Chapter 13: Introduction to Landform Study

I. The Unknown Interior
A. Humans have not penetrated more than one-thousandth of Earth radius.
B. Have inferential knowledge of interior, through monitoring shock waves transmitted through Earth from earthquakes or from human-made explosions.
   1. Knowledge is incomplete.
   2. Deduced that it has a heavy inner core surrounded by three concentric layers of various composition and density.
   3. Four regions are the crust, mantle, outer core, and inner core.
      a) **Crust**—outermost solid layer of Earth, consisting of broad mixture of rock types.
         (1) On average, crust three times as thick under continents as under ocean.
         (2) Makes up less than 1 percent of Earth’s volume.
         (3) **Mohorovici discontinuity (Moho)**—the boundary between Earth’s crust and mantle.
            (a) Thought to be a narrow zone with significant change in mineral composition.
      b) **Mantle**—that portion of Earth beneath the crust and surrounding the outer core, about to depth of 2,900 kilometers (1,800 miles).
         (1) Largest volume of all four shells.
         (2) Scientists believe three zones within mantle: lithosphere, asthenosphere, mesosphere.
            (a) **Lithosphere**—the uppermost zone of mantle and the crust together. (Also, tectonic plates consisting of the crust and upper rigid mantle. Sometimes used as a general term for the entire solid Earth.)
            (b) **Asthenosphere**—plastic layer of the upper mantle that underlies the lithosphere. Its rock is very hot and therefore weak and easily deformed.
            (c) **Mesosphere**—the rigid part of the deep mantle, below the asthenosphere (also refers to atmospheric layer above the stratopause).
      c) **Outer core**—the (molten) liquid shell beneath the mantle that encloses Earth’s inner core.
      d) **Inner core**—the supposedly solid, dense, innermost portion of Earth, believed to consist largely of iron/nickel or iron/silicate.
   4. Understanding of crust and upper mantle has fundamentally changed in last three decades.
      a) **Continental drift**—theory that proposes that the present continents were originally connected as one or two large landmasses that have broken up and literally drifted apart over the last several million years.
      b) **Plate tectonics**—a coherent theory of massive crustal rearrangement based on the movement of continent-sized lithospheric plates.

II. Geographers Focus on the Surface
A. Geographers interested in Earth’s interior only as it influences topography and other surface features, how it affects the nature and characteristics of surface.
B. Composition of the Crust
   1. **Mineral**—a naturally formed inorganic solid substance that has an unvarying chemical composition and characteristic crystal structure.
      a) About 3,500 known, with about 50 new types being found each year.
b) Fewer than 20 minerals account for more than 95 percent of composition of all continental and oceanic crust.

2. **Magma**—molten material in Earth’s interior.
   a) Quantity unknown.


4. **Outcrop**—surface exposure of bedrock.

5. **Bedrock**—buried layer of residual rock that has not experienced erosion.

C. **Igneous Rocks**

1. **Igneous rock**—rock formed by solidification of molten magma.
   a) Many kinds, but principal shared trait is crystalline structure.

2. **Extrusive rock**—molten rock ejected onto Earth’s surface, solidifying quickly in the open air.

3. **Intrusive rock**—rocks that cool and solidify beneath Earth’s surface (may be pushed up to surface or exposed through erosion).
   a) Granite is most common and well known.

D. **Sedimentary Rocks**

1. **Sediment**—small particles of rock debris or organic material deposited by water, wind, or ice.

2. **Sedimentary rock**—rock formed of sediment that is consolidated by the combination of pressure and cementation.
   a) During sedimentation, materials sorted roughly by size (the finer particles carried farther than heavier particles).
   b) **Strata** (plural; stratum, singular)—distinct layers of sediment.
      1. Results in parallel structure (stratification), with layers varying in thickness and composition.
   c) Categorized by how they formed: mechanically, chemically, or organically.
      1. Mechanically accumulated: fragments of preexisting rocks.
         a) For example, shale and sandstone.
      2. Chemically accumulated: precipitation of soluble materials or chemical reactions.
         a) For example, calcium carbonate and limestone.
      3. Organically accumulated: remains of dead plants or animals.
         a) For example, coal and limestone.

E. **Metamorphic Rocks**

1. **Metamorphic rock**—rock that was originally something else (igneous or sedimentary) but has been drastically changed by massive forces of heat and/or pressure working on it from within Earth.
   a) Process recrystallizes and rearranges mineral components.
   b) Some predictability, such as limestone metamorphized becomes marble.
   c) Sometimes metamorphosis so great, can’t determine nature of original rock.
   d) Most common are schist and gneiss.

F. **Relative Frequency of Rock Classes**

1. Lithosphere has very uneven distribution of sedimentary, igneous, and metamorphic rocks.
   a) Sedimentary rocks dominant on surface of Earth, both in United States and rest of world.
      1. This dominance, however, is only on surface, as sedimentary cover is not thick.
         a) Averages less than 2.4 kilometers (1.5 miles).
b) Assume that igneous make up the bulk of the crust, but metamorphic rocks might because of enormous pressures at play beneath crustal surface.

III. Some Critical Concepts
A. Basic Terms
1. **Topography**—surface configuration of Earth.
2. **Landform**—an individual topographic feature, of whatever size.
3. **Geomorphology**—the study of the characteristics, origin, and development of landforms.
4. **Relief**—the difference in elevation between the highest and lowest points in an area (e.g., the vertical variation from mountaintop to valley bottom).

B. Uniformitarianism
1. **Uniformitarianism**—the concept that “the present is the key to the past” in geomorphic processes. The processes now in operation have also operated in the same way in the past and should also operate in future.

C. Geologic Time
D. Geologic time enumerates temporal expanses of almost unfathomable scope.
1. Geologic time encompasses millions and hundreds of millions of years.
   a) Four eras, three most recent being subdivided into 12 periods. Two most recent periods divided into 7 epochs.
2. Chapter 13 offers chart of geologic time expressed in equivalent 1-year scale.
   a) On one-year scale, first 4 months, planet was lifeless.
   b) One-celled life appeared in early May.
   c) Multicelled organisms began evolving in early November.
   d) Antediluvian fishes, the first vertebrates, appeared about November 21.
   e) Amphibians appeared late November.
   f) Vascular plants appeared about November 27.
   g) Reptiles began era of dominance about December 7.
   h) Mammals arrived about December 14; birds arrived December 15.
   i) Flowering plants arrived December 21.
   j) December 24 came the first grasses and first primates.
   k) First hominids came New Year’s Eve.
   l) Homo Sapiens arrived one hour before midnight.
   m) Age of written history equals last minute of the year.
3. If geologic time examined in context of cliff one kilometer high (3300 ft.), an individual’s existence would equal less than the thickness of the finest hair.

IV. The Study of Landforms
A. Focusing just on land surfaces, study must encompass 150 million square kilometers (58 million square miles) scattered over seven continents and innumerable islands.
1. Such study is complex endeavor, requires organized approach, including examining following four elements.
   a) **Structure**—nature, arrangement, and orientation of the materials in feature being studied.
      (1) Geologic underpinning of landform.
   b) **Process**—the actions that have combined to produce the landform.
      (1) Encompasses interaction of forces such as geologic, hydrologic, atmospheric and biotic.
   c) **Slope**—fundamental aspect of shape for any landform.
   d) **Drainage**—refers to movement of water (from rainfall and snowmelt).
B. After identifying the above four basic elements, geographer can analyze topography.
C. Fundamental questions of geographic inquiry:
   1. What? (the form of features)
   2. Where? (the distribution and pattern of landform assemblage)
   3. Why? (an explanation of origin and development)
   4. So what? (the significance of the topography in relationship to other elements of environment and to human life and activities)

V. Internal and External Geomorphic Processes
   A. Variety of topography reflects complexity of interactions between process and structure.
   B. Internal and external processes (chart breakdown on page 391).
      1. Internal processes operate within Earth, drawing energy from heat.
         a) In general, they are building forces, increasing relief of land surface.
      2. External processes operate at base of atmosphere (subaerial), drawing energy from sources above lithosphere (atmosphere or oceans).
         a) Better understood than internal processes; behavior is predictable.
         b) In general, they are wearing-down or destructive forces, diminishing relief of land surface.

VI. The Question of Scale
   A. Scale of observation affects how one perceives and understands a landscape.

VII. The Pursuit of Pattern
   A. Orderly patterns of distribution are much more difficult to discern in geomorphology than in other geographic elements, such as climate.
   B. Overall, global distribution of topography is very disordered and irregular.
   C. Comprehending process (dynamics of topographic development) more important than study of landform distribution.