University of Nairobi, Department of Geology
First Semester 2013/2014

SGL 409: ENVIRONMENTAL GEOLOGY

LECTURE 1: INTRODUCTION

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Aim:

To provide insight into man's interaction with the geological environment.

Content:

Earth systems and cycles. Hazardous geological processes. Pollution and its effect on the life-supporting systems, Chemical dispersion of pollutants, pollution and health. Geomaterials, surface and groundwater, resources, Impact of man on the geological environment. Environmental impact assessment

Practicals/ assignments:

Evaluation of Earth hazards to man, his environment and planning processes

LECTURE	TOPIC	PRACTICAL	DATE
Lecture 1	INTRODUCTION		
Lecture 2	ACTIVE GEOLOGICAL PROCESSES	Y	
Lecture 3	MATERIAL CYCLES IN LIVING SYSTEMS		
Lecture 4	FLOODS		
Lecture 5	LANDSLIDES	Y	
Lecture 6	EARTHQUAKES AND VOLCANIC ACTIVITY		
Lecture 7	SUBSIDENCE		
Lecture 8	POLLUTION AND ITS EFFECTS ON LIFE SUPPORT SYSTEMS		
Lecture 9	CHEMICAL DISPERSION OF POLLUTANTS		
Lecture 10	GEOLOGY POLLUTION AND HEALTH		
Lecture 11	ENVIRONMENTAL IMPACT ASSESSMENT		

Introduction

- Environment
  - total set of circumstances that surround an individual or community
- Environment may be defined to include two parts:

1. Physical conditions

   air, landforms, gases, water which affect growth and development of a community or individual

2. Social and cultural aspects

   ethics, economics, aesthetics etc.

   affect behaviour of an individual or community

Introduction - I

- Environmental geology involves the consideration of **philosophical and cultural aspects** which influence how we perceive and react to our environment as well as the physical earth processes, resources and landforms which may be observed
  - environmental geologists study natural hazards such as floods, landslides, earthquakes, mudflows, volcanic activity etc. **to minimise loss of human life and property damage**

Introduction - II

- also landscape evaluation for site and land use planning
- environmental impact studies
- evaluation of earth materials to determine their potential use as resources

building collapse due to Liquefaction of water saturated sediments causing ground to settle in earthquake situations

5

Introduction - III

- cybernetics - the science of controls - involves study of how physical and biological systems are regulated
- system (defn): any part of the universe that is isolated in thought or in fact for the purpose of studying or observing changes occurring on the various imposed conditions. We have:

(1) closed systems exchange only heat (no matter) (e.g. earth, cooling magma, space capsule); and

(2) open systems -exchange both heat and matter with its surroundings (e.g. estuaries, air, river basins, urban communities, forests)

Introduction - IV

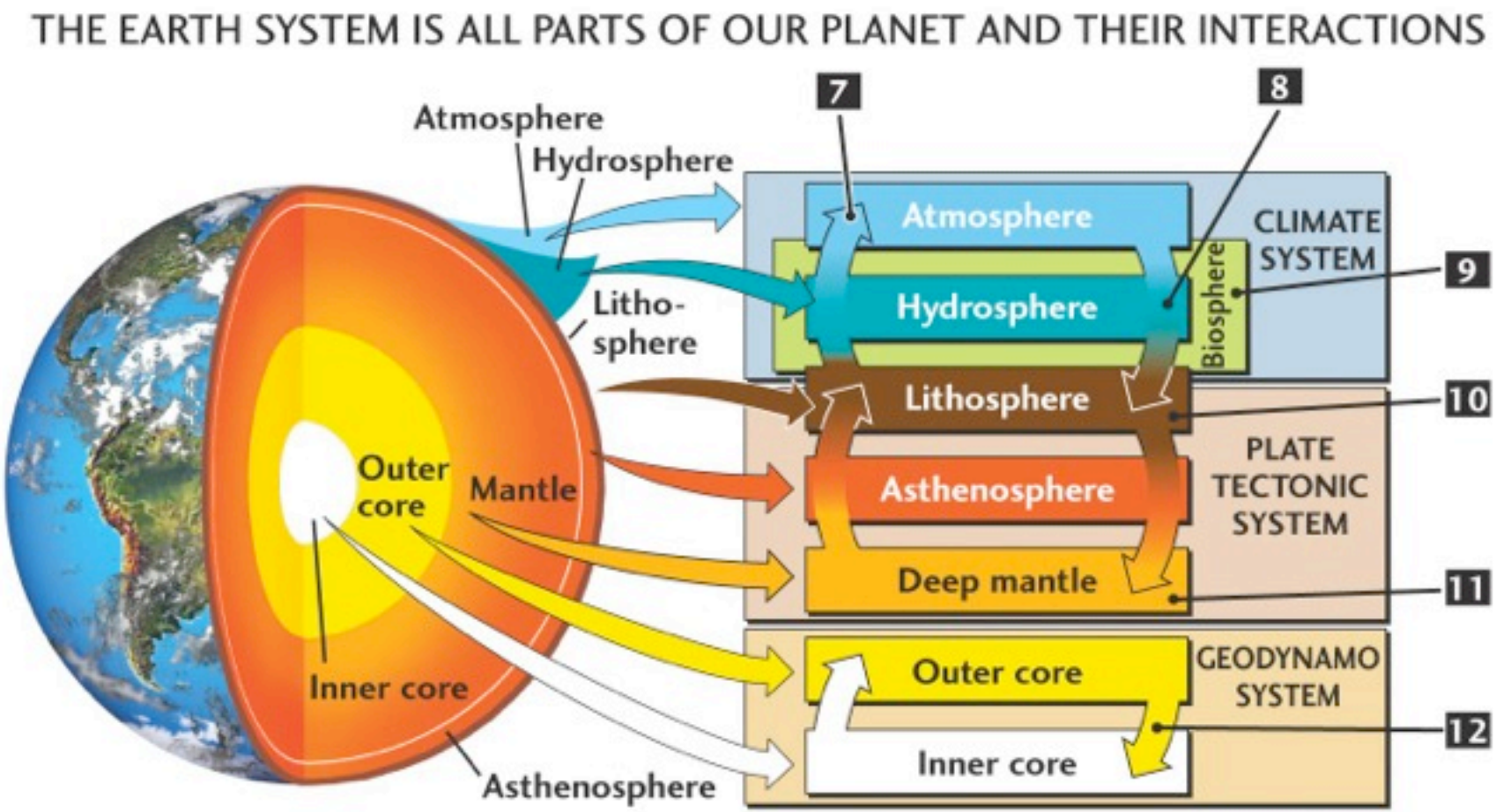
- several related interactions are necessary to the functioning of a system
- a change in one part affects the rest of the system *(feedback mechanisms)*
- a system has boundaries that are selected for convenience
- examples of interactions:
  - movement of energy between sun and group of organisms
  - role of minerals in the interrelationships between the living and non-living environments
  - Cooling lava, heat is lost to the surrounding but new material is neither added nor lost

Introduction - V

- The earth is a closed system, consisting essentially of four spheres:
  - atmosphere,
  - biosphere,
  - hydrosphere,
  - Lithosphere
- The interaction of these spheres is responsible for the surface features of the earth today
- Materials and energy tend to cycle from one reservoir to another

Introduction - V

- WRT energy, Earth is an open system that exchanges mass and energy with its surroundings

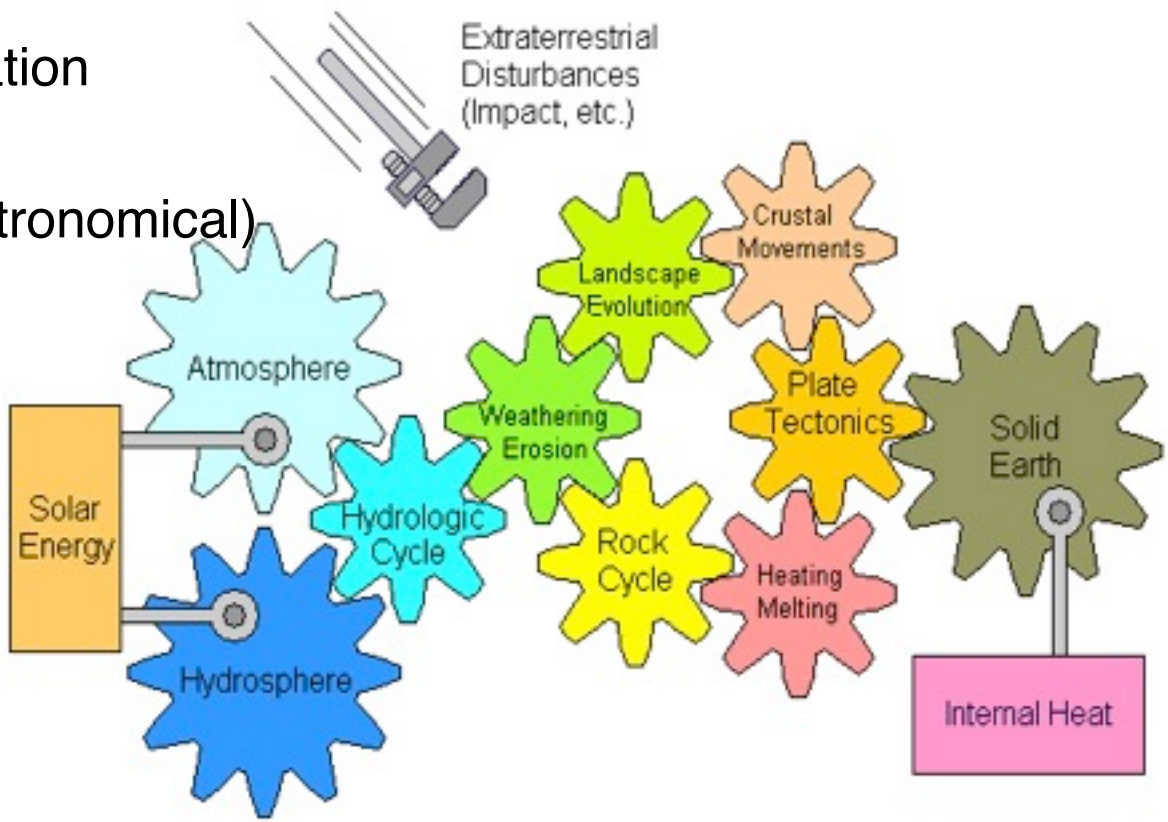


Introduction VI

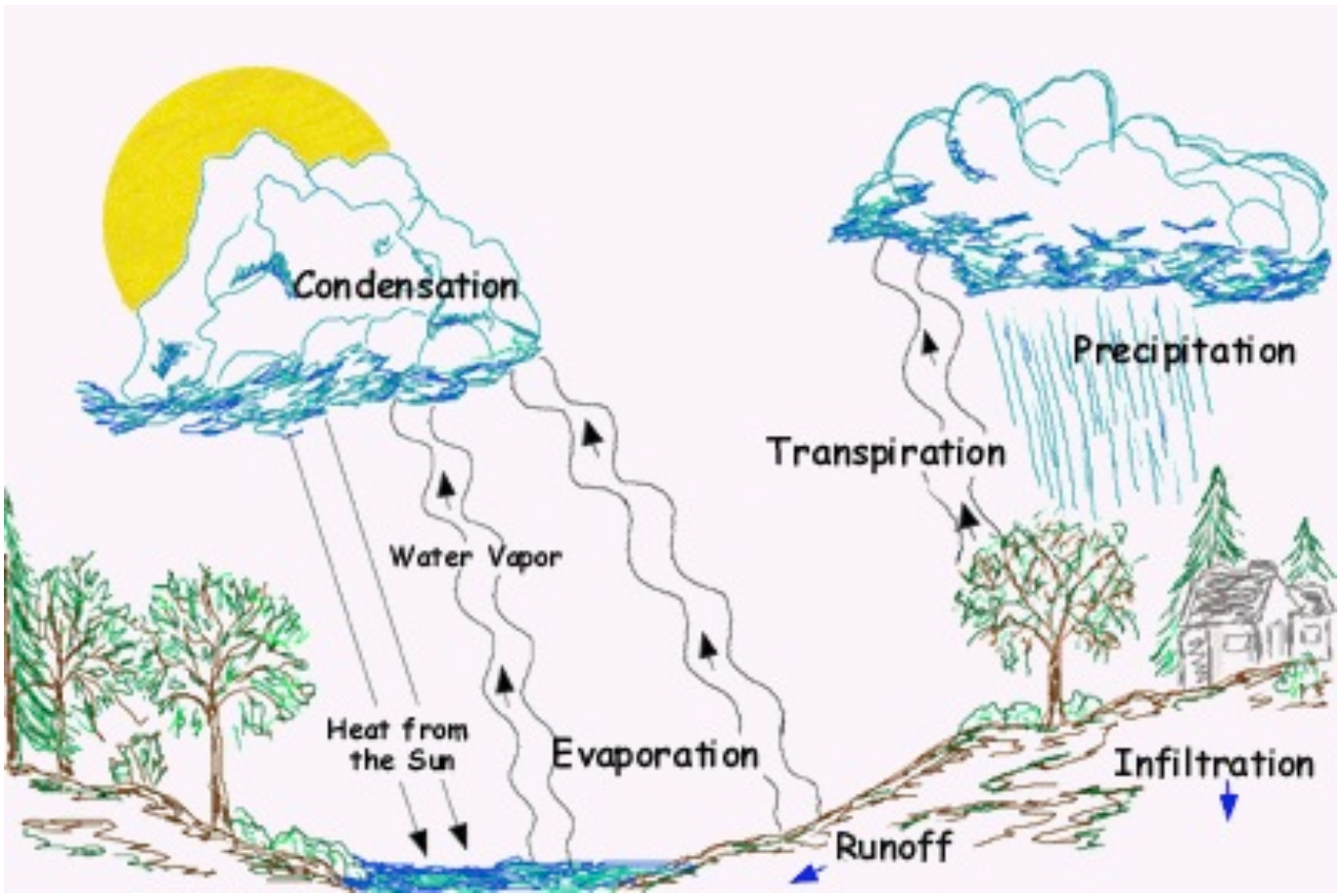
- very difficult to control geological systems
  - their scale, magnitude and power involved is immense
- knowledge and understanding of these processes can nevertheless be applied so that:
  - cities and homes are not built in hazardous locations
  - construction is suited to geology
  - habitats for humans and animals are preserved etc.

Introduction VI – Earth Systems

1. Hydrologic Cycle
2. Tectonic Cycle
3. Rock Cycle
4. Geochemical cycle
5. Atmospheric Circulation
6. Oceanic Circulation
7. External Effects (Astronomical)



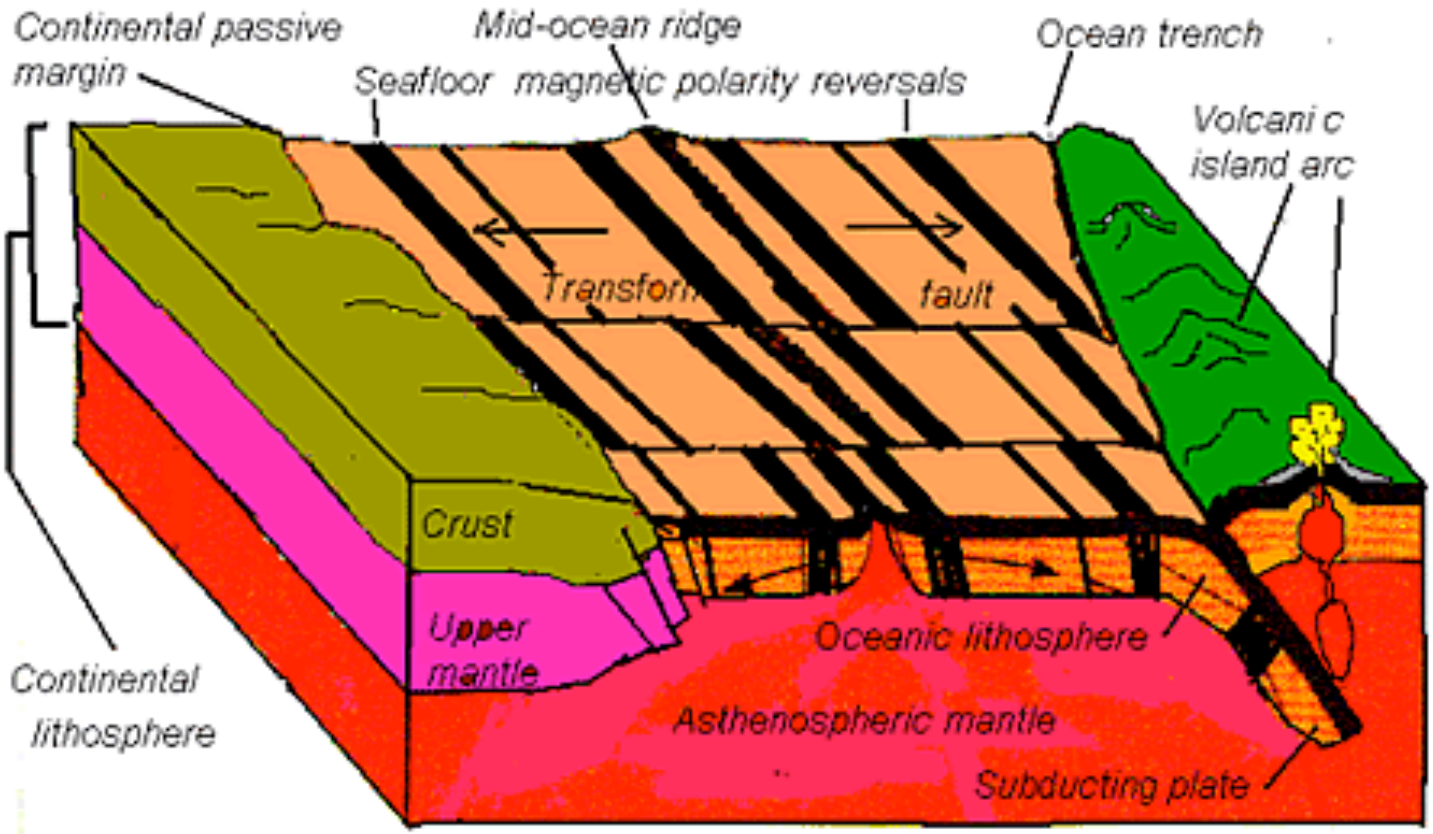
2. Hydrologic cycle - This is the movement of water from the oceans to the atmosphere and back to the oceans by way of: Evaporation, precipitation, Runoff in streams and rivers, infiltration and Groundwater flow



12

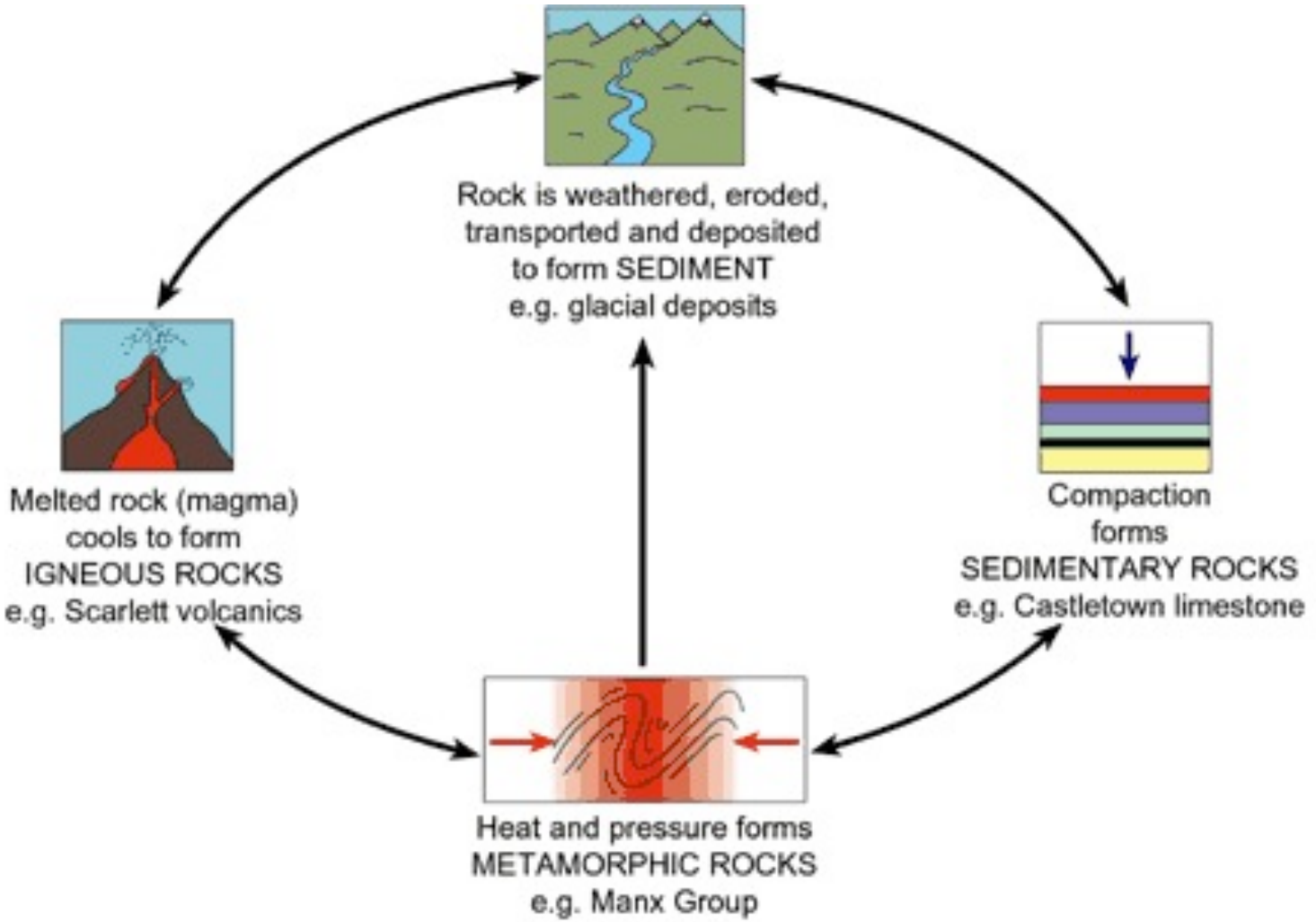
3. Tectonic cycle - This is a process driven by forces deep within the earth. These forces:

- Deform the earth's crust
- Produce external forms such as ocean basins, continents, and mountains

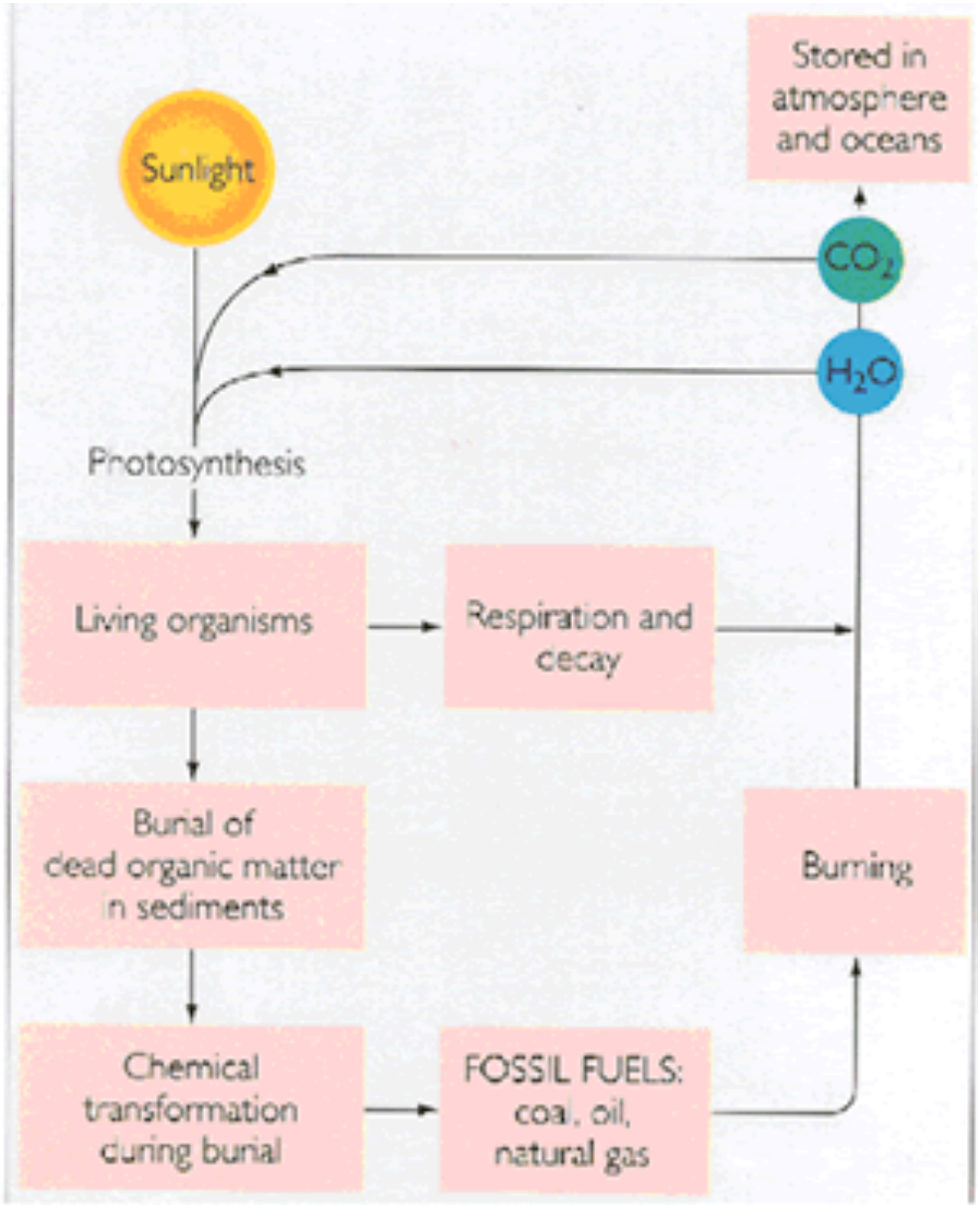


Lithosphere (crust + upper mantle) plates diverge at ocean ridges. Descending ocean plates are remelted at subduction zones, generating earthquakes and island arc volcanoes.

4. The rock cycle is a sequence of processes, which produce the three rock families: igneous, sedimentary, and metamorphic



5. The geochemical cycle is the migratory path of elements during geologic changes. This cycle involves the chemistry of the lithosphere, asthenosphere, hydrosphere, and biosphere.



15

Introduction VII – Geology, Pollution and health

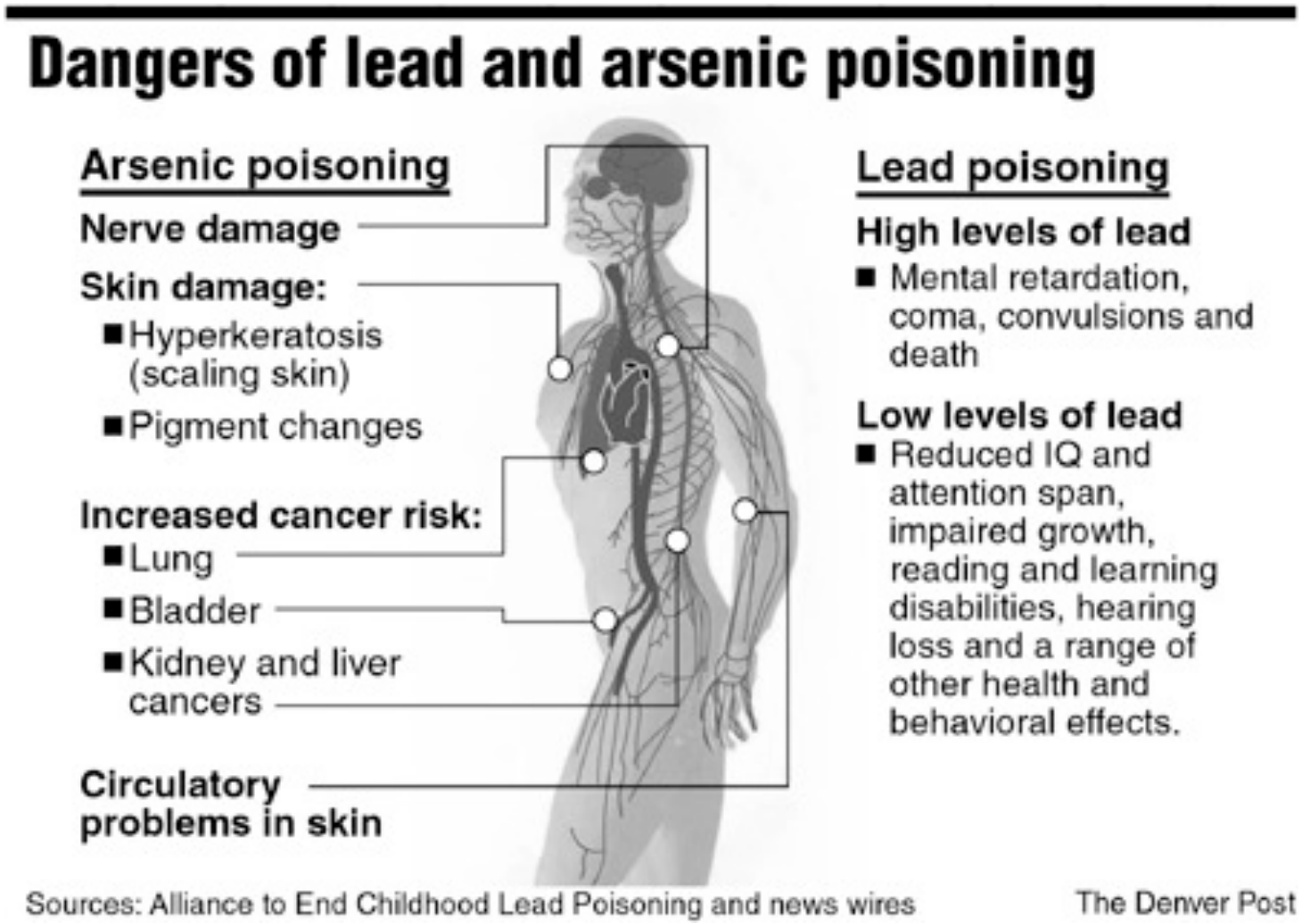
- Toxins
  - Hg, Cd, As, etc.
- Carcinogens
  - Asbestos, Silica Sand
- Radiological hazards
  - Uranium and Thorium decay series (U, Th, Ra, Rn, Po)
- Hazards arise from:
  - Bulk Chemistry
  - Trace impurities
  - Physical State
- Disease and conditions:

  Cancer, fluorosis, nervous diseases

Dental fluorosis

16

Introduction VII – Geology, Pollution and health



Introduction VIII – Hazardous geological processes

- Direct volcanic hazards
  - Lava Flows
  - Ash falls
  - Pyroclastic flows
  - Mudflows
  - Landslides and cone collapse
  - Floods
  - Gases
- Climatic effects
  - Stratospheric ash
  - Sulfur aerosols
- Super-Volcanoes
  - Magma chamber collapse
  - Flood basalts

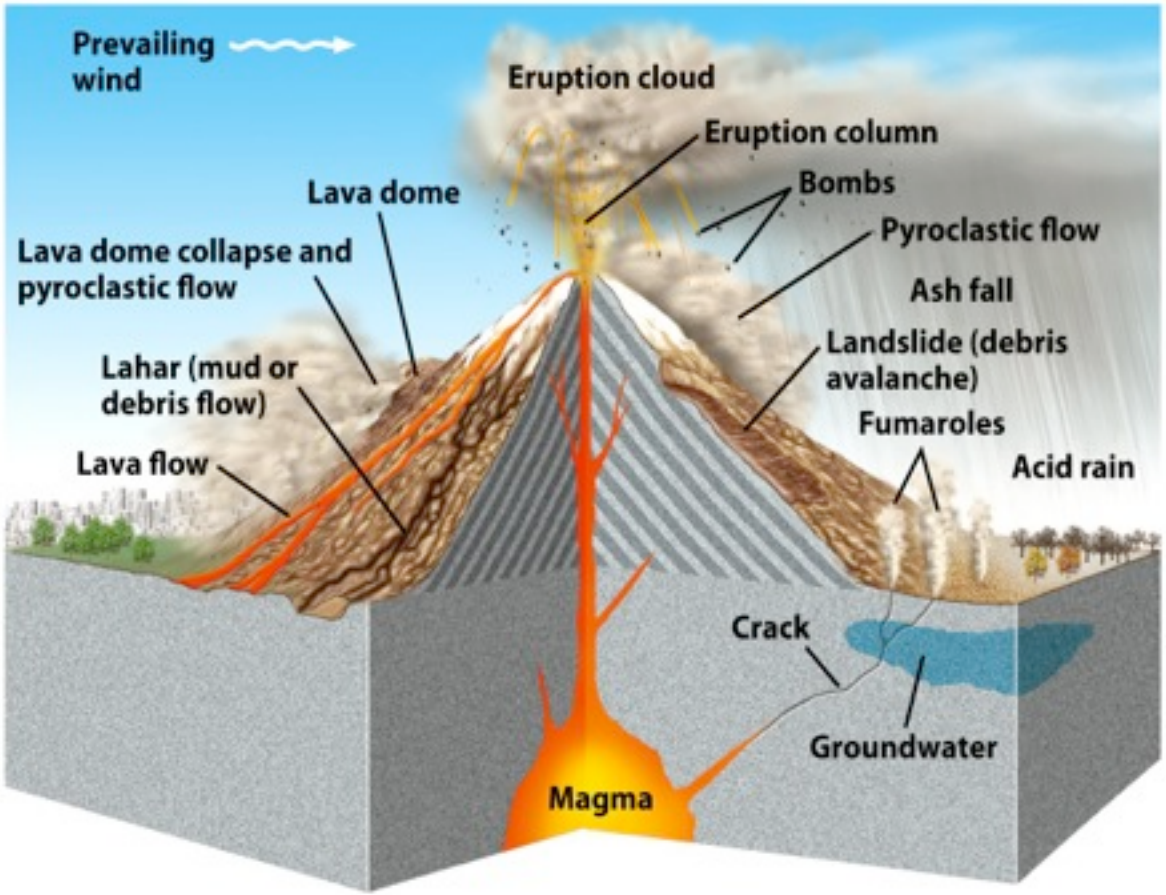


Figure 12.29
Understanding Earth, Sixth Edition
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Introduction VIII – Hazardous geological processes

- Earthquakes
- Causes
  - Plate boundaries
  - Intraplate
- Hazards
  - Buildings, Tsunami, Landslide, Fire
- Hazard Mitigation
  - Construction, Zoning
- Prediction?
  - Short Term (Precursors)
  - Long Term (Seismic Gaps, Paleoseismology)

Chapter 13 Opener
Understanding Earth, Sixth Edition

Earthquake damage in Mexico City, 1985

Figure 13.25
***Understanding Earth*, Sixth Edition**

Tsunami effects in Thailand, 2004

Unnumbered 13 p364a
Understanding Earth, Sixth Edition

Introduction IX - Soils

- Soils are complex entities, resulting from the interaction of:
  - Time, Climate, Vegetation, Drainage
- Types of Soils
- Soil Erosion
  - Poor plowing practices
  - Overgrazing
  - Deforestation
- Other Soil Degradation
  - Climatically inappropriate farming
  - Urbanization
- Soil preservation approaches
  - Contour plowing
  - Strip cropping
  - No-till agriculture
  - Reforestation

Introduction X – Weathering and Erosion, Coastal Processes

- Floods
  - River floods
  - Coastal floods
  - Dam Failure (Natural or Artificial)
- Mass Wasting
  - Soil Creep
  - Mudflows
  - Avalanches
  - Slumps
- Coastal processes
  - Storm surges
  - Erosion
  - subsidence

Geological Activity of Wind - 1

5. The Desert Environment:
Where the Deserts Are

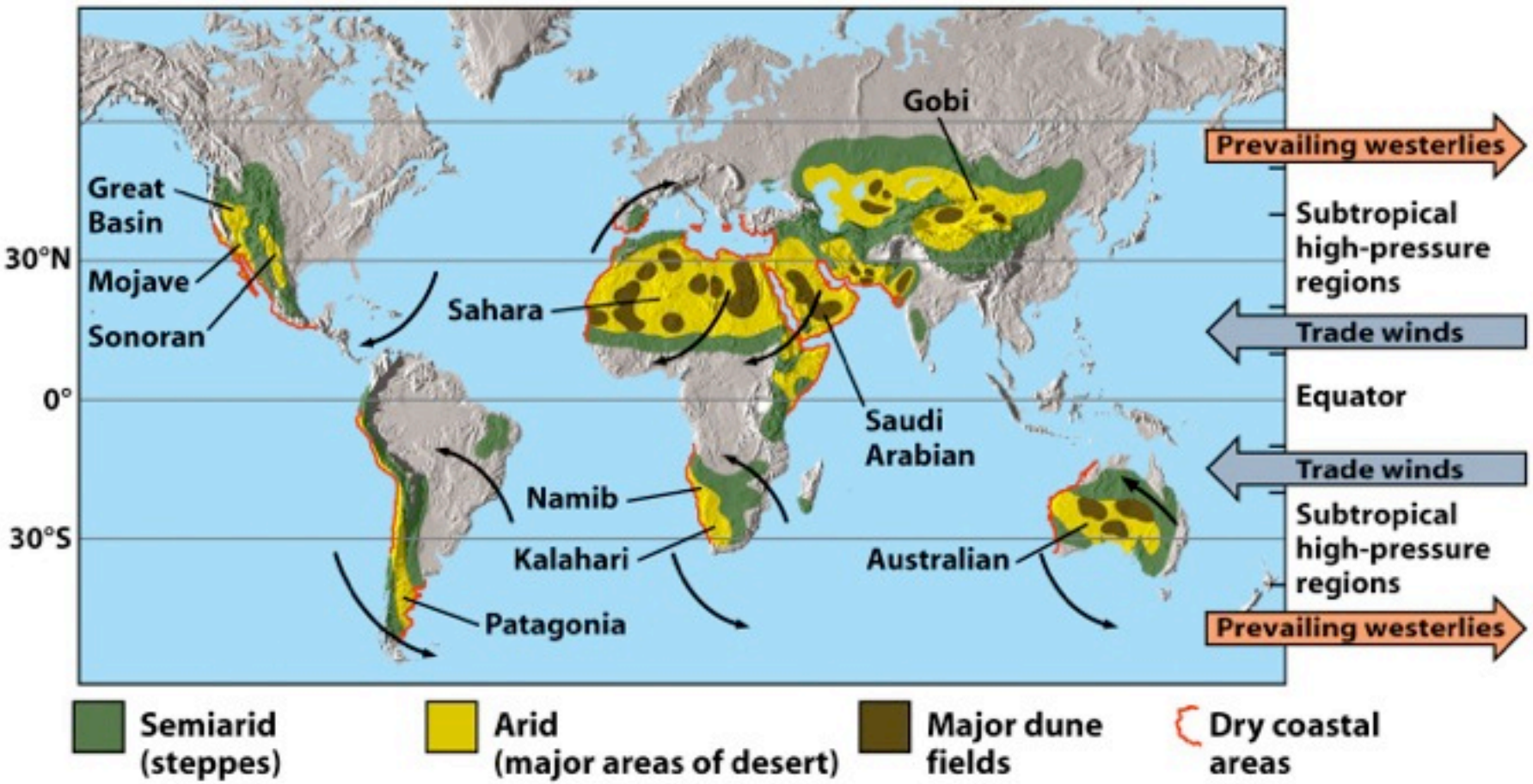

Figure 19.15
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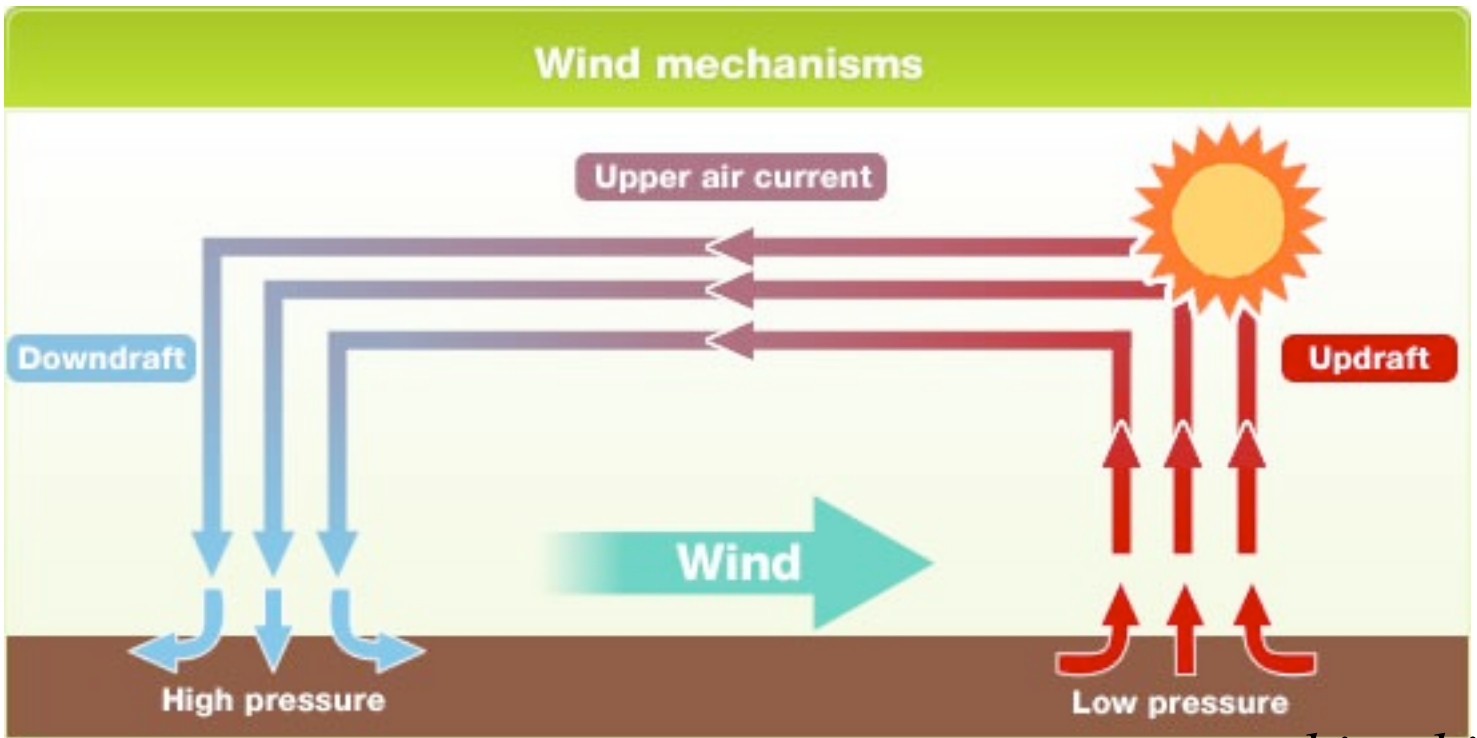
How does wind Blow?



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- the eolian system, like other parts of the hydrologic system, takes its energy from the Sun and the uneven heating of the planet

Introduction XI – Deserts and Wind Erosion

- Desertification
  - Expansion of deserts at the margins due to overgrazing and deforestation
  - North Africa was forested in pre-Roman times
  - Sub-Saharan Africa
- Wind Erosion
  - Loess soils feed the world
  - Present-day wind erosion strips topsoil
  - Burial of vegetation or exposure of roots
  - Respiratory hazards
  - Cost of clearing wind-blown sediment from roads
  - Wind Deposition

Introduction XII – Surface and Groundwater

- Surface Water
- Lack of potable water is the single greatest hazard to human health
- Problems with surface water
  - Disease organisms
  - Contamination by pollutants and sewage
- Overuse of Surface Water

- Ground Water
- Mechanics of ground water
  - Recharge zone, Aquifers, Aquitards, Springs, wetlands and lakes, Artesian systems, Wells, Karst
- Human impacts on ground water
  - Cone of depression
  - Migration of salt water and contaminants
  - Contamination of aquifers
  - Land subsidence
  - Impact on surface water

Introduction XIII – Resources

- Mineral Resources
  - Metallic versus non-metallic
  - Extraction methods
  - Environmental Impacts
- Non-Petroleum energy resources
  - Coal
  - Uranium
  - Geothermal
- Petroleum and Natural Gas
  - Geopolitical and Geological realities
  - Petroleum production
- Non-conventional energy sources
  - Methane hydrates
  - Tar sands
  - Oil shales
  - Oil mining
  - Hot dry rock geothermal
  - Deep Earth gas hypothesis

Introduction XIV – ExtraTerrestrial Hazards

- Can we predict impacts?
- Likely impact scenarios
  - Atmospheric impact and air burst
  - Surface impact causing local damage
  - Surface impact with 100 km damage radius
  - Surface impact with 1000 km damage radius
  - Surface impact with global effects
- What happens during impact
- Environmental Effects
  - Radiant heat and flash burns
  - Blast wave
  - Seismic waves
  - Tsunami
  - Ejecta
  - Stratospheric dust
  - Liberated volatiles (carbon dioxide, sulfur, methane)
  - Impact volcanism - a myth

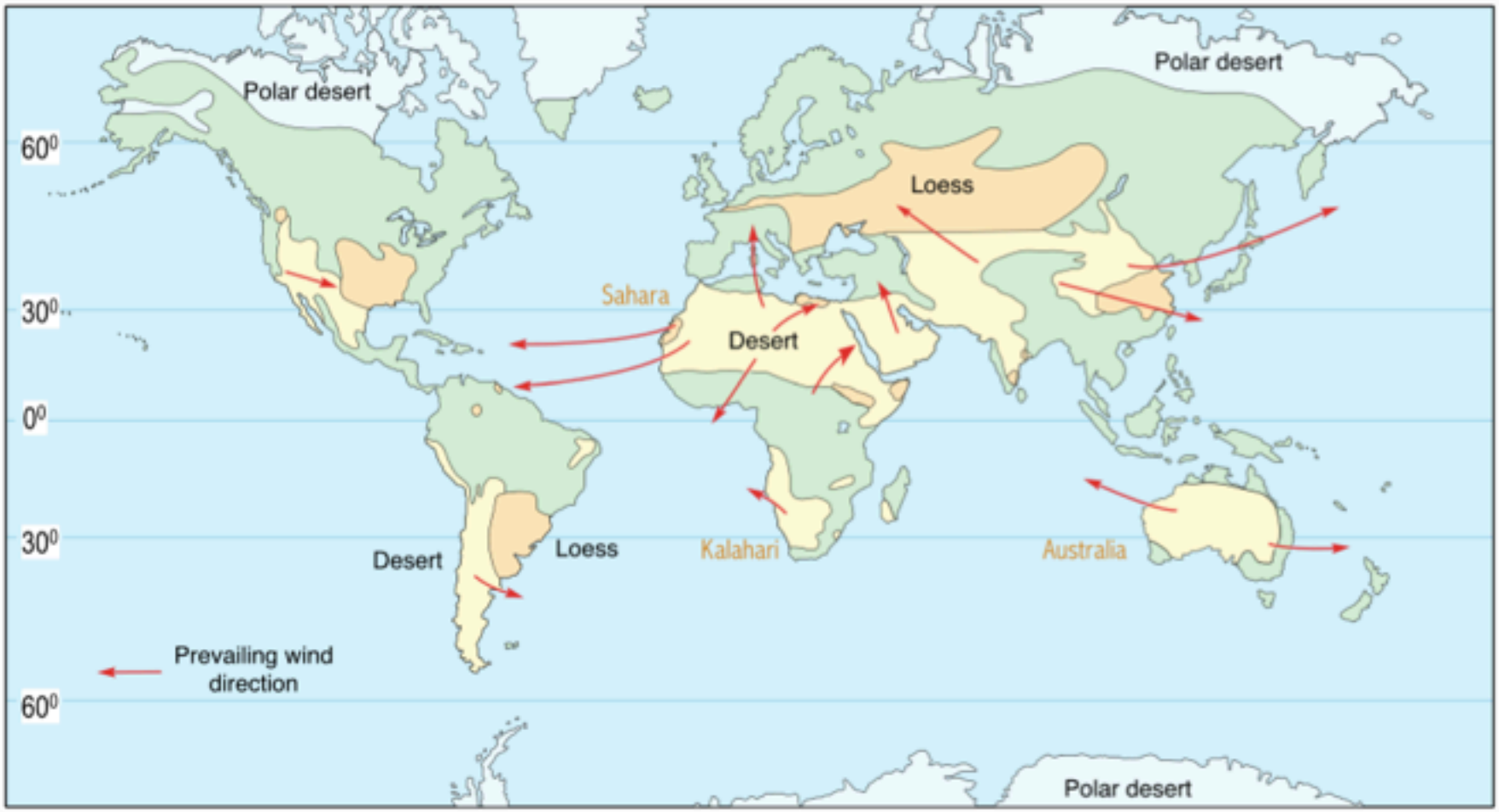
REFERENCE MATERIALS

Murck B.W., Skinner B.J. Porter S.C. 1996. ENVIRONMENTAL GEOLOGY. John Wiley and sons. 534 p.

Pipkin B., Trent D.D., Hazlett R. Bierman P. 2011. GEOLOGY AND THE ENVIRONMENT, 6th Edition Brooks Cole 574

Grotzinger, J and Jordan, T.H. 2010, UNDERSTANDING EARTH, W. H. Freeman; 6th edition edition. 680p

Introduction XI – Deserts and Wind Erosion



The World's Major Deserts, the sahara, the Kalahari and the deserts of Australia are near 30^0 N/S. these bands are under almost constant high atmospheric pressure where dry air subsides
Wind blown dust (loess) Accumulate downwind form major deserts