Hello student.

So the module name is internal

structure of the Earth,

This is your module number:4

It is under Unit 1.

My name is Kimberly Fiona Afonso.

So what are we going to cover

in this particular module?

We are going to understand how the

Concept of seismology is used in understanding the

internal structure of the Earth.

Also to outline the divisions

of the Earth's interior and their

discontinuities separating the same.

So the end of this module you

will study and summarize the

divisions of the earth’s interior

as well as their discontinuities.

So the question is,

how deep have we descended?

We all must have seen in our

neighbourhood some well that must

have been dug a few feet deep or if ever, if

any of you have visited an opencast mine,

you may have seen few layers of

the earth rock that have been

exposed at the surface, or while

traveling by the Konkan Railway.

You may have seen a tunnel that is

Dugout, yet through all this processes

we are not able to drill or understand

how deep the Earth's surface goes

upto, and what lies beneath it.

So there's this project called

as a scientific drilling project.

So what do they do?

They, try to get data of the subsurface Earth,

so they drilled boreholes or wells

deep within the earth surface.

So there is one such borehole that

has been dug at Kola Superdeep,

which is on land in Russia and it is to

a depth of 12,262 meters deep and it

took them 20 years to reach this depth.

Through this project they basically

try to get the rock cuttings

through the surface and analyze what

the Earth’s interior is made up of.

But still the depth is only

12,262 meters deep.

There is this also a drillship

called Chikyu Drillship,

which is a Japanese drillship.

It's used for the same purpose to

understand how deep the earth’s interior is.

Human beings by themselves had descended,

in this particular cave,

which is the deepest known cave on Earth,

and they have descended to

a depth of 2212 meters,

which lies in the Caucasus

Mountains in Georgia.

So this is an image of a drillship,

that drilled through the

subsurface through the Oceanic water.

You have a system of risers which

will then further use the drill

pipes and drill to get the cuttings

back to the surface, so that we

can understand what lies beneath

the Earth's Oceanic crust.

So how else do we understand

what's deep within the Earth?

Luckily we have the earthquakes. Now.

The earthquakes are not good to

humankind when they cause destruction.

However, when an earthquake is triggered,

the vibrations that are set onto the

surface of the Earth will send out

waves in all particular direction.

These waves are useful in studying

the earth’s interior.You can see

in this diagram that an earthquake

has been formed at certain depth

within the Earth's surface.

That depth is called as your

hypocenter or your focus.

The point that lies vertically

above this particular depth

is called, on the surface,

is called as the epicenter,

so, it's from this particular depth

that waves will be generated out, all

throughout the surface of the earth.

So, the science that deals with the

study of earthquakes is called Seismology

and what is *Seismograph*?

It is an instrument that is

used to detect the waves.

This particular instrument,

as you can see in this diagram,

you have a spring.

That is suspended to a load.

This weight of this load you have

a pen that is attached to it,

and you have a rotating drum.

So what does this drum do?

The drum will rotate and it is

attached to a clock-work mechanism, where

the timing is basically marked on the paper.

So as a drum rotates, the pen

will keep marking on the paper.

So when an earthquake forms and is generated,

the ground moves, as a ground moves,

the pen will move.

And that will mark on the surface.

So earthquakes are recorded on this

sensitive instrument called as *Seismograph*.

The drum is rotated by a clockwork

mechanism so that the time is noted,

and this chart that you can see

is called as *Seismogram*,

whereas this instrument that is used to

record it is called as *Seismograph*.

So what are the three different

types of waves that are generated

when an earthquake is formed?

We have the primary wave,

the secondary wave and the L wave.

What are the primary waves?

This primary waves are the fastest

to travel and they are the first to

be recorded at a recording station.

So you have different recording stations

all over the world that will detect

and note the record timing when this

waves reach the recording station.

So this P waves, they can transmit

to solid, liquid as well as the gas.

So basically they will move through

any liquid medium like your

water or oil or rocks as well,

which is your hard surface.

So these in nature, are your

Longitudinal or compressional,

Meaning, if the direction of

propagation is towards the right,

they will move parallel to the

direction of the propagation.

The secondary waves are the 2nd to

be recorded at a recording stations.

These waves they cannot transmit through a liquid.

However,

they do transmit through a solid

but with a lower velocity as

compared to your P waves.

These are transverse in nature,

the direction of propagation is perpendicular

to the direction of propagation,

so the highest velocity and the first

to be recorded in a recording station

is the primary waves, you have

also the L waves,

These ways they cause the

most maximum destruction.

These waves are not really important

in the study of the earthquake,

mainly because these waves

travel only through the surface.

So if you have an earthquake

that's generated at a depth,

it will not really travel within the Earth,

whereas it will travel only on the surface.

So as you can see in this particular

graph this is seismogram

it's an image that has been got

after the arrival of your P waves.

You S waves.

As well as your L waves.

The first to be recorded you

can see is your primary waves,

that is to the left of this image and

the secondary waves somewhere you can

see in the middle of this image that

is a second to be recorded and the

last are the L-waves. You have your time

seen is increasing from left to right.

So the most destructive waves

among all is your L waves.

But they are not important in

the study of the earth.

The time interval between the P waves

arrival of the P waves and S wave will correspond to the

distance from the epicenter.

For example,

if I have an earthquake that's

generated in Goa,

this will be recorded in a

recording station in Bombay,

for example.

So the first time that the P waves

arrive and the S waves arrives,

the difference between them

will give you the corresponding

distance from the epicenter.

And the time elapsed between the

occurrence of the earthquake and when it

was recorded at the recording station

is called as a time travel of the waves.

How much time

basically it took to travel

from the earthquake

where it was generated and from the time

it reached the recording station.

So now, these waves,

when they travel within different

medium or different layers of rock, they,

are either reflected or refracted

at various depth,

they will be refracted if the velocity

of the wave that's traveling from

one layer to the other differs.

For example, if you have two layers,

say on top, you have layer one,

on 2nd you have layer two.

As this waves travel from layer

one to layer two,

If the velocity of layer two is

more than the layer one,

this wave will be refracted away

from the normal,

whereas if the same was layer layer 2.

was less the density or the

velocity was less than layer one?

This wave will bend towards the normal.

So based on this, depending upon the

densities and what the layer is made up of,

whether it's made up of hard

rock material or so or basically

it's made up of liquid material,

these waves when they are generated

and they travel,

they will be reflected and refracted

and it will depends upon the

density of the material or the

chemical composition as well.

So from this we get something called

as your velocity depth curve.

It is possible to understand from this

velocity depth curve the medium

through which the waves travel.

For example,

we have an image right in front

of us, on the X axis you have

the velocity which is given in

kilometers per second, and on your

Y axis you have your depth from

the surface of the

earth to the interior of the earth,

starting from zero and it goes up

to a depth of 6378 kilometers.

So you have the image in pink,

which is your P wave,

whereas in blue is your S wave.

As you can see in this image,

the P wave has a higher velocity

compared to your S waves.

So based on this you will see

that these waves are not really

traveling with the same velocity.

It is either increasing or decreasing.

For example,

look at the depth at 2900 kilometers.

The P wave drastically changes

from 13 kilometers per second,

it reduces to almost around

8 kilometers per second,

and at that particular depth you

will see that your S waves are

from around 6 or around 7

It drops to 0,

so we know that as we have traveled from

the surface of the earth to the interior.

They undergo a velocity increase or decrease,

so that will denote the nature of the medium,

whether it is denser or less dense.

So a change in the velocity at a

particular depth below the surface

of the Earth shows the change in the

nature of the medium or the nature of

the material at that particular depth.

This is the same image over here,

so based on this velocity depth curve,

the interpretation of the internal

structure of the Earth is based on.

The detection of the abrupt changes

in the velocity of the P and the

S waves as it travels from the

focus to the recording station.

Any major change that you can

see in this velocity is called

as a seismic discontinuity.

As you can see at 2900km

there is one sharp abrupt change in the

velocity of the P wave as well as the S wave.

So whenever you come across any major changes

in the velocity of this seismic waves,

it's called seismic discontinuity.

This is the same image you

can see on your left.

You have a person, say,

standing at the crust and he moves

towards the interior of the earth.

You can see how the velocity

changes at different depths.

And that is the reason why we can divide

the Earth based on this abrupt changes.

So now we have two major abrupt changes.

One is the mohorovicic discontinuity and

one is a mantle-core discontinuity.

So what is the mohorovicic discontinuity?

This it will depend upon where

You are standing.

If you are standing below the ocean,

it will.

It will occur at a shallower depth,

but if you're standing on top

of the Himalayan mountains,

it will occur at a greater depth.

This mohorovicic discontinued therefore

differs depending upon where you are standing.

So the occurrence is usually around

30 to 40 kilometers below a continent

whereas 5 to 8 kilometers below

the ocean and 60 to 75 kilometers

below a mountain.

Over here,

upon reaching this depth,

the P waves and S waves show a sharp increase

from velocities from 5.4 kilometers

per second to 7.7 kilometers per

second for your primary wave and

for second wave you have

from 3.35 kilometers per second

to 4.35 kilometers per second.

So after which we know we have

entered another zone because

the velocities increase sharply.

This marks the lowermost layer

that is a crust. Similarly,

you have another discontinuity,

which was an abrupt change that was

seen in your P waves as well as S

waves that occurs at your mantle and core

discontinuity or the Gutenberg discontinuity.

Here the seismic waves as across now the

crust ,  and it enters into another zone.

It travels downward with a

uniform increase in velocity,

thus indicating that the density

of the medium is also increasing

with the increasing depth.

However,

at 2900 kilometers this P waves

become very sluggish or very slow,

or the drop in the velocity and suffers a

decrease in velocity from 13.64 kilometers

per second to 8.1 kilometers per second,

and the S wave stops going any deeper.

They totally go to 0,

so accordingly in the Earth is

divided into 3 main parts,

the crust, the mantle and the core.

As you can see in this image,

you have your crust the mantle and the

core based on the seismic discontinuity.

This other reference,

Thank you.