Hello students,

this is Bachelor of Science third

year geology semester of 5th paper

code is GEC 106 structural geology.

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Outline of the lecture is deformation

deformed and undeformed States and

deformation history
Learning outcomes.

Understand what is deformation,

know the types of deformation,

and understand derivation

of deformation history.

The concept of deformation

understanding deformation is indeed

the heart of the matter because

unless we understand the formation,

we do not know what has happened

or what is going wrong or what

is going right with the rocks.

Deformation is the transformation

from an initial to a final geometry

by means of a rigid body translation,

rigid body rotation, strain, that is

distortion and or volume change.

These are the things that happens

to the rocks when they undergo deformation

There are several ways to express

how that deformation takes place.

That is,

look at the deformation or

check out those folds.

These rocks are fractured.

Himalayan rocks are deformed.

All these expressions tell you that

deformation has occurred in the rock

or the rock has undergone deformation.

In most cases i.e. particularly here the term refers to distortion i.e. strain

expressed in a deformed rock.

Hence distortion that is strain causes a change in the rock in a way

that is expressed as deformation.

It also means a change in form or shape.

Deformation

To describe deformation there are four requirements comparing

the final location of a volume

of rock to where it started out,

Comparing the present orientation of a

volume of rock to its original orientation,

Comparing the present shape of the

volume of the rock to its original shape,

and comparing the present size of

volume of rock to its original size.

So basically deformation is the

difference between deformed

and undeformed states.

It tells us nothing about

what is happened in between,

so we have something rock that was

probably a cube and now it has been

distorted and it is broken into pieces,

so we do not know what is happened

in between for the rock to be

deformed or broken into pieces.

So what do we only see is are the pieces.

Deformation relates to positions

of particles before and after the

deformation history and the position

of points before and after deformation

that can be connected with vectors

which are called as displacement vectors.

Here we can see an image where

there is a cube shown and there

are four points ABCD.

So in this figure the points of interest

in the undeformed volume of rock are ABC&D.

Now the corresponding locations

in the deformed rock

which is shown here are the

position is A here, for B

the position is here, for C

the position is here, and for D

the position is here.

Now the connecting links,
the lines that connect A to A, B to B, C to C,

and D to D are displacement vectors and

the whole family of displacement

vectors is the displacement field.

Now since we have considered only ABCD,

it doesn't mean we cant consider more points.

Now since the same object is deformed

here we can correlate N number of points

into displacement vectors and the entire

the displacement vectors are called as

displacement fields. Hence entire gamut it's called this displacement field.

Now the displacement vectors such as

displayed here in this diagram and in this

diagram do not tell us how the particles

moved during the deformation history.

Instead, they merely link the

undeformed and different states.

Now, here rotation is taken place,

here translation is taken place.

Now the actual path that each particle

follows during deformation history

is referred to as particle path

shown in the right side column.

Hence these are the particle paths and these

are the particle paths for these two images.

Now here this cube has been rotated

and it can be shown in the

form of arrows is displacement field and

each individual particle

within the cube must have moved in

a rotational direction for it to

show particle paths. For translation

the body is moved from this point

to this point.

Hence the displacement field

is shown by straight

arrows pointing in One Direction.

Particle paths are also same,

pointing in One Direction.

When specifically referring to

the progressive changes that

take place during deformation,

The term progressive deformation is used.

Let us see transformations.

There are four types of transformations.

So let us consider example of a

balloon non geologic object to

understand what is

Transformation. So hot air balloon

So when the hot air balloon

changes position during liftoff,

it undergoes translation i.e. each it

changes for its position from the ground,

and it starts moving towards the

air in a vertical direction.

Hence there is translation along with all

of the material points and lines within it.

Next particle rotation,

so when it changes its orientation it

starts wobbling and starts rotating in

the air so that it's so slowly start

spinning in an Eddy it experiences rotation

all of the material points and

lines along with it also rotate.

So when the balloon changes in size due

to heating up or cooling off in the in air,

it undergoes dilation i.e. changing

shape which affects the spacing of the

material points and the lens orientation

and spacing of material lines within it.

Now the 4th point is distortion. When the

hot air balloon changes shaped like for

example it collides with another balloon,

then it changes shape.

So these two changes are

spacing of material points,

and orientation and spacing of

material lines within it.

Now there are two different ways in

which the material can behave as a

rigid body and as a non rigid body.

Now when it moved here there is

an image that shows an original

object and there are images for

rigid body and non rigid body.

So when the original object

is a rigid body it

can undergo translation very easily and

it can undergo rotation very easily.

But when we consider nonrigid deformation,

nonrigid body is a deformation

in which dilation takes place

i.e. the object becomes smaller and

or larger. Then there is another type

of deformation which is non rigid

which is called as distortion wherein

it changes its shape so the earlier

nonrigid does not change its shape,

but it changes its volume but in non

rigid by distortion it changes its shape.

The distinction between the rigid and

non rigid tests rests on whether the

material at the scale of observation moves

intact without a change in shape or size,

rigidbody character and ends instead

experiences a change in shape or size along

the way that is non rigidbody character.

Hence, at these two rigid body translation,

rigid body rotation is for those where

they do not change the shape,

whereas in dilation and in distortion it

changes its shape.

Deformation history.

So it is sometimes possible to extract

information about the deformation

history from naturally deformed rocks.

We have to look at the

structures that have been developed

during this deformation of the rock.

Hence they would represent only

the terminal phases of deformation and

not the entire deformational process.

Deformation is moved from one part of

the deformed rock volume to another,

leaving behind deformed rock that has

recorded conditions during earlier

increments of the deformation.

Thus, the margins

in this figure the margin here

records the first increment of deformation

where in the deformation started here

and then further increments of

deformation could be recorded in

these parts are in the central

parts of the shears,

and these part isnt deformed,

and this part is deformed.

Shear zones can also initiate as narrow

zones and widen over time.

Sometimes what happens is shear zones

usually start with a fracture and then

it develops into multiple fractures

and then it develops into a zone.

Hence here narrow zones are

transformed or widened over time.

So in this case the outer portion of the

Shear zone records are last increments

of deformation or the central portions

will record the last increments,

whereas the peripheral portions will

record the first deformational features.

Hence the search for Deformational

history is not an easy task and

involves a lot of field work,

and noting down or various

observations into the field notebook.

For this I've referred structural geology,

MP, Billings, 3rd edition,

Prentice Hall and Davies,

and Reynolds structural

geology of rocks and regions.

Hoboken Wiley.

Thank you.