METAMORPHISM

GEOLOGY IN THE NEWS: Fossils survive volcanic eruption, help explain formation of Canary Islands

I. CAUSES OF METAMORPHISM

- Slow process- takes millions of years
- Why do we care?
  - Interesting/unusual minerals
  - How particular areas formed
- Temperature- increasing temperature so minerals change but do not melt (like baking in an oven)
  - Geothermal gradient- temperature change over distance change (˚C/km)
    - Average range 20 ˚C/km – 60 ˚C/km
- Metamorphism via heat
  - Contact metamorphism- expose rock to magma/lava, it heats & changes; pretty localized
- Pressure
  - Pascals & bars (1 bar = atmospheric pressure at surface)
  - Pressure gradient
    - Average 300 bar/km
  - Confining pressure- object is getting squeezed evenly from all sides
  - Directed pressure (aka differential)- mainly squeezing in one direction
    - How much pressure is needed?
      - Most metamorphic rocks form at 10-30 km (6-19 mi) below surface
- Exposure
  - How do metamorphic rocks get back to the surface?
    - Rocks can move upward along a fault line
- Metamorphism via pressure
  - Regional metamorphism- occurs on a big scale; mainly pressure changes the rock
- Other metamorphic types

- Fault metamorphism- rocks slide past each other on a fault line & create a lot of friction; the friction created pressure that changes some of the rock; localized
- Metasomatism- make metamorphic rock by exposing it to very hot fluid, like groundwater; forms ore deposits (place where a rare material is in high concentration)
- Seafloor metamorphism- bigger scale metasomatism; as seafloor spreading occurs, hot sea water enters rocks

II. METAMORPHIC ROCKS & ENVIRONMENT

- Parent rock's composition is key in what metamorphic rock forms
- Metamorphic change
  - Grade- how much temperature & pressure increased
  - Index minerals- form under really specific conditions
    - Ex: chlorite, garnet, staurolite, kyanite, silimanite
  - Facies- group of minerals that represent a certain environment
    - Ex: blueschist facies- glaucophane, lawsonite, epidote
    - 7 major facies: zeolite, blueschist, greenschist, hornfels, amphibolite, eclogite, granulite
    - Use facies info to reconstruct how metamorphism occurred
- Length of metamorphism
  - Prograde- portion of rock's history where temperature and/or pressure are still increasing (burial & heating)
  - Retrograde- temperature and/or pressure are not increasing (decompression & cooling)
  - Changes within minerals can record temperature and pressure changes (color coded based on calcium content when seen under a geoprobe)
- Types of metamorphic rocks

- Foliated Metamorphic Rocks- sheets or layers; formed in differential pressure conditions
  - Ex: slate, schist, gneiss
- Nonfoliated Metamorphic Rocks- don't have layers; formed in confining pressure conditions
  - Ex: hornfels, quartzite, marble

STRUCTURAL GEOLOGY

GEOLOGY IN THE NEWS: Hypothesis of worldwide fires during the extinction of dinosaurs debunked

I. STRUCTURAL GEOLOGY

- What is structural geology?
  - How rocks change after they are formed
- Geologic structure- folded or slided layers in rocks (deform)
- Topographic feature- hill, canyon, etc. (things made from erosion & such)
- Tectonic forces
  - Tensional- stretching outward from a common middle-point (ex: tug of war)
    - Similar to divergent movement
  - Compressional- squeezing inward
    - Similar to convergent movement
  - Shearing- things are trying to slide in different directions
    - Similar to transform movement
- Responses to stress
  - Brittle- rock will break after a lot of pressure/force applied
  - Ductile- rock gives way pretty easily but it doesn't break, it bends
  - Response type can vary based on rock type, temperature, pressure, speed of deformation (apply the force quickly, brittle is more likely)