Absolute Dating

How do we use radioactive decay in dating the absolute age of a rock, fossil, or event?
Absolute Dating

- **Absolute Dating** - using radioactive decay to determine the exact age of a rock, fossil, or event
- **Radioactive Decay** - the disintegration of an isotope over time
Step 1: Geologists drill for core samples.
Step 2: Geologists crush the samples into thin sections and a fine powder.
Step 3: Geologists analysis the samples for composition and inconsistencies.
Step 4: Geochronologists use spectrosopes to measure the ratio of stable to unstable products.
Absolute Dating

- **Isotopes** - variations of an element that have the same atomic number but differing atomic masses

  - **Example:**

    - Stable carbon has a mass of 12 units called Carbon-12
    - Isotopic carbon has a mass of 14 units called Carbon-14
Absolute Dating

• **Half-Life** - the time required for half of a radioactive product to decay to a stable product
  
  • In a given sample of a radioactive isotope half of the atoms will decay to a stable product, but the remaining half is still radioactive
Absolute Dating

• Each element has its own half-life that range from fractions of a second to billions of years

<table>
<thead>
<tr>
<th>RADIOACTIVE ISOTOPE</th>
<th>DISINTEGRATION</th>
<th>HALF-LIFE (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-14</td>
<td>$^{14}\text{C} \rightarrow ^{14}\text{N}$</td>
<td>$5.7 \times 10^3$</td>
</tr>
<tr>
<td>Potassium-40</td>
<td>$^{40}\text{K} \leftarrow ^{40}\text{Ar}$</td>
<td>$1.3 \times 10^9$</td>
</tr>
<tr>
<td>Uranium-238</td>
<td>$^{238}\text{U} \rightarrow ^{206}\text{Pb}$</td>
<td>$4.5 \times 10^9$</td>
</tr>
<tr>
<td>Rubidium-87</td>
<td>$^{87}\text{Rb} \rightarrow ^{87}\text{Sr}$</td>
<td>$4.9 \times 10^{10}$</td>
</tr>
</tbody>
</table>
Absolute Dating

• The half-life of an isotope is not affected by any environmental factors such as temperature, pressure, or chemical reactions.
Absolute Dating

- **Uranium-238** - one of the most important isotopes when dating rocks or events millions of years ago
  - Mass: 238 units
  - Decay: Uranium-238 $\rightarrow$ Lead-206
  - Half-Life: 4,500,000,000 years
Absolute Dating

- **Carbon-14** - one of the most important isotopes when dating organic remains within tens of thousands of years
  - Mass: 14 units
  - Decay: Carbon-14 $\rightarrow$ Nitrogen-14
  - Half-Life: 5,700 years
Age of the Earth