CHAPTER
1

Our Earth

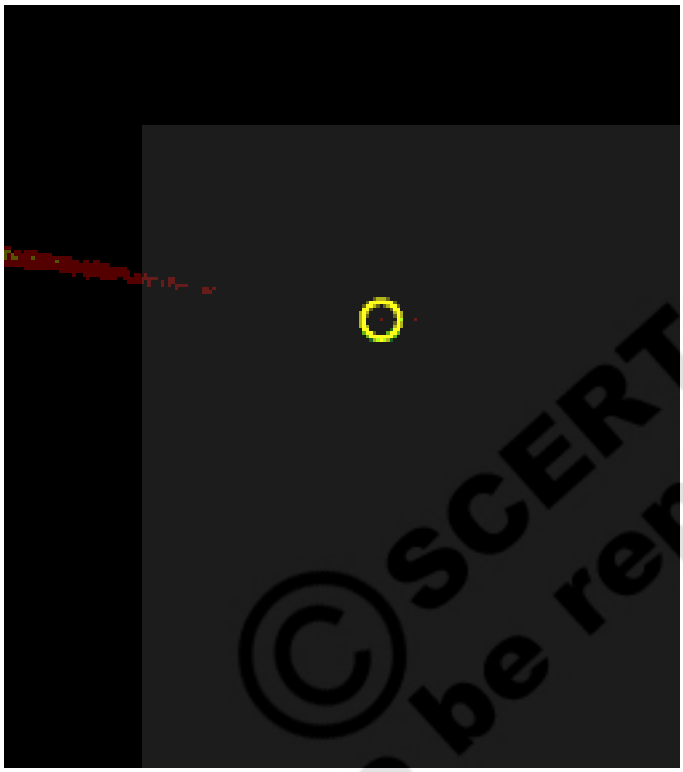


Fig. 1.1: Carl Sagan, a scientist pointed out that all of human history has happened on that tiny pixel shown here inside a yellow circle which is our only home, Earth. This photo taken from the space is known as "Pale Blue Dot".

We live on this Earth along with millions of other animals, plants and micro-organisms. We human beings arrived on this earth about one lakh years ago. More than any other animal, human beings have been trying to make the Earth a better place to live in. We have been constantly trying to change ourselves and our surroundings. In this process we have entered into conflict with other inhabitants of the Earth and amongst ourselves. But, above all we have tried to understand our earth and our activities so that we can live a better life. For long we have looked at the Earth as a storehouse of resources which we can exploit and use at will. Gradually we are realising the fallacy of this viewpoint. Our reckless exploitation of the Earth has meant the destruction of forests, rivers, hills, fellow animals and even fellow humans. This has resulted in what many are calling the 'environmental crises' like global warming and poisoning of our soils, water and air. Today, more than at any other time we need to build a new understanding of the Earth, how it works and what we do on it and what we do with each other.

In class VI to VIII you had studied about diverse people living in different kinds of lands in different times, how they used the forests, soils, water and minerals of the earth. In the following four chapters we will study about the Earth as a large interconnected system we will see how the rocks, soils, minerals, water, air, sunshine, forests, animals and humans interact with each other and change each other constantly.

Our Universe, the Sun and the Earth

For thousands of years humans have been looking into the sky and trying to understand the objects that shine there –the stars that remain fixed vis a vis each other and the Sun, the Moon and the planets which keep moving across the sky. What are these and in what ways are they related to us? How do they affect us? Many people studied these objects very carefully, noting down all movements and happenings in the sky and tried to figure out what they are and how they move and work. Initially people thought that earth was firm and stationary and all others went round it. Since things have been like this for thousands of years they also thought that the earth, the stars and sun have been like this for ever and will be like this for ever – without any change. About five hundred years ago, scientists came up with a new understanding – that the Earth is not in the middle of everything, that it is actually moving around the Sun and that the sun itself is also moving and that the countless stars in the sky are actually so many suns. During the last hundred or so years people have even figured out that stars are born, they grow old and even die!

Scientists have figured out that the stars are actually part of larger groups called galaxies and that there are millions of galaxies in the universe. Now they are of the view that the universe itself started some 13.7 billion years ago with a 'Big Bang' and that it may end several billion years later.

From this were formed galaxies and within the galaxies were formed stars and around many stars planets formed and went around them. In our lives things move very fast, things change every moment. However, these astronomical changes take place over thousands and even millions of years.

Today human beings are investigating and trying to understand these very distant and complex phenomena! To study all this several spaceships have been sent into the sky, human beings have even landed on the moon. Spaceships have landed on nearby planet - Mars and some have even gone beyond the end of our Solar System.

In short, the Sun and the Earth are a part of a much, much larger universe which is constantly moving and changing! The earth and the life on it are products of these changes and are influenced by them!!

- Why do you think people today are curious to know about the secrets of distant stars and galaxies and the beginning of the universe?
- Initially people thought that the earth was in the centre of the universe and human beings the most important creation. What difference does it make to us to know that we are a small insignificant speck in this vast universe?
- Read about the Solar system and the planets that go around the Sun in Chapter X 'Stars and the Solar System' of Class VIII Science textbook for more details.

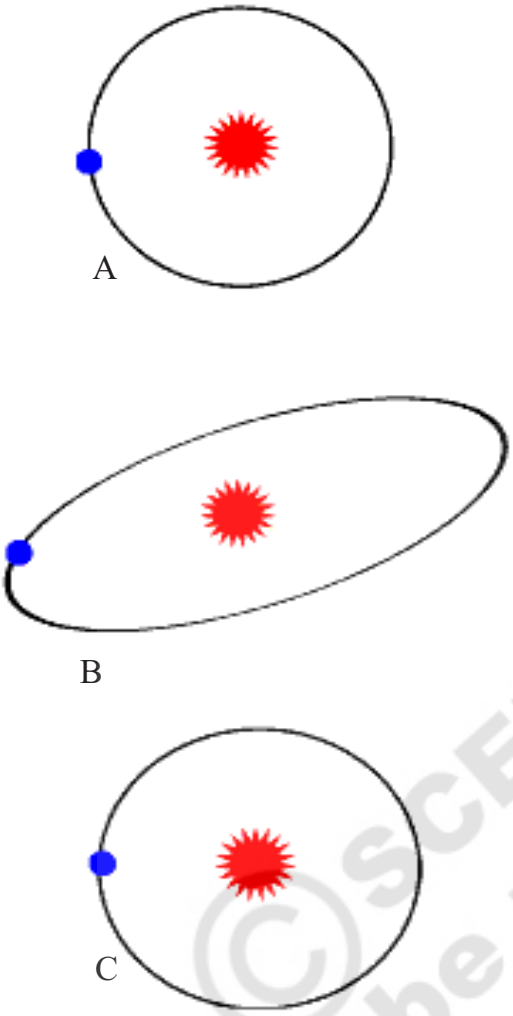


Fig. 1.2: Earth's orbit

Earth as a Planetary Body

Like all planets in our solar system, the Earth rotates on its own axis and goes around the Sun in a definite orbit. The orbit is the path of the Earth around the Sun. This orbit is on a uniform plane which is called the plane of the orbit. Look these pictures of the Earth, Sun and the orbit. Which one do you think is the correct picture?

A. *A circular path*

B. *An elongated oval path*

C. *A scaled oval path (Sun in the middle and 1.4 cm on one side and 1.5 cm on the other side)*

Actually, the Earth's orbit is nearly circular (as in figure C), and the difference between Earth's farthest point (about 152 million km) from the Sun and its closest point (147 million km) is very small. Earth travels around the sun at a speed of 1,07,200 kilometres per hour! At this speed, it takes 365¼ days to complete one revolution. We call this a 'year.' You have studied in class VIII about the energy received by different parts of the Earth from the Sun and how this travel of the Earth around the Sun causes the seasons like winter and summer.

Tick the factors which cause the formation of seasons on the earth:

- Daily rotation of the earth on its axis.
- Monthly movement of the Moon around the Earth.
- Rotation of the Sun on its axis.
- Revolution of the Earth around the Sun.
- Tilt of Earth's axis of rotation to its orbital plane.
- Spherical shape of the Earth.
- Earth's distance from Sun during the annual revolution.

The Word Earth

English word "eorthe" meaning 'ground, soil, dry land.' (Dictionary Online.com)

Indian languages have multiple words for 'earth.' Sanskrit terms include bhoomi, pruthivi, dharani, avani etc. Many Indian languages use variations of these Sanskrit words.

The evolution of the Earth

Scientists are still debating how our Earth was formed. Most scientists are of the view that Earth began to form around four and a half billion years ago. The Earth has reached its present form through several phases. It began as a ball of swirling dust and clouds, and passed through a molten stage. At that time the Earth was very hot and was constantly bombarded by massive rocks and other materials from the space. In this way the size of the Earth grew. The Earth was so hot that it was molten (in hot liquid form). If you boil a thick soup containing many substances you may observe that the heavier particles tend to go to the bottom and lighter particles come to the top. These lighter particles cool at the top and form a layer of crust (like the cream of milk). Similarly, while heavier substances formed the part of the molten core, lighter substances rose to the surface and cooled. Slowly an upper crust of lighter and cooler materials formed covering the molten interior.

As the Earth's interior continued to cool, it contracted and the outer crust wrinkled forming ridges (mountains) and basins (low areas which became oceans later).

The atmosphere of the Earth consisted of different kinds of gases including water vapour. Most of these gases were such that life as we know it today could not have survived on it. It didn't have oxygen which is necessary for us. It took a long time for the air we breath to develop.

The rain filled the great basins on the Earth's crust with water. Thus, the oceans were formed.

For perhaps one half of the long span of Earth's history, the planet Earth remained barren and lifeless. Then life appeared in the oceans. It slowly evolved into diverse plants and animals including human beings over millions of years.

- Do you think the Earth was created suddenly or do you think it was formed by long drawn and complex processes?
- Some people believe that our being on this earth is the result of a series of fortuitous accidents – it is quite possible that there may not have been any life on the earth. Do you agree? Give your reasons.

Internal Structure of the Earth

Let us look at the internal structure of the Earth we live on. We can see the continuity from the early days of the formation of the earth as we try to look deep inside the Earth! It took us years of scientific investigation and analysis of data to form an understanding of the interior of the Earth. The main reason for this is that even the deepest mines we have dug do not go beyond a few kilometres under the surface while the radius or the distance to the centre of the earth is over 6000 kilometres!

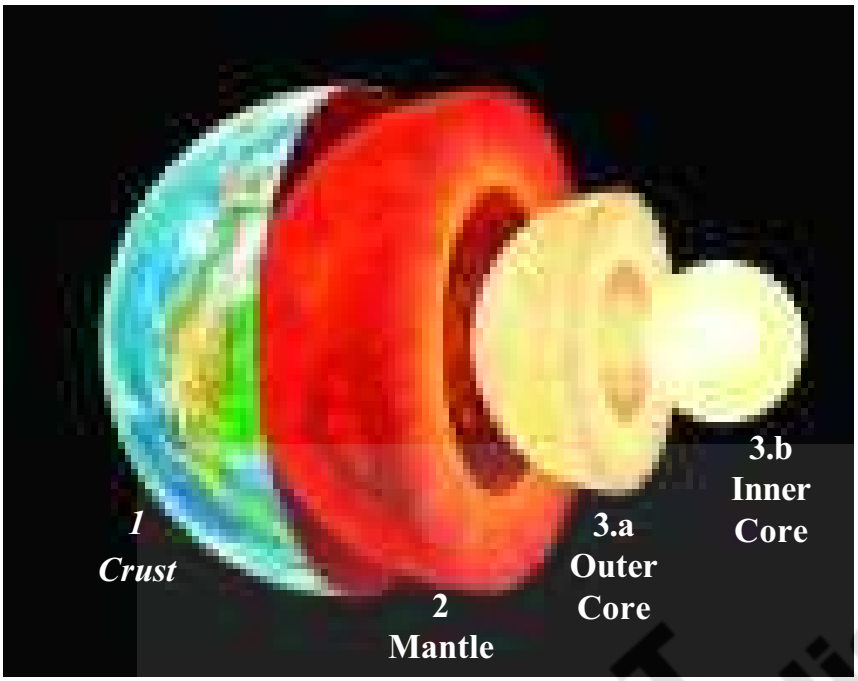


Fig. 1.3: The interior of the earth.

The earth is made up of three main layers

1. ***Crust***
2. ***Mantle***
3. ***Core***

1. Crust: We live on the outer part of the earth which is called the crust. You saw in the last section how this layer was formed. This layer goes up to a depth of 30-100 kms. The crust mostly consists of various kinds of rocks.

2. Mantle: It is 100-2,900 kms in thickness. The upper part of the mantle is a pliable layer over which the crust floats. This consists mainly of chemicals called silicates.

3. Core: The core is 2,900 to 6376 kms in thickness. It is composed of dense and heavy substances like iron and nickel. It can be divided into two sub layers.

Outer Core: 2,900 to 5,100 kms composed of liquid metallic material like nickel and iron.

Inner Core: The solid inner core (5,100 – 6,376 kms) of the earth is made up of Iron compounds and heavy substances like gold.

Interestingly matter from deep inside the mantle shoots up through volcanoes and fissures on ocean floors and cools down to form the earth's crust. In many regions on the earth part of the earth's crust enters into the mantle and once again becomes molten. This constant process of formation and destruction of the crust explains the fact that our Earth is still very active. The crust on which we live is still being changed by earthquakes, volcanoes, subduction of land and rise of mountains due to processes happening deep down the earth.

Do you know?

The crust forms only 1% of the volume of the earth, 16% consists of the mantle and 83% makes the core.

The thickness of the crust is just about the thickness of the shell of an egg, if we assume that the size of the earth is equal to the size of an egg!

- We cannot hope to travel to the mantle to study it. But we can study substances from the mantle. Can you tell what these substances would be and how we can get them?

Movements of the Earth's crust

The shapes and positions of the continents may seem fixed at the time-scale of human experience. However, when you look at how old Earth is, continents have moved, collided, merged and then been torn apart again. Mountains have risen and been razed to the ground, oceans have formed and dried up, valleys have been carved, and so on during the course of earth's eventful history.

In the early 20th century, a German meteorologist and geophysicist Alfred Wagener introduced the theory of Continental drift to describe and partially explain the present arrangement of continents and ocean basins. He postulated a massive super continent, which he called Pangaea (Greek for "whole land"), as having existed 220 million years ago and then breaking apart into several large sections. He suggested that these sections moved away from each other. Over millions of years, some continents collided with others. They are still moving around.

Fig. 1.4: Stages of continental drift

Pangaea is a hypothetical continent from which present continents origi nated by the drift of Mesozoic era to the present. Wagener hypothesised that

the supercontinent of Pangaea broke up to form:

1. Laurensia (present North America, Greenland, and all of Eurasia north of Indian subcontinent) and

2. Gondwana-land (present South America, Africa, Madagascar, India, Arabia, Malaysia, East Indies, Australia and Antarctica).

These two blocks were separated by a long shallow inland sea called the Tethys Sea.

It took millions of years for the continents to reach the present shapes and positions on the globe. Even today many of the continents are moving very slowly, pushing each other – we will read about this in greater detail in the next chapter.

- Look carefully at the map of the world, do you find some continents looking as if they are two pieces of a jigsaw puzzle? Name those continents.
- In which direction Australia is moving?
- In which direction India is moving?

The Earth's Grid System

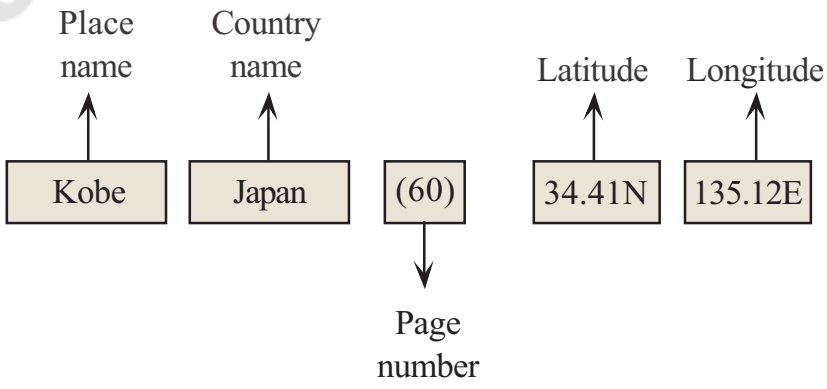
So far we saw the process of the formation of the Earth and its internal structure. Now we will see how it is shown on maps and globes.

Using an atlas to find latitude and longitude of places

You can find the latitude information in a well-produced atlas or online using Google Earth. Here is one example of how to find the latitude and longitude information in the back of the atlas where places are listed alphabetically, similar to the way words are listed in a dictionary.

Example: Find the latitude and longitude information for Kobe.

Find the place name 'Kobe' in the list. Next to that, you will find information about that place. This is a typical atlas listing:

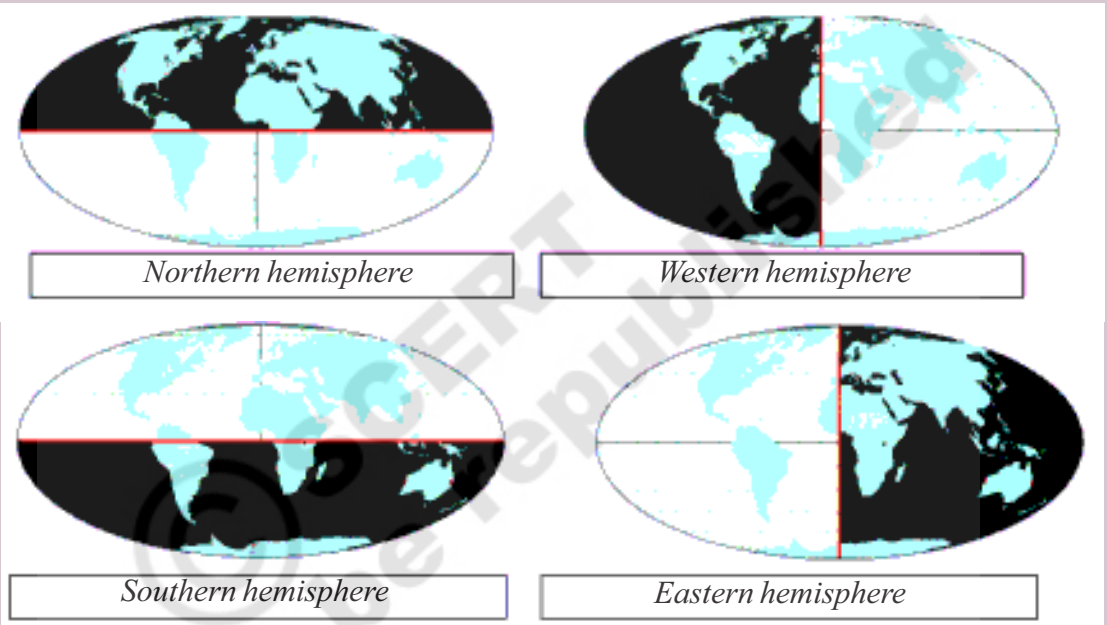


The atlas you use may present the information slightly differently, but these elements will be there.

Now, find the latitude and longitude values for the other places in the list of earthquake-prone places. Locate them on a world map. This will also help you understand the Pacific Ring of Fire and its earthquake-prone places.

On a globe, a network of latitudes and longitudes is drawn. This is called the 'Grid'. With the help of the grid, we can locate places, and learn much about them – how hot or cold it would be there, in which direction should we go to reach it, and what time it would be there at any moment.

- In earlier classes we have studied about hemisphere. Let us revise it in the image below.



With the help of the above maps complete the following table.

Hemisphere	Continents
Northeren hemisphere	
Western hemisphere	
Southern hemisphere	
Eastern hemisphere	

Latitudes

The horizontal circle that goes round the Earth exactly in the middle, at equal distance from the north and south poles is called the 'equator', because it divides earth into (two) equal parts. This is the circle designated as 0° latitude. Following the way angles are designated in geometry, latitudes are expressed in degrees (°), minutes ('), and seconds ("). In many atlases you will not find the minutes and seconds. Look at the fig.1.5.

From the equator, going towards the poles are a series of parallel circles. Each circle

is called a latitude. 'Latitude' comes to us from the Latin word 'latitudo' meaning 'width' – these lines show us the width of the map. Latitude values range from 0° (equator) to 90°North (the North Pole) and 90°South (the South Pole). There is no latitude less than 0° nor greater than 90°. Every latitude must be designated with direction – N for 'north' or S for 'south.'For the equator, there is no north or south designation.

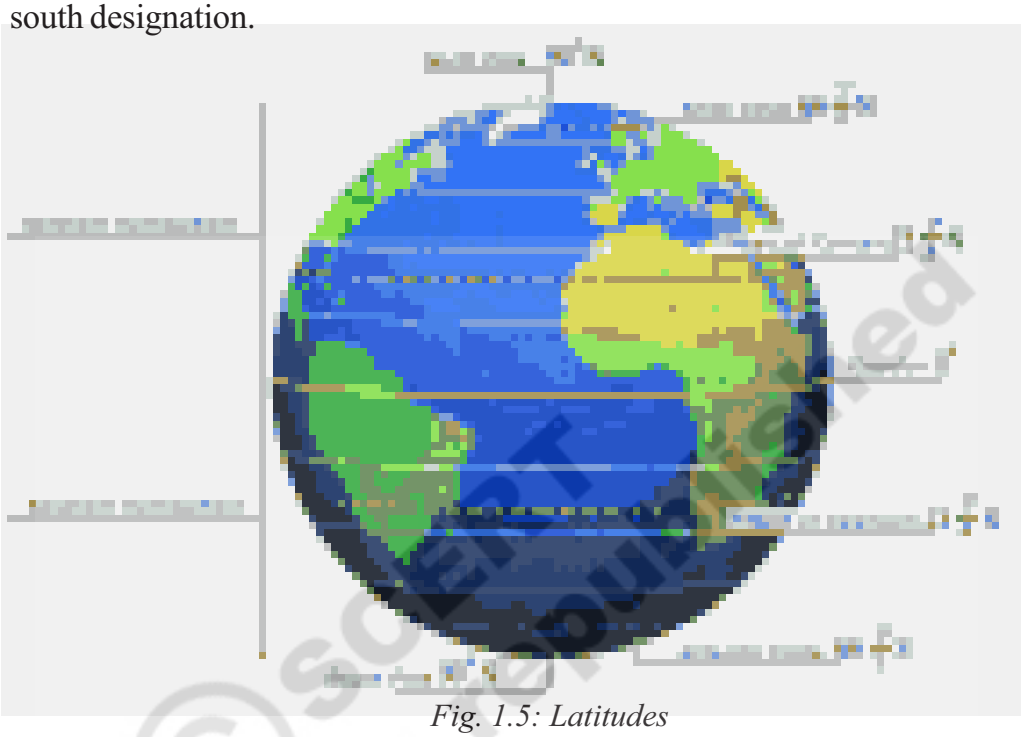


Fig. 1.5: Latitudes

Some latitudes are given special names. These are related to the patterns of sunlight falling on Earth that you would have studied when you learned about the seasons and Earth's revolution around the sun.

Equator is the largest among all the latitudes. All other latitudes on either side gradually become smaller towards poles. At the poles, the 90°N and 90°S are not circles at all! They are just points.

That half of Earth between the equator and north pole is called the northern hemisphere – 'hemi' means half, hemisphere means half a sphere. The half that is between the equator and the south pole is called the southern hemisphere. Counting from one pole to the other, there are 180 main latitudes (not counting the equator).

Longitudes

Latin gives us the word 'longitudo' meaning length, from which we get longitude. Longitudes show us the 'length' or 'height' of a map. Longitudes are not full circles. They are semi-circles connecting pole to pole. Every longitude cuts across every latitude.

The longitude that passes through the astronomical observatory at Greenwich, England is called the 0° meridian, Prime meridian, or Greenwich meridian.

'Greenwich', though it is spelled that way, is pronounced GREN-ich, with accent on GREN.

Several countries tried to fix a longitude that passes through their own territory as the 0° longitude. However, England decided that the Greenwich meridian will be the 0° longitude. They ruled a large part of the world at that time. So, everyone else ended up following their system.

There are 360 longitudes. We organize the main longitudes into two groups: 0° to 180° going east which are the east longitudes, and 0° to 180° going west which are the west longitudes. 0° and 180° longitudes do not have direction markers. Other longitudes have direction markers; for example: 28°E for 28° East longitude, 127°W for 127° West longitude, and so on. Each degree of longitude, just like a latitude, can also be divided into minutes (') and seconds (").

The longitude (180°) directly opposite to 0° longitude is called the anti-meridian (anti, means opposite to).The east longitudes form the eastern hemisphere and the west longtitudes form the western hemisphere.

After all this, remember: latitudes and longitudes are imaginary lines!

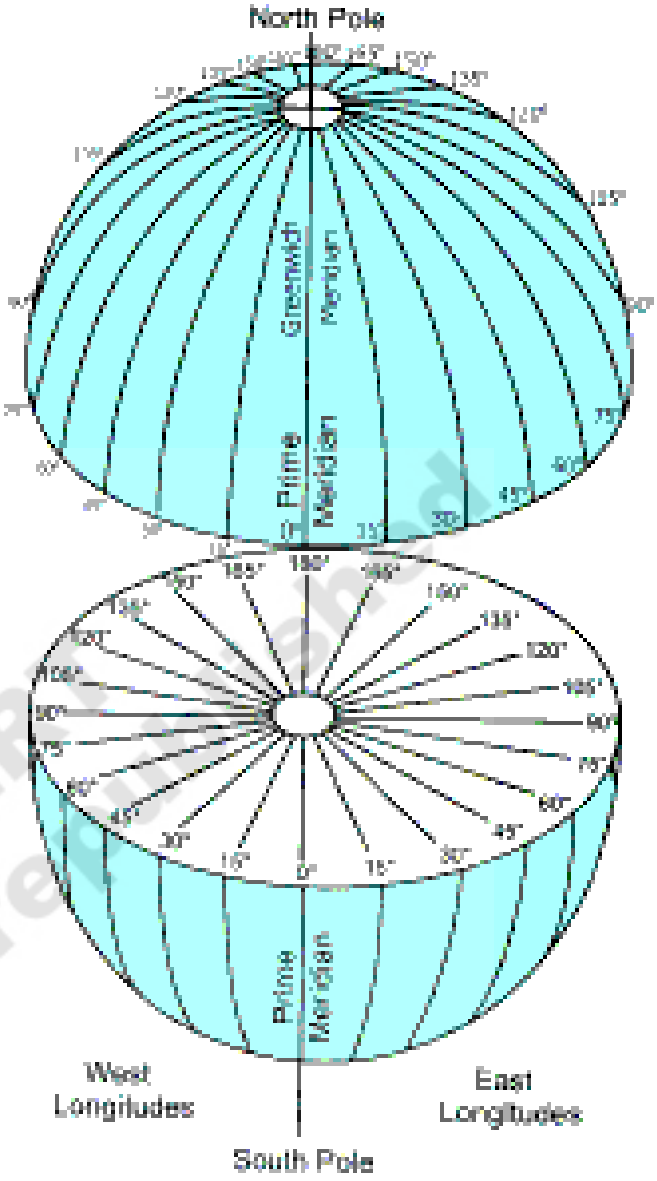


Fig. 1.6: Longitudes

Longitudes and the question of time

It takes 4 minutes for the sun's position to move 1° of longitude. This means that the time is different for each degree of longitude. Here is an example: When the sun is directly overhead at 10°E longitude, the local time is 12:00 (noon). But it is

Other names

Latitudes are also called 'parallels' because they are parallel to each other! Simple!

Longitudes are also called 'meridians.' We get meridian from the Latin meridianus meaning noon, that is when the Sun is directly overhead (noon) at a given longitude. So, longtitudes are related to time.

11:56 am (ante meridiem) at 9°E and 12:04 pm (post meridiem) at 11°E. Obviously, this can cause a lot of confusion.

Therefore, the world is divided into 24 time zones starting from the Greenwich meridian, going east and west. The width of each time zone is 15° of longitude. This means the difference between one time zone and the next is 1 hour (15° of longitude x 4 minutes per ° longitude = 60 minutes). As you go east from Greenwich meridian, you add time; as you go west of the Greenwich meridian you subtract time.

When it is noon (12:00 in the day) on Monday at 0° longitude, it is midnight (12:00 night) at the opposite longitude (the anti-meridian). Just to the west of 180°, the Tuesday is just beginning, while to its east Monday is just ending.

Time and travel

You know that the earth rotates on its axis. And longitudes are imaginary lines we have made. Hence there is a difference in the time as you travel from east to west or west to east. When you are travelling East to West you gain time of 4 minutes as you cross every longitude. But if you are travelling from west to east you lose 4 minutes as you cross every longitude. These are referred as EGA and WLS (EGA - East Gain Add, WLS - West Lost Subtract).

Notice that if you follow the calculated time zone boundaries, some countries would have more than one time zone with less than one hour division; for example India would have two half-hour time zones. That means, the time between western and eastern parts of India would be different by half hour, with the far-flung northeast even more different. This is considered too complicated to be useful.

In such situations, some countries choose the time along one of the meridians that pass through their territory and follow the time of that meridian for the whole country. This time is called standard time. For India, it is Indian Standard Time (IST), for Pakistan it is Pakistan Standard Time, and so on.

The advantage of this is that in India, for example, wherever you are, it is the same time. In countries which span a large number of longitudes, keeping time is more complex. They may divide their country into more convenient time zones, usually with one hour difference between one time zone and the next.

Do you know?

To avoid confusion of time from place to place 82° 30' Eastern longitude is taken as standard Meridian of India and serves as the Indian Standard Time (IST). The exact difference between Greenwich and IST is 5½ hours.

- Using your atlas, find out how many standard time zones these countries have: USA, Australia, Russia, Japan, Zimbabwe, and Chile.
- Swathi works for a call centre in Hyderabad. Her clients are in the USA. She answers clients' questions about the computer problems. She always works during the night. Why is this? Use geography to find out!

Tease your brain!

When it is 12 noon in Greenwich (0°), what is the local time at:

(a) Mumbai (73° E) (b) Chicago (87°30' W) (c) Sydney (151° E)

Key words

1. Big bang
2. Grid
3. Gondwana
4. Prime meridian
5. Time zones
6. Standard time.

Improve your learning

1. Look at the map of India in an Atlas and identify latitude and longitude for the following places:
   Kanyakumari _____ and _____
   Imphal _____ and _____
   Jaisalmer _____ and _____
   Pune _____ and _____
   Patna _____ and _____
2. Identify the words that match with Latitude and Longitude (parallel lines, vertical lines, horizontal lines)
3. Look at the world map of time zone in the text page 13.
   a) If you travel from Vijayawada to Paris to which time zone are you moving? _____
   b) If you are travelling from Hyderabad to Tokyo which time zone are you moving? _____.
4. Why is it difficult to study the formation of the earth and its structure?
5. Read the paragraph under the heading of " Internal structure of the earth" and answer the question.
   How can you say the earth is still very active?
6. What is grid and how does it help us ?
7. Differenciate between a. Local and Standard time b. Equator and Prime meridian
8. If every state follows its local time then what problems will rise?
9. With the help of your teachers find out the standard meridian of given countries.
   1. Nepal 2. Pakistan 3. Bangladesh 4. England 5. Malasiya 6. Japan

World - Time Zones