The Ocean

The word ocean is used to mean:

1. The entire body of salt water that covers much(71%) of the earth's surface
2. The major geographical divisions of this huge body of salt water

Compare the earth´s major oceans in table 8-1, p. 370. Key words: surface area, volume, percentage, the greatest /least average depth, the shallowest

Marginal seas formed in three different ways:

1. When continents came together. The Mediterranean Sea and the Black Sea are thought to have formed when two continents enclosed them.
2. Some marginal seas are separated from major oceans by curved chains of islands called **island arcs,** e.g. the Caribbean Sea and the China Sea.
3. Some marginal seas are thought to have formed as the result of a structural break in a land mass, e.g. the Red Sea and the Gulf of California. In the case of the Red Sea, the continental crust was not only split, but it separated. Ocean crustal rocks have been found in the area of separation.

Section 1 The Bottom of the Ocean

Sounding the ocean bottom

In 1492, when Columbus sailed across the Atlantic Ocean, a common notion was that the ocean bottom was flat and featureless. The only method known to determine the depth of the ocean water was to lower a heavy weight tied to the end of a rope into the water until it hit bottom. Then the length of line was measured. Sailors were usually interested in the position of the ocean bottom only if the water became so shallow that their ship might hit the bottom. Consequently they did not carry enough rope to reach the deep ocean bottom.

Four hundred years later, people were still using the same method. By that time, however, wire had been substituted for rope, and a power-driven winch was used to lower and raise the weight on the end of the wire. Many scientists continued to believe that the ocean bottom was mostly flat. They based their belief on the fact that the bottoms of reservoirs usually become flat because of sediment that settles out of the water.

In 1925, a more modern method of measuring the depth of the ocean was used in a detailed survey of the ocean bottom. In this method, which uses sound and is called **echo sounding,** a sharp noise called a ping travels from the ship to the ocean bottom and bounces back as an echo. The length of time it takes the ping to make the trip down and back is measured and then the distance can be calculated.

A precision depth recorder makes a continuous record of ping echoes on a moving paper. The pings are sent out continuously as the ship moves, and the paper record is a scale representation of the ocean bottom providing profiles of the topography. Thousands of these types of records have shown that the ocean bottom has an even more varied topography than does the land.

What are the words for paper record and the instrument?

Task: Say something about the history of measuring the depth of the ocean bottom.

The topography of the ocean bottom

Read Our Science Heritage on p. 375 and tell the main idea of the text in 5 minutes.

When did the expedition take place? –
What kinds of instruments were available at that time?-

Ocean basins are at a much lower level than the land, formed mainly of dense basaltic rock, whereas continental rocks are mostly granite and granite gneiss. The depth can vary greatly from one location to another, but there are several general features associated with certain earth processes. Fig. 8-6 on p.374 shows several general regions.

An area near the continents is known as the **continental margin.** It is made up of continental crustal materials and rocks. Most sediment eroded from the land is deposited in this part of the ocean.

Features: The **continental shelf**, the part nearest the land, has on the average a very gentle slope. At a depth of about 200 m the steepness increases and the **continental slope** begins. At the base of this slope is another, much gentler slope that leads down to the abyssal plain. This gently sloping area is known as the **continental rise** (= úpatí, necessary to distinguish from oceanic rise = oceánský práh či hřbet).
Erosional valleys and **canyons** cut across the margin. Some of them are deeper and wider than the Grand Canyon in Arizona! They were probably formed by rapidly flowing turbidity currents - mixtures of sediment and water, but they might also have been formed by glaciers during the last Ice Age.

Farther from shore, at a greater depth, is the deep sea floor. This area is affected by the earth processes of sedimentation and volcanism. All ocean crustal rocks are volcanic, formed by underwater eruptions of dark-colored basaltic flows.
Features: ***Seamounts*** – underwater volcanic cones that grow upward from the bottom, layer by layer, usually rising more than 1000m above the floor. Sometimes they reach the ocean surface and form islands. Virtually all islands in the ocean were formed by volcanic activity. See Fig. 8-8 on p.377. Igneous activity beneath these volcanic features causes additional bulges in the ocean crust.
Because of wave action or ocean crustal movement, volcanic islands can disappear beneath the surface of the sea. If the volcanoes have become extinct, then the wave action is able to erode the tops of the seamounts down to sea level. Sometimes the ocean crust beneath extinct volcanoes sinks, lowering the eroded seamounts well below the ocean's surface, forming flat-topped underwater mountains called **guyots.** They are found in deeper parts of the basins and can rise to nearly 1000m above the floor. *Where does the word guyot come from?*

Sporadic turbidity currents spill off the continental margins into the deep ocean. Through time, abyssal hills near continental margins can be covered with hundreds of layers of sediment. Turbidity currents can also extend for hundreds of kilometers across the bottom, leaving large flat areas called **abyssal plains** (roviny)**.** Most of them

make up the deeper parts of the major ocean basins at about 5 km depth. These plains are an example of the flat area that many scientists once thought the entire ocean bottom was like.

A very small percent of the ocean basin has long deep **trenches** that extend downward to about 11.5 km. They are usually bordered by enough volcanic activity to create island arcs. In the case of Peru-Chile Trench, the volcanic activity forms part of the Andes Mountains. The region of volcanic activity that surrounds the basin of the Pacific Ocean is called the **Ring of Fire** and is generally associated with deep sea trenches. Trenches and island arcs indicate areas of collision between separate oceanic crustal plates.

The rest of the ocean basins is made up of the world's biggest and longest mountain system, the **mid-ocean ridges.** The system is about 65 000 km long. In the Atlantic Ocean, the **Mid-Atlantic Ridge** occupies the central third of the entire basin from the Artic Ocean to about the latitude of the southern tip of Southern America. Iceland is a part of the ridge that became an island through volcanic growth. As shown in Fig.8-9 on p.380, the mid-ocean ridge passes between Africa and Antarctica and into the Indian Ocean, where it splits. One branch heads north and forms the Red Sea, the other branch extends southeast and east between Australia and Antarctica and then across the southern portion of the Pacific Ocean where the ridge is less rugged and as a result, it is called the **East Pacific Rise.** It continues under the southeastern part toward Central America where it branches. Part of it disappears near Panama and the other part disappears near Baja California. The mid-ocean ridge system is offset by hundreds of breaks in the crust – fracture zones and is extremely rugged. The fairly deep central **rift valley,** with high peaks near, is a site of active volcanism. Much heat from the volcanic action is absorbed by ocean water. In addition, new ocean-floor crust forms at the ridges.

Check yourself

1. *List the ocean bottom features of the continental margin and describe them.*

2. *List the features associated with the deep basins and distinguish them.*

3. *Describe the mid ocean ridge system in Fig.8-9 and see* Fig. 8-10 on p. 381 that shows two profiles of the Mid Atlantic Ridge system.

4. *What types of geologic activities affect the permanence of ocean islands?*

Resources of the ocean bottom

Task: Read the information on p.381 and make two lists:

1. Types of resources found in and on the continental margins.

See fig.8-11 and answer the question.

2. Types of resources associated with the deep ocean floor.

Are there other uses of the ocean bottom?

-
-

What do you think the following phrases mean?

To be in a dump –
To dump sb –

Properties of Ocean Water - AW Section 2

Salinity

The words *saline [seilain] - salty* and *salinity [sə'liniti] - saltiness are* from Latin *sal*
Salinity is a measure of the amount of total dissolved materials in water defined as grams per kilogram of water – parts per thousand. *Do you happen to know the salinity of average ocean water? –*
As shown in Table 8-2 on p.386, six elements make up over 99% of the salinity of ocean water. *Write their names*:
In which form are they found in water? -
Compare the percentage of dissolved materials and note that two of them are by far the most abundant and they make up common table salt – what are they?

Compare environmental changes that affect the salinity of the Mediterranean Sea and the Black Sea – AW page 387. Prepare a table.

	The Mediterranean Sea	*The Black Sea*
River inflow		
Evaporation		
Mixing		
Salinity		
Parts per thousand		

In the major oceans, three fourths of the water is below one kilometer depth, where the salinity is nearly constant at 34.5 to 34.9 parts per thousand. Along the center of the mid-ocean ridges, however, isolated spots have hot springs which often contain concentrated amounts of dissolved solids. When deep water circulation is restricted, these hot waters can form **brine pools** (=solanky se silně mineralizovanou vodou). The bottom of the Red Sea has brine pools with salinities as high as 257 parts per thousand.

Temperature

Temperature is one of the most frequently measured properties of ocean water. The surface of the open ocean ranges from very cold in the polar regions to room temperature in tropical areas. This difference is caused by the variation in solar radiation at different latitudes. (Fig. 8-14 on page 389)
Fig. 8-15 on p.390 shows the distribution of water temperature with **depth** from north to south through the Pacific Ocean. As you can see, the most rapid temperature changes take place within one km of the surface in the equatorial and temperate regions. (Be careful of the similarity between the words **temperature** and **temperate!)** Water layer in which temperature changes rapidly in the vertical direction is referred to as **thermocline.** Also note that deep ocean water at the equator is about the same temperature as the surface water near the poles.

Density

The density of ocean water depends on the temperature and the salinity. As the salinity of ocean water increases, the density also increases, but if the temperature increases, the density drops – water is less dense. The density of river water will therefore be less than the density of ocean water.
Ocean water moves in large volumes of water called **water masses.** By determining temperature, salinity, and density, scientists are able to identify large water masses and to trace their movement from place to place.

Sea ice

One of the consequences of the temperature, salinity, and density relationship is the lack of sea ice in most of the world's oceans. Salinity affects the **freezing point** of water. The saltier the water is, the colder it must be before it freezes. *How cold must average ocean water be in order to start freezing? Find the answer in the graph in Fig. 8-17 on p. 393.*

Cooling of ocean water occurs at the surface because of cold winter winds. The spray from winter waves can coat the decks and rails of a ship with ice. And yet, the surface of the ocean has no ice. This is because of the relationship between temperature and density. As the surface water gets colder, it becomes denser than the water beneath it and sinks being replaced by less dense water, which is not as cold. This sinking can be stopped only by the bottom or by denser water mass.
In the Arctic Ocean, the middle and lower levels have a high salinity water mass that forms a barrier to the downward mixing of the cold surface waters, that become cold enough to freeze and form **sea ice.** Because of the length of the cold season and the extreme cold, the sea ice eventually forms very thick masses called **pack ice** (=pole ker). See Fig. 8-18 on p.394.

The water in the open Atlantic, Pacific and Indian Oceans never gets cold enough from top to bottom to freeze, but sea ice might form around the margins where the bottom is shallow and horizontal mixing is restricted. It might also form in **bays** and **estuaries** that have salinity of less than 24.7 parts per thousand. Such bodies form ice fairly easily during winter months because such water does not become continuously denser as it is cooled. The water will reach a maximum density at some temperature above the freezing point. Then, as the water gets colder, it becomes less dense and floats on the surface, becoming colder and colder until it freezes. This is the same way that freshwater ponds and lakes freeze.
When you think of ice in the ocean, you might also think of **icebergs**. *What are they - special type of sea ice?*

Check yourself

1. *Where in the world´s oceans does sea ice form?*

2. *How cold must average ocean water be in order to start freezing?*

Water absorbs light

Pictures taken underwater frequently look blue because blue color is absorbed less rapidly than the other colors of the spectrum. The ocean environment can be divided into three zones, depending on the amount of light that has penetrated to that zone.
Photic zone (from Greek phós = light) extends to a depth of 200m. The light is strong enough for the growth of algae (one-celled plants) and basic food source for many animals.
Disphotic zone (dis = reduced, half) ranges between 200 and 1000 m
Only a very tiny, almost immeasurable amount of light - no more algae, only some organisms with extremely sensitive eyes, bioluminescent animals – e.g. the angler [g] fish
Aphotic zone – the bulk of the ocean
Total darkness except for bioluminescence and underwater eruptions of lava. Some scavengers [dž] and "pockets" of life based on a food chain beginning with sulfur-eating bacteria (no photosynthesis involved).

Explain: the bulk of =

Reading for specific information

Task A: *Read about* ***water pressure*** *on page 394 and answer the following questions:*

1. *What is the rate of pressure change with ocean depth?*

2. *What is the approximate atmospheric pressure (in bars) at sea level?*
3. *How are divers with air tanks able to breathe at depths of twenty meters?*

4. *What would happen to a swimmer if he extended his snorkel tube to 1 m?*

5. *Can other organisms live in any depth?*

Task B: *Read about* ***resources of ocean water*** *on page 398 and write the list* ***of*** *them:*

Discussion Topic
Pollution of the ocean – key words: wells, wastes, sewage, disasters / catastrophe

Read the text on UK seas in crisis (in a ROPOT) and write an abstract to inform someone who will not read it.

Section 3 The Circulation of Ocean Water

Directions of motion in a wave

1. *How many directions of motion in a wave are there? What are they?*

2. *What is the resulting motion? –*
3. *Draw and label a profile view of a wave – Fig. 8-24 on p. 403.*

4. *Explain the terms and the relationship between wave base and wavelength.*

5. *How deep must a submarine be to escape the motion of surface waves?*

6. *What do you think the following phrase mean?*

   To be on the same wavelength –

Deep ocean circulation

Read the text on p. 414 and answer the following questions.

1. *What causes most of the circulation in the deeper ocean waters?*

2. *What is **upwelling?***

3. *Why are some of the world's major fisheries located in areas of upwelling?*

The beginning, middle, and end of a wave

Fill in the gaps with one of these words:
across caused during either eventually forward lengths motion other ratio times transmit until

Many ocean waves begin in a state of total confusion. They form in a storm area and are _____by the winds associated with the storm. The water surface under a storm center at sea has a very irregular pattern of waves. Waves of different heights and _____
are formed by the winds within the storm center. Some of the waves exceed a height-to-length _____ of 1 to 7 and collapse. Other waves interact with each_____ to make the surface of the ocean even more confused. Ships and other surface objects such as offshore oil-drilling rigs have a very difficult time _____a storm at sea. Waves _____energy that is directly proportional to the square of the wave height. A wave two meters high has four_____ as much energy as a wave one meter high.

The middle stage of a wave is much more regular than its beginning. As waves move away from a storm center, they separate according to wavelength. Waves with long wavelength travel faster. Eventually a regular rhythmic pattern of waves called **swell** develops. It can cover hundreds of kilometers of open ocean, with the waves all moving _____ without breaking or collapsing. The orbital _____ within the waves of ocean swell is circular. The energy is transmitted _____ the ocean with very little loss.

Most waves _____ end up on a beach. As ocean swell nears the shore, the water becomes shallower. Where the ocean bottom is above wave base, the orbital motion of the water in waves changes from circular to elliptical. As the water continues to become shallower, the elliptical orbit becomes flatter. At the same time, the wavelength shortens and the wave height increases _____ the wave can no longer maintain its shape and collapses, _____ as a foaming mass of water or as a forward-breaking mass of water. The area near the ocean's margins where breaking waves occur is called **surf zone.**

Check yourself

1. *What force in nature creates most ocean waves? –*

2. *What aspect of wave motion is responsible for the development of swell? –*

3. *Describe what happens to a wave as it nears the shore – you may use Fig. 8-27 on p.406.*

Effects of wave action

Fill in the gaps with one of the words from the clue.

Part 1: **because bottom build coast common earthquake per though troughs wiped**

In addition to the waves of stormy seas, there are also huge waves that form as a result of wave interference. Wave shapes are additive. When the swells from different storm centers pass through the same water and the crests and _____ coincide, a single crest forms that is equal in height to the sum of the two original crests. When two or more high waves of about the same wavelength have their crests coincide, the resultant **rogue wave** is usually big enough to cause problems for ships. They can form and disappear very quickly. The south-eastern _____ of Africa is known for fairly frequent rogue waves which develop heights up to twenty meters.

Perhaps the most rapid damage to a shoreline is caused by a huge wave called a tsunami – a group of waves with fourteen or more crests caused by an underwater _____somewhere along the ocean _____ . At sea, the waves of a tsunami may have a height of only 2 m and a wavelength of up to 160 km. It can take up to 15 minutes for successive wave crests to pass a given point on the surface of the ocean even _____ they may be traveling more than 600 km _____ hour. _____of their height-to-length ratio, these waves are scarcely noticeable out at sea.

But as the waves of a tsunami approach the shore and the water becomes shallower, they can _____to a height of 50 m. Railroad locomotives can be tossed like toys, buildings smashed, trees snapped like toothpicks. Whole villages and cities can be _____out. Tsunami are most _____around the margins of the Pacific Ocean.

Part 2: **approach cliffs few loose may shelf slips supply**

Along the margins of the oceans, waves can directly attack the land. The constant **pounding of waves** can, over long periods of time, reduce boulders and rocky_____ to particles of gravel and sand. Waves also create movement of_____ particles and water in the surf and on the beach. Waves _____ the shore diagonally, which causes a zigzag motion of water along a coastline. The sand _____ be moved hundreds of kilometers. If the _____of sand from rivers and eroding sea cliffs were to stop, then most of the sand beaches would eventually disappear. The coastline along the Pacific of North America has a narrow continental _____.

In a _____places , submarine canyons cut across the shelf and fairly close to the shore. The sand that is moving along the shore _____ down into these canyons and drains onto the ocean bottom.

Note the different ways of translating the word **pounding:**

Pounding of waves – vlnobití
Pounding of guns – odstřelování
Pounding of hooves (sg. hoof) – dusot kopyt
Pounding of hammer / heart – bušení, rány

Translation and a summary
(The beginnings of some sentences are already given as in sentence transformation.)

1. Je možné, že kaňony a údolí byla vytvořena ledovci během poslední doby ledové.
The canyons and valleys …

2. *Domníváme se, že Středozemní moře se vytvořilo, když ho uzavřely dva kontinenty.*
The Mediterranean Sea …

3. Svoji domněnku založili na skutečnosti, že …

4. Liší se hloubka oceánských pánví značně?

5. Jaké neobvyklé druhy organismů se nacházejí v obohacených vodách kolem aktivních vulkanických riftových údolí?

6. Když je omezena cirkulace hlubokých vod, mohou se v horkých pramenech vytvářet solanky.

Task:
Read the text on tides on the following page (*on p. 409 in AW textbook****) and write a summary.*** *Follow the steps to write the summary in an effective way.*

1. Read the passage several times.
2. Decide on the key ideas and mark them.
   Write down key words.
3. Put away the original and rewrite your notes in your own words.
4. Change the order of the points if necessary to make the construction more logical.

5. Re-read your summary (after some time) to check that you have included all the important information clearly and expressed it as economically as possible.

Tides

If you've ever built a sand castle on an ocean beach, you've probably noticed that over a period of time the waterline moves either toward the castle or away from the castle. This happens because the level of the sea at a particular location rises and falls during the course of a day.

About once every twelve hours, the waterline reaches what can be called the high water mark. When the waterline reaches this level, the ocean at that location is said to be at **high tide**.

After the waterline reaches the high water mark, the waterline then moves back down toward the open sea until it reaches a low water mark. When the waterline reaches its lowest point, the level of the sea in that area is at **low tide**.

High tide is the result of huge bulges in the level of the ocean. The bulges are caused mainly by the moon and the movement of the earth and moon. Figure 8-30 shows the bulges in sea level in relation to the position of the moon.

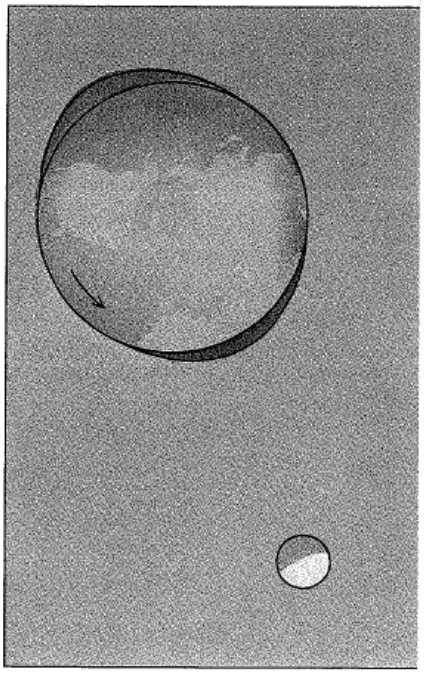
You will notice that there are actually two bulges. The one nearest the moon is caused by the force of gravity from the moon attracting objects on the earth's surface. The moon pulls on all parts of the earth. But the pull is strongest at the points closest to the moon. The earth's solid surface is not greatly affected by the moon's gravitational pull. But the water on the earth's surface is noticeably affected because water is fluid and can change its shape. The bulge directly opposite the moon, on the other side of the earth, is caused by the rotation of the earth and moon through space.

The fact that sea level at any location goes from high tide to low tide and back again is due to the earth rotating on its axis. The solid earth is actually rotating under the bulges of water.

Tides affect the kinds of plants and animals that can live along the margins of the oceans. Tides can cause alternate wetting and drying of land areas. Rising and falling tides create tidal currents in coastline environments. Incoming tidal currents can bring salt water into an area that has fresher water at low tide. Incoming and outgoing tidal currents also affect the temperature of an environment.

Tides also affect people who live, work, or travel near the water's edge. Tidal changes affect the depth and the water speed and direction in harbors and along coastlines. For that reason, ships frequently schedule their arrivals and departures to coincide with a certain tidal condition. Other nearshore and offshore activities, such as fishing and recreation, are also affected by tides.

Figure 8-30. How does the moon affect the level of the ocean's surface on the earth?



Ocean – Revision Test

True or False? Cross out the false statements and correct them.

1. Concentrated amounts of dissolved solids can be found anywhere along all the mid-ocean ridges.
2. Warmer surface water near the equator is less dense than the cooler surface water near the poles.
3. Salt water freezes at lower temperature.
4. Deep ocean water at the equator is cooler than the surface water near the poles.

5. At base level the orbital motion of a wave almost disappears.
6. Fishing industry is often located in swelling areas.
7. Blue color is absorbed most rapidly in water.
8. Deep ocean temperatures are highly variable

9. Local storms may also affect the timing and the strength of the tides along a coastal area.
10. The tides are usually weaker at the head (the narrow end) than at the mouth of a V-shaped bay.

Write the synonyms of these words:

bulk (of the ocean)-
coincide –
successive (wave) –
temperate –
vertical mixing –

entire -
restricted –
scarcely –
rarely –
excess –

Match the suitable words:

Ice nutrients point pressure salt tank tube winter

table
freezing
water
severe

air
dissolved
snorkel
pack

Explain these terms:

Brine pool –

Clockwise –

Pounding –