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2 Acquisition and history of water on Mars

Michael H. Carr[†] *and James W. Head*[*]

[†]U. S. Geological Survey, Menlo Park, CA, USA
[*]Department of Geological Sciences, Brown University, Providence, RI, USA

2.1 Introduction

The purpose of this chapter is to summarize the geologic history of Mars and the role water has played in the evolution of the surface so that subsequent chapters on more specific topics can be viewed in a broader context. It focuses mainly on surficial processes such as erosion, sedimentation, and weathering, rather than on primary terrain-building processes such as impact, tectonism, and volcanism since surficial processes provide more information on surface conditions under which lakes could have formed. The role of liquid water in the evolution of Mars is puzzling. With a mean annual temperature of 215 K and a mean surface pressure of 6.1 mbar (Haberle et al., 2008) liquid water can exist at the surface only locally and temporarily under anomalous conditions. Yet geologic evidence for the widespread presence of liquid water is compelling, particularly for early Mars, and claims have also been made of present-day water activity. One of the outstanding unsolved problems of Martian geology is how conditions necessary for liquid water could have been so sustained at the surface on early Mars as to result in pervasive aqueous weathering and widespread formation of valley networks and lakes.

Martian surface features have been divided into three age groups—Noachian, Hesperian, and Amazonian—on the basis of intersection relations and the numbers of superimposed impact craters (Scott and Carr, 1978; Tanaka, 1986). Noachian terrains survive from the early heavy bombardment era. The era was named for the heavily cratered Noachis region, following the long-established terrestrial practice of naming eras after type localities. The rest of Mars' history was divided into two eras, the Hesperian named for Hesperia Planum and the Amazonian named for the younger Amazonis Planum. From estimates of Martian cratering rates as a function of time (Ivanov, 2001), Hartmann and Neukum (2001) estimated that the Noachian era ended around 3.7 Gy ago and that the Hesperian era ended around 2.9–3.3 Gyr ago. The date of the end of the Noachian is unlikely to be grossly in error, but the date for the Hesperian–Amazonian boundary could incorporate significant errors. Dating younger (<1 Gyr) terrains, where small craters must be used, is even more uncertain because of the nonuniform distribution of secondary craters (McEwen et al., 2005) and the possibility of a long-term decline in impact rates (Quantin et al., 2004).

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