12.002 Physics and Chemistry of the Earth and Terrestrial Planets
Fall 2008

The Moon

Before the Apollo missions, Urey proposed Moon was undifferentiated object-never melted since formation

Now we know that it is composed of two terranes:

1. Highlands (mostly highlands) - rough high topography, bright, heavily cratered (84% of surface)

2. Mare - low, dark, lightly cratered (16% of surface)

1966 gamma ray spectroscopy from Soviet Luna 10 orbiter:
Measured ^{40}K, ^{235}U, and ^{232}Th and found them to be chondritic or subchondritic over highlands (like mantle) and superchondritic over mare. Conclusion: Lunar mare are basaltic but lunar highlands are not granitic like Earth's continents.

1968 US Surveyor landers. First in situ analyses of mare and highlands sites.

1969 - 1972 six Apollo manned missions – 380 kg of rock and soil

Mare composed of basalt (pyroxene, olivine, plagioclase). Ages 3.9 - 3.2 Ga (mare volcanism persisted to 1 Ga). Meteorites, young mare basalts - Urey is wrong: Moon is differentiated

Highlands have two plagioclase-rich compositional types:
-Anorthosite (>98% anorthite $CaAl_2Si_2O_8$ which is Ca-rich, Na-K poor plagioclase)
-Mg-suite (plagioclase and pyroxene and olivine)

All the rocks are extremely dry!

Major element composition of the bulk Moon is grossly similar to Earth's mantle
Uncompressed density 4050 kg m^{-3} for Earth versus 3300 kg m^{-3} for Moon

Differences between Earth and Moon:
Moon enriched in FeO, depleted in Fe metal
Moon depleted in siderophile elements (iron-loving)
Moon depleted in volatile and moderately volatile elements (Na,K)
Moon enriched in refractory elements (Ca, Al, Ti)