describe porosity and permeability.
4. What is an aquifer?
5. What happens when groundwater reacts with limestone?
6. How do stalactites and stalagmites form?
7. What is the water table?
8. How does surface topography affect the shape of the water table?
9. What is effluence, and how does it help maintain year-round flow in many rivers?
10. Describe an open aquifer.
11. Describe a closed aquifer, and the formation of an artesian well.
12. What can happen when too much groundwater is removed from an aquifer?
13. What factors can lead to groundwater contamination?
14. How do engineers attempt to limit groundwater contamination from landfills?
15. How quickly does groundwater recharge in a natural setting?
16. How is groundwater recharged?
17. What problems need to be addressed in terms of groundwater management?
18. What is the role of the hydrogeologist?

22. Wind, Dust and Deserts (Unit#2)
Land in arid climates is shaped in particular ways. This program shows how deserts are defined by infrequent precipitation and how desertification relates to proximity to the equator, proximity to mountains, and ultimately plate tectonics. Images of landscapes illustrate how wind creates features such as dunes, playas, blow-outs, and even oases.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. Where are most deserts located?
2. What is a desert?
3. Describe how proximity to the equator affects the formation of deserts.
4. Describe the rain shadow effect and the formation of deserts.
5. How does plate tectonics affect the formation of deserts?
6. What other factors influence the location and formation of deserts?
7. Describe the affect of precipitation on the desert.
8. What are alluvial fans?
9. Why do most deserts have interior drainage patterns?
10. How is sand transported by wind?
11. What are playas?
12. Describe the formation of desert pavement.
13. Describe the formation of desert varnish.
14. What is desertification?
15. How can the removal of vegetation lead to desertification?
16. How did ranching and farming practices contribute to the Dust Bowl of the 1930s?
17. How did modern technology contribute to the desertification of sub-Sahara Africa?
18. Discuss efforts to reduce desertification on a global scale.
19. Why do you think that desert lands are so fragile?

23. Glaciers (Unit#2)
Many of the world's most beautiful landscapes were made by glaciers. This program shows how, explaining glacial formation, structure, movement, and methods of gouging and accumulating earth. The program provides images of glaciers and glacial landforms such as moraines, and discusses how study of glaciers may help us understand ice ages and the greenhouse effect.

Read the questions first. Then answer them while watching this episode of "Earth Revealed".

1. What do glaciers leave behind when they retreat?
2. Describe how snow is converted to glacial ice.
3. What part of a glacier moves quickest? What part moves slowest?
4. What is basal slip?
5. Why do continental ice sheets flow away from their center?
6. What is the snowline?
7. What are striations?
8. What is till?
9. What are moraines?
10. Summarize the theories concerning the origin of ice ages.
11. Why do rivers often run faster during an ice age?
12. How do atmospheric CO_2 levels relate to ice ages?
13. How long ago did the last ice age end?
14. How much have atmospheric CO_2 levels increased since 1850? Why has this happened?

Chapter outlines:

Chapter 4: **Weathering, Soil, and Mass Wasting**

Concept 1: Define and describe the processes of weathering and erosion, including examples of negative and beneficial effects of these processes.

Concept 2: Use examples to explain the difference between mechanical and chemical weathering and the variation in the rate of weathering.

Concept 3: Discuss soil composition, texture, structure, formation, and classification.

Concept 4: Provide examples of various types of mass wasting and describe the controls and triggers of this process

I. Earth's external processes include
- A. Weathering – the disintegration and decomposition of material at or near the surface
- B. Mass wasting – the transfer of rock material downslope under the influence of gravity
- C. Erosion – the incorporation and transportation of material by a mobile agent, usually water, wind, or ice

II. Weathering
- A. Two kinds of weathering
  - 1. Mechanical weathering
    - a. Breaking of rocks into smaller pieces
    - b. Four processes
      - 1. Frost wedging
      - 2. Unloading
      - 3. Biological activity
  - 2. Chemical weathering
    - a. Alters the internal structures of minerals by removing or adding elements
    - b. Most important agent is water
      - 1. Oxygen dissolved in water oxidizes materials
      - 2. Carbon dioxide (CO_2) dissolved in water forms carbonic acid and alters the material
    - c. Weathering of granite
      - 1. Weathering of potassium feldspar produces
        - a. Clay minerals
        - b. Soluble salt (potassium bicarbonate)
        - c. Silica in solution
      - 2. Quartz remains substantially unaltered
      - 3. Weathering of silicate minerals produces
        - a. Soluble sodium, calcium, potassium and magnesium products
        - b. Insoluble iron oxides
        - c. Clay minerals
    - d. Can also produce physical changes by spheroidal weathering

B. Rates of weathering
    1. Advanced mechanical weathering aids chemical weathering by increasing the surface area
    2. Important factors are
        a. Rock characteristics
            1. Mineral composition and solubility
                a. Marble (calcite) readily dissolves in weakly acidic solutions
                b. Silicate minerals weather in the same order as their order of crystallization
            2. Physical features such as joints
        b. Climate
            1. Temperature and moisture are the most crucial factors
            2. Chemical weathering is most effective in areas of warm temperatures and abundant moisture
    3. Differential weathering
        a. Caused by variations in composition
        b. Creates unusual and spectacular rock formations and landforms

III. Soil
  A. An interface in the Earth system
  B. A combination of mineral matter, water, and air – that portion of the regolith (rock and mineral fragments) that supports the growth of plants
  C. Soil texture and structure
    1. Texture
        a. Refers to the proportions of different particle sizes
            1. Sand (large size)
            2. Silt
            3. Clay (small size)
        b. Loam is best suited for plant life
    2. Structure
        a. Soil particles clump together to give a soil its structure
        b. Four basic soil structures
            1. Platy
            2. Prismatic
            3. Blocky
            4. Spheroidal
  D. Controls of soil formation
    1. Parent material
        a. Residual soil – parent material is the bedrock
        b. Transported soil – parent material has been carried from elsewhere and deposited
    2. Time
        a. Important in all geologic processes
        b. Amount of time to evolve varies for different soils
    3. Climate
    4. Plants and animals
        a. Organisms influence the soil's physical and chemical properties
        b. Furnish organic matter to soil
    5. Slope
        a. Angle
            1. Steep slopes often have poorly developed soils
            2. Optimum is a flat-to-undulating upland surface
        b. Orientation (direction the slope is facing) influences
            1. Soil temperature, and
            2. Moisture

E. Soil Profile
1. Soil forming processes operate from the surface downward
2. Horizons – zones or layers of soil
a. Horizons in temperate regions
1. *O* – organic matter
2. *A* – organic and mineral matter
3. *E* – little organic matter
4. *B* – zone of accumulation
5. *C* – partially altered parent material
b. *O* and *A* together called topsoil
c. *O*, *A*, *E*, and *B* together called solum, or "true soil"

F. Soil types
1. Hundreds of soil types worldwide
2. Three very generic types
a. Pedalfer
1. Accumulation of iron oxides and Al-rich clays in the B horizon
2. Best developed under forest vegetation
b. Pedocal
1. Accumulate calcium carbonate
2. Associated with drier grasslands
c. Laterite
1. Hot, wet, tropical climates
2. Intense chemical weathering

G. Soil Erosion
1. Recycling of Earth materials
2. Natural rates of erosion depend on
a. Soil characteristics
b. Climate
c. Slope
d. Type of vegetation
3. Soil erosion and sedimentation can cause
a. Reservoirs to fill with sediment
b. Contamination by pesticides and fertilizers

IV. Weathering creates ore deposits
A. Process called secondary enrichment
1. Concentrates metals into economical deposits
2. Takes place in one of two ways
a. Removing undesired material from the decomposing rock, leaving the desired elements behind
b. Desired elements are carried to lower zones and deposited

B. Examples
1. Bauxite, the principal ore of aluminum
2. Many copper and silver deposits

V. Mass Wasting
A. The downslope movement of rock, regolith, and soil under the direct influence of gravity
B. Gravity is the controlling force
C. Important triggering factors are
1. Saturation of the material with water
a. Destroys particle cohesion
b. Water adds weight

2. Oversteepening of slopes
    a. Unconsolidated granular particles assume a stable slope called the angle of repose
    a. Stable slope angle is different for various materials
    b. Oversteepened slopes are unstable
3. Removal of anchoring vegetation
4. Ground vibrations from earthquakes

D. Types of mass wasting processes
1. Generally each type is defined by
    a. The material involved
        1. Debris
        2. Mud
        3. Earth
        4. Rock
    b. The movement of the material
        1. Fall (free-fall of pieces)
        2. Slide (material moves along a well-defined surface)
        3. Flow (material moves as a viscous fluid)
    c. The rate of the movement
        1. Fast
        2. Slow
2. Forms of mass wasting
    a. Slump
        1. Rapid
        2. Movement along a curved surface
        3. Along oversteepened slopes
    b. Rockslide
        1. Rapid
        2. Blocks of bedrock move down a slope
    c. Debris flow (mudflow)
        1. Rapid
        2. Flow of debris with water
        3. Often confined to channels
        4. Serious problem in dry areas with heavy rains
        5. Debris flows composed mostly of volcanic materials on the flanks of volcanoes are called lahars
    d. Earthflow
        1. Rapid
        2. On hillsides in humid regions
        3. Water saturates the soil
        4. Liquefaction - a special type of earthflow sometimes associated with earthquakes
    e. Creep
        1. Slow movement of soil and regolith downhill
        2. Causes fences and utility poles to tilt

    f. Solifluction
        1. Slow
        2. In areas underlain by permafrost
        3. Upper (active) soil layer becomes saturated and slowly flows over a frozen surface below

Chapter 5: **Running Water and Groundwater**

Concept 1: Describe the distribution of H2O within the Hydrosphere and the movement of H2O through the hydrologic cycle.

Concept 2: Describe the process of streamflow and the factors influencing stream erosion, transportation, and deposition.

Concept 3: Give examples illustrating the connection between landscape features and runoff including channels, stream valleys, flooding events, and drainage patterns.

Concept 4: Discuss the occurrence and movement of groundwater.

Concept 5: Explain unique features and environmental concerns associated with groundwater and the use of groundwater as a nonrenewable resource including: subsidence, contamination, and sinkholes.

I. Earth as a system: the hydrologic cycle
- A. Illustrates the circulation of Earth's water supply
- B. Processes involved in the cycle
  1. Precipitation
  2. Evaporation
  3. Infiltration
  4. Runoff
  5. Transpiration
- C. Cycle is balanced

II. Running water
- A. Streamflow
  1. Factors that determine velocity
     a. Gradient, or slope
     b. Channel characteristics
        1. Shape
        2. Size
        3. Roughness
     c. Discharge
- B. Upstream-downstream changes
  1. Profile
     a. Cross-sectional view of a stream
     b. From head (source) to mouth
        1. Profile is a smooth curve
        2. Gradient decreases from the head to the mouth
  2. Factors that increase downstream
     a. Velocity
     b. Discharge
     c. Channel size

3. Factors that decrease downstream
    a. Gradient, or slope
    b. Channel roughness

C. Base level
1. Lowest point a stream can erode to
2. Two general types
    a. Ultimate
    b. Temporary, or local
3. Changing causes readjustment of the stream – deposition or erosion

D. The work of streams
1. Erosion
2. Transportation
    a. Transported material is called the stream's load
        1. Types of load
            a. Dissolved load
            b. Suspended load
            c. Bed load
        2. Load is related to a stream's
            a. Competence
                1. Maximum particle size
            b. Capacity
                1. Maximum load
                2. Related to discharge
        3. Deposition
            a. Caused by a decrease in velocity
                1. Competence is reduced
                2. Sediment begins to drop out
            b. Stream sediments
                1. Called alluvium
                2. Well-sorted deposits
            c. Features produced by deposition
                1. Deltas
                    a. Exist in oceans or lakes
                    b. Distributaries often form in the channel
                2. Natural levees
                    a. Form parallel to the stream channel
                    b. Area behind the levees may contain
                        1. Back swamps
                        2. Yazoo tributaries

E. Stream valleys
    1. Valley sides are shaped by
        a. Weathering
        b. Overland flow
        c. Mass wasting
    2. Characteristics of narrow valleys
        a. V-shaped
        b. Downcutting toward base level
        c. Features often include
            1. Rapids and
            2. Waterfalls
    3. Characteristics of wide valleys
        a. Stream is near base level
            1. Downward erosion is less dominant
            2. Stream energy is directed from side to side
        b. Floodplain
        c. Features often include
            1. Meanders
            2. Cutoffs
            3. Oxbow lakes
F.Floods and flood control
    1. Floods are the most common geologic hazard
    2. Causes of floods
        a. Weather
        b. Human interference with the stream system
    3. Flood control
        a. Engineering efforts
            1. Artificial levees
            2. Flood-control dams
            3. Channelization
        b. Nonstructural approach through sound floodplain management
G. Drainage basins and patterns
    1. A divide separates drainage basins
    2. Types of drainage patterns
        a. Dendritic
        b. Radial
        c. Rectangular
        d. Trellis

III. Water beneath the surface (groundwater)
A. Largest freshwater reservoir for humans
B. Geological roles
    1. As an erosional agent, dissolving by groundwater produces
        a. Sinkholes
        b. Caverns
    2. An equalizer of streamflow

C. Distribution and movement of groundwater
1. Distribution of groundwater
a. Belt of soil moisture
d. Zone of aeration
1. Unsaturated zone
2. Pore spaces in the material are filled mainly with air
b. Zone of saturation
1. All pore spaces in the material are filled with water
2. Water within the pores is groundwater
c. Water table – the upper limit of the zone of saturation
2. Movement of groundwater
a. Porosity
1. Percentage of pore spaces
2. Determines how much groundwater can be stored

b. Permeability
1. Ability to transmit water through connected pore spaces
2. Aquitard – an impermeable layer of material
3. Aquifer – a permeable layer of material

D. Features associated with groundwater
1. Springs
a. Hot springs
1. Water is 6-9°C warmer than the mean air temperature of the locality
2. Heated by cooling of igneous rock
b. Geysers
1. Intermittent hot springs
2. Water turns to steam and erupts
2. Wells
a. Pumping can cause a drawdown (lowering) of the watertable
b. Pumping can form a cone of depression in the water table
3. Artesian wells
a. Water in the well rises higher than the initial groundwater level
b. Types of artesian wells
1. Nonflowing
2. Flowing

E. Environmental problems associated with groundwater
1. Treating it as a nonrenewable resource
2. Land subsidence caused by its withdrawal
3. Contamination

F. Geologic work of groundwater
1. Groundwater is often mildly acidic
a. Contains weak carbonic acid
b. Dissolves calcite in limestone
2. Caverns
a. Formed by dissolving rock beneath Earth's surface
b. Formed in the zone of saturation
c. Features found within caverns

1. Form in the zone of aeration
2. Composed of dripstone
a. Calcite deposited as dripping water evaporates
b. Common features
1. Stalactites hanging from the ceiling
2. Stalagmites developing on the cave floor

3. Karst topography
a. Formed by dissolving rock at, or near, Earth's surface
b. Common features
1. Sinkholes
a. Surface depressions
b. Formed by
1. Dissolving bedrock
2. Cavern collapse
2. Caves and caverns
c. Area lacks good surface drainage

Chapter 6: **Glaciers, Deserts, and Wind**

Concept 1: Define the key term glacier including examples of different types and the locations where they are found.

Concept 2: Discuss glacial movement and investigate the budget of a glacier.

Concept 3: Describe the features produced by glacial erosion and deposition.

Concept 4: Examine the causal theories of glacial ages including the glacial events of the Pleistocene epoch.

Concept 5: Discuss geological processes in arid climates, including the development of the Basin and Range region and examples of erosional and depositional features produced by wind and water.

I. Glaciers: a part of two basic cycles in the Earth system
A. Glaciers are a part of both the hydrologic cycle and rock cycle
B. Glacier - a thick mass of ice that forms over land from the compaction and recrystallization
of snow and shows evidence of past or present flow
C. Types of glaciers
1. Valley, or alpine glaciers – form in mountainous areas
2. Ice sheets, or continental
a. Large scale
b. e.g., Over Greenland
3. Other types
a. Ice caps
b. Piedmont glaciers

D. Movement of glacial ice
    1. Types of glacial movements
        a. Plastic flow
        b. Slipping along the ground
    2. Zone of fracture
        a. Uppermost 50 meters
        b. Crevasses form in brittle ice
    3. Zone of accumulation – the area where a glacier forms
    4. Zone of wastage – the area where there is a net loss due to melting
E. Glaciers erode by
    1. Plucking – lifting of rock blocks
    2. Abrasion
        a. Rock flour (pulverized rock)
        b. Striations (grooves in the bedrock)
F. Landforms created by glacial erosion
    1. Glacial trough
    2. Hanging valley
    3. Cirque
    4. Arte
    5. Horn
    6. Fiord
G. Glacial deposits
    1. Glacial drift
        a. All sediments of glacial origin
        b. Types of glacial drift
            1. Till
                a. Material that is deposited directly by the ice
                b. Glacial erratics (boulders embedded in till)
            2. Stratified drift
                a. Deposited by meltwater
                b. Sediment is sorted
    2. Depositional features
        a. Moraines
            1. Layers or ridges of till
            2. Types
                a. Lateral
                b. Medial
                c. End
                    1. Terminal end moraine
                    2. Recessional end moraine
                d. Ground
        b. Outwash plain, or valley train
        c. Kettles
        d. Drumlins
        e. Eskers
        f. Kames

H. Glaciers of the past
1. Ice Age
a. Began 2 to 3 million years ago
b. Division of geological time is called the Pleistocene epoch
c. Ice covered 30% of Earth's land area
2. Indirect effects of Ice Age glaciers
a. Migration of animals and plants
b. Rebounding upward of the crust
c. Worldwide change in sea level
d. Climatic changes

I. Causes of glaciation
1. Successful theory must account for
a. Cooling of Earth, as well as
b. Short-term climatic changes
2. Proposed possible causes
a. Plate tectonics
1. Continents were arranged differently
2. Changes in oceanic circulation
b. Variations in Earth's orbit
1. Milankovitch hypothesis
a. Shape (eccentricity) of Earth's orbit varies
b. Angle of Earth's axis (obliquity) changes
c. Axis wobbles (precession)
2. Changes in climate over the past several hundred thousand years are closely associated with variations in Earth's orbit

II. Deserts
A. Geologic processes in arid climates
1. Weathering
a. Not as effective as in humid regions
b. Mechanical weathering forms unaltered rock and mineral fragments
c. Some chemical weathering does occur
1. Clay forms
2. Thin soil forms
2. Role of water in arid climates
a. Streams are dry most of the time
b. Desert streams are said to be ephemeral
1. Flow only during periods of rainfall
2. Different names are used for desert streams
a. e.g., Wash
b. e.g., Arroyo
c. e.g., Wadi, donga, or nullah
c. Desert rainfall
1. Rain often occurs as heavy showers
2. Causes flash floods
d. Poorly integrated drainage
e. Most erosional work in a desert is done by running water

B. Basin and range: the evolution of a desert landscape
    1. Uplifted crustal blocks
    2. Interior drainage into basins produces
        a. Alluvial fans and bajadas
        b. Playas and playa lakes
    3. Erosion of mountain mass causes local relief to continually diminish
    4. Eventually mountains are reduced to a few large bedrock knobs called inselbergs projecting above a sediment filled basin
C. Wind erosion
    1. By deflation
        a. Lifting of loose material
        b. Produces
            1. Blowouts
            2. Desert pavement
    2. By abrasion
D. Types of wind deposits
    1. Loess
        a. Deposits of windblown silt
        b. Extensive blanket deposits
        c. Primary sources are
            1. Deserts
            2. Glacial stratified drift
    2. Sand dunes
        a. Mounds and ridges of sand formed from the wind's bed load
        b. Characteristic features
            1. Slip face – the leeward slope of the dune
            2. Cross beds – sloping layers of sand in the dune
        c. Types of sand dunes
            1. Barchan dunes
            2. Transverse dunes
            3. Longitudinal dunes
            4. Parabolic dunes
            5. Star dunes