September 10, 2018
Beginnings of Oceanography an Oceanic Trade
Note Taker: Julia Winberg

- 900-700 BC, Greeks begin to travel outside Mediterranean
- Red Sea: Named for cyanobacteria which is red
    - Cyanobacteria fixes nitrogen
    - Cyanobacteria “makes its own fertilizer” from nutrients in the ocean
    - This particular cyanobacteria in Red Sea: **Trichodesmium**
    - But back in 900 BC, they only know that the water is red
- **Trade** drives oceanic exploration
- **Food** (and the search for it) drives oceanic exploration
- **Politics** drive oceanic exploration
- **Threats** (like volcanoes or the environment or people) drive oceanic exploration
- Polynesians
    - Canoe-like ships
    - **No modern tools!**
    - Travelled millions of miles across the Pacific
    - Explored dozens and dozens of islands
    - Approx. 30k years ago (this is when they were thought to discover New Guinea)
    - Approx. 10k years ago they discovered Society Islands
    - Philippines discovered approx. 20k years ago
    - Hawai’i, the farthest away and their greatest achievement, discovered approx. 1500 years ago
    - Easter Island, ~1200 years ago
    - Motivated by famine, volcano, war, (likely looking for resources)
    - Left behind archaeological (pottery) and DNA evidence
- Hoku’lea
    - Modern-day Hawaiian tribute to Polynesian explorer ancestors, who didn’t use any modern tools
    - Voyaging large part of Polynesian ancestry, source of culture and pride for today’s Polynesians
    - Hoku’lea named after Hawaiian word for Arcturus, the Bear star

    - The Hoku'lea is a replica of the double-canoe-style boat that Polynesians would have used to explore
    - In 1970, Hoku'lea begins voyages, 1976, she voyages to Tahiti from Hawaii, which takes 31 days for a 2500 mile voyage
    - Travels throughout Pacific, reuniting Polynesian culture, strengthening, reviving, healing pride
- Early Polynesian Navigation
    - **NO** modern tools
    - Instead, you had:
        - Currents
        - Waves
        - Winds
        - Stars
        - Sun
        - Animal presence/ Species you see
        - Reflections of islands in cloud cover
        - Bird species around your boat (frigate or bird might indicate land closeby)
        - Sound and direction of swells
        - Smell of water, seaweed (open ocean has no smell)
    - All of these could possibly indicate the presence of an island in the distance. You would become an expert at reading these in order to lead your ship.
    - **Stick Chart:** Ancient map showing patterns of currents or waves, shells demarcating islands
- Vikings in North Atlantic
    - Explored well before Columbus: 800, 900, 1000
    - Pillagers: traveled with battle gear to be able to loot and raid
    - Erik the Red: Famous viking, Traveled from Iceland to Greenland
    - Bjarni Herjolfsson: Discovers Newfoundland
    - Leif Ericson, son of Erik the Red, Advertises Newfoundland as Vinland for grapes, but Vikings had to leave Vinland by 1450 because of political issues with the native tribes there (war)
    - Said that vikings used to take mushrooms in order to amp themselves up for battle

    - Vikings used double-ended ship with oars and rowers on one side (steer-board, later called starboard)
- Zheng He
    - 1405-1433
    - 48 to 317 ships (largest fleet known to man, dwarfs Magellan and Columbus)
    - 28k crewmembers
    - Figured our source of scurvy (vitamin C deficiency) and grew vertical gardens on his ships, lots of citrus
- James Cook
    - 1728-1779
    - Three expeditions
        - **Endeavor (Pacific)**
        - **Resolution (Pacific and South America)**
        - **Adventure (North Pacific, Asia)**
    - First expeditions with science-based intentions to learn more about the ocean
    - Mapped the Pacific, essentially went from the Arctic to the Antarctic
    - First depth soundings: Dropping weighted rope with weight covered in wax down to bottom of the ocean and then pulling it back up (currents might make these readings inaccurate)
    - Winds and Current observations
    - Subsurface temp. Measurements
    - Attempts Biological Sampling: phytoplankton, larvae to larger fish
    - Cook is first to bring planet into oceanic perspective with awareness of the ocean
- H.M.S Beagle
    - Ship Darwin sailed on
    - Darwin: terribly sea sick, observations were on land because he wanted to get off the ship as much as possible, sometimes got off the ship and walked the coast before meeting it at port
- Lt. Charles Wilkes
    - Around this time, oceanography is dominated by wealthy men, a lot of them are in the Navy. Wilkes is one of them.
    - American, explored coast of Antarctica
    - USS Vincemes

    - Explores Oregon, San Francisco Bay, Hawaii (but was already discovered by Polynesians)
    - Disappointment Bay
- Lt. Matthew Maury (also a Navy guy)
    - Father of Physical Oceanography
    - Writes *The Physical Geography of the Sea,* the first oceanographic textbook.
- Challenger Expedition
    - Charles Wyville Thompson (another rich dude)
    - Late 1800s, December
    - 70k nautical miles
    - Sampling the ocean
    - Begins to explore Marianas Trench
    - 362 sample/observation stations, which he made an effort to make as unifotm as possible: Depth, Sample of bottom, and Sample of bottom water
    - Thompson has a scientific question in mind: **"Is there life at the bottom of the ocean?"**
- **Azoic Theory: There is no life at the bottom of the ocean**
- There are competing opinions to this theory despite it being relatively accepted. People laying **telegraph cables** across the Atlantic have seen animals and life on the cables they pull up.
- Edward Forbes
    - Champion of Azoic Theory, No life below 550m
- Thompson disspells Azoic Theory on the Challenger expeditions
- He completes 133 dredges, and discovers 4700 species
- Fridtjof Nansen
    - Explorer of the Arctic Circle and Greenland
    - Dogsled Skier
    - Wins Nobel Peace prize after saving a bunch of refugees
    - Productive guy to say the least
    - Nansen Sampling bottle named for him, still a tool used today, snaps shut at a certain depth so you get a pretty accurate sample of a certain part of the water column

    - Nansen leads the Fram Schooner, which at one point got stuck in ice in the Arctic Circle
- Marine Research Today
    - Nay Exploration
    - Woods Hole Oceanographic Institute: Premier institute for oceanography, started in 1871
    - Bathysphere, 1930, first deep sea dive. 923m.
    - Trieste, another deep sea dive on Nay exploration, 1960, plexiglass protection on board (yikes).
    - James Cameron, donates Alvin to NOAA, Alcin had completed 4400 dives, very productive submersible

Wednesday, September 12, 2018

Building a Universe

"You and I are flesh and blood, but we are also stardust."

-AP Bio Textbook, Prof. Fulweiler's favorite quote

- Major Constituents of Living Tissue: (CHONPS)
    - Hydrogen
    - Carbon
    - Nitrogen
    - Phosphorous
    - Sulfur
    - Oxygen
- These make up 95% of the biosphere, which is the global sum of all ecosystems and the zone of life on Earth, including Biotic and Abiotic components
- A bit of Chem review
    - Atomic #: no. of protons
    - Atomic weight: average mass of atoms of an element, calculated using the relative abundance of isotopes in a naturally occurring element
    - Isotope: Atom with same number of protons but different number of neutrons
- Universe begins with Hydrogen and Helium
- Big Bang: H and He created, this is called **nucleosynthesis,** about 13.7 billion years ago

- 1 billion years later, the stars formed and with them, other heavier elements.
- Most elements besides Hydrogen and Helium are made in what is called **stellar nucleosynthesis**
- In a star, under really high temperature and pressure, elements can bond, creating other elements.
- It is said that there are 200-400 billion stars in our Milky Way galaxy alone, and that there are 3,000 galaxies in just a pinhole view of space.
- There are more stars than grains of sand on all the beaches on planet Earth.
- Emanuel Swedenborg
    - The Nebular Hypothesis and the Solar Nebular Disk Model
- Nebula: Ball of gas and dust
    - Nebula heats, flattens, and spins, Hydrogen and Helium condense it
    - Metal rock “seeds” cool down, and sink as they cool
    - Dust and Rocks slam into one another
    - Gaseous dust begins to leave
    - ALL OF THIS reveals the PLANETS
- Terrestrial, denser planets are closer to sun
- Gaseous planets further away on the outside of the solar system
- Early Earth
    - Collisions big factor in Earth coming together, transfer of kinetic energy into heat
    - Compression
    - Radioactive Decay of elements (uranium, potassium)
- Think of Early Earth as mixing cake batter
    - Material melting and mixing together
- Planet begins to cool as these things trail off and decline
- Heavier things sink into the middle
- Separation and differentiation
- Core of Earth is Iron and Metals
- 100 million years after initial accretion, metals slowly begin to separate out, building a molten core
- Density Stratification
    - Reminder: density is mass per unit volume
    - Density runs the planet: atmosphere, weather, etc.

- Global differentiation
    - Light stuff on the outside, heavy stuff in the middle
    - Crust- mantle-liquid outer core- solid iron inner core
    - All of life teetering on this thin veneer of livable surface
- Each of Earth's layers has distinctive chemical composition: Crust is different from Core
- Crust made of lighter elements like aluminum, core made of iron
- Formation of the Moon (Giant Impact Hypothesis)
    - Moon was part of Earth.
    - A planet or asteroid the size of Mars slammed into Earth and freed up a piece of it
    - Here's why we think this is true: Moon rock is much younger than other celestial bodies, only about 30-55 million years
    - Moon has no iron core and is much less dense than Earth, even though it has a similar composition to the Earth
    - Giant Impact could also explain why the Earth is tilted
- Origin of Earth's Atmosphere
    - Partial Melting resulted in outgassing about 4 billion years ago
    - Water vapor, carbon dioxide, hydrogen
    - Methane and ammonia
    - Think of steam leaving food or smoke blowing off a volcano
- Where did the Ocean come from?
    - Water vapor cools and condenses, maybe from outgassing.
    - It rains for about 20 million years. Heavy, heavy rains. Accumulates in Ocean Basin.
    - Oceans only about 4 billion years old
    - Oceans could also be from asteroids, maybe comets (otherworldly water? Maybe ice comets?)
    - This is very hot area of debate

Friday, September 14, 2018

Hurricanes

- There are many different names for Hurricanes:
    - Tropical Cyclone
    - Huracan: Caribbean Taino people's God of Wind, inspired "hurricane"
    - Typhoon: "Great Wind"
- Hurricanes are defined by wind speed
    - 119 km/h, 74 mph.
- Tropical depression: 38 mph or below
- Tropical storm: 38-73 mph)
- What drives a Hurricane?
    - Sea Surface Temperature (SST)
        - Big deal with climate change and increasing heat in the ocean, storms increasing
    - Water needs to be 79 degrees F, this is the "magic number"
    - A LOT of sea surface temps today are above average-- more energy and more heat to build storms
- Atmospheric Circulation
    - Think about boiling water: steam rises up, cools off and sinks down again
    - Most of the atmosphere functions as a convection cell with heat moving in a circular motion, heating, rising, sinking, cooling. This drives weather patterns
- Heat rises, cold air sinks
- Warm air = more water vapor
- **Wind = moving energy**
- Pressure
    - High pressure, molecules are close together. It's cold.
    - Low pressure, molecules are far apart, it's warm.
    - The Earth's upper troposphere is cool, Earth's surface is warm
    - High pressure: Dry, sunny weather
    - Low pressure: rain or snow
- Hurricanes:
    - Start as a low pressure cell. The wind feeds water vapor. Air rises, low pressure develops, and the storm develops.
    - A lot of hurricanes start as thunderstorms moving west off of Africa

    - Hurricanes need low wind in upper atmosphere, otherwise they will be broken apart
- Hurricane Anatomy:
    - Diameter varies a lot: typically 124 miles across, but can be up to 500 miles. They can get really big.
    - **Eye: High pressure center of storm**
    - As soon as a hurricane makes landfall, it begins to lose energy
    - Hurricanes rotate because of the Coriolis Effect
    - High pressure on top of the storm pushing down on it
- Categorizing Hurricanes
    - Saffir-Simpson Scale
        - **1: 74-95 mph, winds produce damage**
        - **2: 96-110 mph, extensive wind damage**
        - **3: 111-129 mph, devastating**
        - **4: 130-156 mph, catastrophic**
        - **5: 157 mph or higher, catastrophic**
- There is an imaginary band around the center of the earth where hurricanes are most popular. Think Philippines, Florida area
- The most dangerous part of a hurricane is the right front quadrant of the storm. If the hurricane were a clock, it would be the area from 12 to 3. Because the storm twists counterclockwise (Coriolis effect), and moving forward, the most powerful landfall will be where the front of the storm is “swinging around” to the left.
- Destruction
    - High Winds
    - Intense rainfall
    - Storm Surge (most dangerous)
- Rainfall can exceed one inch an hour, huge amount, especially if it’s a slow moving storm
- Rain and sea spray removes friction between the land and the storm, allowing it to save energy and continue even if it made landfall
- **Storm Surge: Low pressure, dome of water, can reach 1m high in open ocean, pushed into land when hurricane makes rainfall, causing floods.**
- Effects of a storm surge can be felt before the hurricane makes landfall.

- Shoreline geography matters a lot during a storm. Flat shorelines (think: Carolinas) make storm surge way more dangerous and can take a really long time to recede.
- Hurricane Katrina’s storm surge was around 25 feet. This is a lot. Storm surges are no joke.
- Hurricane Florence related dangers: What’s on land? What is potentially toxic that should not be spread around by a flood or put into the ocean? What do we do about this?