
It has recently been suggested that, in post-Noachian times, the climate of Mars has changed episodically such that liquid water became temporarily stable at the surface (1, 2). For this to happen, a surface atmospheric pressure of at least a few bars was probably required (3). Warm, wet climatic conditions have long been postulated for the Noachian (4,5) on the basis of pervasive dissection of Noachian terrains by branching valley networks. The Noachian also appears to have been a period of relatively rapid obliteration of surface features, consistent with, though not necessarily proof of a thicker atmosphere and warmer climatic conditions. Here, the average obliteration rate in post-Noachian times is estimated from crater dimensions on surfaces that preserve a basal Hesperian crater size frequency distribution. These rates are then compared with Noachian obliteration rates estimated from the size frequency distribution of rimmed and rimless craters in Noachian terrains.

Erosion rates have been previously estimated for different kinds of materials and different aged surfaces. Obliteration rates at the Viking 1 landing site, believed to be a volcanic plain, have been estimated to be $10^2$ to $10^3$ micrometers per year (6). Erosion rates are clearly much higher in other places, such as northwest of Isidis, where the etched appearance of the surface indicates that bedrock was once mantled with some easily erodible deposit that has been partly removed (7). Obliteration of craters can be accomplished by a variety of means, such as eolian erosion, eolian deposition, creep of near surface materials, and burial by volcanic or impact debris. Areas of upper Noachian or basal Hesperian age were located that are free of the effects of discreet local deposits, such as those around Isidis, and which are also flat and so not subject to surface creep. The intent was to isolate the effects of erosion and deposition by the atmosphere. Obliteration rates were estimated from the depths of the surviving craters.

According to Scott and Tanaka (8), 1200 craters>2 km in diameter have accumulated per $10^6$ km$^2$ since the base of the Hesperian. The floors of several large craters were found that preserved this basal Hesperian crater frequency distribution at least down to crater sizes of a few hundred meters. An example is shown in figure 1. The solid line is an extrapolation from 2 km to smaller diameters assuming a -3 slope. The depths of the craters were measured photometrically using the technique developed by Davis and Soderblom (9). Although there is variation from location to location, on depth to diameter plots the values tend to fall within a channel defined by two parallel lines as shown in figure 2. The upper line represents the dimension of the crater when first formed. The values assumed were those from Pike and Davis (10). The lower line simply encloses the data on the plot. As a crater becomes
progressively more obliterated they move vertically down the plot, so that the average obliteration rate can be estimated from the intersection of the lower line with the x-axis, and from the time since the base of the Hesperian, which by analogy with the Moon, is assumed to be 3.8 billion years. In the example given all craters 350 meters in diameter appear to have been preserved. The obliteration rate, a combination of rim erosion and crater filling, has been approximately 65 meters, giving an obliteration rate of 0.02 micrometers per year. Most of the 65 meters loss in the internal relief of the crater is likely to be due to filling by eolian debris.

Obliteration rates during Noachian times are estimated differently and more crudely. Crater counts were made of large highland areas, and the craters classified into rimmed and rimless. We do not know whether the observed population accumulated during the last 100 million years of the Noachian or the last 500 million years. From these limits, estimates can be made of the cratering rate at different diameter, and obliteration rates are estimated from the original rim heights from Pike and Davis (1984). The estimates ranged from 2 to 10 micrometers per year. Thus obliteration rates in the Noachian appear to be two to three orders of magnitude higher than during post-Noachian. The cause of this difference is uncertain but the presence of a thick atmosphere during the Noachian and general absence of a thick atmosphere later is a possibility.

References