IMPLICATIONS OF THE INNER SOLAR SYSTEM CRATERING RECORD FOR THE EARTH. N. G. Barlow, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058.

Scars of the early intense episode of impact cratering which is retained on the Moon, Mercury, and Mars are lacking on the Earth because of fluvial, aeolian, volcanic, and plate tectonic action on the latter. Crater statistical studies of Venera radar images suggest that Venus also does not retain large expanses of heavily cratered terrain (1, 2). In order to understand the environment which the earth was exposed to early in its history we must look to the cratering record retained in the heavily cratered regions of the Moon, Mercury, and Mars.

The Relative crater size-freqeuncy distribution plotting technique clearly shows frequency variations from the D^{-2} distribution function purported to describe the cratering record throughout the solar system. Two populations of impacting objects have been suggested for the inner solar system based on the shapes and densities of the size-frequency distribution curves of the Moon, Mercury, and Mars. The heavily cratered regions of these three objects all show distribution curves which cannot be represented by a single-slope distribution function at all crater diameters. This type of multiple sloped distriubion curve is representative of the size-frequency distribution of objects responsible for the period of heavy bombardment. The lunar mare and martian northern plains display a curve which can be represented by a power law function with differential slope -3. This curve is statistically different from that seen in the highlands (3) and is representative of the size-frequency distribution of objects (primarily asteroids and comets) which have been responsible for the cratering record since the end of heavy bombardment.

The similarities among crater size-frequency distribution curves for the Moon, Mercury, and Mars suggest that the entire inner solar system has been subjected to the two populations of impacting objects but erosion on Earth and Venus has obliterated the record of heavy bombardment impactors on these two planets. Absolute age versus crater density relationships established for the Moon place the end of heavy bombardment at about 3.8 BY ago (4), and this time horizon probably holds at least throughout the Earth-Moon system. Thus, based on the cratering record for the Moon, Mercury, and Mars, we can infer that the Earth experienced a period of high crater rates and basin formation prior to about 3.8 BY ago. The lack of evidence for life forms during and shortly after the period of heavy bombardment may be due at least in part to the hostile conditions existing at this time. Recent studies have linked mass extinctions of terrestrial fauna to large impacts (5), so life forms may have been unable to establish themselves until impact rates decreased substantially and terrestrial conditions became more benign. Although organic material dating from 3.8 BY has been suggested to occur in sediments from Isua, Greenland, fossils are not widespread in terrestrial rocks until 3.5 BY ago, 0.3 BY after the presumed end of heavy bombardment in the Earth-Moon system (6).

The possible periodicity of mass extinctions has led to the theory of fluctuating impact rates due to comet showers in the post heavy bombardment period (7). The active erosional environment on the Earth complicates attempts to verify these showers by obliterating geological evidence of older impact craters. Uncertainties in dating the existing impacts causes large statistical errors which tend to mask any alleged evidence of comet showers (8). The Moon displays few geologic units which formed less than 2.8 BY ago

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

and studies of small craters superposed on young crater ejecta blankets also produce statistically questionable evidences for comet showers (9, 10). Mars exhibits a number of geologic units with varying crater densities, thus spanning various ages, and will provide the best information on fluctuations in the inner solar system cratering record when absolute ages for these regions become available (11). However, at the present time evidence from the cratering record for the existence of comet showers is inconclusive.

The estimated size of the impactor purportedly responsible for the Cretaceous-Tertiary mass extinctions is 10 km in diameter (7). Using scaling relations for crater diameter versus impact diameter (12), a 10 km diameter impactor would create a 440 km diameter crater on the moon and a 350 km diameter crater on Mars, assuming cometary density and impact velocity. No craters >200 km exist on the lunar mare and only 3 craters >300 km exist on the martian plains. Thus impactors greater than or equal to the size postulated for the K-T impactor have been rare within the inner solar system since the end of heavy bombardment. Although the greater gravitational cross-section of the Earth may preferentially attract some of these large impactors, the evidence from the inner solar system cratering record suggests that mass mortalities caused by catastrophic impacts on the Earth should not be expected to be common events.

References: (1) Basilevsky A.T., et al., 1987, *J. Geophys. Res.*, **92**, 12869-12901. (2) Barlow N.G., 1988, *LPS XIX*, 34-35. (3) Woronow A., Strom R.G., and Gurnis M., 1982, In *Satellites of Jupiter* (D. Morrison, ed.), 237-276. (4) Soderblom L.A., et al., 1974, *Icarus*, **22**, 239-263. (5) Alvarez L.W., et al., 1980, *Science*, **208**, 1095-1105. (6) McKay C.P., Mancinelli R.L., and Stoker C.R., 1989, *4th International Conference on Mars*, 40-41. (7) Hut P., et al., 1987, *Nature*, **329**, 118-126. (8) Grieve R.A.F., 1984, *J. Geophys. Res.*, **89**, B403-B408. (9) Guinness E.A. and Arvidson R.E., 1977, *Proc. Lunar Planet. Sci. Conf. 8th*, 3475-3494. (10) Neukum G., 1988, *LPS XIX*, 850-851. (11) Barlow N.G., 1988, *Icarus*, **75**, 285-305. (12) Holsapple K.A. and Schmidt R.M., 1982, *J. Geophys. Res.*, **87**, 1849-1870.

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System