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which likely resulted in the episodic and temporary presence of large bodies of water, particularly in the northern plains. The Valles Marineris, which appear to have largely formed by the end of the Hesperian, may have episodically contained lakes that drained to the east to form outflow channels. Many of the changes suggest a climate change at the end of the Noachian and start of the growth of a thick cryosphere, although the magnitude of the change and its cause remain unclear.

2.6 Amazonian era

The Amazonian Period extends from roughly 3 billion years ago, the middle of the terrestrial Archean, to the present, encompassing two-thirds of the planet's history. Despite the long time represented by the period, only a modest amount of geologic activity occurred, compared with earlier periods, and the extremely low erosion and weathering rates that typified the upper Hesperian continued (Golombek et al., 2006). Partly as a consequence of the low rates of terrain building, the effects of some surficial processes such as those involving ice and wind are more evident than those for earlier eras and perhaps the most distinguishing feature of the Amazonian is the abundant evidence for the action of ice, particularly at mid-to-high latitudes. Processes driven by obliquity variations are also more evident for this era although such processes likely occurred throughout all of Martian history.

2.6.1 Volcanism

Volcanic activity in the Amazonian was largely in, and peripheral to, Tharsis and Elysium, where the large shields continued to grow and lava plains continued to accumulate. However the eruption rate appears to have declined significantly. The eruption volumes estimated by Greeley and Schneid (1991) and the chronology of Hartmann and Neukum (2001) suggest that average eruption rates dropped from roughly 1 km^3 $year^{-1}$ in the Hesperian to roughly 0.1 km^3 $year^{-1}$ in the Amazonian. Most of the Amazonian volcanic plains are distinctively different from the earlier Hesperian plains. The earlier plains (e.g., the Lunae, Solis, Chryse, Hesperia, Syrtis Major, Hellas Plana) typically have numerous wrinkle ridges but few primary flow structures. In contrast, most of the Amazonian plains have few wrinkle ridges but numerous primary volcanic structures such as flow fronts, lava channels, and lines of skylights at the crests of lava ridges. Crater ages of tens of millions of years for volcanic surfaces in Tharsis and Elysium (Neukum et al., 2004; Berman and Hartmann, 2002) and crystallization ages as young as 150 MY from Martian meteorites (McSween, 2002) suggest that Mars is still episodically active, although at very low rates.

2.6.2 Ice

Ice likely played a significant role in modifying the landscape throughout much of Mars' history but its effects are most evident for the Amazonian. The possibility that extensive ice deposits were left in low areas after large Hesperian floods was