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Review of Mariner 10 Observations: Mercury Surface Impact Processes

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Mercury's surface was first revealed by Mariner 10 imaging. Generally, Mercury is heavily cratered, with less cratered regions, similar to the Moon. Craters range from nearly saturated small craters (many show clustering suggestive of secondaries) up to enormous multi-ringed basins, of which Caloris is the most prominent. Dozens of basins have been tentatively identified. Morphometric statistics of Mercury's craters have been compared with those for other terrestrial bodies and interpreted in terms of differences in surface gravity and other factors.

Craters are used for both relative and absolute age-dating of geological units. Early interpretations of Mercury's cratering record drew analogies from the Moon: it was supposed that most craters and basins formed about 3.9 Ga, during the same Late Heavy Bombardment (LHB) that dominated lunar cratering. Through superposition relationships with other geological features (e.g. lobate scarps), a tentative chronology for Mercury's geological history was derived, raising potential incompatibilities with geophysical inferences about interior cooling rates and processes that generate Mercury's magnetic field. Sources for Mercury's craters are numerous. They could have varied with time and could differ from the cratering histories on other bodies. They include: the Near-Earth asteroids and their cousins (of which few have yet been found) that orbit entirely interior to Earth's orbit; short- and long-period comets, including sun-grazers; vulcanoids, an as-yet-undiscovered hypothetical population of remnant planetesimals from accretionary epochs, orbiting mainly inside Mercury's orbit; and secondary cratering by ejecta from basins and large primary craters. Endogenic crater-forming processes (e.g. volcanism) are also possible. Differences in asteroid/comet cratering rates (perhaps including the LHB) are not expected to vary by large factors for Mercury compared with the Earth-Moon system or Mars. But if vulcanoids were/are important, they could have extended the duration of Mercury's intense cratering into epochs far later than the LHB.

Secondary cratering may be much more important than previously thought. Studies of both the sparsely cratered surface of Europa and of Mars have recently suggested that the steep branch of the crater size-frequency relation for craters smaller than a few km (originally identified by Shoemaker as the "secondary" branch but later attributed to the inherent size-distribution of collisionally evolved asteroids) really is dominated by secondaries from primaries larger than 10 km. Possibly, many supposed primary craters several tens of km in size may instead be secondaries from basin-forming impacts. MESSENGER imaging will address these issues.