Rocks cover the entire Earth!

What happens when rocks break?

Why do we care about the strength of rocks?

Some natural disasters are caused by breaking rocks.

Why do we care about the strength of rocks?

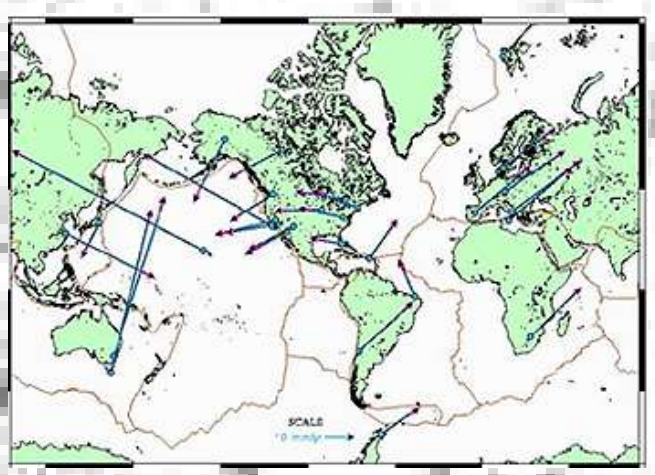
And, sometimes we break rocks on purpose!

What can break rocks?
Stress!

There are many things in nature that cause stress.

Area

Pressure
Force

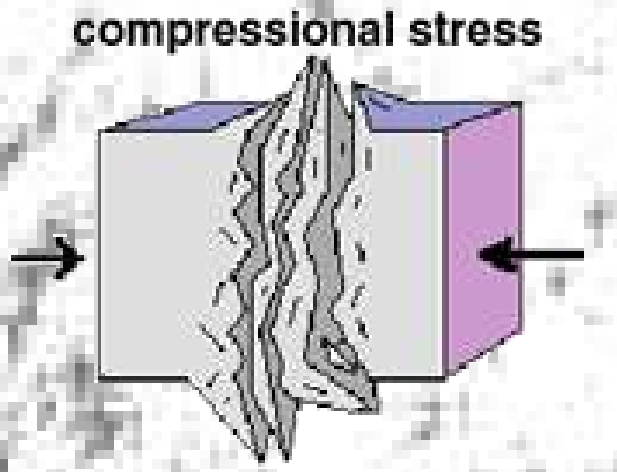


One cause is plate movements in the earth.

What can break rocks? Stress!

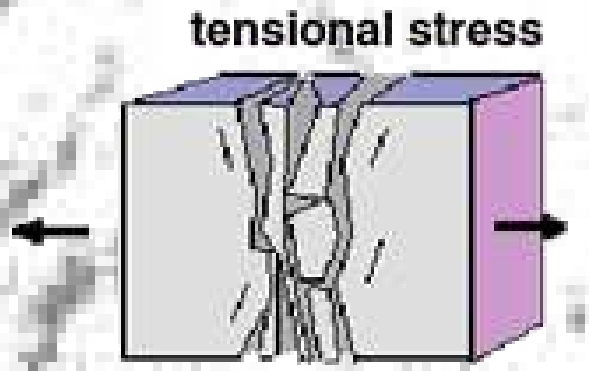
There are 3 types of stresses.

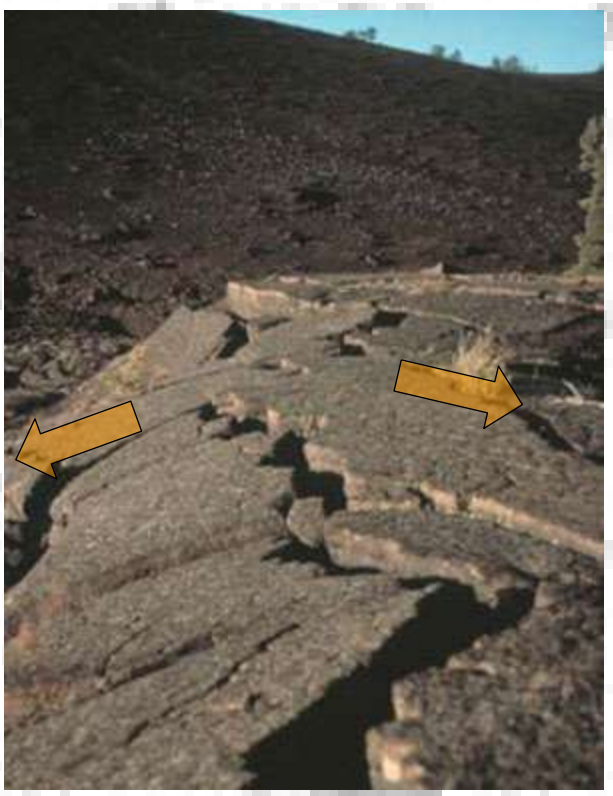
1. Compressional Stress



What can break rocks? Stress!

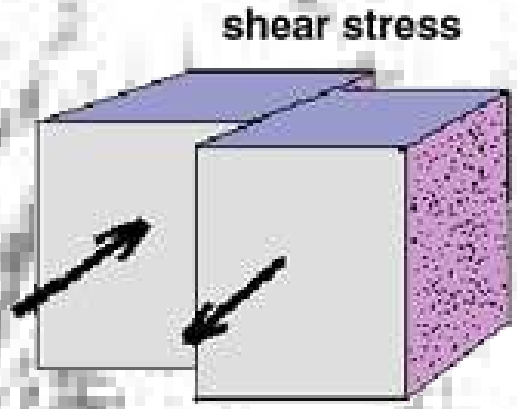
2. Tensional Stress

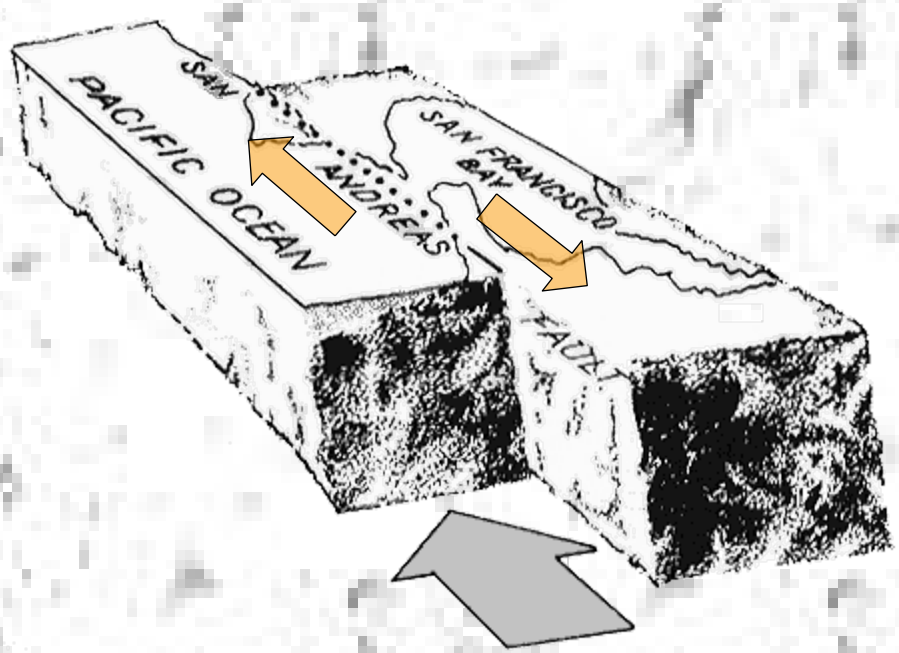




What can break rocks? Stress!

3. Shear Stress





What can break rocks? Stress!

Weathering also causes stress in rocks, resulting in rock breakage.

What can break rocks? Stress!

There are 3 types of weathering.

1. **Physical**

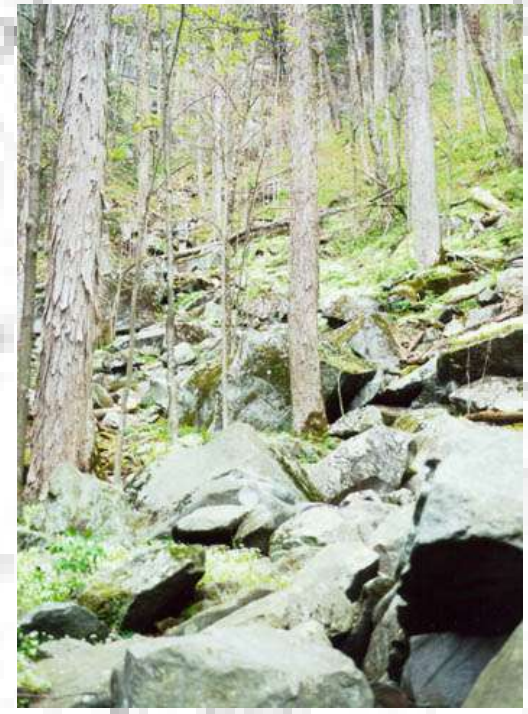
   Wind
   Water
   Freezing
   Repeated
   wetting & drying

What can break rocks? Stress!

2. **Chemical**
   - Acid rain
   - Rust

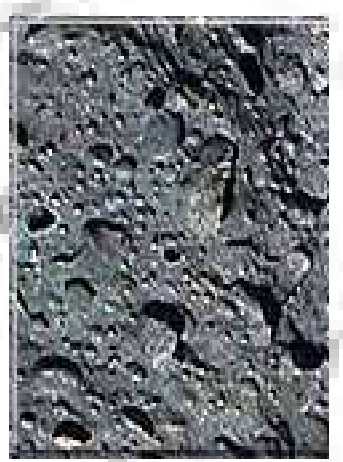
What can break rocks? Stress!

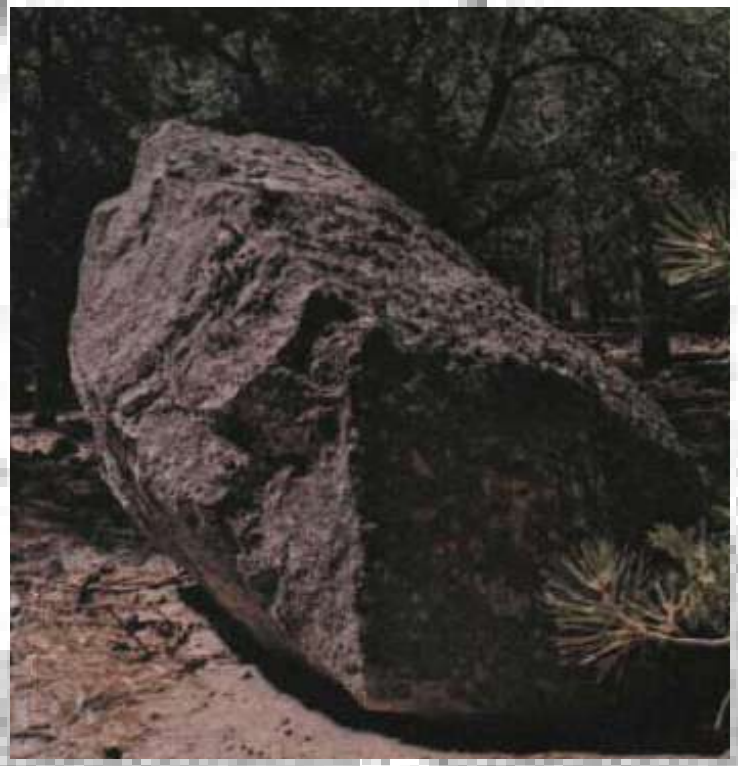
3. **Biological**
   - Tree roots
   - Animals
   - Human activity



What does rock strength depend upon?

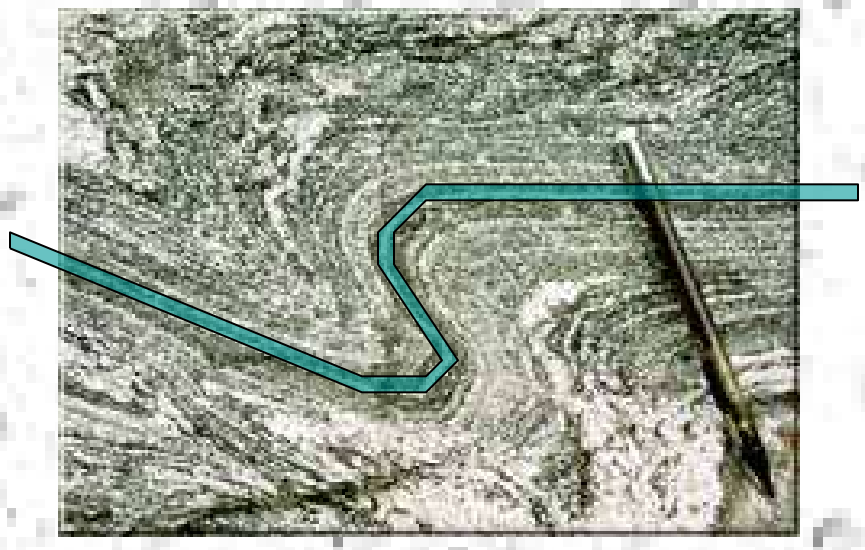
Type of rock
Texture of rock
Chemical composition
Internal structures
Fluids in rock





What does rock strength depend upon?

Planes of Weaknesses



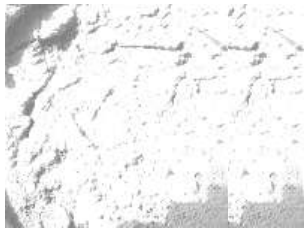
How do we determine rock strength?

Take samples

Observe

Use special testing equipment

Image sources:



Description: Ghosted picture of a rock. (slide backgrounds)
Source: www.msnbc.msn.com/ id/6969396/

Description: Photograph of rocky cliffs.
Source: http://vulcan.wr.usgs.gov/Imgs/Jpg/BeaconRock/beacon_rock_basalt_columns_2003.jpg

Description: Image of the earth.
Source: http://www.tfhrc.gov/pubrds/julaug98/images/earth.jpg

Description: Photograph of a construction vehicle and some large landscaping rocks.
Source: http://boulder.noaa.gov/const_photos/excav/p16.jpg

Description: Photograph of a five-story building tipping over towards the street.
Source: http://www.ngdc.noaa.gov/seg/hazard/icons/small_res/18/18_379.jpg

Description: Photograph of a long, three-story building bending almost horizontally backwards.
Source: http://www.ngdc.noaa.gov/seg/hazard/icons/small_res/18/18_379.jpg

Description: Aerial photograph of some large buildings falling over.
Source: http://www.ngdc.noaa.gov/seg/hazard/icons/small_res/18/18_379.jpg

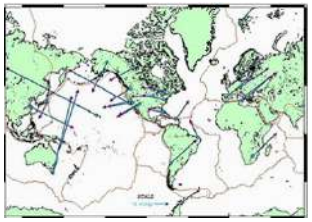
Description: Photograph of thousands of medium-sized rocks debris flowing through city streets.
Source: http://pr.water.usgs.gov/public/venezuela/venezuela_photos.html

Description: Image of a danger sign, warning people of a tsunami hazard zone.
Source: http://pubs.usgs.gov/circ/c1187/images/tsunami.gif

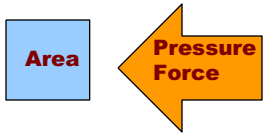
Description: Photograph of a huge boulder smashing a small house.
Source: http://www.ngdc.noaa.gov/seg/hazard/icons/small_res/18/18_379.jpg

Description: Photograph of a tunnel excavated through rock for a pipe to go through the tunnel.
Source: http://www.usbr.gov/uc/progact/animas/photogallery/owtunnel/index-owt.html

Description: Photograph of a construction vehicle breaking up rocks.
Source: http://www.fhwa.dot.gov/environment/greenerroadsides/mdbev_bc.jpg

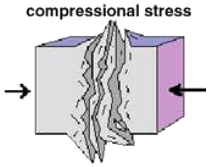


Description: Image of a world map, showing the crustal plate boundaries.
Source: rst.gsfc.nasa.gov/ Intro/Part2_1c.html



Description: Image of a square area being pushed at by a pressure force arrow.
Source: Megan Podlogar, ITL Program, College of Engineering, University of Colorado at Boulder.

Description: Photograph of two hands being pressed together.
Source: Megan Podlogar, ITL Program, College of Engineering, University of Colorado at Boulder.



Description: Diagram showing compressional stress (a rock being pushed together).
Source: Michael Kimberly, North Carolina State University, U.S. Geological Survey, http://earthquake.usgs.gov/ image_glossary/stress.html

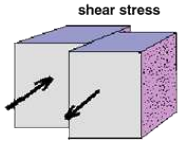
Description: Photograph of a girl observing a large rock that shows evidence of past compression.
Source: http://www.lbl.gov/Publications/Currents/Archive/images/May-30-2003/LHS_LiveWall.jpg

Description: Photograph of one hand pulling the fingers of a second hand.
Source: Megan Podlogar, ITL Program, College of Engineering, University of Colorado at Boulder.

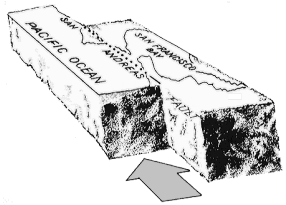
Description: Diagram showing tensional stress (a rock being pulled apart).
Source: Michael Kimberly, North Carolina State University, U.S. Geological Survey, http://earthquake.usgs.gov/ image_glossary/stress.html

Description: Photograph of a rocky ground with a huge crack.
Source: http://www.nps.gov/crmo/glossary/pressure-ridge.jpg

Description: Photograph of two hands being rubbed together.
Source: Megan Podlogar, ITL Program, College of Engineering, University of Colorado at Boulder.



Description: Diagram showing shear stress (a rock with forces in opposite directions).
Source: Michael Kimberly, North Carolina State University, U.S. Geological Survey, http://earthquake.usgs.gov/ image_glossary/stress.html



Description: Diagram of crustal plate movement and the San Andreas Fault, with one plate moving one way and the other in the opposite direction.
Source: http://pubs.usgs.gov/gip/earthq3/blocks1.gif

Description: Photograph of thin trees growing between large rocks, with water flowing around the rocks.
Source: pubs.usgs.gov/of/ 2004/1007/volcanic.html

Description: Photograph of eroded rock formations.
Source: http://geology.er.usgs.gov/eespteam/Mtleconte/website/images/Pic_19m.jpg

Description: Photograph of rocky ground that as been eroded by a stream of flowing water.
Source: http://nationalatlas.gov/geology.html

Description: Photograph of a waterfall flowing over a large, rounded rock.
Source: http://geology.er.usgs.gov/eespteam/Mtleconte/website/images/Pic_19m.jpg

Description: Photograph of large, blackened rocks.
Source: http://www2.nature.nps.gov/geology/parks/tica/tica_virtual_fieldtrip/Stop7.htm

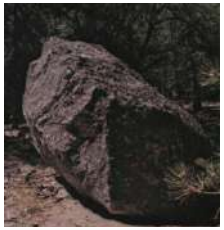
Description: Photo of a stream running between large, rust-colored rocks.
Source: http://www2.nature.nps.gov/geology/parks/tica/tica_virtual_fieldtrip/Stop7.htm

Description: Photograph of a fox looking into a hole in a rocky ground.

Source: www.nps.gov/wica/ Prairie_Dog.htm

Description: Photograph of thin trees growing between large rocks.
Source: http://geology.er.usgs.gov/eespteam/Mtleconte/website/gallery.html

Description: Close-up photograph of a porous black rock.
Source: wrgis.wr.usgs.gov/ docs/parks/rxmin/rock.html

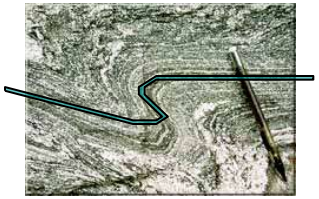


Description: Photograph of a large rock with clear-cut edges.
Source: http://www.fhwa.dot.gov/environment/visql/pg26img45.jpg

Description: Close-up photograph of a conglomerate rock, made up of many smaller rocks.

Source: wrgis.wr.usgs.gov/ docs/parks/rxmin/rock2.html

Description: Photograph of a layered sedimentary rock with a line drawn along a layer to emphasize the bedding plane.
Source: wrgis.wr.usgs.gov/ docs/parks/rxmin/rock2.html



Description: Photograph of black and white striped metamorphic rock with a line drawn along a layer to emphasize the foliation plane.
Source: http://wrgis.wr.usgs.gov/docs/usgsnps/rxmin/rock3.html

Description: Photograph of two core samples of basalt, one porous and the other smooth.
Source: capp.water.usgs.gov/ gwa/ch_h/H-Pliocene1.html

Description: Photograph of a man working at the bottom of a deep hole in rock.

Source: www.dot.ca.gov/hq/esc/ geotech/ft/washdefect.htm

Description: Photograph of a man with a clipboard looking at compression test machines in a lab.
Source: www.dot.ca.gov/hq/esc/ geotech/ft/washdefect.htm