The Ocean

- The entire body of salt water that covers much(71%) of the earth's surface
- 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:

- When continents came together. The Mediterranean Sea and the Black Sea are thought to have formed when two continents enclosed them.
- 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.
- 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 sediments 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?-

Oceans 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 and 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. *Do you remember the map we already looked at last semester?* 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 –

Homework

Write your own definitions of all the terms in section 1.

Section 2 Properties of Ocean Water

Salinity

The words *saline [seilain]* - *salty* and *salinity [sə'liniti]* - *saltiness are* from Latin *sal*
Definition:

What six elements make up over 99% of the salinity of ocean water? Which of these are by far the most abundant? Find the info in Table 8-2 on p.386

What is the correct pronunciation of the elements and ion (form found in water)?

What is the salinity of average ocean water? –
What environmental changes can affect the salinity?

Compare the salinity of the Mediterranean Sea and the Black Sea. Prepare a table.

	The Mediterranean Sea	*The Black Sea*
River inflow		
Evaporation		
Rainfall		
Vertical 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, they can form **brine pools**.
Which seas have brine pools with very high salinities?

Temperature and density

What geographic variables affect the temperature of ocean water?-
Explain the variation of solar radiation (by comparing). You can find help in Fig. 8-14 on p.389.
What are the key words?

Fig. 8-15 on p.390 shows the distribution of water temperature with depth from north to south through the Pacific Ocean.
Where do the most rapid temperature changes take place?-

Be careful of the similarity between the words **temperature** and **temperate!**

How does deep ocean water at the equator compare in temperature with surface water near the poles? –

The density of ocean water depends on the temperature and the salinity.
How does temperature affect water density? –
How does salinity affect water density? –

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. *Where does sea ice form? –*

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? See Fig.8-17 on p. 393 to give the answer.*

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. *Can you explain that? –*

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.**
See Fig. 8/18 on p.394, describe the shape and explain its formation. –

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. *Where do you know this process from? –*
What is the main idea of the paragraph above?-

*What are **icebergs?** Are they special type of sea ice? –*

Water absorbs light

What color are the pictures taken underwater? Why?-

The ocean environment can be divided into three zones, depending on the amount of light that has penetrated to that zone. *Read the information on pages 396 and 397 and write characteristics of the depth zones including sea life forms.*
Photic zone (from Greek phós = light) to a depth of

Disphotic zone (dis = reduced, half) between 200 and
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 fish
Aphotic zone – the bulk of the ocean
Total darkness except for bioluminescence and underwater eruptions of lava. Some scavengers and "pockets" of life based on a food chain beginning with sulfur-eating bacteria (no photosynthesis involved).

Check yourself
What are natural the sources of light in the deep ocean?

Give the meanings of these expressions: algae [dži:]- angler fish [g]-
fireflies - bulk – scavanger [dž] -

Share the following two tasks in pairs:

Task A: *Read about* ***water pressure*** *on page 394 and prepare a summary for your classmate. When he has listened to your summary, ask him or her following questions and check his answers. If you agree on the same, hopefully correct, answers, write them. If not, read the particular paragraph again, but this time aloud, and try to come to an agreement. Your classmate can only listen, but not read!*

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 on your worksheet. Leave some space for additional notes. When you have answered the questions in task A, dictate the list of your task B to your classmate and check his spelling. He or she is not allowed to follow the text in the textbook, but should be encouraged to ask you additional questions.*

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

Homework
Write the new terms of section 2 and their definitions.

Section 3 The Circulation of Ocean Water

Directions of motion in a wave

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

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

What is the relationship between wave base and wavelength? -
Show the directions of movement of the water in the wave you drew.

Write the definitions of the terms and give their Czech meanings:
Crest-
Trough [trof]**-**
Wave height –

Wavelength –

Wave base –

Swell – a regular pattern of waves of similar wavelength.
x
Upwelling – a process by which deep, cold water comes to the surface

What do you think the following phrase mean? First explain in English.
To be on the same wavelength –

The beginning, middle, and end of a wave

Read and fill in the gaps with suitable words.

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 _____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_____ 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 _____to wavelength. Waves with long wavelength travel_____. Eventually a regular rhythmic pattern of waves called _____develops. It can cover hundreds of kilometers of open ocean, with the waves all moving _____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 _____. As the water continues to become shallower, the elliptical orbit becomes_____ . 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
What force in nature creates most ocean waves? –
What aspect of wave motion is responsible for the development of swell? –

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

Effects of wave action

Fill in the gaps with suitable words. If you have no idea, choose one of the words from the clue below the text.

In_____ 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 _____in height to the sum of the two original crests. When two or more high waves of about the same wavelength have their crests _____, 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.

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 may be moved hundreds of kilometers. If the _____of sand from rivers and eroding sea cliffs _____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 _____close to the shore. The sand that is moving along the shore _____ down into these canyons and drains onto the ocean bottom.

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 _____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 _____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.

Clue: Addition approach because bottom build cliffs coast coincide common earthquake equal fairly few loose per shelf slip successive supply though troughs were wiped

Note the different ways of translating the word **pounding:**
Pounding of hammer / heart – bušení, rány
Pounding of hooves (sg. hoof) – dusot kopyt
Pounding of guns – odstřelování

Writing Summaries - Competition

Student A – Tides

Read the text on tides on p. 409 and take notes to write a summary as your homework.

Student B (preferably the more advanced of the pair) – Surface Ocean Currents

Read the text on p. 411 – 414 and take notes to write a summary as your homework. Prepare a small presentation for the next lesson – just the talk, as we shall use the pictures in AW textbook, but if you want to, you may bring some additional visual aids.

The best summaries will be copied for the rest of the class, so do try your best. Save your time and type the summary – possible mistakes or arrangements can be easily made.

……

Next lesson

Deep ocean circulation

What causes circulation in the deeper ocean waters? –

Why are some of the world's major fisheries located in areas of upwelling?-

Translation
Tthe beginnings of some sentences are already given:
Je možné, že kaňony a údolí byla vytvořena ledovci během poslední doby ledové.
The canyons and valleys …

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

Svoji domněnku založili na skutečnosti, že …

Liší se hloubka oceánksých pánví značně?

Jaké neobvyklé druhy organismů se nacházejí v obohacených vodách kolem aktivních vulkanických riftových údolích?

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