Pacific Island navigation is able to construct "linear" constellations – that is to say a string of stars all of which rise at the same point. So when one of these is over head you would know your latitude!

The Pacific Islanders also "read" currents – the general movement of the water. Between the stars and the currents, they are able to find their way fairly accurately. They also know the positions of certain islands and would be able to recognize them when nearby.

Islands also tend to have clouds over or around them and so seeing specific localized clouds would also be a clue to their position. In some instances, for example at night, the sound of the waves on a beach would indicate there was an island nearby.

The Pacific Islanders made charts showing the currents and the islands and the stars. Some of these are on exhibit in the Peoples of the Pacific Hall at the Museum of Natural History. See if you can find them in the Hall.

HISTORICAL EVENTS LED TO AN AGE OF EXPLORATION WHICH INVOLVED EUROPEANS SETTING OUT TO FIND NEW TRADING PARTNERS. THESE LED TO THE EUROPEANS DISCOVERING NEW PLACES – BOTH LANDS AND SEAS

In 711, the Moslems had taken over Spain. The Spanish fought them for many years and finally forced the Moslems were driven out Jan 2 1492. This is the same year that Columbus heads out to the New World. A number of explorers travelled to Africa and the "New World" looking for passages to Asia and new trading partners.

From the beginning of the 15th Century, there was a European exploration of the world. Among them were

a. Christopher Columbus (1492) reaches islands in Caribbean
b. Portuguese reach west Pacific (Arabs precede them) and Spanish reach Eastern Pacific
c. Ponce de Leon (Florida 1513);
d. Hernán Cortés (arrived NW 1511 Conquest of Mexico 1591-21)

e. Ferdinand Magellan (1521) first to cross the Pacific
f. Francisco Pizzaro who explored Peru and battle the Inca (1524 and 1526; 1532- 33 conquest of Peru)
g. Fernando De Soto who traveled through the SE US as far as the Mississippi (1539)

Colonies form

a. Roanoke Colony formed and vanishes 1585 (Birthplace of Virginia Dare – first British Child born in NW Becomes the "Lost Colony"
b. Jamestown 1607 (First permanent English settlement)
c. Plymouth 1620

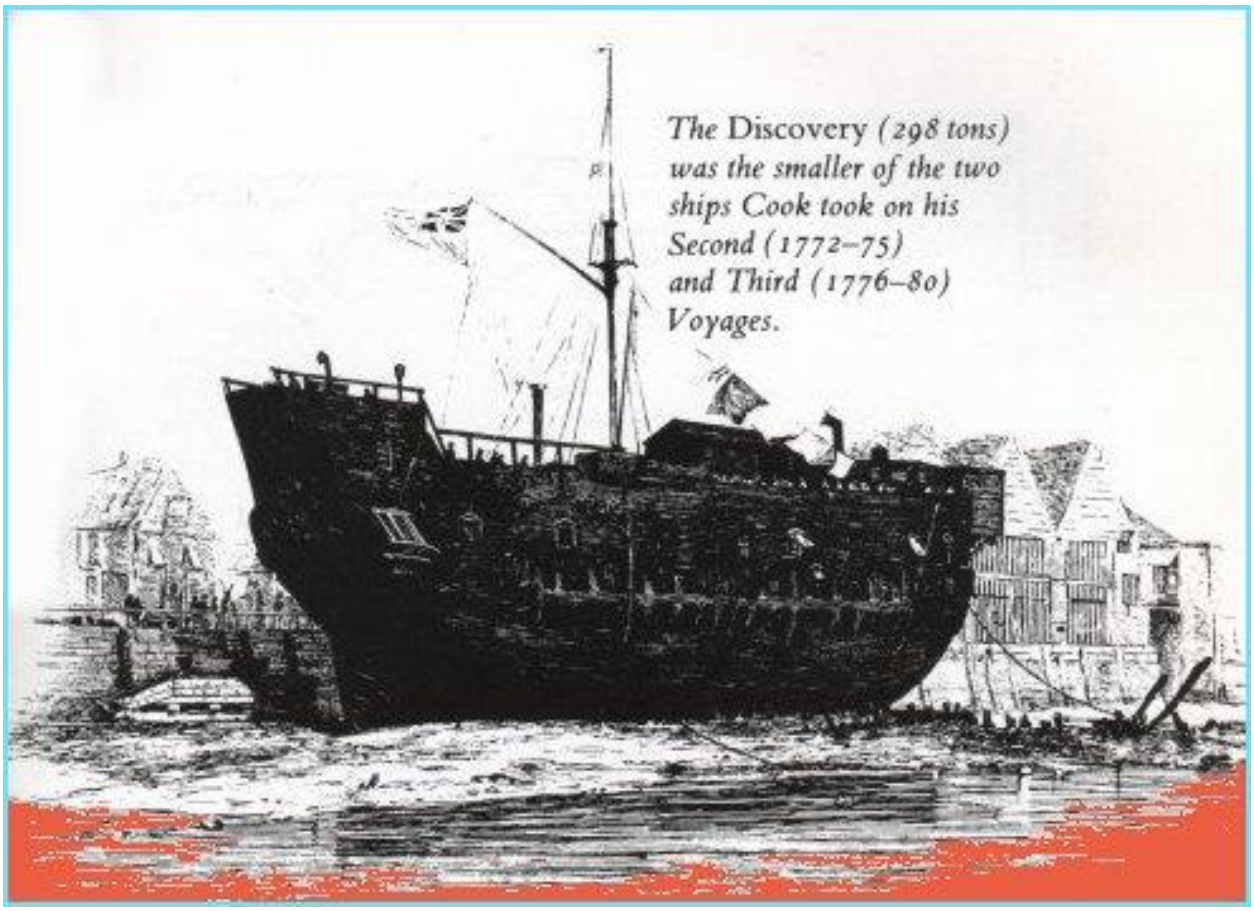
Captain James Cook:
James Cook made three expeditions into the Pacific. The first of the three voyages were 1768-1771

These early expeditions are of course on square rigged ships (mast go across the ship from starboard to port. Crew has to climb in the rigging to haul sails in and so on.

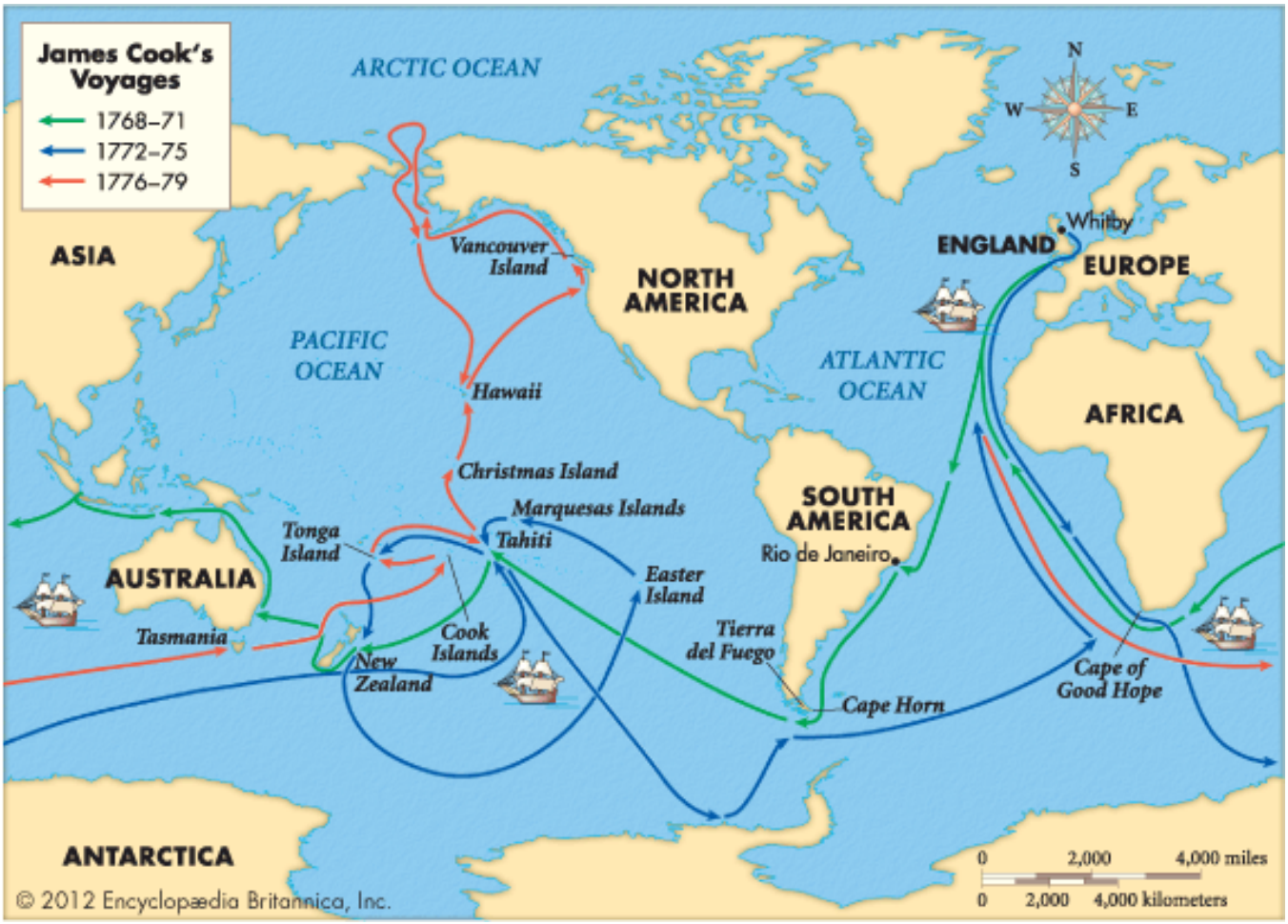
His first ship was the Endeavour, on the second and third voyage his ship was the Resolution. On voyage II he was accompanied by another ship called the Adventure and on the third voyage he was accompanied by the Discovery

The Endeavour (replica)

The Resolution (painting)


The Discovery (298 tons)
was the smaller of the two
ships Cook took on his
Second (1772–75)
and Third (1776–80)
Voyages.

Discovery



CAPT. COOK'S VOYAGES

Captain James Cook set out to locate and map the Islands of the pacific. He made three voyages. On the first his locations on the map were quite good, but on the second voyage they were better. This accuracy was caused by an invention called the chronometer which aided in navigation.

He is known as the first person to circumnavigate the globe in 1771 during which time he made maps of the East Coast of Australia and of New Zealand. He watched diet carefully for his crew and eliminated scurvy a disease caused by a deficiency of vitamin C, characterized by swollen bleeding gums and the opening of previously healed wounds, which particularly affected poorly nourished sailors until the end of the 18th century.

He tried to find a Northwest passage from the Atlantic to the Pacific and found there was none (at the time). He had gotten furs in this area.

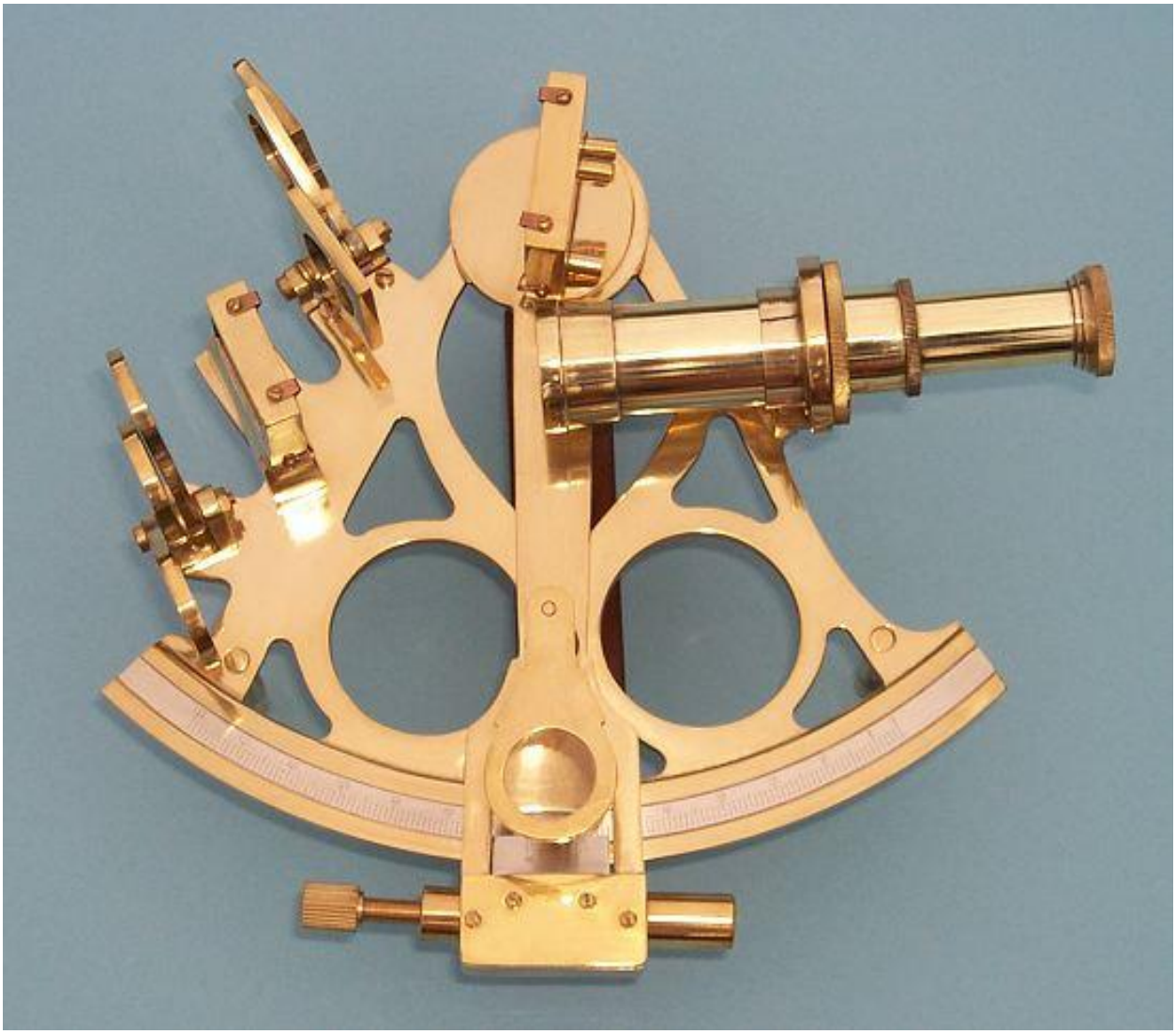
He returned to the Hawaiian Islands in the winter of 1778–1779 and was killed in Kealakekua Bay on Valentine's Day 1779 His sailors found that the furs brought huge amounts of money in China and nearly mutinied to go back to Alaska and get more. This is the start of the fur trade.

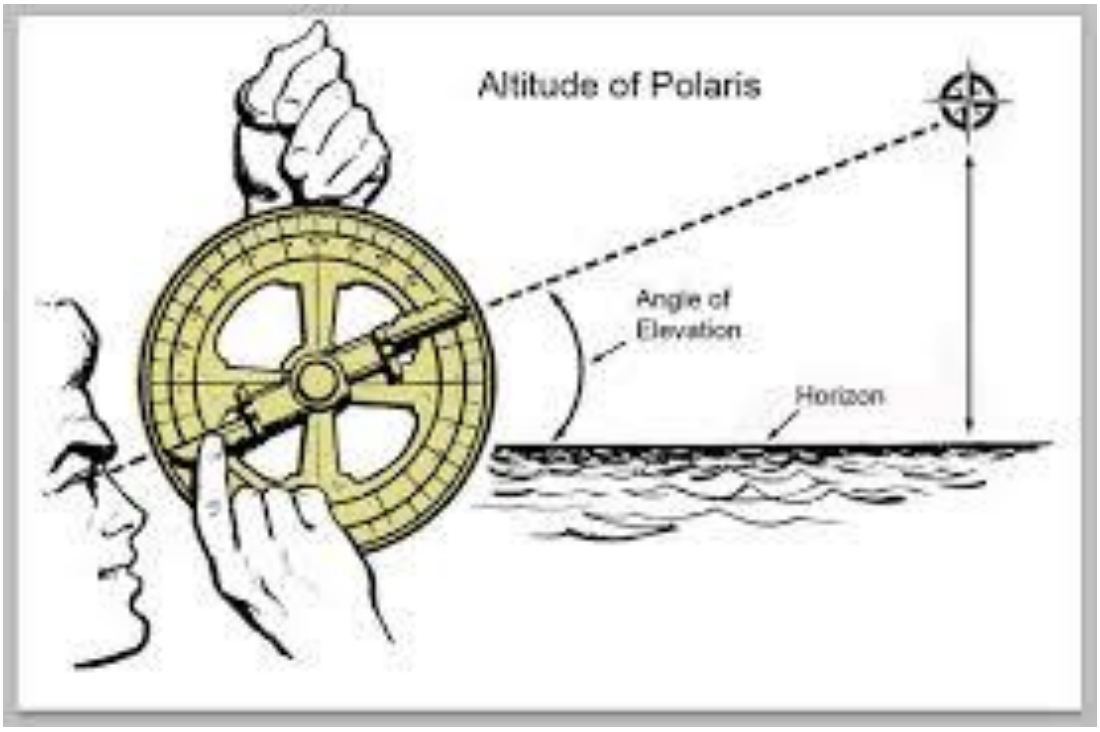
So what was the role of the chronometer in navigation?

LATITUDE AND LONGITUDE

One of the critical problems in ocean travel is the absence of landmarks. The locating of oneself on the ocean is done by locating oneself where 2 lines cross one another. The lines running from north to south are called longitude lines and the ones circling the globe parallel to the equator are called latitude lines. The finding of both lines is done in the past in the west largely astronomically reckoned. There is a form of navigation called dead reckoning which is actually derived from deduced reckoning, in which the navigator estimates t he speed and direction of a vessel and "deduces" where it is.

Finding one's latitude is fairly simple, but requires some knowledge of the stars at night. The earth rotates once on its axis roughly every 24 hours. During the time when the stars are visible, they can be used to determined ones latitude fairly simply. The earth's rotation axis points to the star "Polaris" sometimes called "The Pole Star". If one were standing directly at the North Pole it would be directly overhead at 90 degrees above the horizon. As one travels further south, the pole star would appear to leave its position overhead and finally rest on the horizon - or 0 degrees above the horizon when the observer was on the equator. So one's latitude can be told by measuring how many degrees above the equator the North Star appears on a sextant





and that would be one’s latitude. This works in the northern

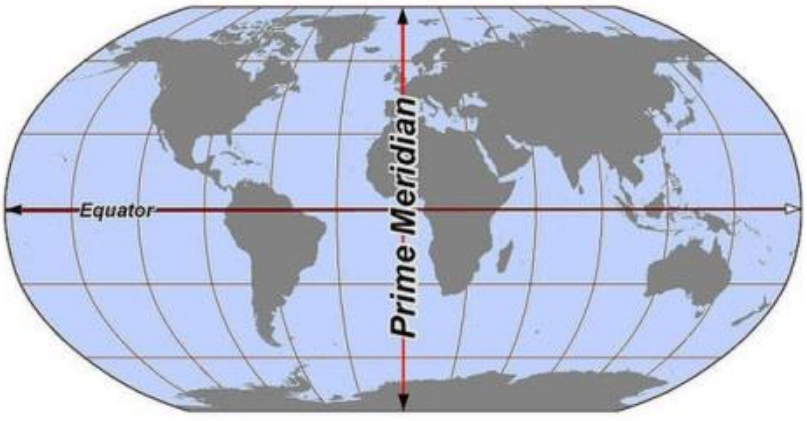
hemisphere. In the southern hemisphere the same principle applies but with a different marker.

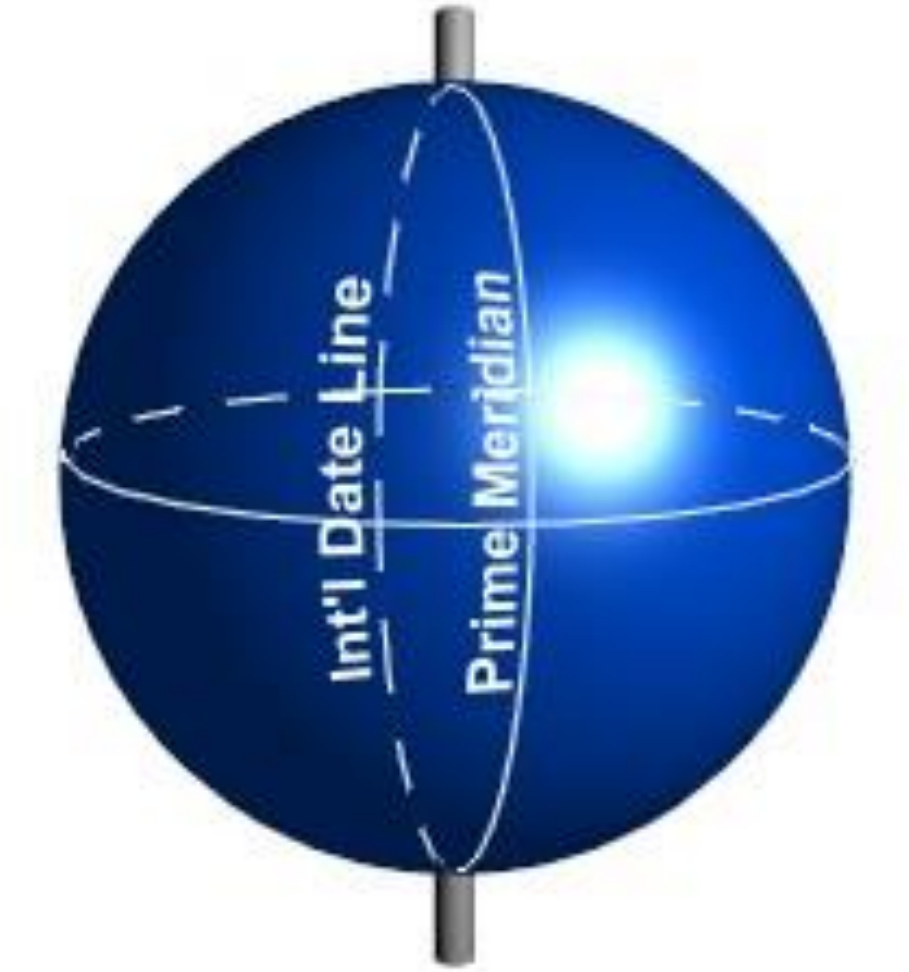
Finding one's longitude is a bit trickier.
The North Pole is an easy point of identification for north. It is the point around which the world rotates. But how does one discover east and west?

Here is a problem. Which of the United States is furthest north? Which is furthest east? Which furthest west? Remember you can go from NY to California by travelling either east or west. One just takes longer!

North? Alaska
South? Hawaii
West? Alaska
East? Alaska

Alaska can be the furthest in two directions because we have to define a starting point from which east and west are measured. That point is recognized as the Greenwich Prime meridian which is the point of the Greenwich observatory in London.





Anything east of that line is considered to be “east longitude” anything west of it is “west longitude”. So the highest number for any place longitudinally is 180 degrees. After that, you are in the other “direction”. If you travel 180 east or west you will meet on the other side of the globe which is roughly the position of the International Date Line. So, since Alaska crosses the International Date Line, it is on both sides – therefore it is the furthest east as well as the furthest west. (remember you always have to mark with your meridian is EAST or WEST)

The actual international date line is rather zig-zag so that some countries can have all of their area on the same day. All of Alaska is on the same side of the date line, but not on the same side of east/west division 180º opposite the prime meridian!


Time for
the Navy


GALVANO-MAGNETIC CLOCK
LEADENHALL ST
The Shepherd
24-hour Gate Clock
The Time Ball
Ordnance Survey
Bench Mark
Public Standards
of Length
BRITISH YARD
TWO FEET
ONE FOOT

With this in mind we can discuss how one can finds one longitude. How many degrees are there in a circle? 360. How many hours in a

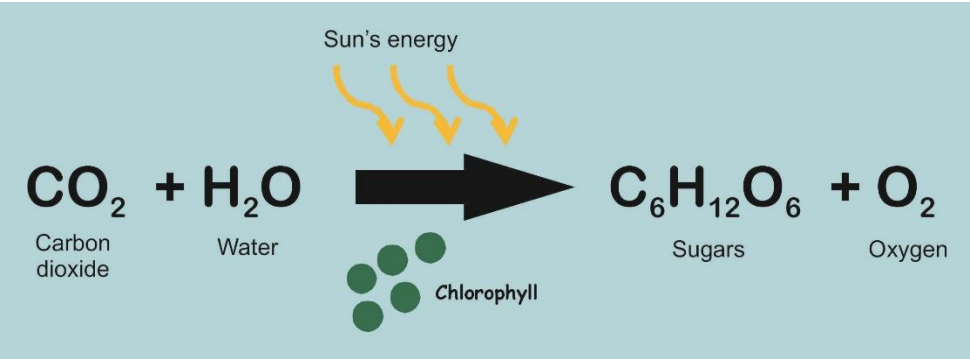
day? 24. So how many degrees are there in an hour? (divide 360 by 24 and the answer is 15). So for every hour away from the p
rime
meridian you are 15 degrees away from it. Ships would take a chronometer or a clock on the ship set at the time at the Prime Meridian. When the sun was directly overhead on the ship, the navigator would know it was “noon” and look at the clock which might say 1300 hours (1 p.m.) So there is an hour difference in time between the ship and London. This would mean that the ship is 15 degrees west of the prime meridian.

Charles Darwin

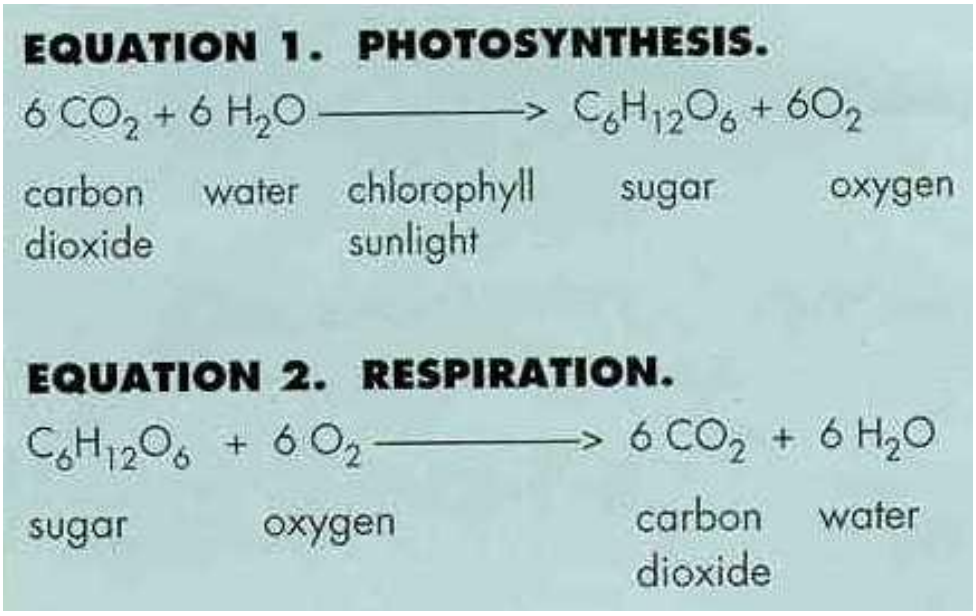
Darwin traveled on a ship called “The Beagle” captained by Robert Fitzroy. The ship was to undertake a journey that would last nearly 5 years. The ship left on 27 Dec, 1831. Charles Darwin as naturalist whose job, basically was to disprove the idea of evolution which was growing in popularity at the time.

Darwin made two significant hypotheses on the trip. One had to do with his theory of reef formation, The other had to do with the idea of biological evolution. We deal here with the first of the two – reef formation

First. What is a reef made of? Largely coral. What is coral? Coral is an animal belonging to a phylum called Cnidaria. This phylum contains animals which are sessile (don't move) like sea anemones and corals and well as some organisms which are motile (can move) like jelly fish. Animals, which are motile, may be able to propel themselves against a current which are called "nekton" while those which are moved about by the current are called "plankton". Now the coral are small animals which secrete a calcium carbonate which forms the hard kind of "exoskeleton". The coral are involved in a symbiotic relationship (mutually beneficial) with a dinoflagellate – that photosynthesize (are able to create their own food by taking water and carbon dioxide and in the presence of sunlight, turn it into sugar and oxygen and share some the material with the coral.

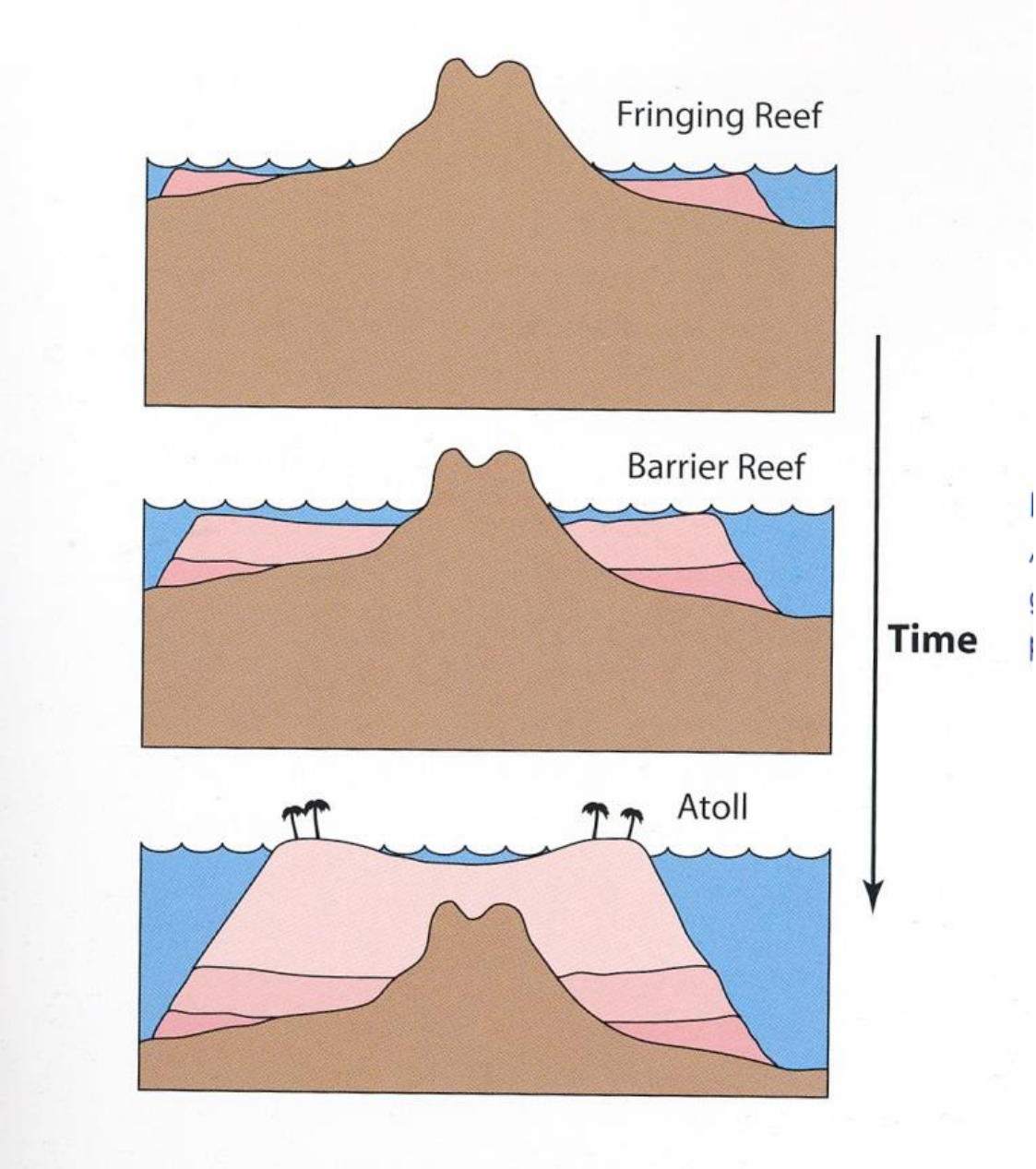


Uses carbon dioxide and gives off oxygen



Uses carbon and gives off carbon dioxide

This makes them “autotrophs” and opposed to “heterotrophs” which have to eat to survive. Autotrophs are considered “primary producers” and are at the very bottom of the food chain. The dinoflagellates benefit from the protection of the coral whose nematocysts or stinging cells (like those in jelly fish) are used to neutralize prey. The coral exhale CO_2 that is needed by the dinoflagellates for photosynthesis. The dinoflagellates are a kind of algae (more about algae later) and give the coral their color. In times of stress, the coral may expel the dinoflagellates and appear pale. This is a process called “bleaching”. This gives the coral a short term survival for whatever causes the stress. The later can regain the algae if the stress isn’t severe enough to kill them Darwin’s theory of coral formation was based on an observation of many reefs. Some reefs surrounded islands, others had lagoons and still others had not island in the middle. He postulated that the islands arose from undersea volcanos which stopped erupting. Then the corals begin to form around the island. They need to be close enough to the surface for there to be the sunlight needed for the algae’s photosynthesis.



Video on atoll https://www.youtube.com/watch?v=pRD8ZwdPYsY

An undersea volcano spews up an island and stops erupting. Coral begins to build up around the island's edge called a fringing reef. After a while erosion tales place and the edge of the island disappears and the top of the volcano also erodes. At this point the reef is a barrier reef.

Finally the entire islands is eroded away and all that is left is the reef, now called an "Atoll"

The Challenger Expedition

This voyage is seen as the beginnings of the scientific study of the ocean – oceanography. It lasted from 1872 to 1876. Organized by Charles Wyville Thomson from the University of Edinburgh and the Merchiston - Castle School organized the expedition. The ship, The Challenger, was gotten from the Royal Navy. Traveling over 70,000 miles it collected an immense amount of information. The expedition catalogued over 4,000 previously unknown species.

The goals were to investigate the physical conditions of the deep sea in the great ocean basins (as far as the neighborhood of the Great Southern Ice Barrier) in regard to depth, temperature, circulation, specific gravity and penetration of light.

a. To determine the chemical composition of seawater at various depths from the surface to the bottom, the organic matter in solution and the particles in suspension. To ascertain the physical and chemical character of deep - sea deposits and the sources of these deposits.

b. To investigate the distribution of organic life at different depths and on the deep seafloor.

There were many misconceptions about water and what was in it.
An example of this had to do with the nature of water itself.
It was originally thought that as one descended in the ocean, the water would become more and more dense reaching a rather thick consistency. It was thought that things would not sink to the bottom because the water would be compressed to such a density that things would no longer sink any further and would be suspended at some level among the ocean floor. Even as late as the sinking of the Titanic, it was thought by many that the ship would have not reached the bottom and would in fact be "floating" at a level somewhere in the depths, but not at the bottom. Although it was known that this was not the case, many people still believed it.

While the ocean does not become more dense at lower depths, it does become heavier as water piles up above it. It simply is not heavy enough to compress the water any great degree. Every 33 feet (or 10 meters) down, there is an increase in pressure of one atmosphere (which is about 15 pounds per square inch). Inn whether I atmosphere is 1.013.25 millibars.
Interestingly enough water does get somewhat denser as it get colder, but when it freezes, it becomes less dense and the molecules form a different structure. This is why ice floats.

WHAT KIND OF WAYS ARE THERE TO DEFINE THE GEOGRAPHY OF THE OCEAN?
In order to talk about the ocean, we need to know something about the way scientists classify its areas. There are two dimensions involved – one has to do with the distance from the shore, the other has to do with the depth of the water. These are critical distinctions since they have a strong impact on the kinds of adaptation that life forms make to those zones Ocean Zones
Starting at the shore line there is a zone which is called "the splash zone". This zone is one which is generally not covered by water at any time, but receives a "spray" from the surf. Because it is generally not under water for any period of time, it will not be discussed particularly here.

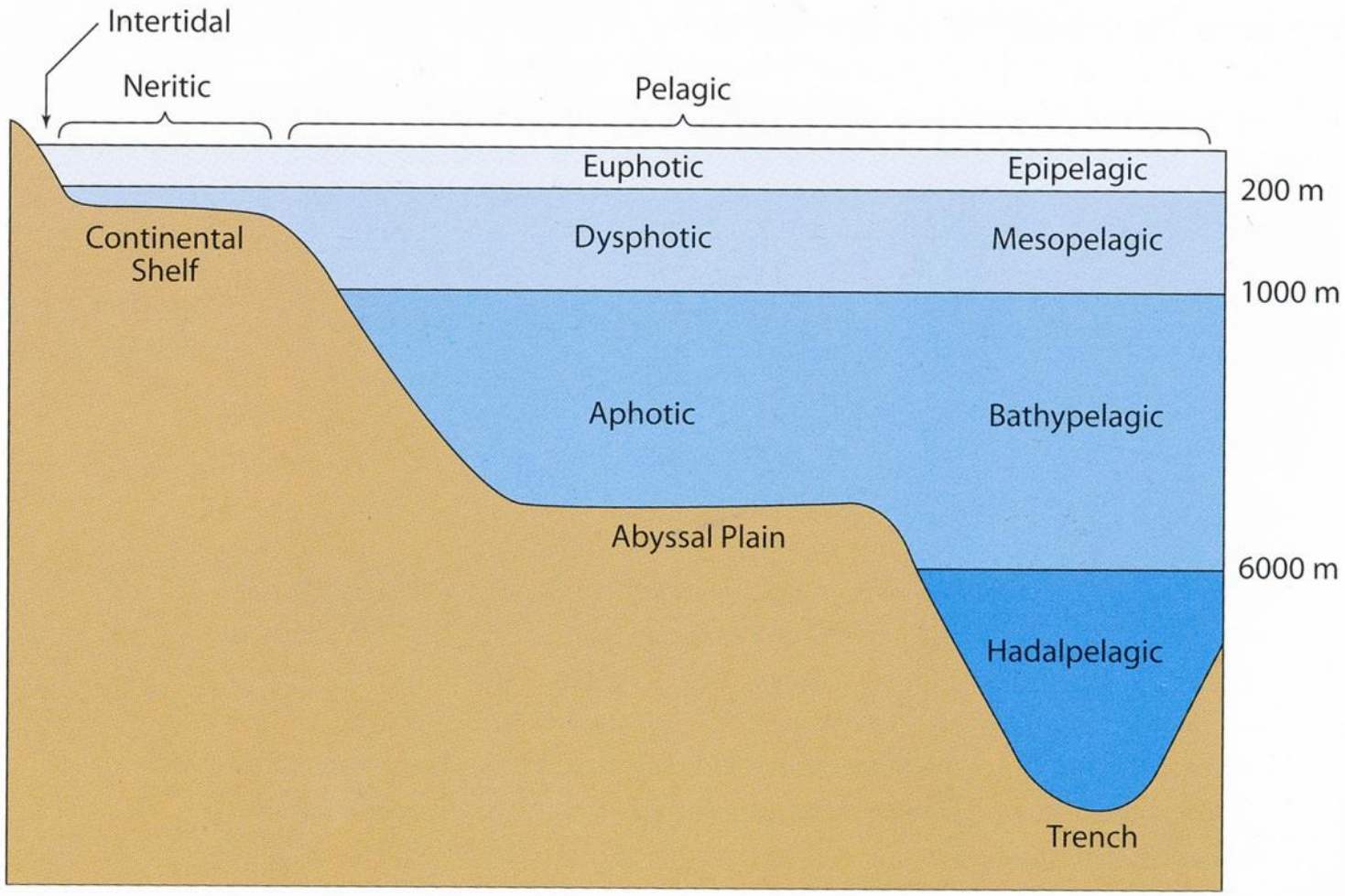


Figure 2.10. The named zones of the ocean.

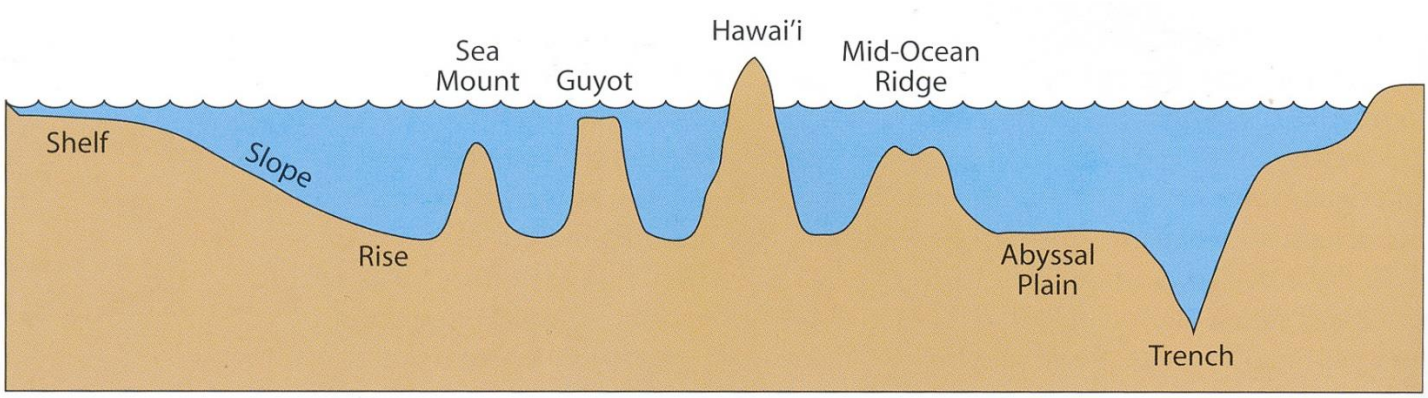
The next zone out is the intertidal zone, sometimes called the “littoral zone”. This is the area that is underwater part of the time and exposed to the air at other times. Organisms found in this area must be able to handle periods when they are exposed toair and other times when they are not. This means, among other things that the organisms which need buoyancy – that is they may lack any kind of support system like a skeletal system or they need the water to keep them up would have to handle periods of time when the water was not there to do that. The animals and plants that live in the zone, such as anemones, barnacles, chitons, crabs, green algae, isopods, limpets,

mussels, sea lettuce, sea palms, sea stars, snails, sponges, and whelks, must often deal with rough waters and well as exposure.

The next section from the shore is called the “neritic zone” and refers to that part of the ocean that is over the continental shelf. This the area where the continent drops off toward the deep ocean called the abyssal plain. The water that lies over the abyssal plain is called pelagic.

In terms of depth, the upper level of the ocean is called Euphotic (or epipelagic). Euphotic means “good light” and refers to those areas where sunlight can penetrate enough for photosynthesis to take place Below that layer lies the dysphotic (bad light) level (or mesopelagic) Here the is some light but not enough for photosynthesis to occur. Bel ow that is the aphotic zone (no light) or bathypelagic.

In the deep trenches in the ocean the term hadalpelagic is sometimes used.



Common features of the ocean floor (not drawn to scale).

The underlying structure of the ocean floor was thought to be just a basin, but in fact the terrain is as varied as on land.

Starting with the shore, the continental shelf drops off slowly and then rather rapidly. The bottom of the ocean is not smooth like the bottom of a bowl. The ocean has a number of complex features that include

mountain ranges , sea mounts, and trenches A seamount is a mountain that rises from the ocean floor; a submerged flat-topped seamount is termed a guyot. By arbitrary definition, seamounts must be at least 3000 ft (about 900 m) high, but in fact there is a continuum of smaller undersea mounts, down to heights of only about 300 ft (100 m). Some seamounts are high enough temporarily to form oceanic islands, which ultimately subside beneath sea level. There are on the order of 10,000 seamounts in the world ocean, arranged in chains (for example, the Hawaiian chain in the North Pacific) or may occur as isolated features. In some chains, seamounts are packed closely to form ridges (for example, the Walvis Ridge in the South Atlantic). Very large oceanic volcanic constructions, hundreds of kilometers across, are called oceanic plateaus (for example, the Manihiki Plateau in the South Pacific).

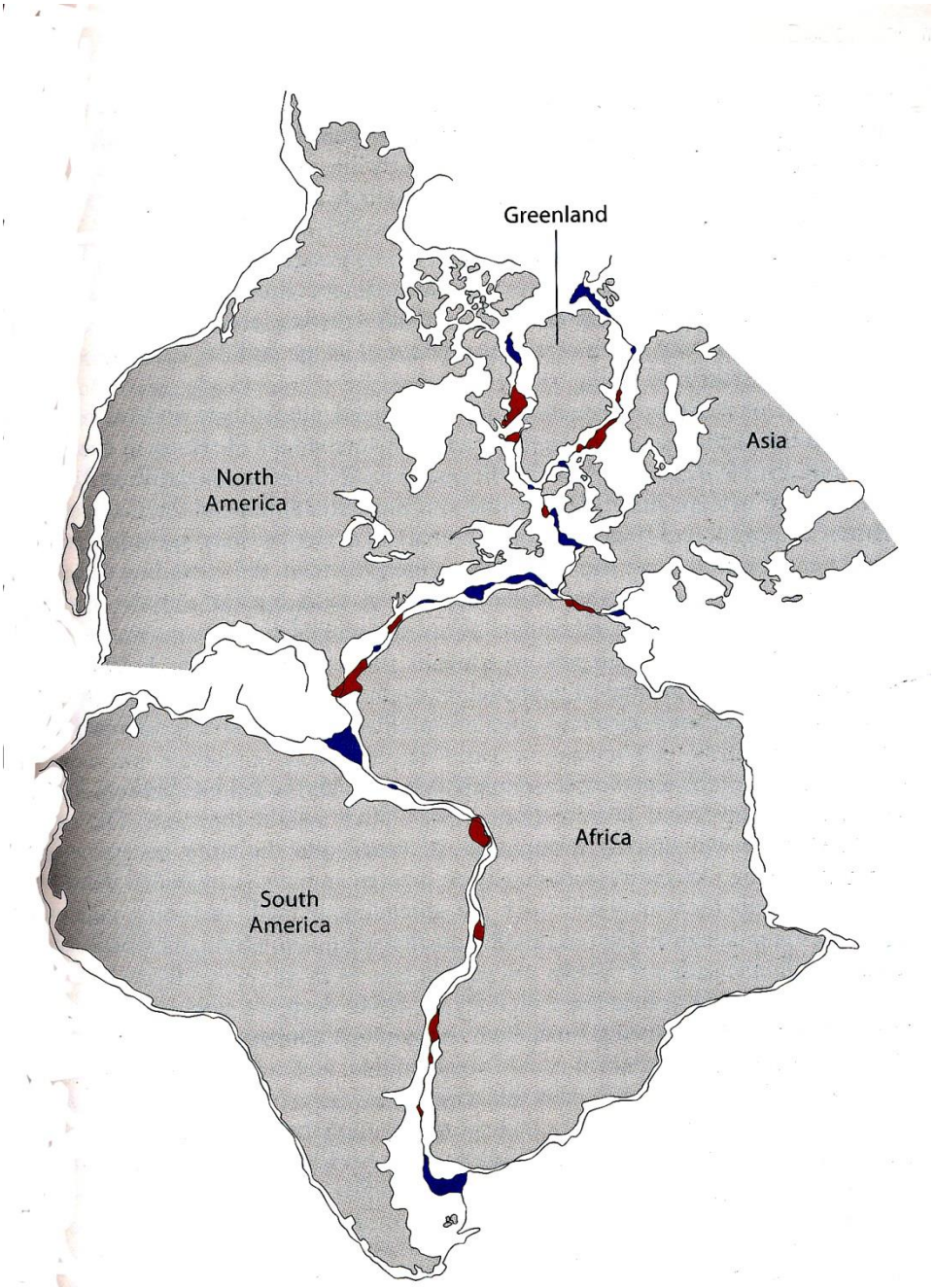
Seamounts are formed by volcanic activity and can be taller than 10,000 feet. They can be isolated or part of large mountain chains. The New England Seamount contains more than 30 peaks that stretch 994 miles from the coast of New England. Seamounts often have a high level of biological productivity because they provide habitats for many species of plants and animals. Over 200 species of sea creatures have been observed at a single guyot in the New England Seamounts are great locations to discover new species because each seamount houses different types of animals, including many that can only be found in guyot habitats.Seamounts are home to many commercial fish and are therefore very beneficial to our economy. Seamounts are also important to the field of medicine, as any number of undiscovered species may lead to new drugs or medical treatments.

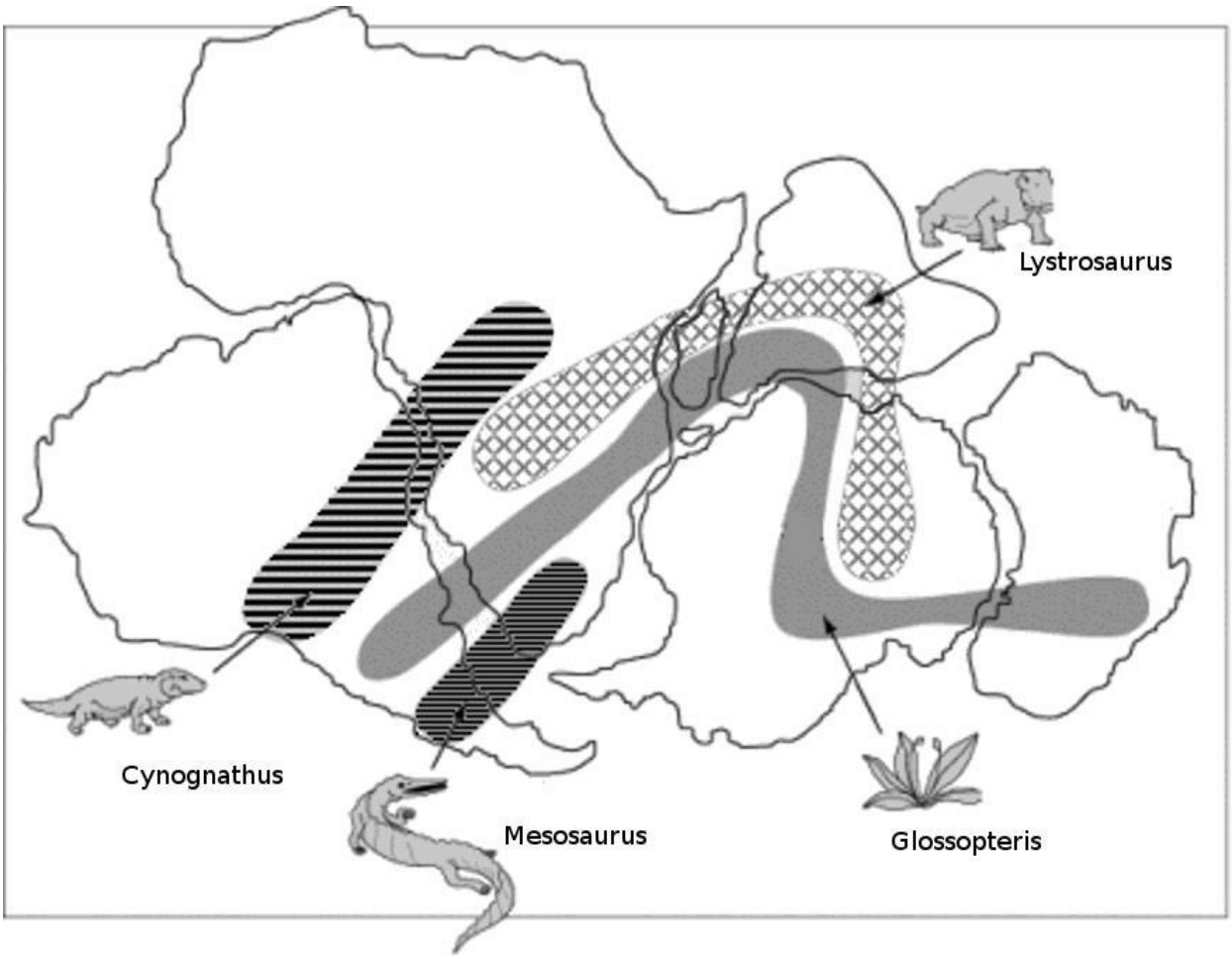
Guyots are seamounts that have built above sea level. Erosion by waves destroyed the top of the seamount resulting in a flattened shape. Due to the movement of the ocean floor away from oceanic ridges, the sea floor gradually sinks and the flattened guyots are submerged to become undersea flat-topped peaks.

CONTINENTAL DRIFT AND MID OCEANIC RIDGE

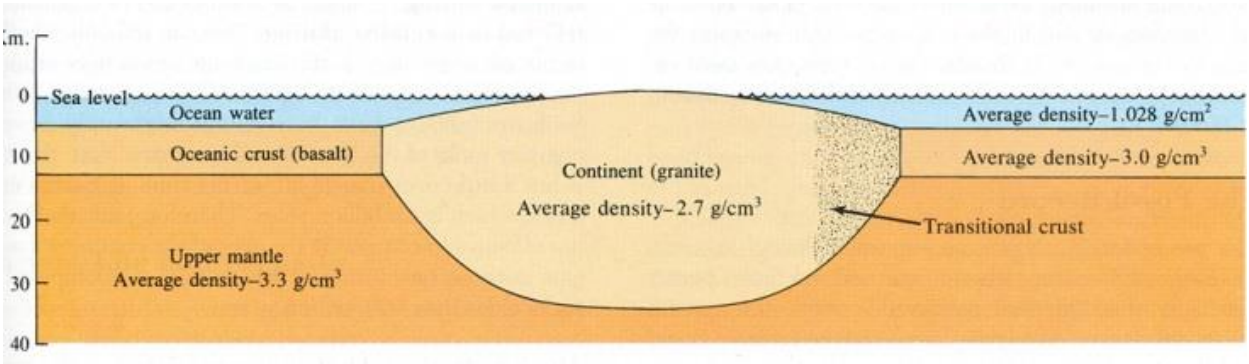
Alfred Wegener, in 1912 proposed the idea that the continents were actually floating and moved.

This appeared to be the solution to distributions of fossils that were found in S. America and Africa



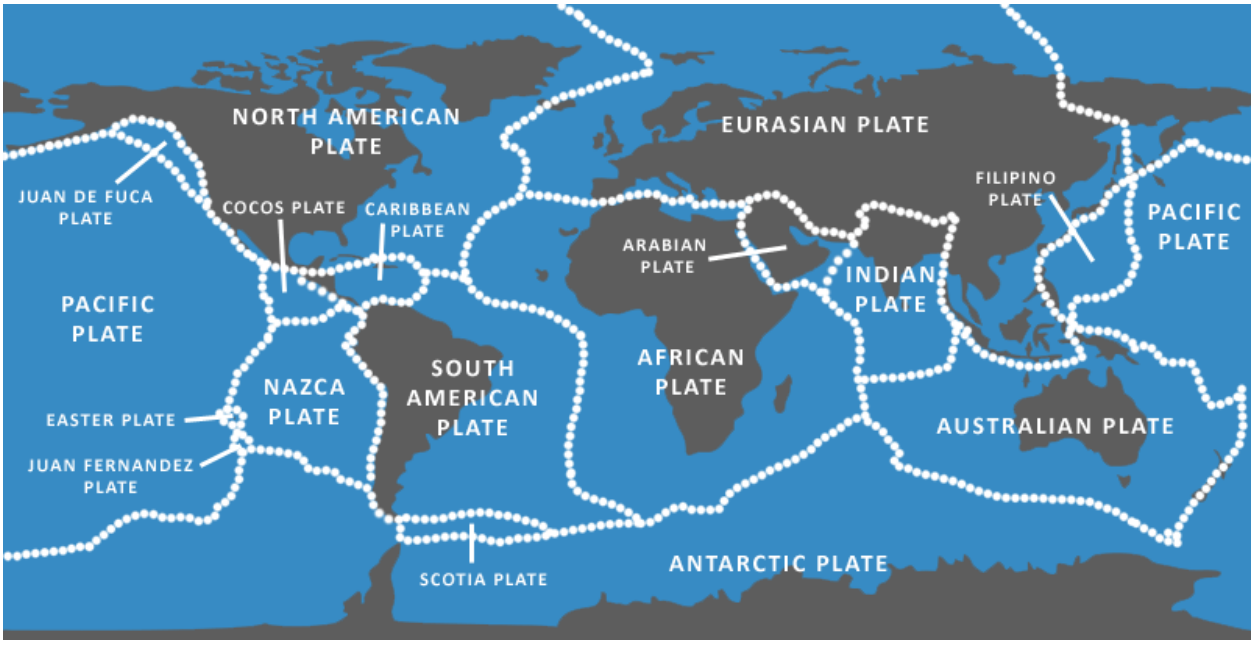


The idea was generally rejected because there was no way to show how the continents could be moved. The continents are less dense than oceanic crust and the upper mantle and so could “float” on them.



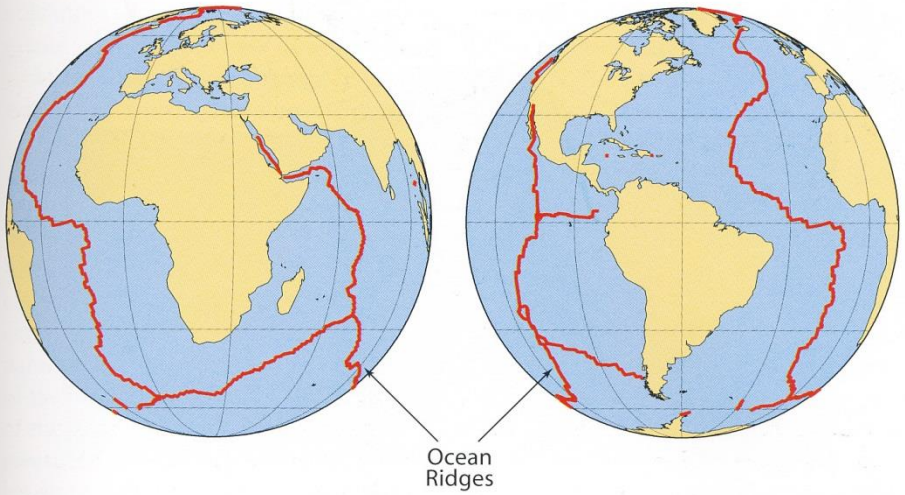
Although the theory was not initially accepted since the idea of continents floating seemed inconceivable. The idea gained more and more acceptance as new evidence appeared. The idea is now accepted.

VIDEO Continental Drift 11 Stock animation

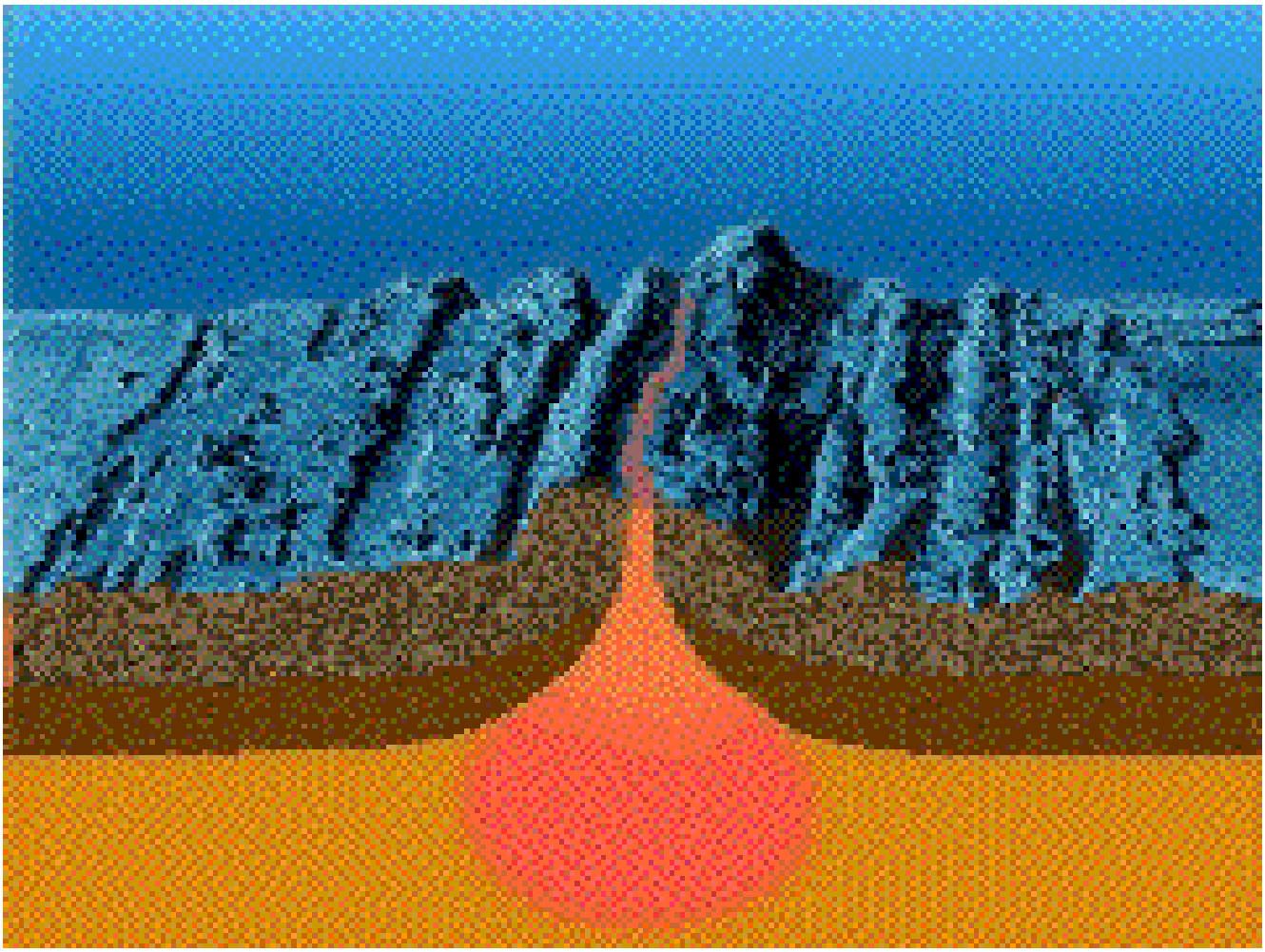


MID OCEANIC RIDGE

Along the boundries of the plates is The Mid-Ocean Ridge system that forms the most extensive chain of mountains on Earth, with more than 90 percent of the mountain range lying in the deep ocean. It runs about 40,390 miles and averages about 8,200 feet. However, some of the ridge appears above the water. Iceland is an example. Along the ridge boundaries, molten rock rises through the sea floor. These volcanic eruptions are very deep and often go unnoticed. In 1783 an eruption in Iceland was sufficiently bad that it destroyed crops, and killed more than 10.000 Icelanders – about a quarter of the population. NOAA says “Like the rest of the deep-ocean floor, we have explored less of the mountains of the Mid-Ocean Ridge system than the surface of Venus, Mars, or the dark side of the Moon. Use of submersible or remotely operated vehicles to explore the mid-ocean ridge has provided information on less than 0.1 percent of the ridge!”



Spreading sites between tectonic plates form an extensive system of ocean



The meeting of two plates sometimes makes it possible for water to enter the area as happens with the Red Sea, which was formed when the Arabian peninsula was split from the “Horn of Africa” but the Red Sea Rift – he space formed by the African and Arabian plates. This started in the Eocene and had greater movement in the Oligocene.

On the other hand, water may overrun the land as a result of the increasing amounts of water from a warming trend as happens with the Persian or Arabian Gulf

THE OCEAN IS ALWAYS IN MOTION. WHY IS THIS IMPORTANT?

First we need to know what kinds of movement there are in the ocean.

Three Kinds of Water Movement

I. Tides

II. Waves
III. Currents

TIDES

Tides are regular movement of the ocean, most noticeable at the shore line as the water moves further and further up the shore and then recedes.
Much of the world has 2 a day but some places are somewhat different. Variation is caused by a number of factors, but the basic movement of the ocean's water in tides remains the same.

We have heard about them already, rather briefly when we mentioned the littoral or intertidal zones. The intertidal zone is the area that is covered and uncovered as the tides some in and out. But what causes that and what problems does it make?

Caesar and tides in Britain

When Caesar invaded Britain, his ships arrived at a high tide. The soldiers disembarked and when they wound up in a battle, they attempted to retreat onto the ships and leave. Unfortunately for them, the tide had "gone out" (ebbed) and the ships they had arrived in were now on the beach and not in the water. They had to continue fighting until the tide came in (flowed) and the ships were lifted back up and could sail away.
Caesar was of course, familiar with the tides, but in the Mediterranean where they behave somewhat differently!

Tides are classified in terms of whether they are high, low, spring or neap tides. The term “rip tide” is inaccurate in that what is being discussed there is a “rip current”. It isn’t a tide. What used to be called “tidal waves” have more recently been called “tsunami” (the Japanese for a “harbor wave”) since tsunami have nothing to do with tides (although as we will see they tend to look like a tide).

When the tide is coming in – that is the water is moving further and further up the shore, it is said to “flow”. When the water is moving down and away from the shore it is said to “ebb”. High tide is when the water comes in and low tide is when it goes out. Spring tides are exceptionally high tides and neap tides are exceptionally lower tides. What causes the tides?