Landform Construction and Destruction

Megageomorphology

Constructional Landforms

- built up.
- associated with active tectonics, usually at plate boundaries.
- fault scarps
- fault block mts.
- rift valleys
- volcanoes

Destructional Landforms

- carved by erosion and weathering.
- all landforms are, in part, destructive because they lie above sea level.

All landforms are products of the interplay of 3 factors:
- Tectonics (orogeny, epeirogeny, extension, volcanism)
- Erosion
- Climate

Erosion → Tectonics

- removal of crustal mass generates isostatic rebound and uplift.
- app. 80% of height removed will be replaced by rebound.
- “the pull of erosion”
**Tectonics → Erosion**

- Intensity of erosion increases with elevation.
  - slopes are steeper.
  - slopes have less vegetation.
  - high slopes have cooler, wetter climates.
  - high slopes host glaciers.

**Climate → Erosion**

- Humid climates erode faster than arid climates.
- Humid climates erode deeply incised valleys.
- Arid regions erode more evenly.
- Cold climates produce alpine glaciers - most effective agents of erosion - cut deep, wide valleys.
- Frigid climates host ice sheets - slow agents of erosion.

**Chemical Weathering**

\[
\text{CO}_2 + \text{H}_2\text{O} = \text{H}^+ + \text{HCO}_3^- \\
\text{H}^+ + \text{feldspar} = \text{Ca}^+ + \text{clay} + \text{silica}
\]

\[
\text{to the ocean} \\
\text{HCO}_3^-, \text{Ca}^+, \text{silica}
\]
Chemical weathering of silicate rock reduces the level of CO\textsubscript{2} in the atmosphere, cooling the climate.

**Tectonics → Climate**

- High landmasses change the balance of heating on the Earth’s surface and block or redirect weather systems.
- Elevation of a landmass creates a cooler, wetter climate.
- High mountains create humid vs. rain shadow zones = the Orographic Effect

**Isostatic Mountain Building**

- Humid climate
- Arid climate

Erosion of Surface
Isostatic Mountain Building

Humid climate

Arid climate

Erosion of Surface

Equivalent mass eroded away
Isostatic Mountain Building

Humid climate  Arid climate

original land level

Isostatic Rebound

Peaks at higher elevation following erosion of valleys and isostatic rebound.
Isostatic Mountain Building - Himalaya

- 8 ma - rising Himalayan landmass causes intensification of summer monsoon.
- Southern margin of landmass develops humid climate.
- Erosion intensifies as glaciers and rivers remove mass from deep valleys.
- Isostatic rebound uplifts High Himalaya, which intensifies rain shadow.

![Diagram showing Isostatic Mountain Building - Himalaya](image)

- Intensified Monsoon
- Rain Shadow
- Isostatic equilibrium
- 8800 meters
- 5000 meters
- High Himalaya
- Tibetan Plateau

![Diagram showing Summer Low and Monsoon](image)
Three Stages in the Evolution of Mountain Ranges

Formative Stage
- Tectonic event thickens or heats the crust, causing uplift
- Uplift rate > erosion rate
- Erosion rate increases with increasing elevation
  - Negative feedback loop
Three Stages in the Evolution of Mountain Ranges

Steady State
- Uplift slows or erosion rates rise until both are balanced.
- Negative feedback maintains mountains at nearly constant elevation, perhaps for millions of years.

Example:
Metamorphic rock of the Manhattan Prong (NYC and S. Connecticut)
- Mineral assemblages indicate P-T conditions at 7 miles depth.
- Rock was buried beneath Taconian Mountain Belt during Middle Ordovician (450 Ma).
- Isostacy has resulted in the unroofing of 7 miles of crust in the last 450 million years.