

**Origin of the Earth and Moon:
What problems can be addressed
by a return to the Moon?**

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Prepared for Tempe Moon Workshop; February 28, 2007

“Giant Impact” Hypothesis

- paradigm for Origin of the Earth and Moon

Moon forms from debris ejected when early Earth suffered an oblique collision with another protoplanet (Hartmann and Davis, 1975; Cameron and Ward, 1976)



Satisfies several constraints:

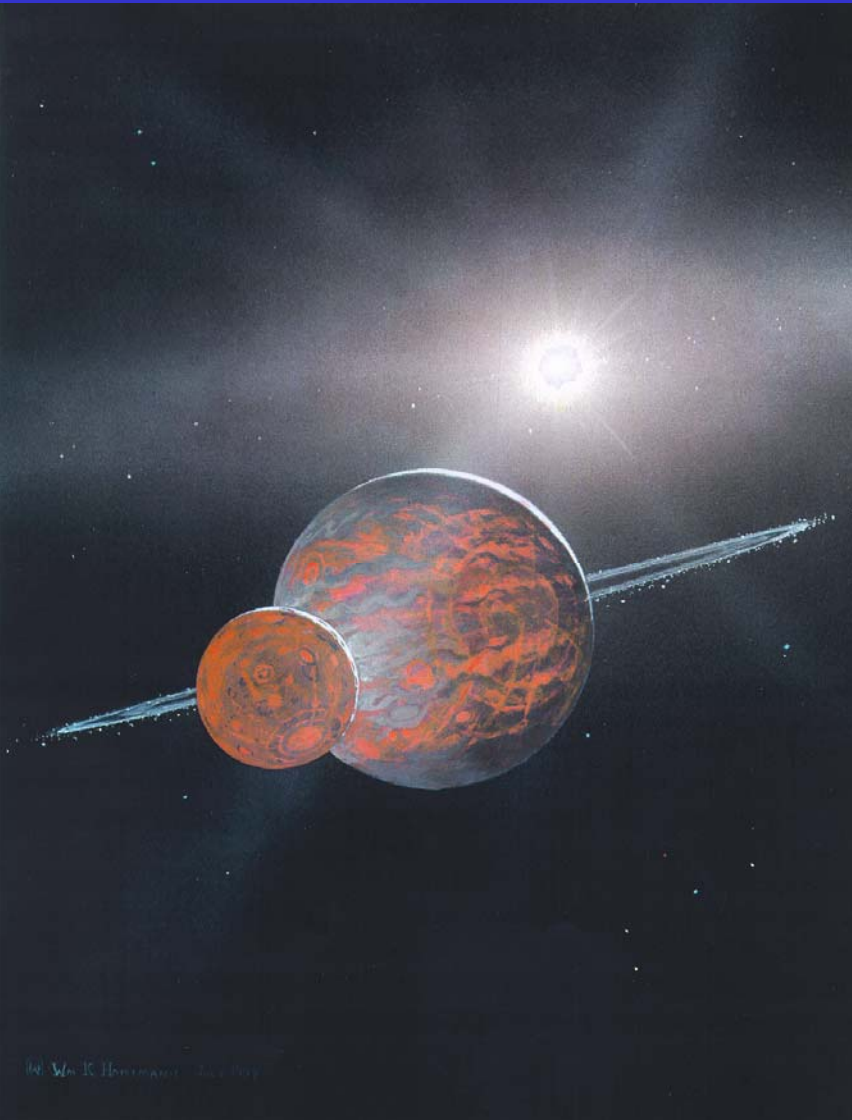
- Hot early history (magma ocean)
- Small lunar core ($\leq 0.03 M_L$) consistent with modelling of Fe-depleted protolunar material.
- Earth-Moon system angular momentum

Outstanding problems

Most are geochemical and may be due to Apollo sample bias

- Age of the Moon ?
- Why are volatile elements depleted ?
- What is the bulk composition of the Moon?:
Refractory lithophile elements and core-mantle-crust
- Late accretion events – how many?
 - Late veneer
 - Late Heavy Bombardment
 - Terrestrial atmospheric loss by late impact?

Problem #1: Age of the Moon



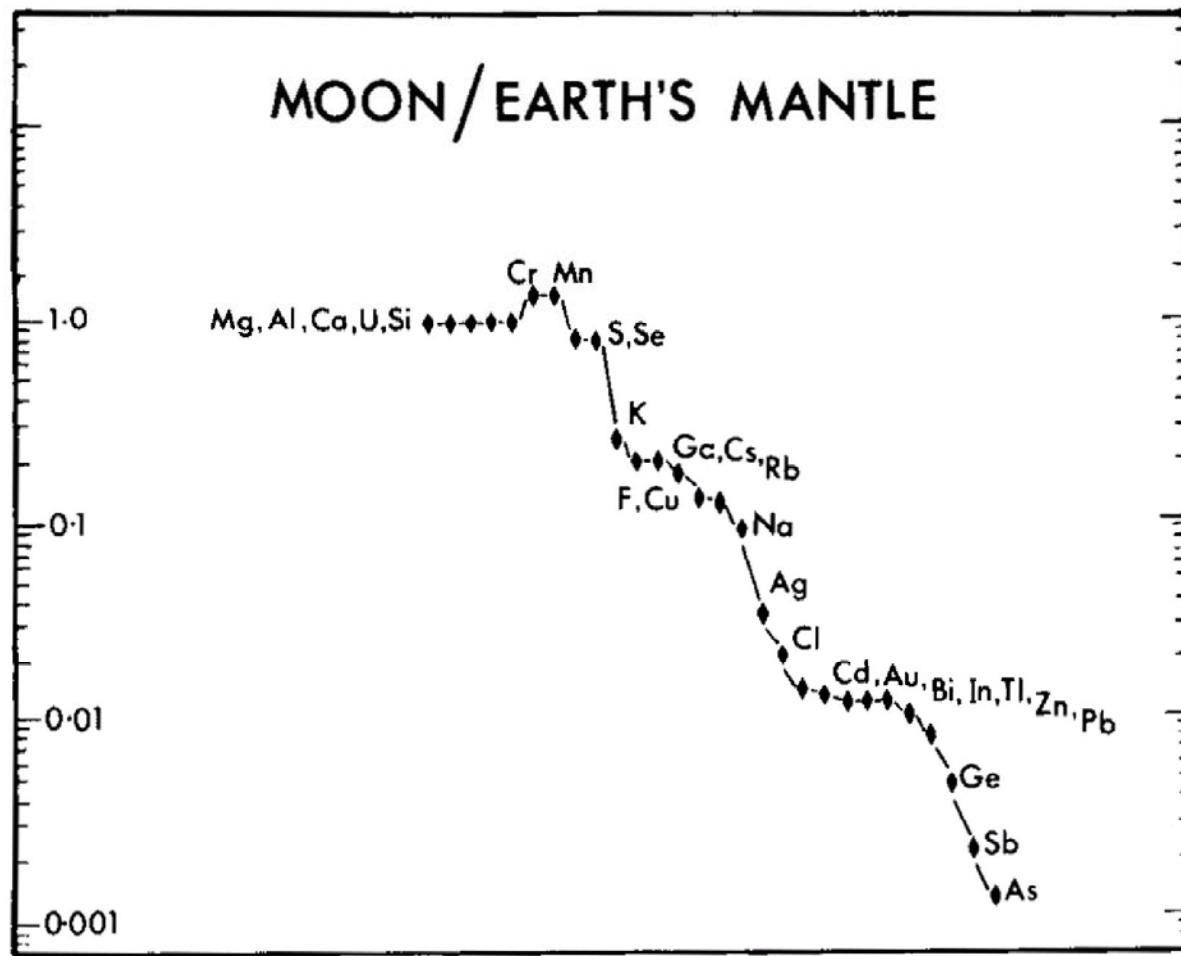
Ferroan anorthosites – 4.46 Ga.
Hf-W age of Moon – 4.54 Ga.

80 Ma age difference !!
Explanation?

⇒ New samples from far away from PKT may help resolve age difference.

⇒ Lunar meteorites have taught us the value of samples from new sites.

Problem #2: Why are volatile elements depleted?



- In, Pb (others?) compromised in Apollo suite?

- Depletion due to giant impact?

=> New samples could be carefully collected from targeted lithologies for best resolution of the problem

from Ringwood (1979)

Problem #3: What is the bulk composition of the Moon?: Refractory lithophile elements and core-mantle-crust

- Interior structure of the Moon

 - core: size and composition?

 - mantle: what is actual mineralogy? (xenoliths?)

 - crust: how thick and what composition?

- Influence of PKT on our models?

=> Samples from the upper mantle (or deep crust) and away from PKT (South Pole Aitken) will provide new constraints on the lunar interior and bulk composition

Problem #4: Late accretion events – how many?

- Late veneer

=> Difficult to quantify with HSE “contaminated” lunar samples

- Late Heavy Bombardment

=> needs to be tested with samples collected away from PKT/Imbrium

- Terrestrial atmospheric loss by late impact?

=> Is there a record in lunar materials?

=> Are there Earth samples on Moon ???

Summary

- Geochemical models are bound by limitations of Apollo collection
- New samples would provide new constraints on classic problems
- Diversity of samples is the key – multiple sampling sites should be employed – even if 500 m apart!
(e.g., we don't need large Apollo 15 style “Great Scott “ basalts on new collecting trips)