METAMORPHISM & METAMORPHIC ROCKS

Place in Rock Cycle

Conditions during Metamorphism

• Metamorphic rocks provide clues as to what happens deep in the earth’s crust
  – “Freeze” in a record of conditions when rock recrystallized.
  – Pressure & Temperature increase downward.
  – Show effects of tectonic activity

Introduction

• Metamorphism
• Metamorphic rock
• Parent rock
• Equilibrium

Stability of Minerals

• Minerals Stable at the earth’s surface are likely to be Unstable at depth.
• Example: Shale made of clay is stable at surface. Clay becomes converted to micas & other minerals at high T and P.

METAMORPHIC ROCKS

• Changed rocks
  – But neither melt or are weathered
  – Change in the solid state
• Textural changes (always)
• Mineralogy changes (usually)

COMMON ROCKS

• Nonfoliated
  – QUARTZITE*
  – MARBLE*
• Foliated
  – SLATE*
  – SCHIST*
  – GNEISS*
• *need to be able to identify

Geothermal Gradient

• Average is 25 degrees C/Km (75 F/mile)
• Locally higher or lower
  – If magma nearby, will be higher

Pressure Gradient
• Due to increasing weight downward of overlying rocks.
• Not much variation from place to place
• Increase is approximately 1 ton/square inch/mile

CONTACT METAMORPHISM

• Local- Usually a zone only a few meters wide
• Heat from plutons intruded into “cooler” country rock

COMMON ROCKS

• Limestone => MARBLE
  – No change in minerals, only change in texture
• Sandstone => QUARTZITE
  – quartz grains welded together
• Shale => HORNFELS “Baked” rock

REGIONAL METAMORPHISM

• High P & high T throughout a large volume
  – Exposed throughout a region after uplift & erosion
  – Different combinations of high T & high P
  – Differential stress
• FOLIATION develops
  – parallelism of planar constituents
  – due to tectonic forces during metamorphism
• Rocks names based on type of foliation
• Common Rocks formed during progressive metamorphism:
  • SLATE
    – splits easily along flat surfaces
    – uses
  • SCHIST
    – visible parallelism of platy minerals (e.g. mica)
  • GNEISS
    – alternating dark and light (with feldspar) layers or lenses

Plate Tectonics & Metamorphism

• Variations in geothermal gradient across convergent boundary
  – different combinations of pressure and temperature
• Where foliation develops and its orientation

HYDROTHERMAL ROCKS & MINERALS

• Hot water moving through rocks.
• Alteration at mid-oceanic ridges
• Metasomatism
– Ions introduced in rock by hot water
– Ore deposits (Fe, tungsten)
• Minerals deposited in cracks or pores as water cools or pressure decreases.
  – Quartz most common
• Veins
• Disseminated ore deposits
• Metals mined:
  – Copper, Zinc, Lead, Gold, Silver,