

# Giant impact hypothesis and formation of the Moon

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## 1) Outline

### Competing Origin Models

- **Fission (from Earth):** Moon spun off from a rapidly rotating early Earth (Darwin, 1879; Binder, 1980).
- **Co-accretion (“sister planet”):** Earth and Moon formed together in the same region (Schmidt, 1959).
- **Gravitational capture:** Moon formed elsewhere and was later captured by Earth (Gerstenkorn, 1955).

### Why these were challenged:

(1) **Motion:** The model must match Earth’s spin and the Moon’s orbit; some ideas require an unrealistically fast-spinning Earth or an unlikely “slow-down” to capture the Moon.

(3) **Composition:** Moon rocks look very similar to Earth’s outer rocks, but the Moon has much less iron and fewer volatile materials, older models struggled to explain both.

## 3) Evidence

### How can a disk become one Moon?

- **Roche limit:** Inside roughly 2.9 times the earth’s radius debris cannot clump (stays as ring); outside it can accrete into the Moon (Canup, 2004; Salmon and Canup, 2012).
- **Small core:** The Moon is relatively iron-poor, consistent with mantle-like debris (Wieczorek et al., 2006).
- **Hot start:** Volatile depletion and an early magma ocean imply high-temperature formation (Salmon and Canup, 2012; Wieczorek et al., 2006).

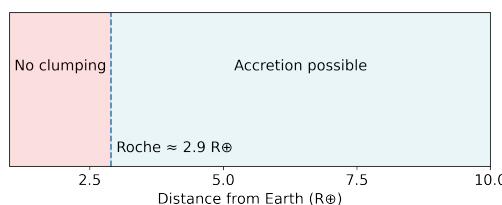


Figure 2: Roche limit: inside the limit debris stays a ring; outside it can accrete into a Moon.

## 2) Giant Impact Hypothesis

A Mars sized protoplanet dubbed Theia struck the young Earth at an oblique angle, melting and vaporizing parts of both bodies and ejecting a large amount of mantle material into orbit. That hot debris formed a disk around Earth, which cooled and gradually accreted to become the Moon while the remaining material rejoined Earth.



Figure 1: Giant Impact hypothesis graphic representation.

1. Proto-Earth and Theia
2. Giant impact ejects debris
3. Debris disk forms
4. Debris coalesces into the Moon

## 4) Looking Ahead

1. How could Artemis II and Artemis III missions help us learn how the Moon was created?
2. What samples or measurements from the lunar surface would give the clearest clues about the Moon’s origin?
3. If Artemis finds more water or different rock ages than expected, how could that change our ideas about Moon formation?



## References

### References

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