

# 1 CHAPTER 1

## **Introduction to Planet Earth**

### 2 **Chapter Objectives**

- Identify characteristics and geographic features of Earth's four (+1) principal oceans.
- Understand differences between an ocean and a sea.
- Summarize the early history of ocean exploration and understand the importance of the Library of Alexandria on the development of oceanography and world knowledge.
- Realize details of how technology has played a role in exploration and understanding the oceans.
- Explain the steps involved in the scientific method, including the difference between observation, hypothesis, scientific theory, and fact.

### 3 **Chapter Objectives (continued)**

- Briefly explain the origin of the solar system using the nebular hypothesis.
- Discuss the origin of the atmosphere and oceans, including the dynamics of ocean salinity over time and the changes to atmospheric oxygen levels.
- Describe how radioactive decay allows scientists to determine how old rocks are.
- List important Earth history events associated with the geologic time scale.
- Understand the composition, structure and physical properties of the Earth's interior.

### 4 **Overview**

- 70.8% Earth covered by ocean
- Interconnected global or world ocean
- Oceans contain 97.2% of surface water

### 5 **Principal oceans**

- Pacific
  - Largest, deepest
- Atlantic
  - Second largest
- Indian
  - Mainly in Southern Hemisphere

### 6 **Principal oceans**

- Arctic
  - Smallest, shallowest, ice-covered
- Antarctic or Southern Ocean
  - Connects Pacific, Atlantic, and Indian
  - South of about 50° S latitude
- 








### 7

### 8 **The Seven Seas**









- Smaller and shallower than oceans
- Salt water
- *Usually* enclosed by land
  - Sargasso Sea defined by surrounding ocean currents
- To the ancients, they were:
  - Red Sea, Mediterranean Sea, Persian Gulf, Black Sea, Adriatic Sea, Caspian Sea, Indian Ocean















### 9 **Comparison of elevation and depth**










- Average depth 3729 m (12,234 ft)
- 
- Average elevation 840 m (2756 ft)

- 
- Deepest ocean Mariana Trench 11,022 m (36,161 ft)
- 
- Highest mountain Mt. Everest 8850 m (29,935 ft)
- 10 
- 11  **Early exploration**
  - Pacific Islanders traveled long distances
    - Small islands, widely scattered
- 12  **Navigational Stick Chart**
  - Micronesia's Marshall Islands
- 13  **European cultures**
  - Phoenicians
    - Mediterranean Sea, around Africa, British Isles
  - Greeks
    - Pytheas reached Iceland 325 B.C.
      - Able to calculate latitude (but not longitude)
    - Ptolemy map 150 A.D.
    - Library of Alexandria 3<sup>rd</sup> century B.C.
    - Eratosthenes – circumference of Earth
- 14 
- 15  **The Middle Ages**
  - Vikings explored N. Atlantic Ocean
    - Iceland and Greenland 9<sup>th</sup> and 10<sup>th</sup> centuries A.D.
    - Leif Eriksson Vinland 995 A.D.
    - Greenland, Vinland settlements abandoned by 1450 A.D.
  -
- 16  **The Age of Discovery in Europe 1492-1522**

Search for new Eastern trade routes by sea

  - Portugal trade routes around Africa (Prince Henry the Navigator)
  - Europeans explore North and South America
    - Columbus, Cabot
  - Magellan and del Caño circumnavigate world
- 17  **Voyages of Columbus and Magellan**
- 18  **British Naval Power**
  - British Isles dominant naval power from 1588 to early 1900s
    - Spanish Armada 1588
- 19  **Beginning of voyaging for science**
  - Capt. James Cook (1728-1779)
    - Ships *HMS Endeavour*, *Resolution*, *Adventure*
    - Mapped many islands in Pacific
    - Systematically measured ocean characteristics
    - Marine chronograph (longitude)
- 20 
- 21 
- 22  **Cook's voyages**
- 23  **Bathysphere**
  - William Beebe, 1934
  - Record depth: 923 meters
- 24 


- 25  **Alvin**
- Robert Ballard, 1964
  - Discovered:
    - Hydrothermal vents (1977)
    - Wreck of the Titanic (1985)
  - Mother ship: *Atlantis*
  - Frequently visits San Diego
- 26  **Nature of scientific inquiry**
- Natural phenomena governed by physical processes
  - Physical processes similar today as in the past
  - Scientists discover these processes and
  - Make predictions
- 27  **Scientific method**
- Observations
  - Hypotheses
  - Testing and modification of hypotheses
  - Theory
  - Probably true versus absolutely true
  - Science is continually developing because of new observations
- 28  **Scientific method**
- 29  **Formation of Solar System and Earth**
- Nebular hypothesis
    - Nebula=cloud of gases and space dust
      - Mainly hydrogen and helium
    - Gravity concentrates material at center of cloud (Sun)
    - Protoplanets from smaller concentrations of matter (eddies)
- 30  **Ghost Head Nebula**
- 31  **Nebular Hypothesis Illustrated**
- 32  **Nebular Hypothesis of Solar System Formation**
- 33  **Protoearth**
- Larger than Earth today
  - Homogeneous composition
  - Bombarded by meteorites
    - Moon formed from collision with large asteroid
  - Heat from solar radiation
    - Initial atmosphere boiled away
    - Ionized particles (solar wind) swept away nebular gases
    -
- 34  **Artist's Conception of Protoearth  
(what's wrong here?)**
- 35  **Protoearth**
- Radioactive heat
    - Spontaneous disintegration of atoms
  - Heat from contraction (protoplanet shrinks due to gravity)
  - Protoearth partially melts
  - Density stratification (layered Earth)
- 36  **Relative positions and orbits of the planets**
- Plus the newly-designated "dwarf planet"
- 37  **Relative actual sizes of the planets**
- Minus you-know-who...
- 38  **Earth's internal structure**

- Highest density material at center (core)
- Lowest density material at surface (crust)
- Earth layered
  - Chemical composition
  - Physical properties
- 39  **Chemical composition**
  - Crust
    - Low-density, mainly silicate minerals
  - Mantle
    - Mainly Fe and Mg silicate minerals
  - Core
    - High-density, mainly Fe and Ni
- 40  **Layered Earth**
- 41  **Physical properties**
  - Lithosphere
  - Asthenosphere
  - Mesosphere
  - Outer core
  - Inner core
- 42  **Physical properties**
  - Lithosphere
    - Cool, rigid, brittle
    - Surface to about 100 km (62 miles)
  - Asthenosphere
    - Warm, plastic, able to flow
    - From 100 km to 700 km (430 miles)
  -
- 43  **Internal Structure of Earth**
- 44  **Lithosphere**
  - Oceanic crust
    - Underlies ocean basins
    - Igneous rock basalt
    - Average thickness 8 km (5 miles)
    - Relatively high density
      - 3.0 g/cm<sup>3</sup>
  -
- 45  **Lithosphere**
  - Continental crust
    - Underlies continents
    - Igneous rock granite
    - Average thickness 35 km (22 miles)
    - Lower density
      - 2.7 g/cm<sup>3</sup>
- 46  **Asthenosphere**
  - Upper mantle
  - Plastic—deforms by flowing
  - High viscosity—flows slowly
  -
- 47  **Isostatic adjustment**
  - Buoyancy
    - Less dense “floats” higher than more dense

- Continental crust “floats” higher than oceanic crust on plastic asthenosphere
- 48  **Isostatic Adjustment**
- 49  **Origin of Earth's atmosphere**
  - Partial melting resulted in outgassing about 4 billion years ago
    - Similar to gases emitted from volcanoes
    - Mainly water vapor
    - Carbon dioxide, hydrogen
    - Other gases such as methane and ammonia
- 50  **Origin of Earth's oceans**
  - Water vapor released by outgassing
  - Condensed as rain
  - Accumulated in ocean basins
  - About 4 billion years ago
- 51  **Outgassing Continues...**
- 52  **Ocean salinity**
  - Rain dissolves rocks
  - Dissolved compounds (ions) accumulate in ocean basins
  - Ocean salinity based on balance between input and output of ions
  - Ocean salinity nearly constant over past 4 billion years
- 53  **Life in oceans**
  - Earliest life forms fossilized bacteria in rocks about 3.5 billion years old
  - Marine rocks
  - Life originated in oceans?
- 54  **Stanley Miller's experiment**
  - Organic molecules formed by ultraviolet light, electrical spark (lightning), and mixture of water, carbon dioxide, hydrogen, methane, and ammonia
- 55
- 56  **Evolution and natural selection**
  - Organisms adapt and change through time
  - Advantageous traits are naturally selected
  - Traits inherited
  - Organisms adapt to environments
  - Organisms change environments
- 57
- 58  **Types of life forms**
  - Heterotrophs (most bacteria and animals)
  - Autotrophs (algae and plants)
    - Anaerobic bacteria (chemosynthesis)
    - Photosynthetic autotrophs
      - Chlorophyll captures solar energy
- 59  **Photosynthesis and respiration**
- 60  **Oxygen crisis**
  - Photosynthetic bacteria release oxygen (O<sub>2</sub>) to atmosphere
  - About 2 billion years ago, sufficient O<sub>2</sub> in atmosphere to oxidize (rust) rocks
  - Ozone (O<sub>3</sub>) builds up in atmosphere
    - Protects Earth's surface from ultraviolet solar radiation
- 61  **Oxygen crisis**
  - About 1.8 billion years ago, most anaerobic bacteria killed off by O<sub>2</sub>-rich atmosphere
  - Photosynthetic organisms created today's O<sub>2</sub>-rich atmosphere
    - O<sub>2</sub> makes up about 21% of gases in modern atmosphere
    - Animals thrive

62 

63  **Atmospheric Oxygen Concentration**


64  **Age of Earth**


- Radiometric age dating
  - Spontaneous change/decay
  - Half-life
- Earth is about 4.6 billion years old

65 

66  **Earth's Timeline**

- Deep time ("billions and billions")

67  **Geologic Time Scale (simplified)**

68  **End of CHAPTER 1 –**

**Introduction to Planet "Earth"**