

1. Earth's large satellite, Moon, has played a critical role in Earth's evolution. Before the Apollo missions returned samples, there were numerous competing theories for lunar origin. Sample return and subsequent analysis has provided further constraints.

- a.) What rock types predominate in the 382 kg of lunar rocks returned?

- b.) What do the texture and grain size indicate about the conditions of formation?

- c.) How much of the moon surface was sampled? What lunar regions remain unsampled?

- d.) Compare terrestrial and lunar basalts.

- e.) The bulk (95%) of the lunar rocks remain in storage, not yet analyzed. Why do you think so much has been 'archived'? Is this prudent or excessive?

- f.) What makes up the lunar “Regolith”? What formed it?

2. Currently at 60.4 Earth radii (c.384,800 km) away, the Moon recedes from the Earth.

a) With the Moon's retreat Earth's rotation decelerates at a current rate of 2 millisec per century. Going back in time, and assuming a linear deceleration rate, how long was the day during the Devonian Period, 300 million years ago (Ma), how long was the day in the Cambrian, 550 Ma? At this rate, how far back until the day has zero length?

b) With shorter days, the year would have a greater number of days. Analysis of growth bands in *Rugose* (coral) records 400 days in the Devonian year; Stromatolites (algal mats) give 425 days for the Cambrian. Are these compatible with the current rate in a)?

c) Tidal amplitude scales with the inverse cube of lunar distance. An equilibrium value for the open ocean measures 55 cm, with considerable variation over the Earth. For the Moon $\frac{1}{2}$ its current distance, what would lunar tides average? What would the amplitude be for the Moon at $\frac{1}{4}$ its current distance?

d) The moon's distance from Earth has increased over the last 4 billion years. At its current distance, the moon perfectly eclipses the sun. Coincidence? Maybe not. Indeed, it has been speculated this represents no accident, but has been 'engineered' as a message (a variation of the premise in Arthur C. Clarke's *2001*). How would you test the idea? What do the values in 2b imply about this scenario?

3. Moon's internal structure. Reanalysis of Apollo (1969-72) seismic data (see "Seismic detection of the lunar core", Weber et al., Science, 2011, under 'Moon' on class website) has better defined the lunar interior. What new technique was applied on the old data? How do their results show the Moon further resembles the Earth?

4. View the 2012 Shoemaker Lecture, Fall AGU meeting: Maria Zuber, “Gravity, Topography & the Early Evolution of the Moon”: How are the gravity measurements made on the far side of the moon? How do these findings support the giant impact origin for the moon? Water ice deposits would provide an invaluable resource for future lunar expeditions. What is the current evidence for ice deposits?

https://www.youtube.com/watch?v=zI-mV_FtCbc

5. What critical role does the Moon play in the 'Rare Earth' hypothesis? How unusual do you judge this scenario: a terrestrial planet with a satellite one-third its size? (Ward and Brownlee, Chapter 10).

6. A recent study (Wohlert and Wood., 2015, under 'Moon' on website) suggests a link between the moon and the development of Earth's core and thus the magnetic field. Briefly describe the experiment that supports this. (Connection detailed in interview with Bernard Wood: <http://phys.org/news/2015-04-earth-ate-mercury-like-body-early.html>)