Testimony

Public Hearing of the
President's Commission on Moon, Mars and Beyond

May 3, 2004

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New York Center for Studies on the Origins of Life

A NASA Specialized Center of Research and Training

Apollo 15 astronaut, Jim Irwin, at Hadley-Apennine

Geochemistry in Planetary Science & Astrobiology

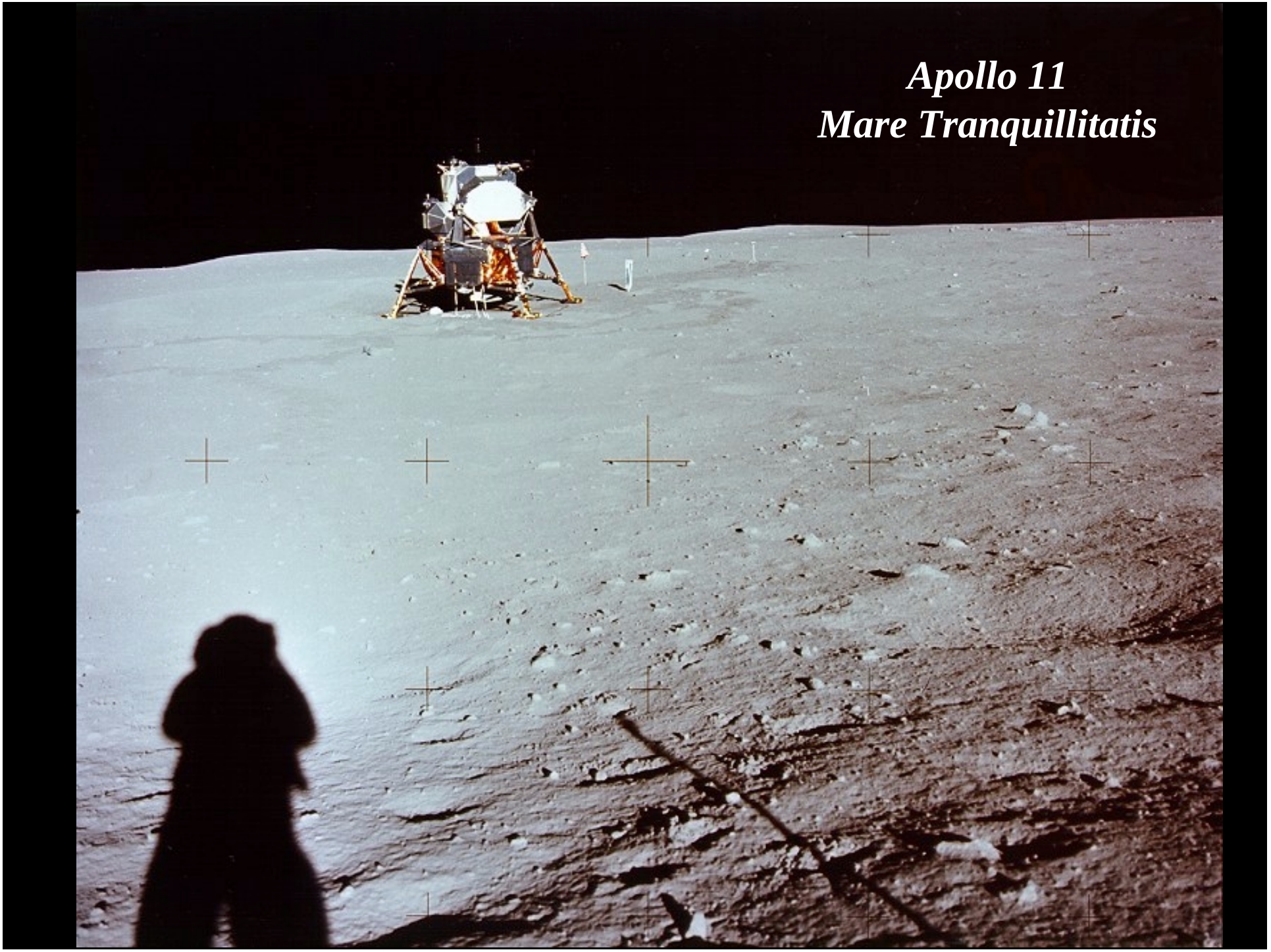
- The Moon remembers events that the Earth has long forgotten. The Moon has preserved a rich, accessible, long-duration geochemical memory, including the first 600 million years of our Solar System.
- Time-dependence of the Late Heavy Bombardment: When did sustainable life arise on Earth?
- The cataclysmic bombardment …
  … affected the sustainability of early life on Earth (and elsewhere in the Solar System?).
  … delivered volatiles and prebiotic organic molecules to the Earth and other planets.
  … launched materials from one planet to another (Earth/Mars cross-fertilization?).
- Are the chemical and isotopic compositions of volatiles and prebiotic molecules, which were delivered early to the planets, preserved in the Moon's polar regions?

- Are there ancient pieces of Earth (and other planets) on the Moon that could serve as geochemical *Rosetta Stones*?
- Since chemical and isotopic analyses of the Earth's atmosphere reveal complex, global biogeochemical cycles, what could continuous monitoring of Mars' atmosphere tell us about global chemical cycling related to life and other processes there?
- Are the periodicities of geochemically defined climate cycles on Earth also reflected on Mars (e.g., ice cores from polar regions)? Are variations in the Sun's luminosity indicated?
- The Moon also preserves a memory of the impact flux since the rise of *complex life* on Earth (e.g., last 550 million years). Have episodes of increased flux contributed to mass extinction events? Can this record inform us about future threats?
- New questions and challenges drive new technologies.

- Due to the Moon's extensive geochemical memory of important events in the Solar System, lunar exploration can provide information that is central to fundamental questions in Astrobiology (e.g., late heavy bombardment; delivery of volatiles and organic molecules).

- These science goals can be addressed using missions with orbital remote sensing capabilities, robotic sample-returns, and human exploration.

- The experience gained by, and the technologies developed for, these ambitious lunar missions will be important for building toward successful, human explorations of Mars.


Apollo 11
Mare Tranquillitatis

Historical Perspectives on Extraterrestrial Life

Michael J. Crowe (1986) *The Extraterrestrial Life Debate 1750-1900.*
Cambridge University Press, 680 pp.

* * * Ambiguity * * *

- David Brewster (1781-1868); William Whewell (1794-1866)
- William Herschel (1738-1822)
- Gottfried Wilhelm Leibniz (1646-1716)
- Isaac Newton (1642-1727)
- Christian Huygens (1629-1695)
- Copernicus (1473-1543); Kepler (1571-1630)
- Nikolaus Krebs (1401-1464)
- Lucretius (99-55 B.C.)
- Epicurus (341-270 B.C.)
- Plato (428-348 B.C.); Aristotle (384-322 B.C.)

- **Future generations will not look at the sky in the same way that we have. Instead of pointing at constellations, they may point at individual stars where life-bearing planets have been detected using American science and technology.**

- **Just as many explorers and their host-nations are remembered for their courage in defining and accomplishing deeds that history has recorded as great, …**

… American astronauts deserve *epic* programs that are worthy of their skill and courage, and that will be historically durable.

- **The epic journeys proposed in the President's *Moon, Mars, and Beyond* initiative could become a lasting source of inspiration and epiphanies for future generations.**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Southern Crown
"We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know that place for the first time."
T. S. Eliot in "Four Quartets"