2/5

Metamorphism & Structural Geology

- Geology in the news: fossils survive volcanic eruption, help explain the formation of the Canary Islands

Intro to metamorphism

  - Slow
  - Why do we care?
- Temperature: not melting, that would make igneous rocks!
  - Think of cooking a frozen pizza
  - **Geothermal gradient**
  - Average: 30 C/km
  - Typical gradient range: 20-60 C; lots of variation
    - Graph top line: high geothermal grade
- Metamorphism via heat
  - **Contact metamorphism**
    - Pressure is not so important here
    - Magma flows into a new area, and these rocks around it start to heat up
    - Localized in its scope (layers very near sill are undergoing metamorphism, but top and bottom layers aren't.
- Pressure
  - Pascals and bars
    - 1 bar = atmosphere pressure at the surface (metric unit)
  - **Geopressure gradient**: ~300 bar/km depth
  - **Confining Pressure**: rock is being squeezed evenly from all sides (uniform); think of swimming in water
  - **Directed/Differential Pressure**: 1 primary direction that the pressure comes from
  - Pressure determines the type of metamorphic rock formed
- How much pressure is needed?
  - Most metamorphic rocks form at 10-30 km depth (mid-lower crust)
    - Q: how many miles is that? (1 mi=1.6 km)
      - 6.2-18.6 mi
- Exposure
  - How do metamorphic rocks get back to the surface?
    - Entire body of rock is moved along faults
- Metamorphism via Pressure
  - Regional metamorphism: opposite of contact met.
    - Large scale
    - Temperature doesn't matter as much

        - Rocks trapped in subduction zones
- Other metamorphic types
    - Fault metamorphism
        - Along fault lines, lots of friction and pressure
        - Metamorphism occurs to the rocks along the fault line
        - Get scraped and ground up, crushed, as rocks move
            - Some layers get distorted
        - Lots of small faults in SC, fault metamorphic rocks
    - Metasomatism
        - Hot water moves through the rock
        - Some material flushed out
        - Water-saturated with minerals can take minerals out of rock and deposit new minerals in it's place
    - Ore Deposits
        - Byproduct of metasomatism
        - High concentration of minerals left behind by water
- Metamorphism via Fluid
    - Seafloor metamorphism: similar to metasomatism, but bigger scale
    - Occurs a divergent oceanic boundary
    - Cold seawater can start to circulate through the new rock, causing a reaction where some minerals are pushed out and new ones take their place
    - Basalt can turn into greenstone

Metamorphic Rocks & Environments

- What metamorphic rock forms?
    - Depends on the parent rock
- Metamorphic change (minor/significant)
    - Grade- how much change occurred
        - Low, intermediate, high
        - Next is partial melting→back to igneous
        - Diagenesis is too shallow
    - Index minerals
        - Forms at a very specific temperature and pressure gradient
        - Red=index minerals
        - Black=not specific, all grades (muscovite, quartz, feldspar)
        - Can tell exact conditions of formation
    - Facies: group of minerals that represent a certain environment that they all could form
        - Ex- Blueschist facies: glaucoplhane, lawsonite, epidote
            - Higher pressure, low temperature (regional, collision boundaries/subduction)

        - Mapped out onto temperature/pressure diagram
        - 7 major
        - Hornfels: only form under low pressure, high temperature (contact)
    - **Ocean plate temperature does not increase rapidly because the plate has been at the bottom of the ocean for billions of years, covered in cold ocean water. Frozen things take a long time to defrost!**
    - use facies info to reconstruct how metamorphism occurred

- Length of metamorphism
    - Prograde: when either the temperature and/or the pressure are still increasing
    - Retrograde: temperature and pressure are decreasing
    - Maximum temperature=peak of metamorphism
    - Change within minerals can record pressure/temperature changes

- Types of metamorphic rocks
    - 1. Foliated: form from differential pressure
        - slate (low), schist (intermediate), gneiss (high)
    - 2. Non-foliated: no layers/sheets. Form from confining pressure
        - hornfels (low), quartzite (intermediate), marble (high)
            - quartzite and marble are easily confused
            - to correctly identify, use hardness test or acid test (marble reacts, is softer)