The most important part of the scientific method is Observation.

Observations can be basic primary observations.

or

Tests (challenges) are observations based of a prediction from a theory or hypothesis.
Publication and review process now important part of scientific method.

Uniformitarianism geological process at work today are similar to those throughout geologic time (and space)

Progression of our basic knowledge of the Earth’s Size, mass and density

Eratosthenes experiment

Arc = 8,000 km
Angle = 7.2 degrees
\[ X = \text{circumference of Earth} \]
\[ 360/X = \text{angle/arc} \]
2200 years ago these observations resulted in estimate of Earth circumference of 39,300 km
\[ R = x/\text{angle (radians)} \]
Estimate Earth’s mass from Gravity
\[ g = \frac{G \cdot m}{r^2} \] acceleration due to gravity
\[ M = \frac{g \cdot r^2}{G} \]
Density of Earth = Mass of Earth / volume
\[ \text{Volume} = \frac{4}{3} \cdot \pi \cdot r^3 \]

The average density of Earth is much higher than that of the crust
5.5 g/cc vs 2.7 g/cc

<table>
<thead>
<tr>
<th>Depth (km)</th>
<th>Elevation (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Himalayan Mountains</td>
<td></td>
</tr>
<tr>
<td>Marianas Trench</td>
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<tr>
<td>Mt. Everest</td>
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<tr>
<td>Mariana Islands</td>
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<tr>
<td>Challenger Deep</td>
<td></td>
</tr>
</tbody>
</table>

Typical elevation of land surface is 0–1 km
Typical depth of ocean is 4–5 km
Earth’s average composition is similar to that of meteorites.

In the Earth's crust:
- Silicon: 28%
- Oxygen: 46%
- Aluminum: 8%
- Iron: 6%
- Magnesium: 4%
- Calcium: 2.4%
- Potassium: 2.3%
- Sodium: 2.1%
- Other (<1%)

In the whole Earth:
- Iron: 35%
- Oxygen: 30%
- Silicon: 15%
- Magnesium: 15%
- Aluminum: 1.1%
- Calcium: 1.1%
- Sulfur: 1.9%
- Nickel: 2.4%
- Other (<1%)
Density of Earth's Major Layers

**Crust**
-硅 (28%)
-铝 (8%)
-铁 (6%)
-镁 (4%)
-钙 (2.4%)
-其它 (5.6%)
-氧 (46%)

**Mantle**
-镍 (5%)
-铁 (85%)
-硫 (5%)
-氧 (5%)

**Outer Core**
-镍 (6%)
-铁 (94%)

**Inner Core**
-氧 (24%)
Energy sources for Earth
1) Solar radiation, 2) Solar energy responsible for climate
3) Original heat of collapse (internal)
4) Radioactivity (internal)
5) Heat radiated to space (solar and internal)
6) Meteors move mass from space to Earth (same as 3).
Convection causes hot water to rise...

...where it cools, moves laterally, sinks...

...warms, and rises again.

Hot matter from the mantle rises...

...causing plates to form and diverge.

Where plates converge, a cooled plate is dragged under...

...sinks, warms, and rises again.
Source of ocean and atmosphere
**Geology areas of study**

Engineering – landscape stability  
Environmental – contaminants  
Geochemistry – chemical reaction with Earth material  
Geochronology – age material  
Geomorphology – landscape  
Geophysics – physics of the Earth and to study Earth (seismology)  
Hydrogeology – groundwater  
Mineralogy – properties of minerals  
Paleontology – fossils and life  
Petrology – rocks  
Sedimentology – deposition and rocks  
Stratigraphy – layering of rock  
Structural geology – rock deformation  
Tectonics – plate movement and related features