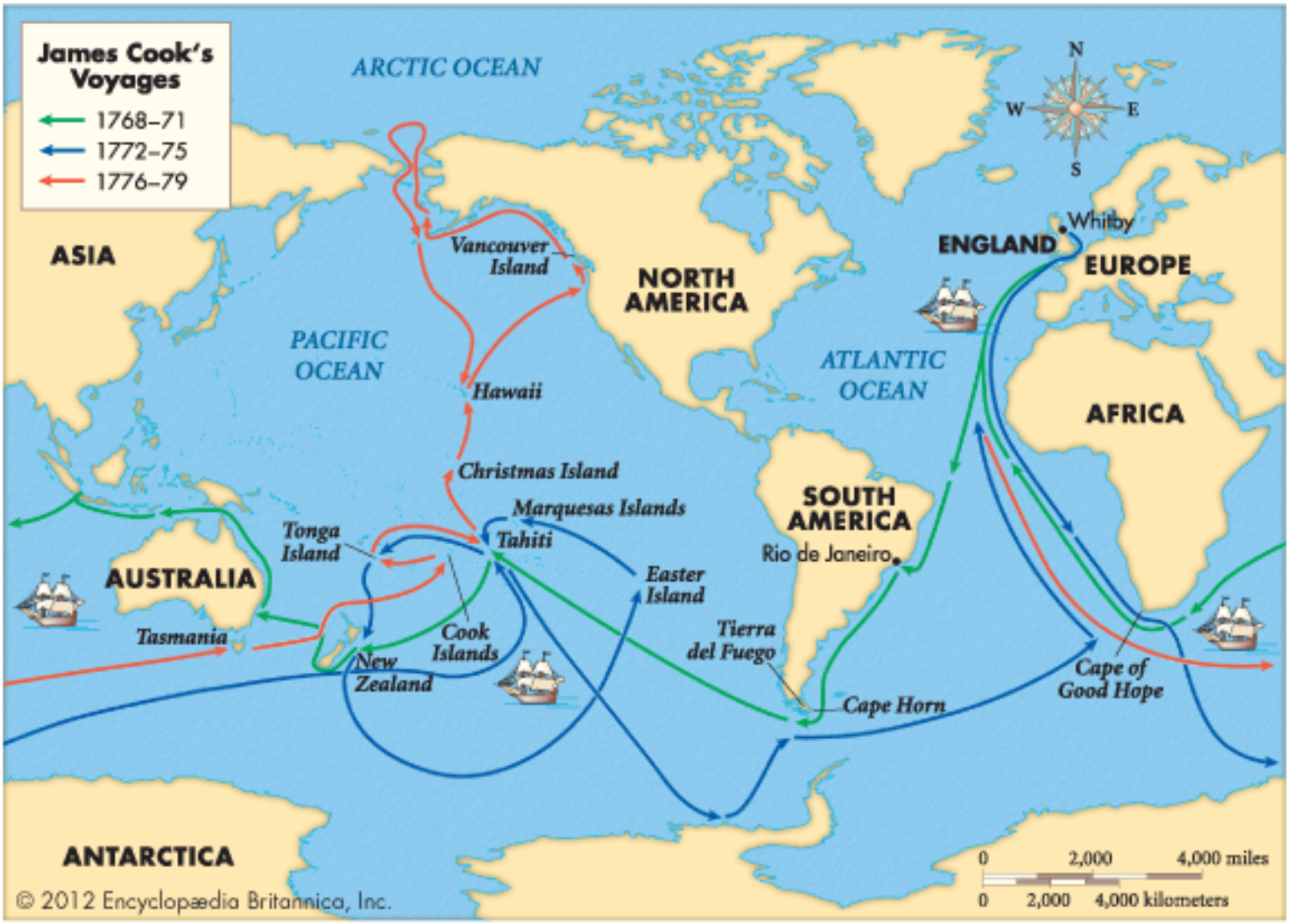
LECTURE 2

Cook:

Captain James Cook set out to locate and map the islands of the pacific. He made several 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, about which we will have a word,



Navigation:

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 the 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 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.

Fining 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

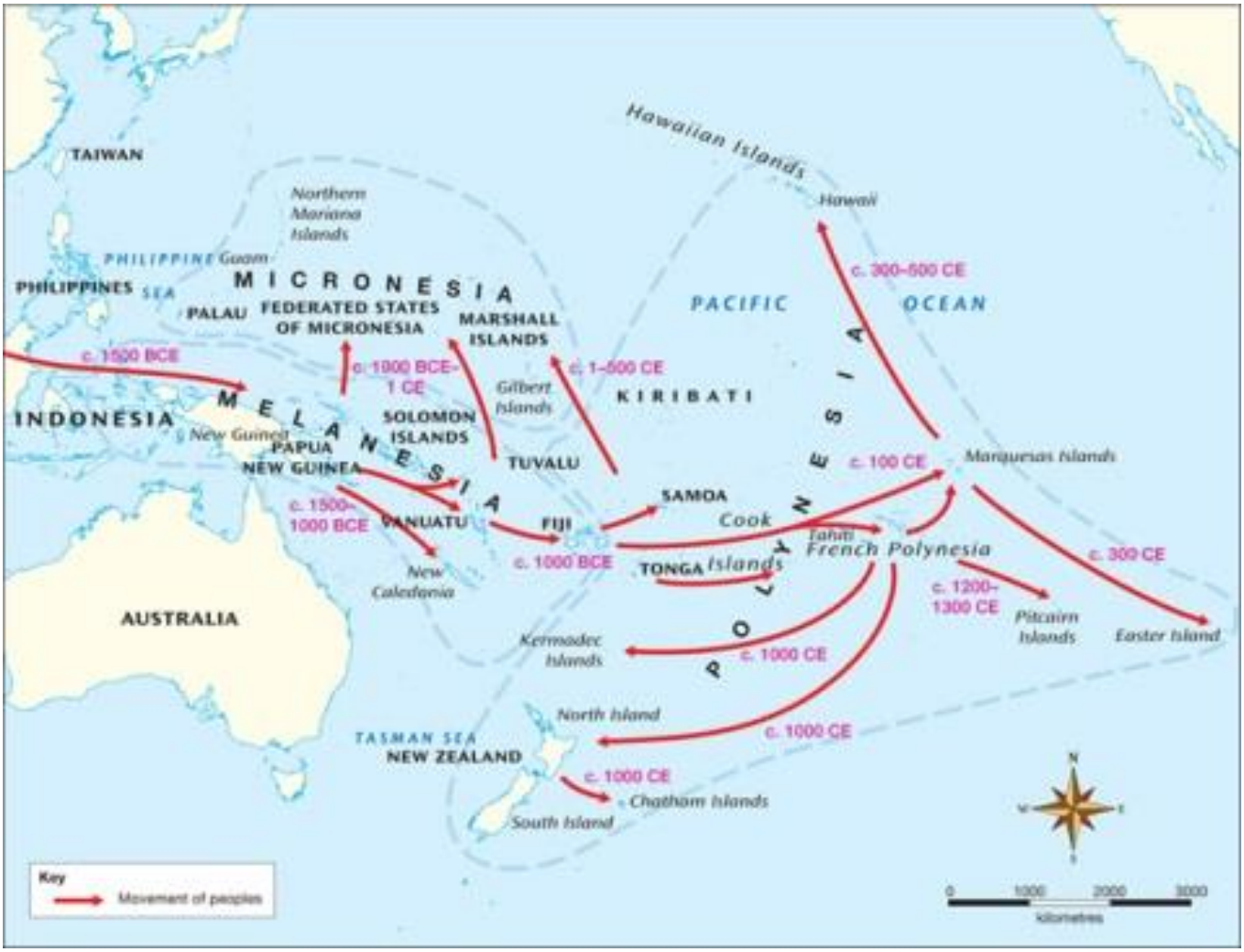
West? Alaska

East? Alaska

Alaska can be the furthest in 2 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.

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 prime 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.


TAIWAN
Hawaiian Islands
Hawaii
Northern Mariana Islands
PHILIPPINE SEA
Guam
PHILIPPINES
MICRONESIA
PALAU
FEDERATED STATES OF MICRONESIA
MARSHALL ISLANDS
PACIFIC OCEAN
c. 300–500 CE
c. 1500 BCE
c. 1000 BCE–1 CE
c. 1–500 CE
Gilbert Islands
KIRIBATI
INDONESIA
New Guinea
MELANESIA
SOLOMON ISLANDS
PAPUA NEW GUINEA
TUVALU
POLYNESIA
c. 100 CE
Marquesas Islands
c. 1500–1000 BCE
VANUATU
FIJI
SAMOA
Cook Islands
Tahiti
French Polynesia
c. 1000 BCE
TONGA
c. 300 CE
New Caledonia
c. 1200–1300 CE
Pitcairn Islands
Easter Island
AUSTRALIA
Kermadec Islands
c. 1000 CE
North Island
TASMAN SEA
NEW ZEALAND
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2000
3000
kilometres
Key
Movement of peoples

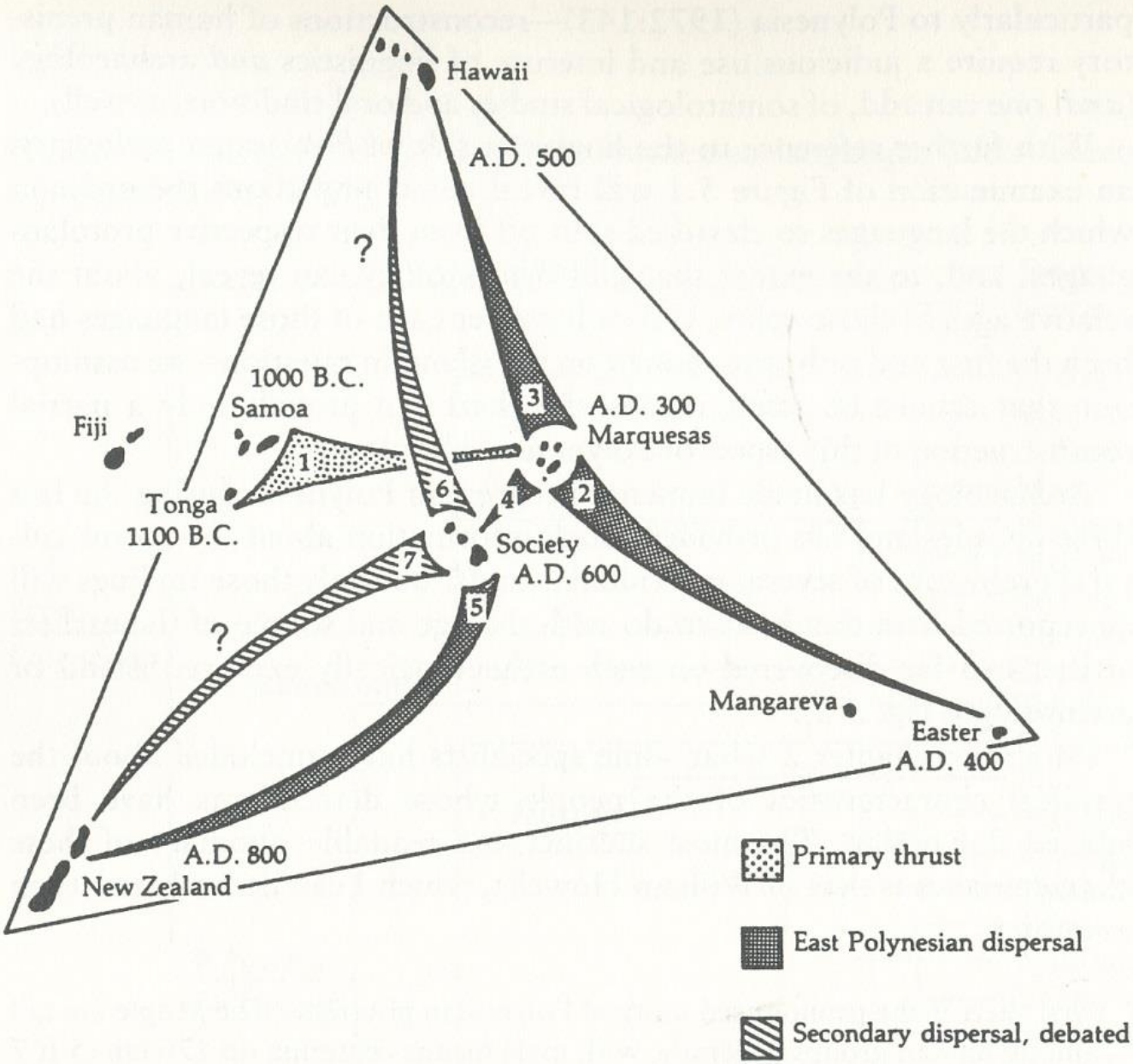


Figure 5.2. The chronology of island discovery by founding populations, based on earliest known archaeological artifacts (after Jennings 1979)

Darwin:

Darwin traveled on a ship called "The Beagle" captained by Robert Fitzroy. The ship was to undertake a journey that would last 4 years and took o 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.

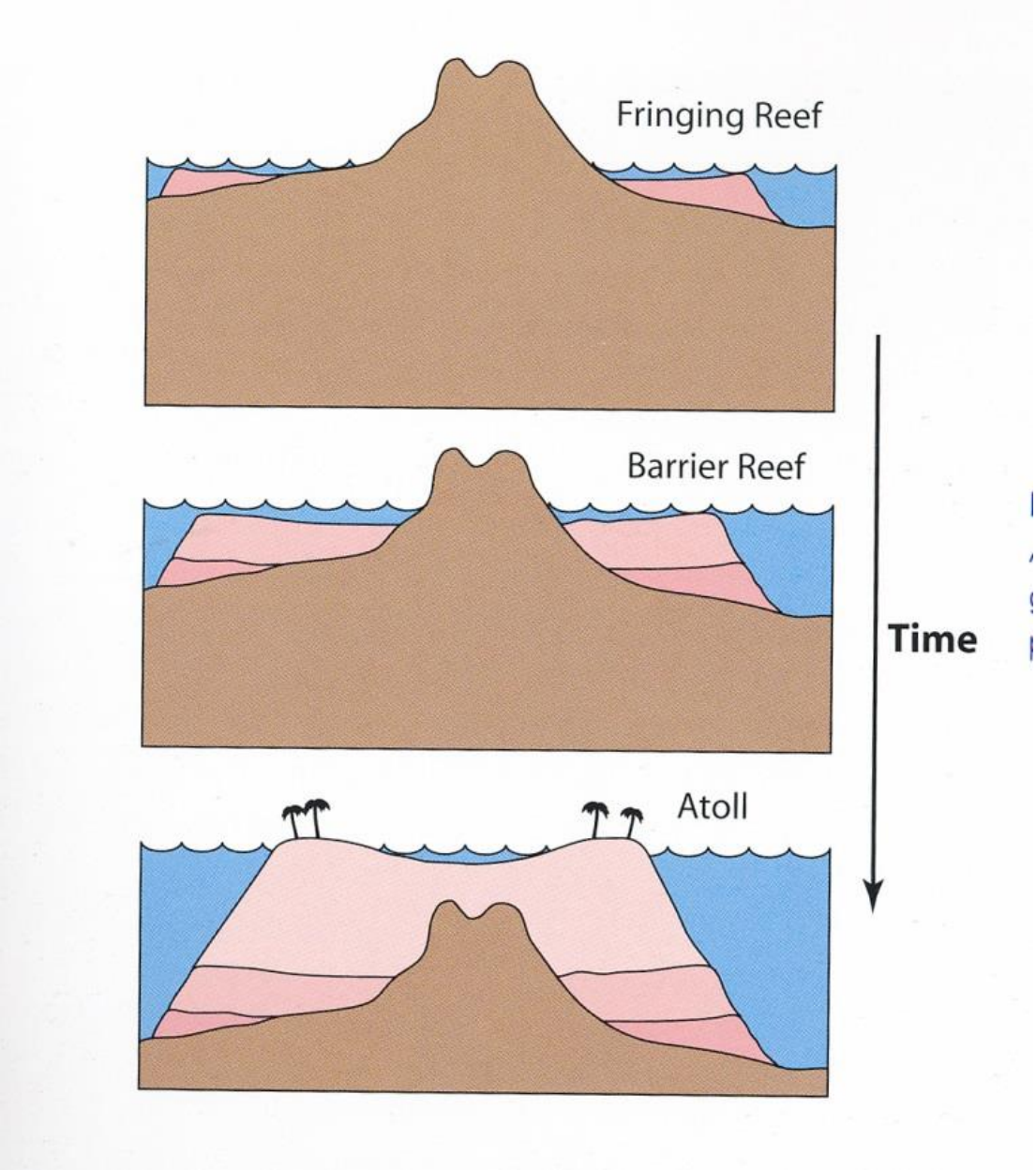
First. What is a reef made of? Largely coral. What is coral? Coral is an animal belonging to a phylum called Cnidaria. This phylum contains animals which are sessile (don't more) like sea anemones and corals and well as some which are motile (can move) like jelly fish. Animals, which are motile, maybe 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. 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 CO2 which 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.



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 is a **barrier reef**

SEAMOUNTS AND GUYOTS

The Challenger Expedition

The nature of the water. Does not compress much. 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.

Ocean Zones

The ocean is divided into a number of zones based in part by depth and distance from the shore. These are critical distinctions since they have a strong impact on the kinds of adaptation that life forms make to those 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.

The next zone out is the intertidal zone, sometimes called the "littoral zone". The is the area which 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 to air 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 skeletal system and 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 which 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

OCEAN LAYOUT

The Underlying structure of the ocean floor.

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 which include mountain ranges , sea mounts, and trenches

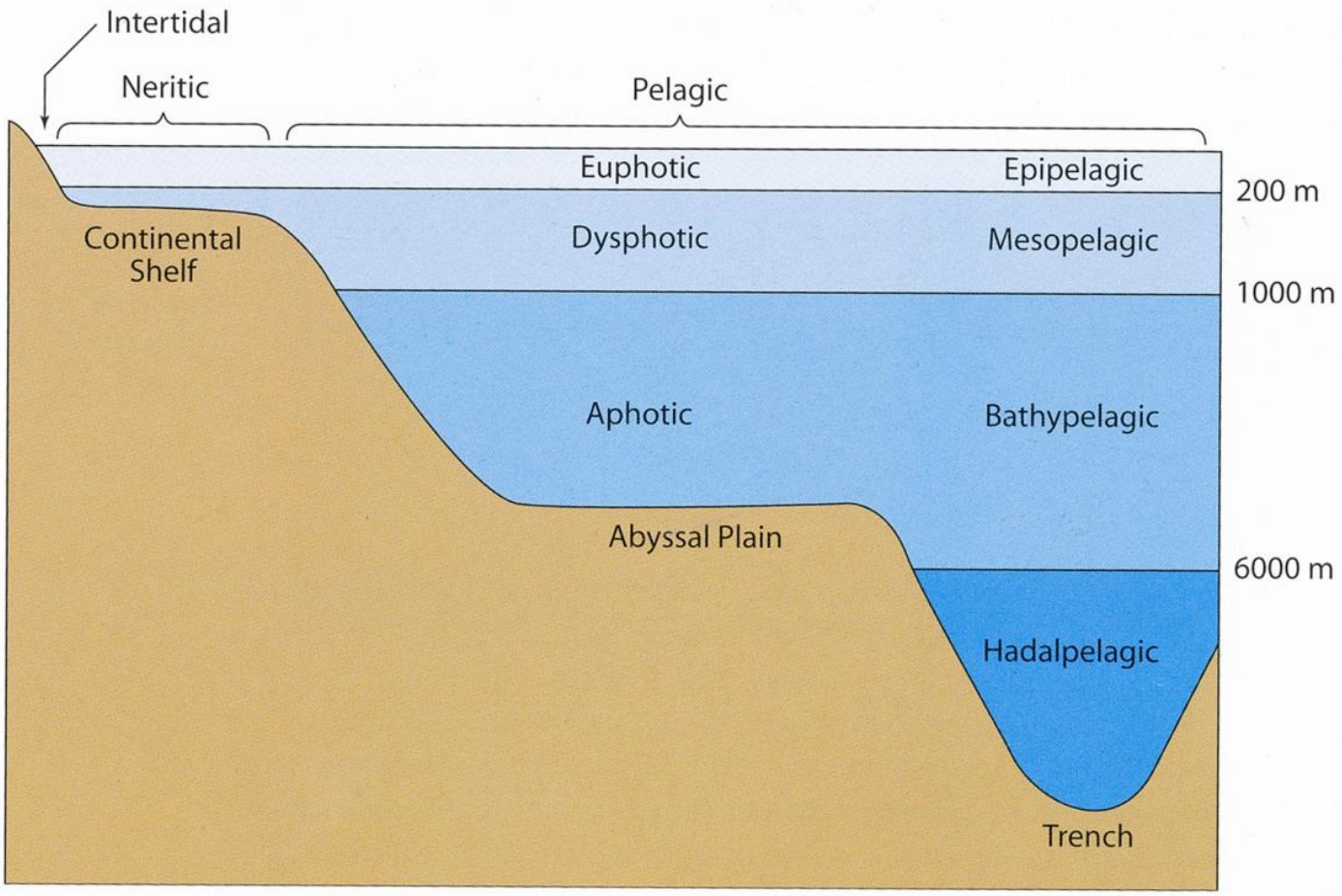


Figure 2.10. The named zones of the ocean.

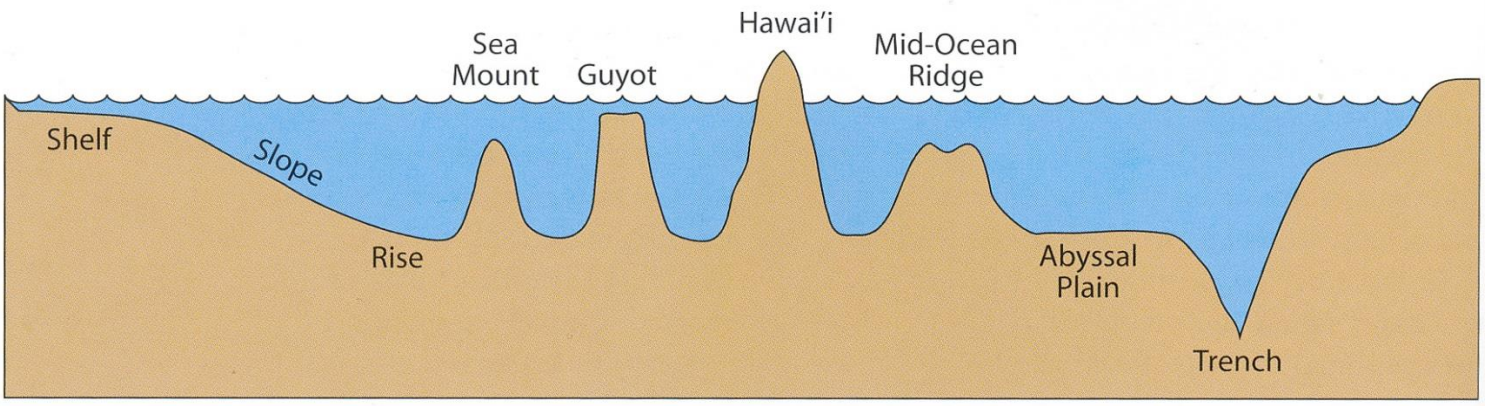


Figure 2.7. Common features of the ocean floor (not drawn to scale).

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 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).

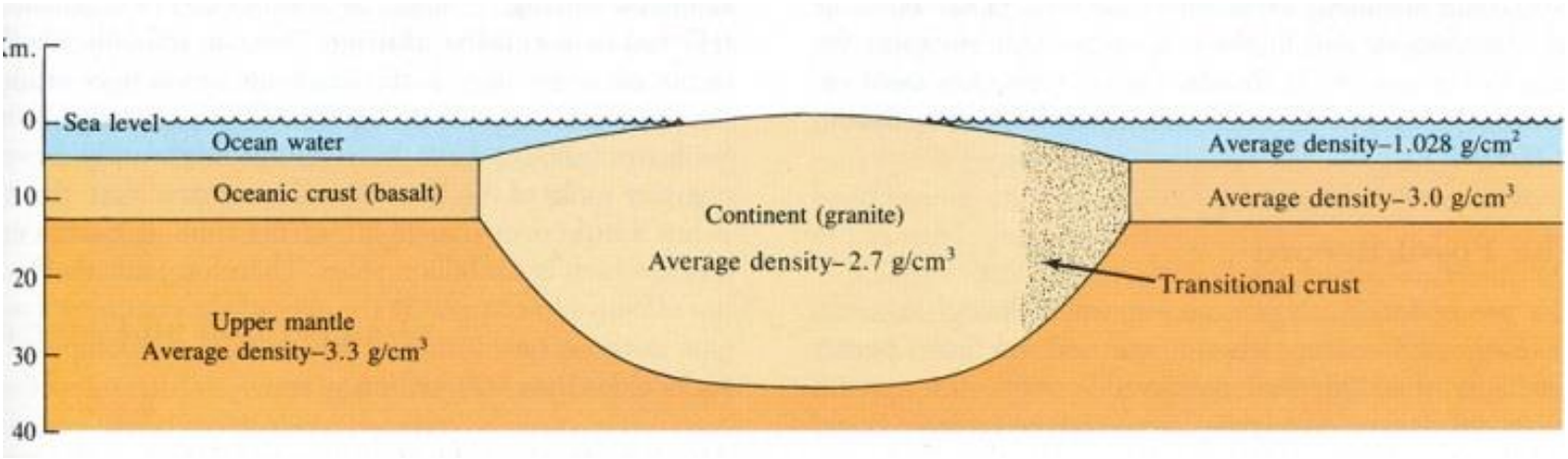
Seamounts are formed by volcanic activity and can be taller than 10,000 feet. They can be isolated or part of large mountain chains. The New England Seamount contains more than 30 peaks that stretch 994 miles from the coast of New England.

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 Seamount. 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



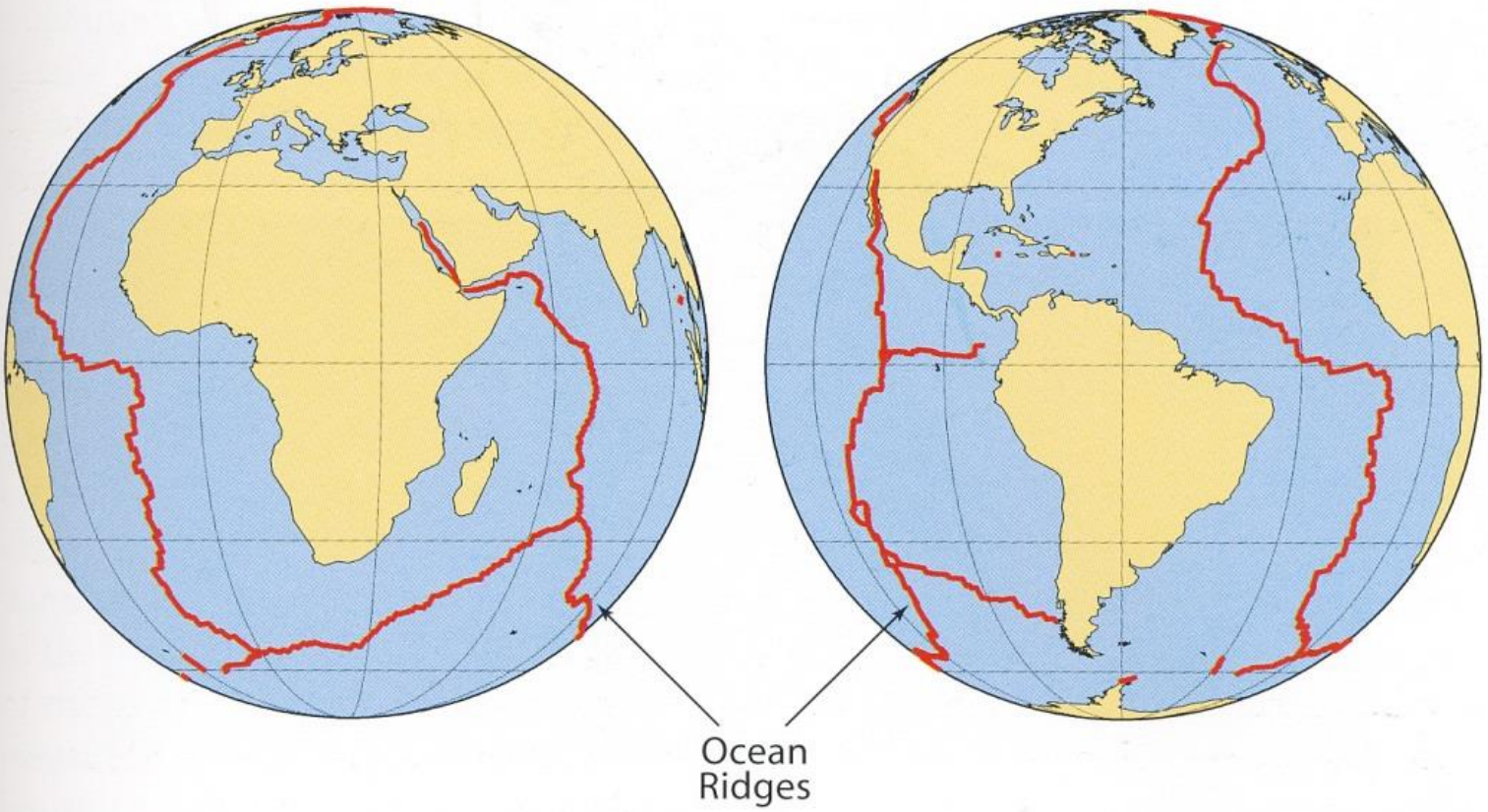
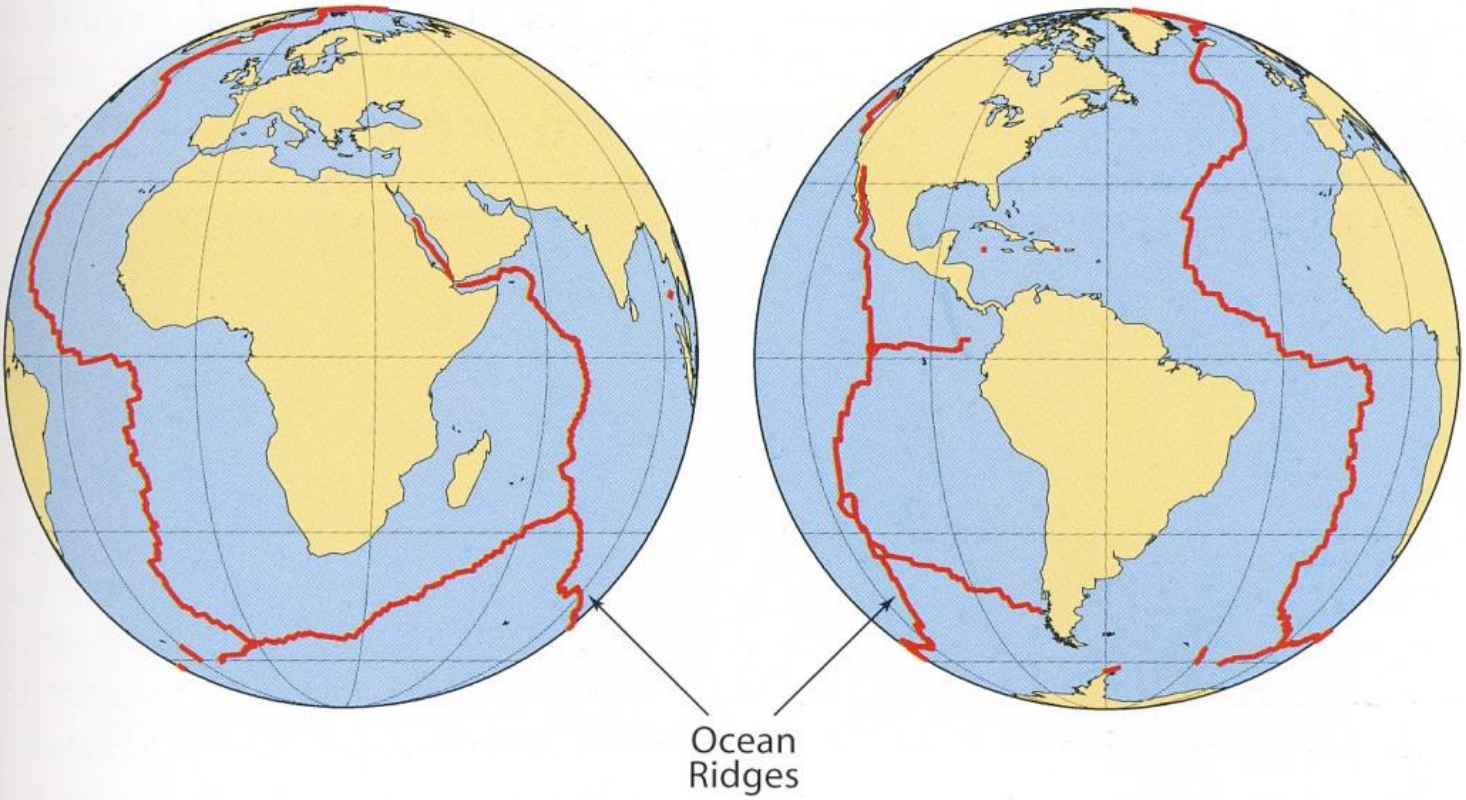


Figure 2.8. Spreading sites between tectonic plates form an extensive system of ocean ridges.



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