The geologic records of Mars and the Earth are very different. Most of the Martian geologic record, particularly that relating to liquid water, dates back to the Noachian and Hesperian, prior to 3 billion years ago, close to the middle of the terrestrial Archean. The record of liquid water from the Amazonian, which constitutes two-thirds of Mars' geologic history, is very sparse, although not absent, and restricted mainly to gullying of slopes, rare groundwater eruptions, and melting of ice. In contrast, most of the geologic record on Earth dates from after 3 billion years ago, the earlier record having been destroyed as a result of the much higher rates of geologic activity on Earth and surface conditions that enabled high rates of erosion and weathering.

2.2 Acquisition and retention of water

Excess ^{182}W in Martian meteorites indicates that Mars' core formed remarkably quickly, within 20 million years of Solar system formation, and the 4.53 Gyr age of ALH84001 shows that at least some crust formed within a few tens of millions of years (Borg et al., 1997; Lee and Halliday, 1997). Rapid core formation and estimates of present average crustal thickness of several tens of kilometers (Zuber et al., 2000) place constraints on thermal evolution models. According to Hauck and Phillips (2002), heat flows would have peaked at 60–70 mWm^{-2} around 4.4 Gyr ago and then declined almost linearly to a present value of not more than 10–20 mWm^{-2}, and possibly much lower, as suggested by the lack of flexure of the lithosphere under the present polar loads (Johnson et al., 2000; Phillips et al., 2008). According to the Hauck and Phillips model, by 4 Gyr ago over 70% and possibly considerably more of the crust would have accumulated. They also conclude that the mantle must have been wet and that delivery of water and other volatiles such as sulfur to the surface by volcanism during and subsequent to this early era could have affected surface environments.

One of the more surprising results of the MGS mission was the discovery of large magnetic anomalies, mostly in the southern highlands (Acuna et al., 1999; Connerny et al., 1999). Anomalies are mostly absent around the large, easily recognizable impact basins. The simplest explanation is that pre-Noachian Mars had a magnetic field that left large anomalies that were subsequently destroyed in and around impact basins such as Hellas, Utopia, Argyre, and Isidis (Solomon et al., 2005 and references therein). Some of the anomalies in the southern uplands are striped, drawing comparisons with terrestrial seafloor features (Connerny et al., 1999), although there is no geomorphic evidence for plate tectonics. Nimmo (2000) alternatively suggested that the anomalies may be due to the presence of deep dike swarms.

The amount of water acquired during accretion and subsequently outgassed and retained at the surface to participate in geologic processes is very uncertain. It depends, among other things, on the mix of meteorites and comets that accreted to form the planet, which has been estimated from modeling the mix of meteoritic materials required to reproduce the global composition of Mars inferred from the