Deformation of rocks

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How Rocks Become Deformed

Rocks are deformed by:

folding and

faulting.

Deformation of rock involves changes in the shape and/or volume of these substances.

Changes in shape and volume occur when stress and strain causes rock to buckle and fracture or crumple into folds.

Types of stress: the forces associated with folds and faults

- **Stress: is the FORCE acting on a body of rock**

- **Strain: is the response of a rock to stress. It generally involves a change in shape or volume of the rock.**

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There are three types of tectonic forces or stresses that deform rocks:

- Compressional forces
- Tensional forces
- Shearing forces

- When stress is applied, rocks initially respond by deforming **elastically**. These are **reversible** changes.

- When the stress is removed, the rock returns to its original size and shape.

Once the elastic limit of the rock is exceeded by the stress, the rock will:

- 1. **Deform plastically**, resulting in permanent changes in size and shape (such as folding), or
- 2. **Fracture** (i.e. break)

- A fracture is a crack in a rock.
- A fault is a fracture along which movement has occurred.

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- Strata will break if rocks behave in a brittle fashion and/or confining pressure is low.

- When rocks that contain hard minerals like quartz or calcite are shallowly buried, it results in fractures.

- Rocks nearer the surface of the Earth, where temperatures and pressures are lower, rocks will behave like a brittle solid and will fracture once their elastic limit is exceeded.

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- If strata are ductile and/or the confining pressure is high, deformation result in bending or folding.

- Rocks will deform plastically and will fold under conditions of high temperatures and pressures, like those deep within the crust of the Earth.

- Rocks containing pliable (can be bent) minerals like gypsum or clays, or rocks that are deeply buried (>10 km depth) become folded when subjected to stress.

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Whether a rock behaves in a **BRITTLE** or **DUCTILE** manner depends on:

1. **composition**

2. **rate of stress**
high rate (fast) -> brittle behavior.

3. **temperature**
high temp (deep) -> ductile behavior

4.**pressure of overlying rocks**
high (deep) -> ductile behavior

Compressional forces

Compressional forces – squeeze and shorten bodies creating:

- **anticlines,**
- **synclines and**
- **thrust faults.**

Associated with convergent boundaries.

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Tensional forces

Tensional forces – stretch a body and pull it apart, creating:

normal or extensional faults.

Associated with divergent boundaries where plates are moving apart.

Shearing forces

- **Shearing forces – push two sides of a body in opposite directions causing**

shearing zones in rocks and occurring at transform fault boundaries.

For plastic deformation of rock to occur a number of conditions must be met, including:

- The rock material must have the ability to deform under pressure and heat.
- The higher the temperature of the rock the more plastic it becomes.
- Pressure must not exceed the internal strength of the rock. If it does, fracturing occurs.
- Deformation must be applied slowly.

Fold

A fold can be defined as a bend in rock that is the response to compressional forces.

Folds are most visible in rocks that contain layering.

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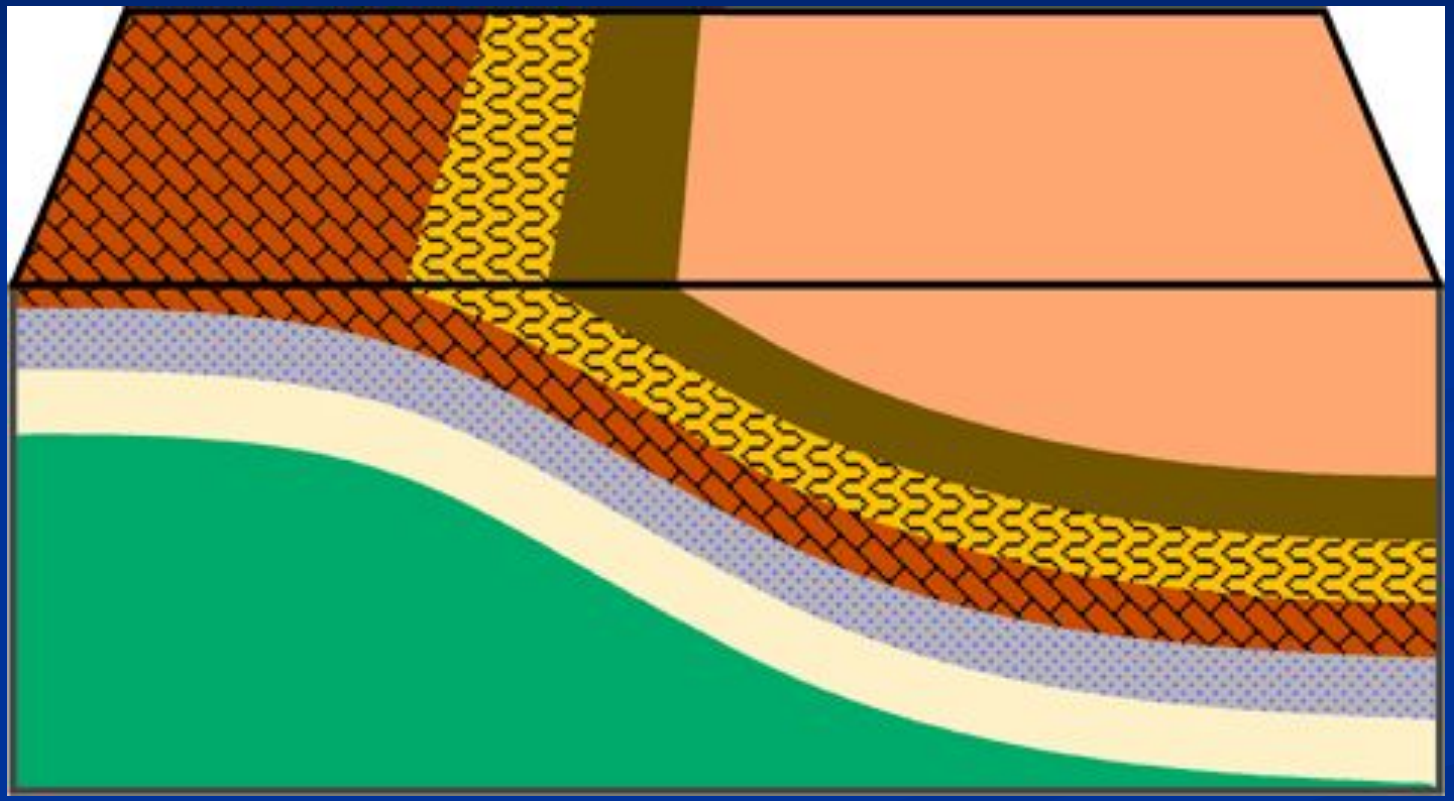
A number of different folds have been recognized and classified by geologists:

- Monocline
- Anticline
- Syncline

The simplest type of fold is called a monocline.

This fold involves a slight bend in otherwise parallel layers of rock.



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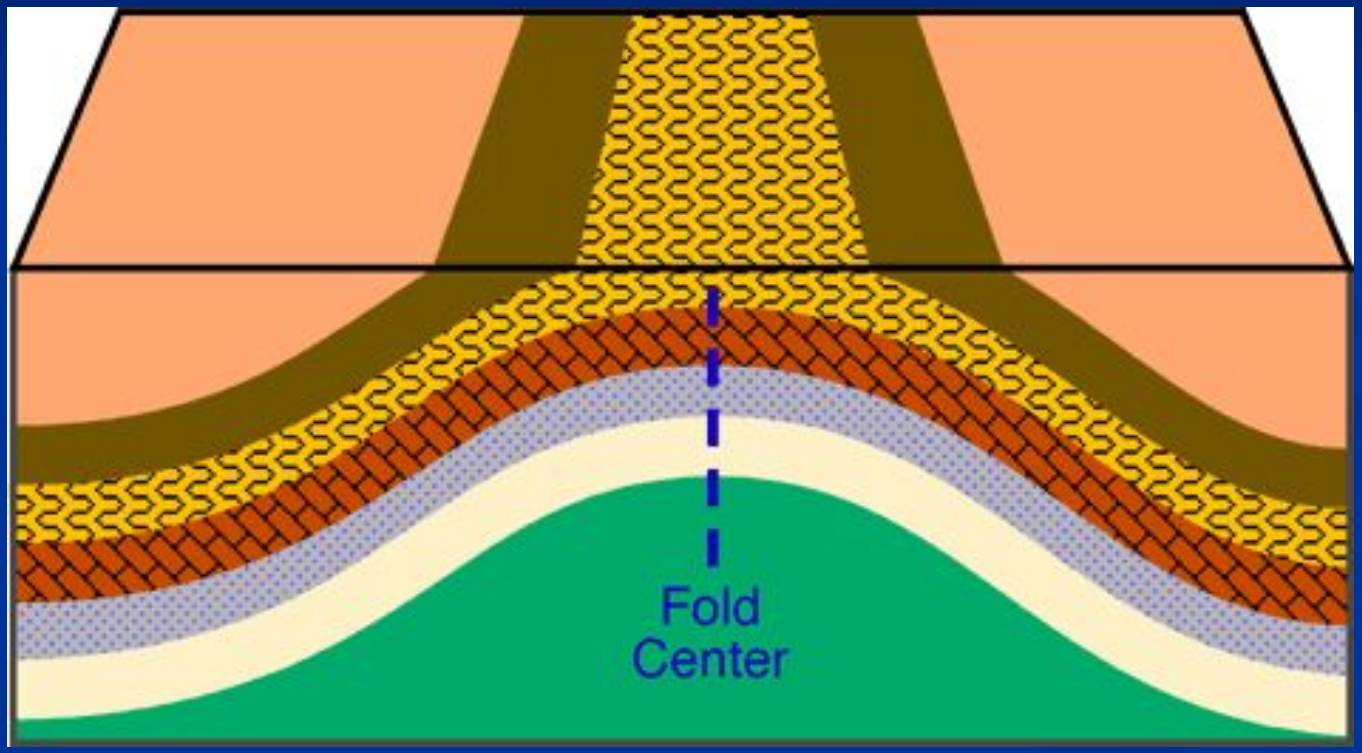
An anticline **is a convex up fold in rock that resembles an arch.**



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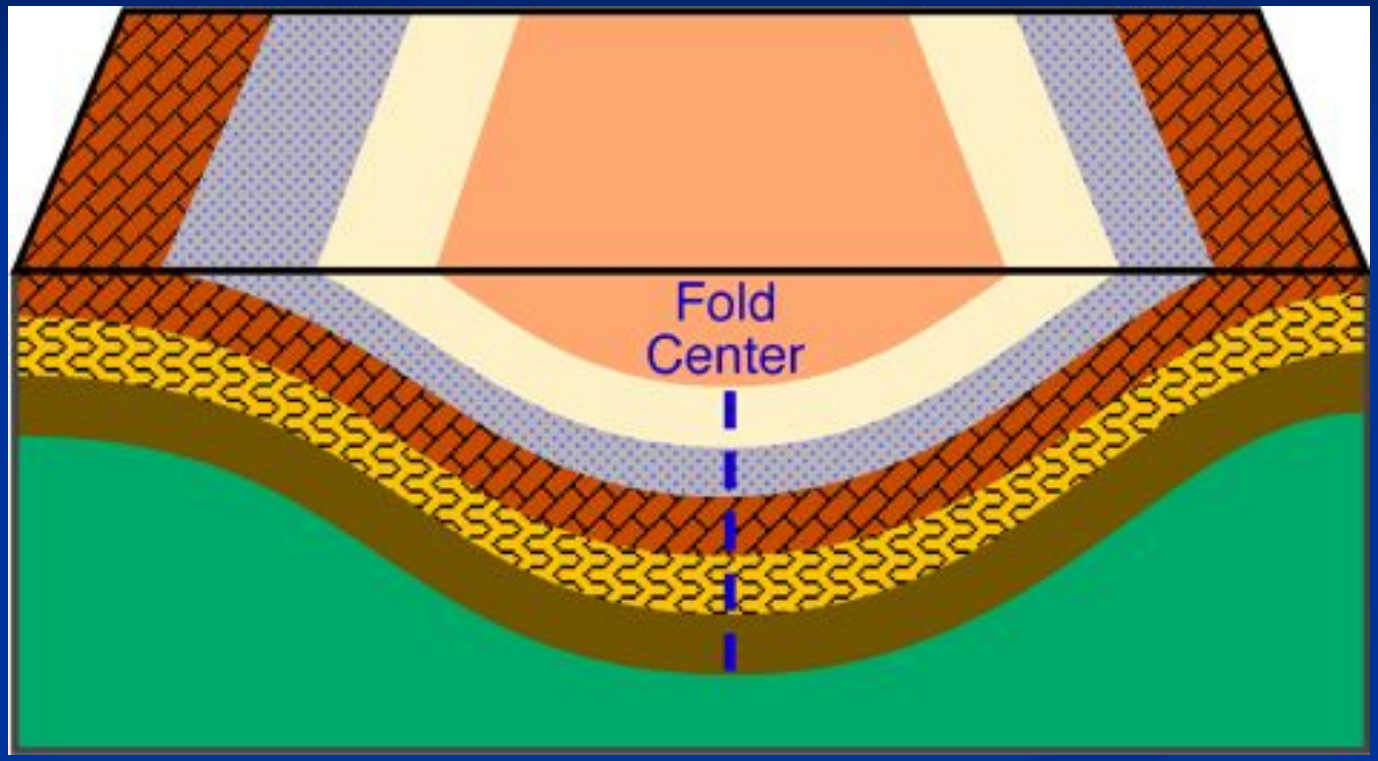
A syncline is a fold where the rock layers are warped downward.



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Synclinal folds in bedrock

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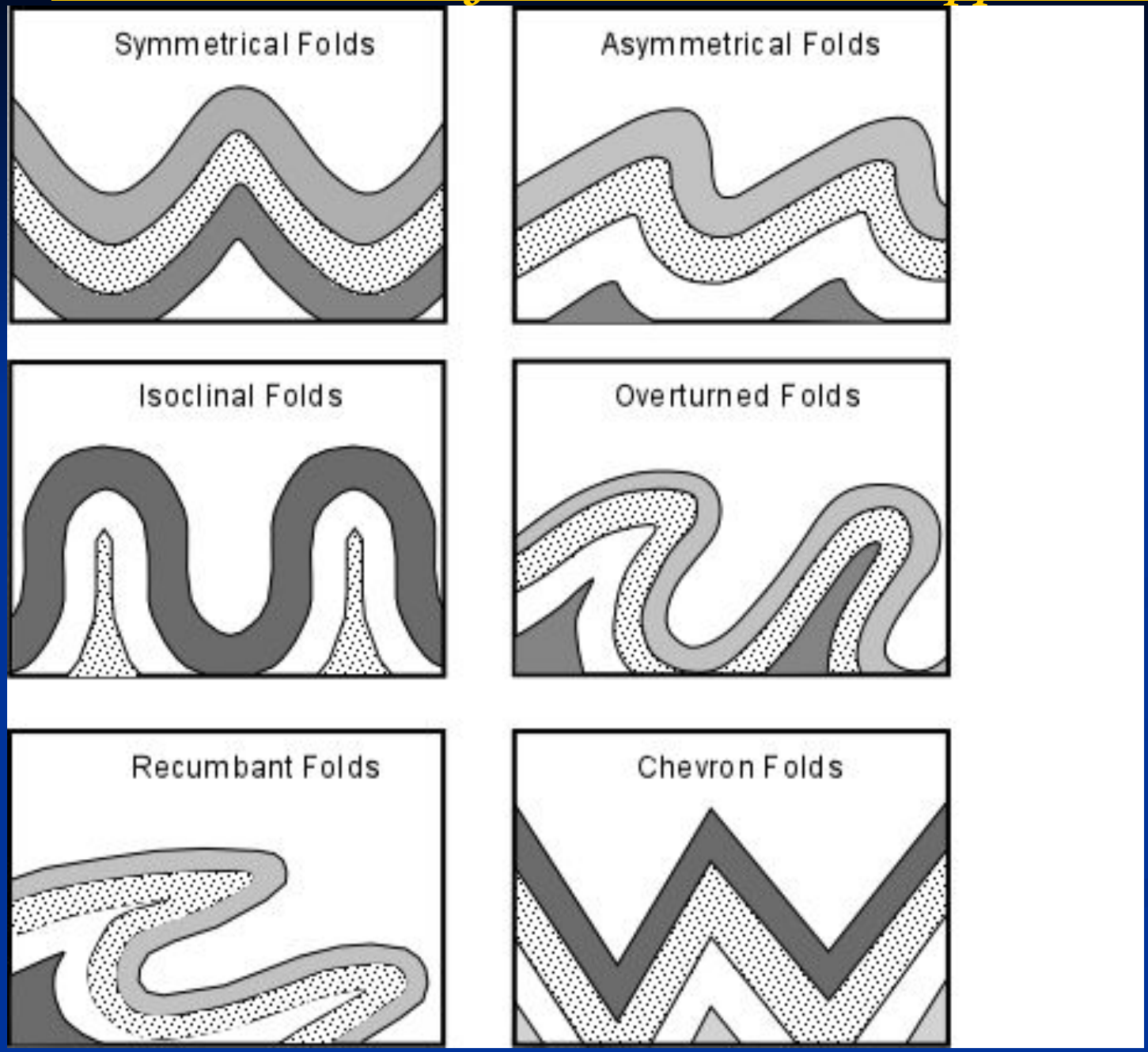
Folds can be classified based on their appearance.



Faults

- **Faults form in rocks when the stresses overcome the internal strength of the rock resulting in a fracture.**

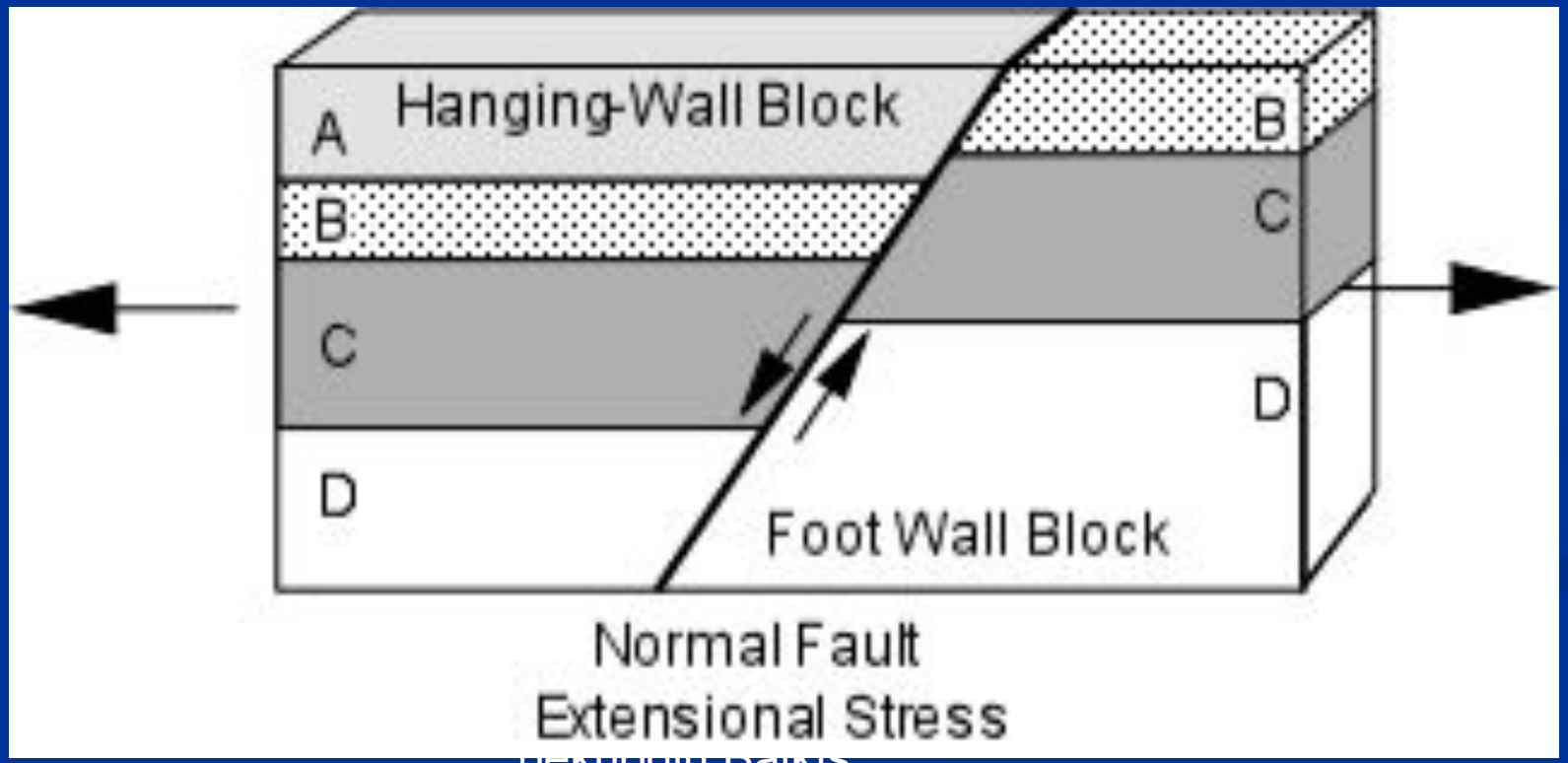
Faults occur from both:

- **tensional (shearing) and**
- **compressional forces.**

Hanging wall and Footwall

For any inclined fault plane:

- the block above the fault is the hanging wall block
- the block below the fault is the footwall block.



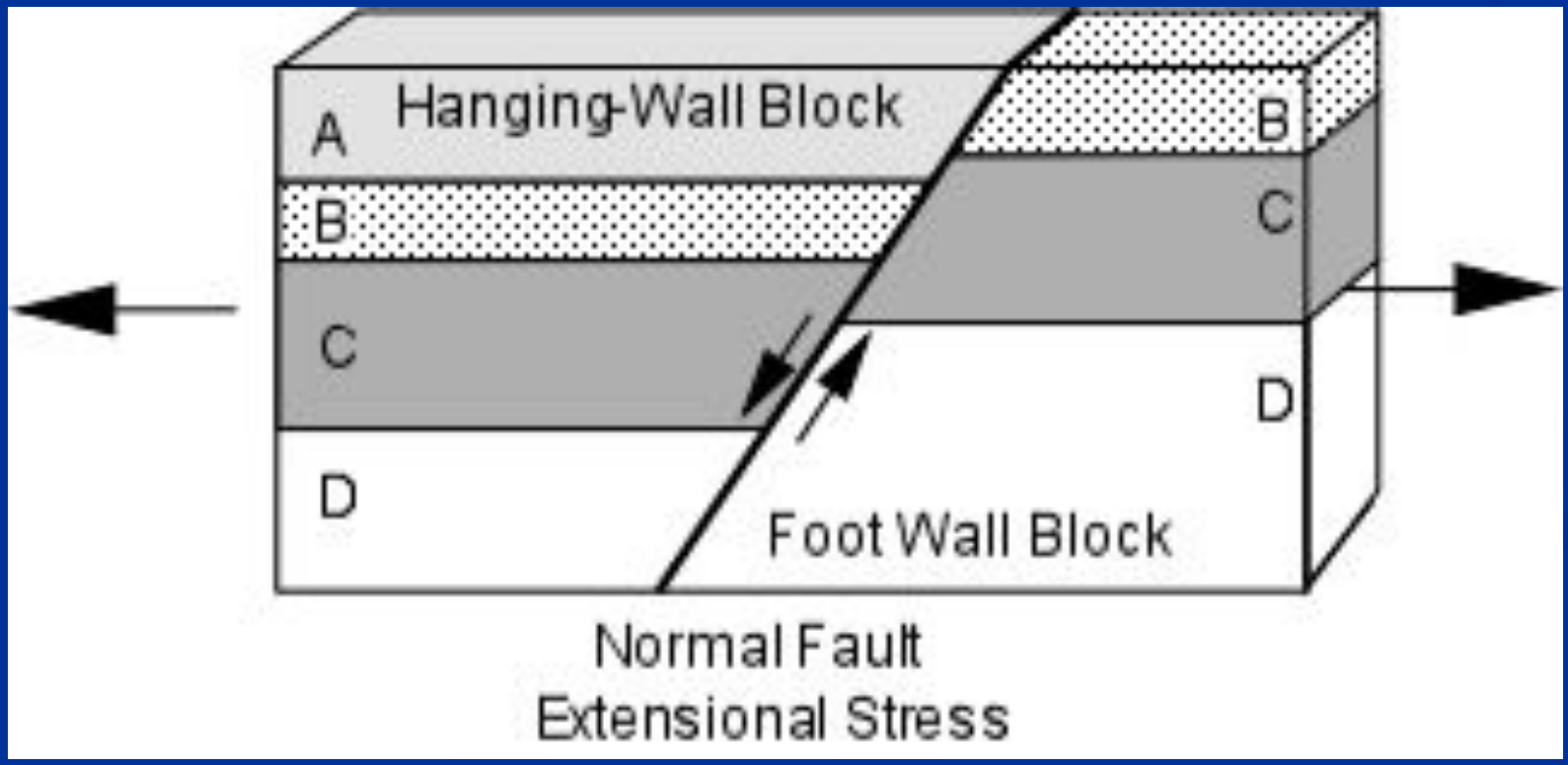
Different kinds of faults:

These faults are named according to the type of stress that acts on the rock and by the nature of the movement of the rock blocks either side of the fault plane.

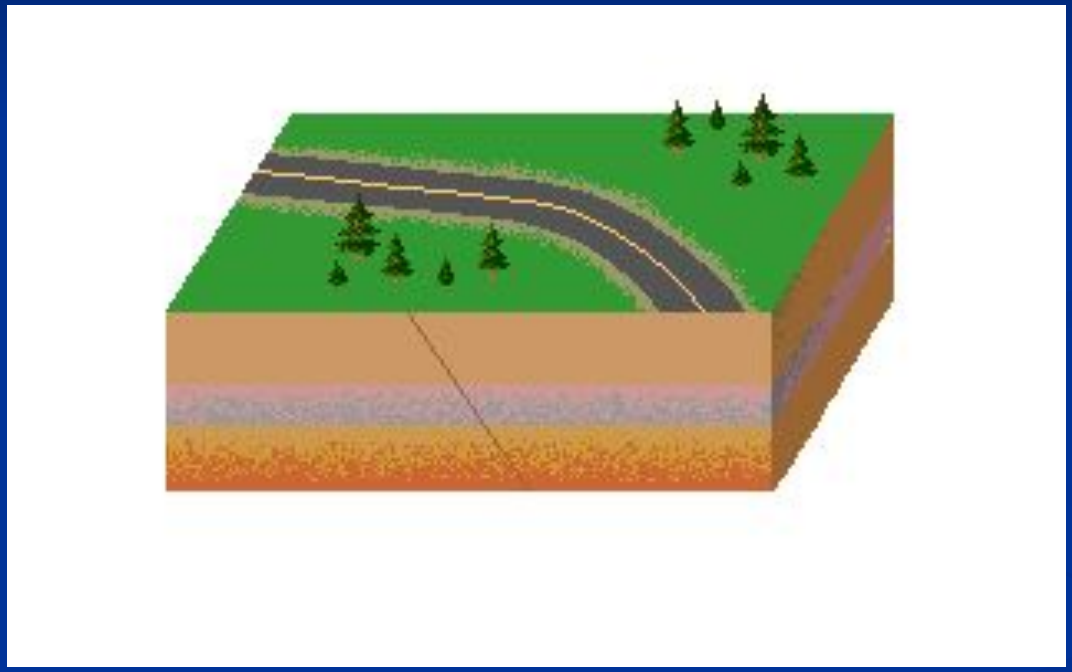
- Normal fault
- Reverse fault
- Thrust fault
- Strike-slip fault

Normal Faults

- are faults that result from horizontal tensional stresses in brittle rocks.
- the hanging-wall block moves down relative to the footwall block



Normal Faults



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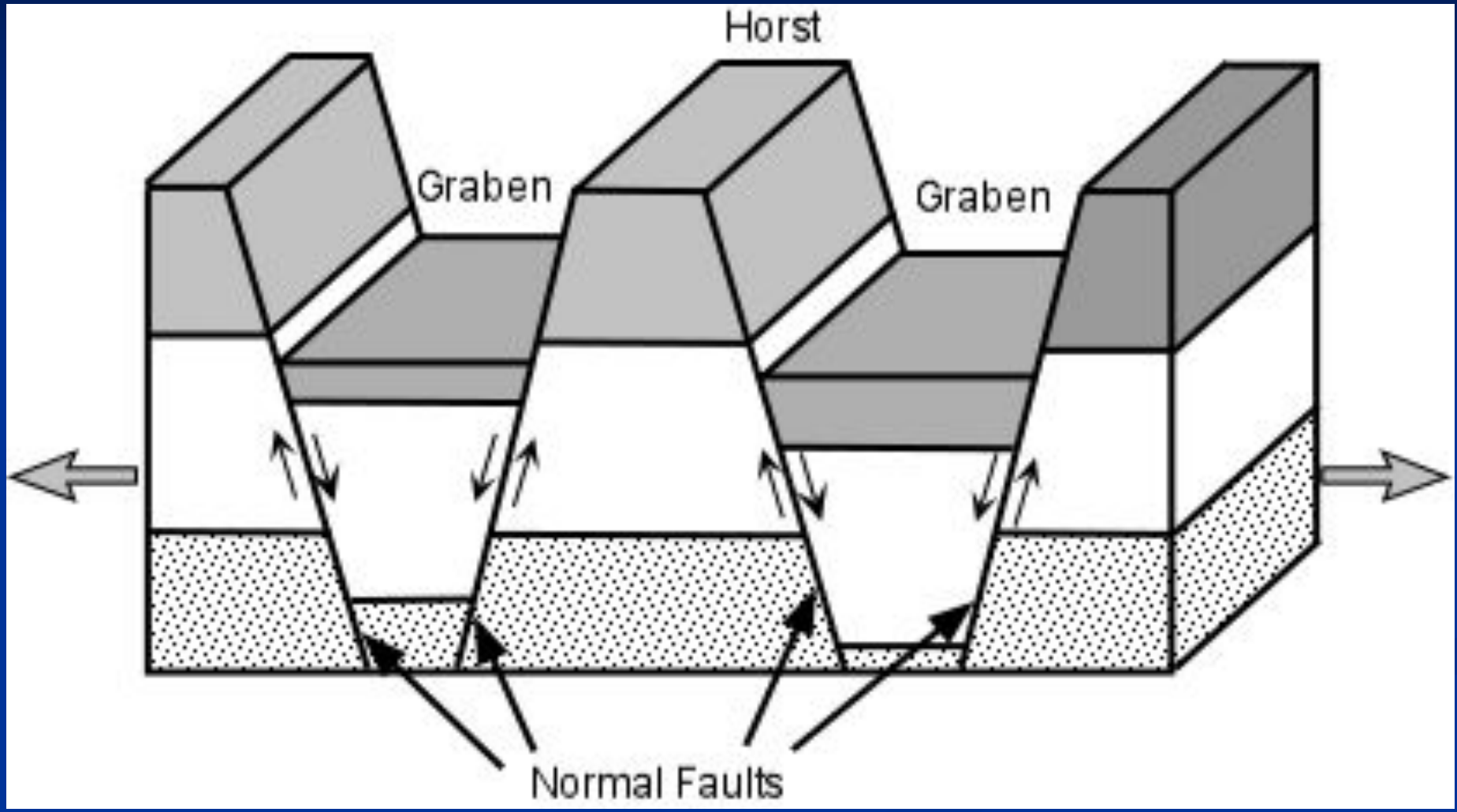
Normal fault



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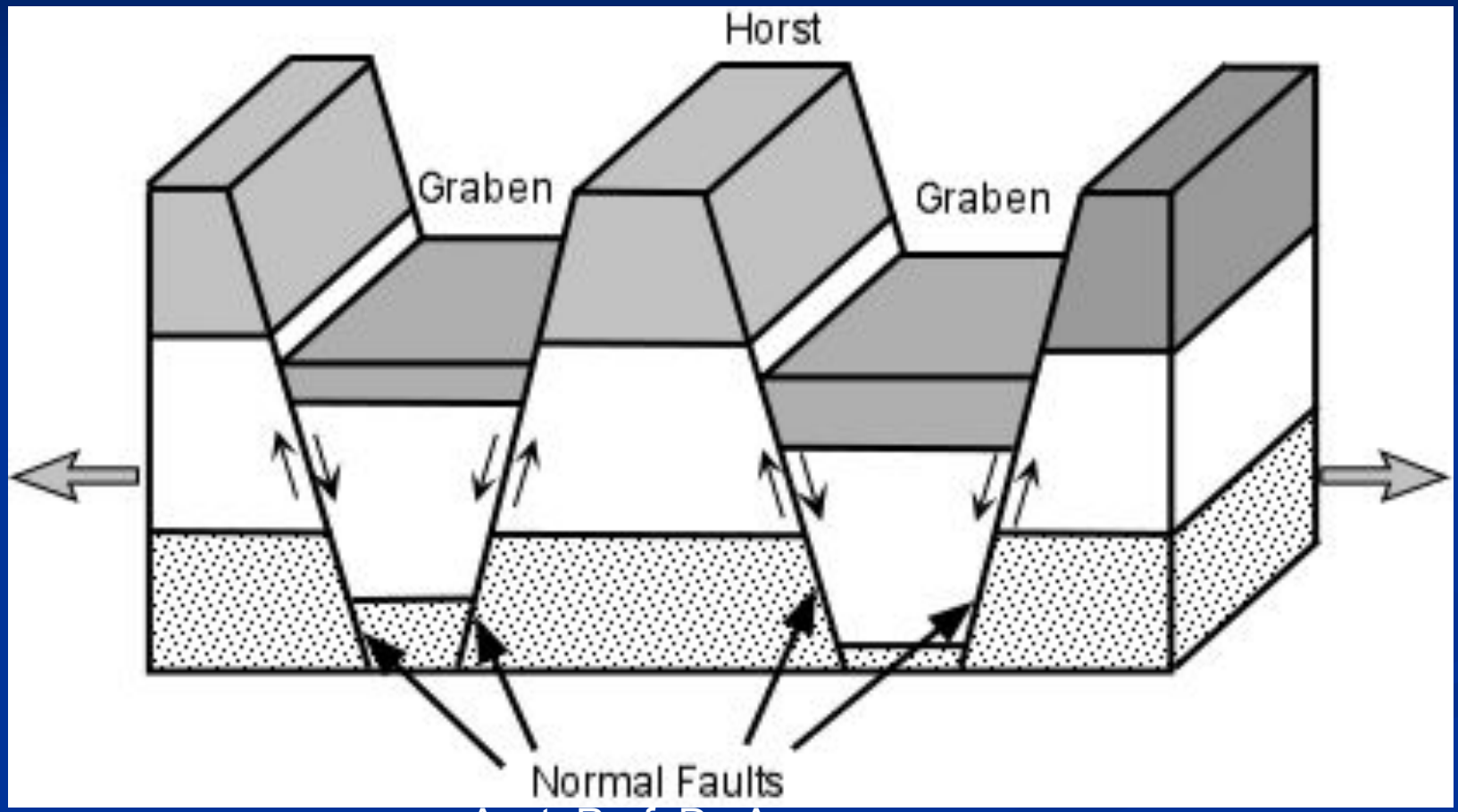
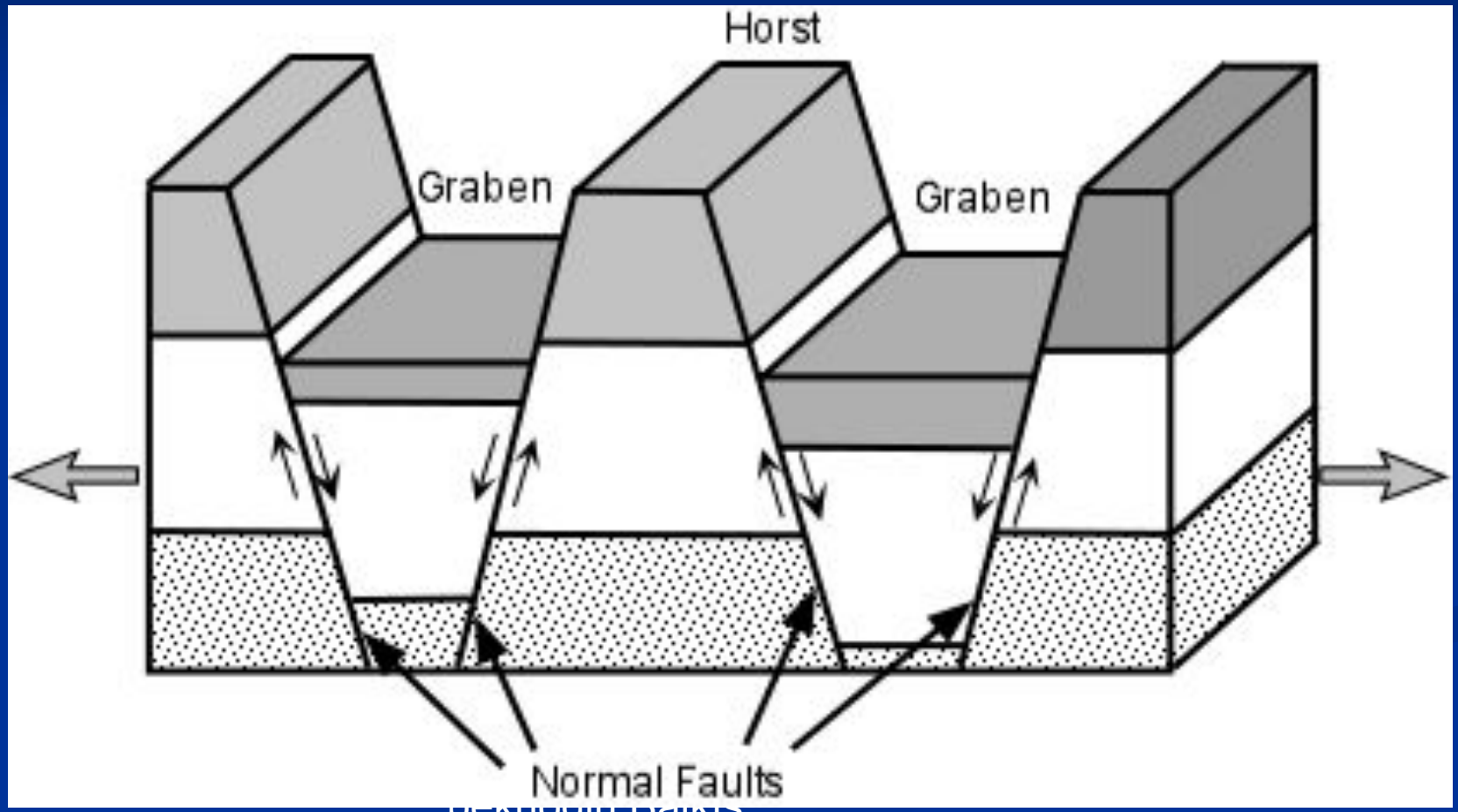
Grabens AND Horsts

- the down-dropped blocks form grabens
  -the grabens may form rift valleys:
  (The East African Rift Valley)



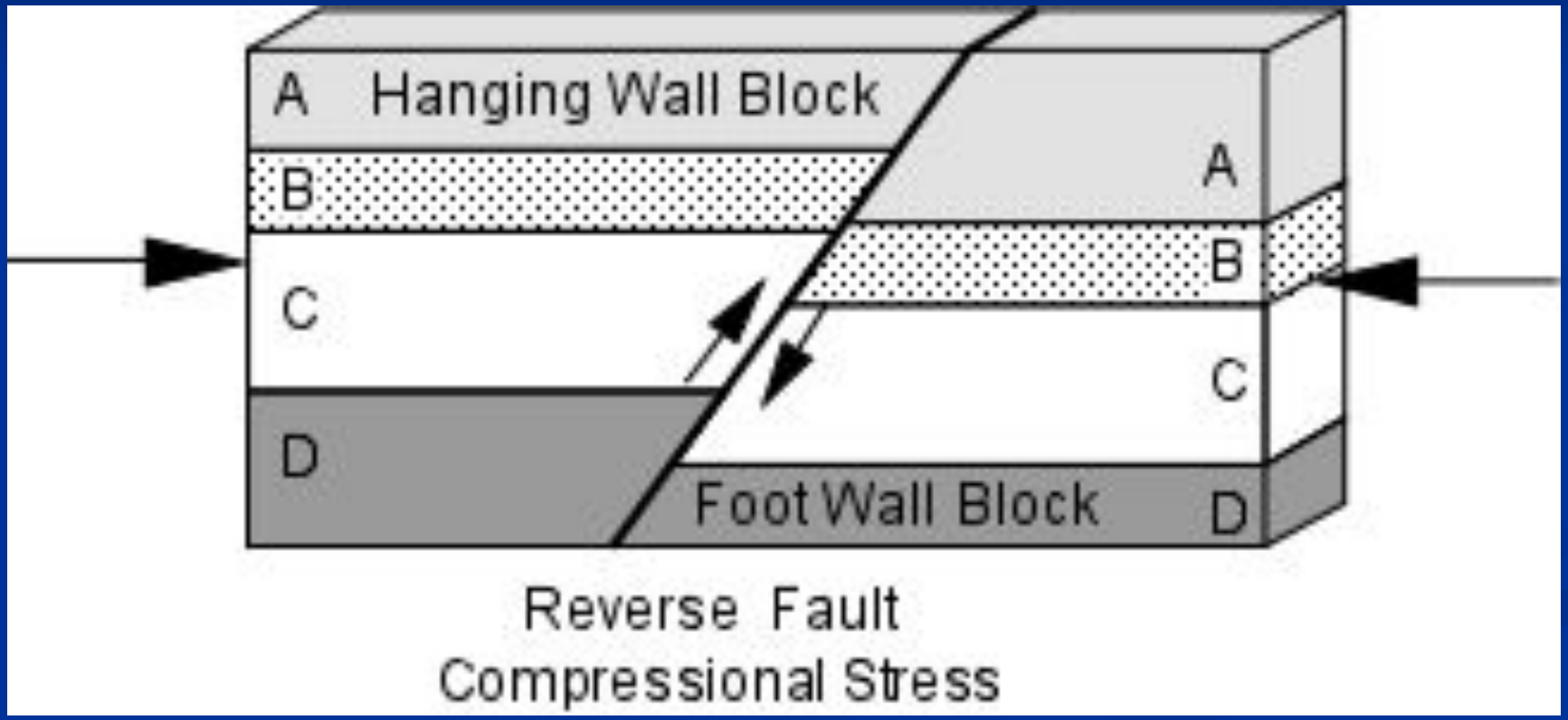
the uplifted blocks form horsts.

- may form linear mountain ranges.



Reverse Faults

are faults that result from horizontal compressional stresses in brittle rocks, where the hanging-wall block has moved up relative the footwall block.



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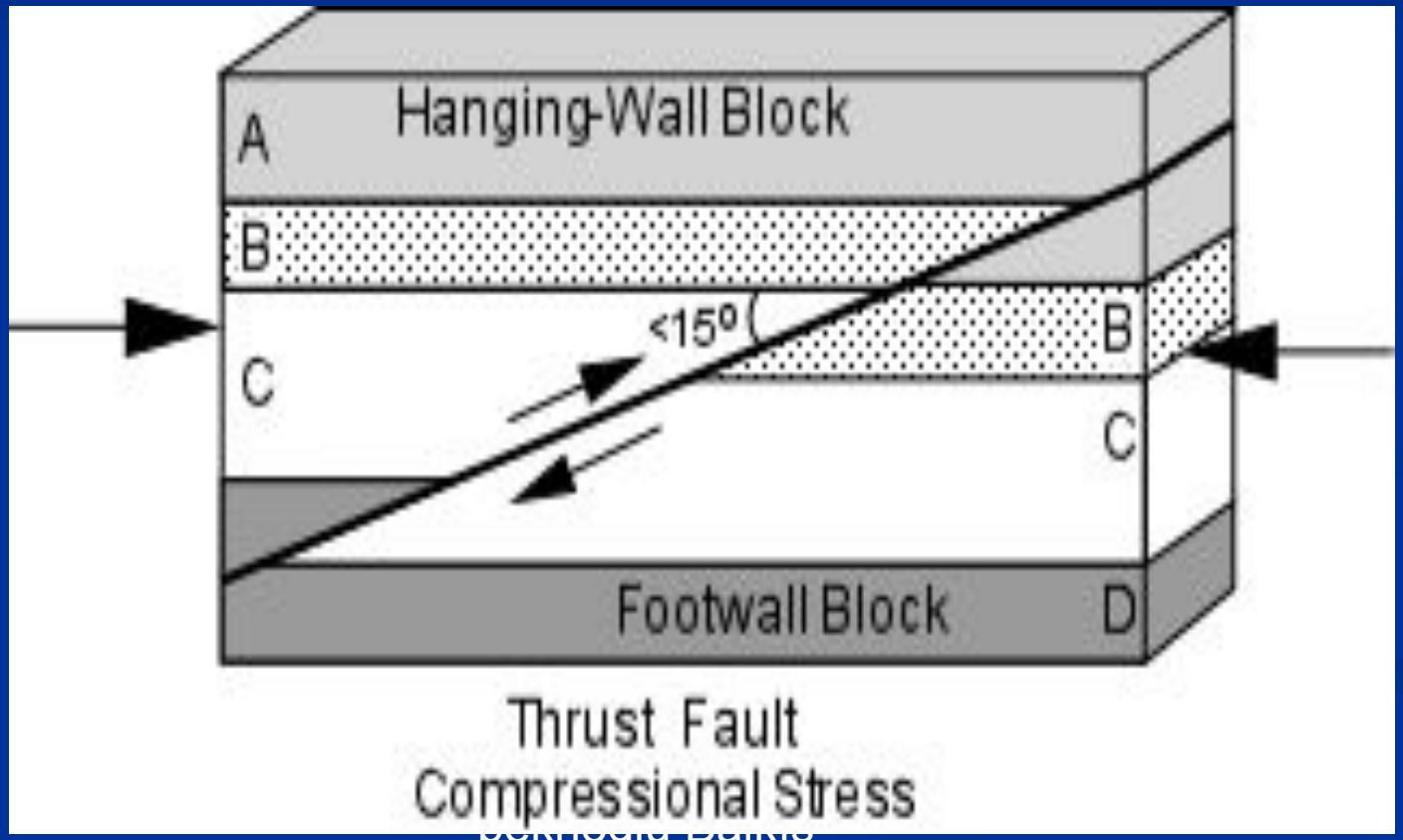
A Thrust Fault

- A Thrust Fault is a special case of a reverse fault where the dip of the fault is less than 15° and
- can result in older strata overlying younger strata.



Thrust Fault
Compressional Stress

Strike Slip Faults

- relative motion on the fault has taken place *along a horizontal direction*.

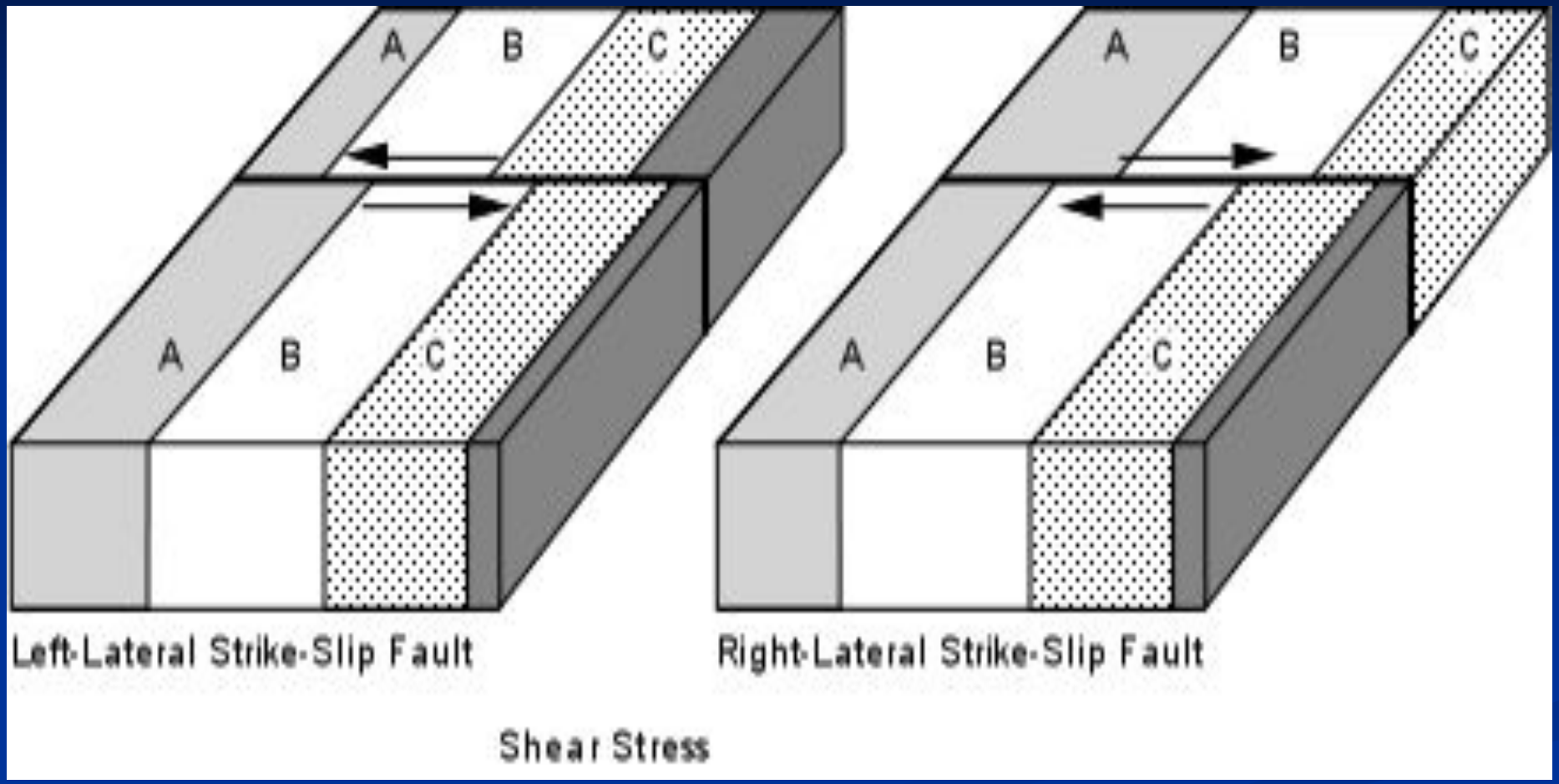
- result from shear stresses acting in the crust.

Two varieties, depending on the sense of displacement:

- If the block on the other side has moved to the left, - the fault is a left-lateral strike-slip fault

- If the block on the other side has moved to the right, a right-lateral strike-slip fault.

Strike Slip Faults



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