REVISION OF THE MARTIAN RELATIVE AGE CHRONOLOGY. Nadine G. Barlow, Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721.

A number of martian chronologies, both absolute and relative, exist in the literature. These histories are derived primarily from Mariner 9 images of small (<10-km diameter) craters in localized regions of the planet. The higher quality Viking Orbiter images have not been in a convenient format for global mapping until recently when the USGS 1:2M photomosaic series was completed. Thus, no planet-wide chronologic studies have been developed from this more recent data.

Using the Viking 1:2M photomosaic series, I have divided the surface of Mars into approximately 25 generalized geologic units and a number of localized regions. All craters ≥8-km in diameter were mapped and classified by a variety of properties. The crater size/frequency distribution curves were determined for each of these units. The relative plotting technique was used since the shapes and positions of the distribution curves on this type of plot give information on the relationship of the terrain to the period of heavy bombardment (see Barlow and Strom, 1986, for further discussion of this technique).

It was found that approximately 60% of the martian surface dates from the period of heavy bombardment. Areas within the southern highlands which show no erosion by lava flows ("pure uplands") are the oldest regions on the planet. Jovis Tholus, Uranius Tholus, Tyrrhena Patera, Ulysses Patera, and Ceraunius Tholus also formed early in martian history, contrary to what is commonly believed (volcanic data is from a study by Katz and Strom, 1984). The time of the Hellas and Argyre impacts was determined from the crater information on the rims of these basins. They are found to be similar in age to the intercrater plains in the southern highlands, Hellas being slightly older than the intercrater plains and Argyre slightly younger. Tharsis Tholus, Hecates Mons, Albor Tholus, and Apollinaris Patera are approximately contemporaneous with the formation of Argyre as are the various fractured and dissected highlands regions. The fractured highlands south of the present-day Tharsis Province probably indicate that the Tharsis Bulge was beginning to form around this time. The volcanic plains south-southwest of the Hellas Basin formed long after the impact creating the Hellas Basin.

The use of the relative plotting technique has solved the controversy over the age of the ridged plains. These plains definitely show a heavy bombardment-type distribution curve, but the lower crater density relative to the highlands indicates that these regions formed near the end of heavy bombardment. Lunae Planum, Hesperia Planum, Syrtis

Major Planitia, Sinai Planum, and Chryse Planitia all fall into this category. The floors of the Hellas and Argyre Basins as well as the volcanic constructs of Hadriaca Patera, Biblis Patera, and Uranius Patera also formed near the end of heavy bombardment.

The remaining 40% of the martian surface has formed since the end of heavy bombardment and is located primarily in the northern hemisphere. The northern plains was divided into several localized regions and it was found that a variety of formation ages exist for these plains units. The post-heavy bombardment period can be divided into older, intermediate, and younger sections based on crater densities. The older division contains the general units of plains and mottled plains, the local units of Utopia Planitia, Solis Planum, Isidis Planitia, Elysium Planitia, Syria Planum, and Vastitas Borealis, the Elysium Mons volcano, and the chaotic terrain and fractured plains surrounding Tharsis. The intermediate period saw the formation of the equatorial layered deposits, Amazonis Planitia, Mare Acidalium, Arcadia Planitia, Alba Patera, the latest episode of resurfacing by the outflow channels, and the beginning of Valles Marineris. The most recent period of martian history includes the formation of the polar layered deposits, Tharsis plains, Olympus Mons, and the floor of Valles Marineris.

This study has provided a more detailed chronology than currently exists in the literature and has created some changes to the currently accepted geological evolutionary sequence of Mars. The period of heavy bombardment, although dominated by impact processes, experienced many forms of volcanic activity and at least one episode of intense fracturing. Most small volcanic constructs and the ridged plains regions are found to date form this early period, contrary to common belief. The fracturing and dissection of the highlands helps to provide further constraints on the timing of events such as the formation of the hemispheric dichotomy and the formation of the Tharsis Bulge. The northern plains are found to consist of a number of differently aged regions. Plains units bordering each other can be vastly different in age, as demonstrated by Sinai Planum and Solis Planum. The difference in age between the chaotic terrain and the outflow channels together with differences in the distribution curves among craters of various erosional states found on the channels supports the theory of episodic periods of flooding (Neukum and Hiller, 1981).

Mars has experienced a very active geologic history, with two identifiable periods of peak activity (Figure 1). The first gentle peak corresponds to the formation of the extensive intercrater plains in the highlands. The second peak is sharper and is due to the recent formation of the northern plains. This revised relative chrnology will help provide constraints on the various geologic and thermal evolutionary models proposed for Mars.


References:

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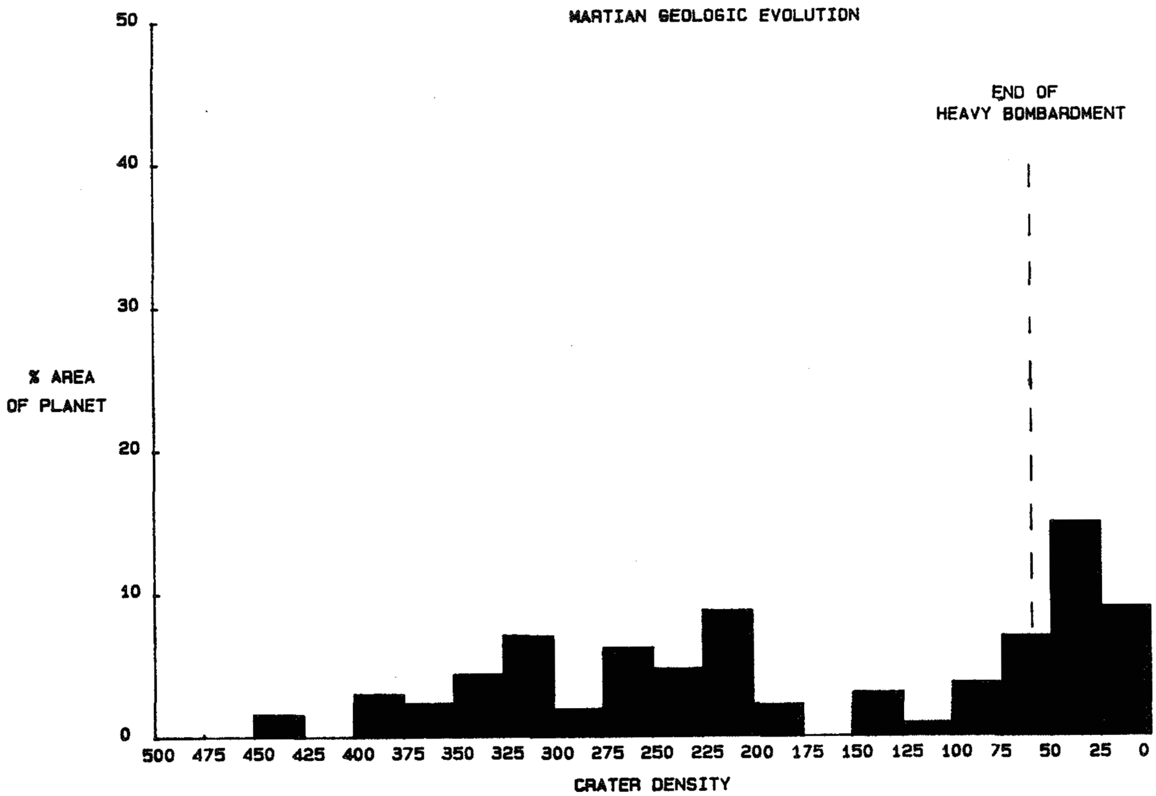


Figure 1: Histogram of the percentage of the martian surface displaying a particular range in crater density. This graph provides an indication of the minimum level of geologic activity at any particular point in martian history. Crater density is defined as the number of craters ≥8-km diameter/$10^6$ $km^2$.