The Terrestrial Planets

Formation of the Solar System I

- Nebula = cloud of gas & dust
- Contracts under self-gravity
- Flattens into disk: solar nebula
- Dust is vaporized

Formation of the Solar System II

- Dust condenses
- Dust sticks together to form rocks
- Rocks collide to form planets
Terrestrial Planets

4 Kinds of Planets

<table>
<thead>
<tr>
<th></th>
<th>Density</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jovian</td>
<td>About 1</td>
<td>H, He</td>
</tr>
<tr>
<td>Uranian</td>
<td>1.5</td>
<td>Water</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>3-5</td>
<td>Iron, rock</td>
</tr>
<tr>
<td>&quot;G&quot;</td>
<td>2</td>
<td>Rock, ice</td>
</tr>
</tbody>
</table>

Astronomy 20

Terrestrial Planets

Structure

- Iron Core
- Rock Mantle
- Rock Crust
- Atmosphere (optional)

Which layer is densest?
Least dense?
Why are they arranged this way?

Process: differentiation

Terrestrial Planets

Heating of Core

Astronomy 20
Cooling of Core

1) Conduction
2) Convection
3) Eruption

Surface Processes

Impact cratering
Erosion
Volcanism

Impacts

Rocky or icy object

This is going to leave a mark called a...
Impact Crater

Barringer Meteor Crater, Arizona

Crater Features

Aristillus
Aristoteles
Eudoxus

An object this size will make a crater this big!

Ratio of sizes is about 10:1

The Moon

Impact Craters

Aristoteles
Eudoxus
Rays

- Darken after about 100 million years.
- Best seen at local noon.

How can you find the youngest craters on the Moon?

Crater Sizes

Simple craters: < 25 km
Complex craters: 25-300 km

This puppy is the size of the L.A. basin!
Complex Craters

Copernicus

Manicougan impact crater, Quebec

Mimas

400 km
Double-ringed craters

Impact Basins

Check Question

- Which crater is largest?
Terrestrial Planets

Volcanism

Earth

- Volcanic plains
- Shield volcanoes
- Stratovolcanos

Terrestrial Planets

Volcanism

Shield volcanoes

Terrestrial Planets

Volcanism

Stratovolcanos

Fujiyama
Volcanism
volcanic plains

Tectonics

Plate tectonics
- Lithosphere
- Plates
- Convection in mantle
Check Question

Q. This mountain is an example of:
1. Impact cratering
2. Volcanism
3. Tectonics
4. Erosion

Simplified History

Formation 4.6 Gyr ago

Early Heavy Bombardment

Impact Rate

Radioactive core heating

Cooling core/Declining impacts

Present

Billion years ago

4.6 Gyr ago

How to measure ages?

- Relative dating –
  - Principle of Superposition
- Rough dating
  - Crater counts
- Absolute dating –
  - Radioisotopic dating of rocks.
Principle of Superposition
Can you order the events?

A. Volcanic Eruption
B. Fault
C. Crater
D. Crater

Crater counts
The older the surface, the more craters.

Enceladus
Old
Young

Radioisotopic Dating
A radioactive element decays into a daughter element at a predictable rate, regardless of temperature.
Half-life

Half-life – time it takes for 1/2 of X to decay into Y.

Examples of radioactive isotopes:

\[ ^{238}\text{U} \rightarrow ^{206}\text{Pb} \quad 4.5 \text{ Gyr} \]

\[ ^{40}\text{K} \rightarrow ^{40}\text{Ar} \quad 1.3 \text{ Gyr} \]

\[ ^{14}\text{C} \rightarrow ^{14}\text{N} \quad 6,000 \text{ yrs} \]

Radiocarbon Dating

Carbon-14 decays to Nitrogen-14

Half-life = 6000 years

<table>
<thead>
<tr>
<th>Year</th>
<th>C-14</th>
<th>N-14</th>
<th>Fraction left</th>
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<tbody>
<tr>
<td>0</td>
<td>8000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6,000</td>
<td>4000</td>
<td>4000</td>
<td>1/2</td>
</tr>
<tr>
<td>12,000</td>
<td>2000</td>
<td>6000</td>
<td>1/4</td>
</tr>
<tr>
<td>18,000</td>
<td>1000</td>
<td>7000</td>
<td>1/8</td>
</tr>
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Example Question

Element X decays into element Y with a half-life of 10 million years.

How old is a rock that is found to be 1/4 X?
The Age of Meteorites

- Meteorites are rocks that fall from space.
- Most meteorites are about the same age.
- Age = 4.56 billion years.
- This is the age of the solar system.

SIZE

- Moon: 1% Earth mass
- Mercury: 5%
- Mars: 10%
- Venus: 80%
- Earth: 100%

Geological activity:

- No atmosphere
- Thin atmosphere
- Heavy atmosphere

It's good to be around a terrestrial planet!