Visual Crater Dating

by Martin Lewicki

A telescopic view of the cratered and battered lunar surface gives the impression of a chaotic geologic history. There are the smooth maria with few craters and then the highlands where craters overlay more craters to saturation. But careful observers should be able to discern a sense of chronological order to the formation of lunar features. By knowing some of the sequences of formation of the lunar surface we can "read" the Moon's history, if only in a general sense.

At first glance it is obvious that the heavily crater highlands must have formed much earlier than the mare. This period began in the pre-Nectarian era, about 4.4 billion years ago. This also produced the early mare basins when there were still a large number of large asteroid/comets impacting the Moon. But these basins did not begin to fill with lava until the Imbrian era 3.8 billion year ago. Lab tests indicate that the lava had the consistency of oil (at room temperature) and could flow over vast distances. This period saw the creation of craters such as Plato, Sinus Iridium and Archimedes. Indeed these craters are themselves filled with lava from these flows.

The following Eratosthenian era produced Eratosthenes itself, Langrenus and Aristoteles. These craters actually look like they impacted on the maria after its solidification. This era began 3.2 billion years ago and lasted 2 billion years and also produced further lava flows in the Procellarum, Frigoris and Vaporum basins.

The Copernican era began 1.2 billion years ago and continues to the present. By this time the rate of cratering had greatly decreased. You can identify craters of this period especially with their characteristic ejecta ray patterns. The most prominent is of course Tycho with some of its rays reaching as far a Mare Nectaris. Its youthfulness (101 million years) is evident in that it looks "fresh" with virtually no adjacent or overlapping smaller craters. Then there is Copernicus itself (a bit older 810 million years). Other craters from this era are Kepler and Aristarchus. As ray craters age, their ejecta rays darken owing to the effects of solar wind and blend with the surround soil.

Speaking of ejecta, take a look at the floor of Alphonsus (best at gibbous phase with at least a 6cm), though from the Imbrian era it sports four small craters with dark ejecta blankets. Two of them are placed on rilles that reveal their volcanic (or pyroclastic) nature. Perhaps then it is not surprising that Alphonsus was chosen as the target of the hard-lander Ranger 9 spacecraft in 1965 and that it is also a favourite target of LTP (Lunar Transient Phenomena) observers.

Moon Librations

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In its monthly orbit around the Earth the Moon rotates with the same face locked to the Earth. Because of the geometry of the Moon's elliptical orbit in relation to Earth and other small gravitational effects of the Earth and Sun, the Moon appears to rock slightly tipping different portions of its limb toward us. This allows us to view 59% of its surface. The Moon Libration diagram shows the date in the month (every two days) and the amount in degrees (to nearest degree) the limb is tipped toward us. Included are phases and dates of perigee and apogee.

Maximum libration occurs on the 26th at 7.6° at the Serenitatis limb between Full Moon and Last Quarter, and minimum libration occurs on the 20th at 3.5° at the Fecunditatis limb between First Quarter and Full Moon.