Evidence for a Second Martian Dynamo from Electron Reflection Magnetometry

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A global dynamo-driven magnetic field at Mars can shield the atmosphere from erosion by the solar wind. Atmospheric pressure affects temperature and the stability of surface water. Thus the history of the Martian core dynamo is closely linked to the history of surface habitability.

Using the technique of electron reflection magnetometry, we investigate the magnetic anomaly signatures of 20 Martian volcanoes. Most show magnetic lows characteristic of thermal demagnetization of crust in the presence of no significant global field. However, one of the oldest volcanoes, Hadriaca Patera, appears to be a magnetic source, suggesting thermoremanent magnetization in the presence of a substantial ambient field following its last major period of magmatism. We compare the relative ages (according to the Hartmann & Neukum cratering time-scale) and magnetic signatures of these 20 volcanoes and 7 giant impact basins and conclude that, ~300 Myr after the cessation of an early dynamo, a second dynamo episode may have started around ~3.85 Gyr ago and lasted for 150-400 Myr. See figure below.

This additional period of magnetic shielding may have helped to maintain a substantial atmosphere for a longer period than previously thought, thus impacting the climate and conditions for life on early Mars.

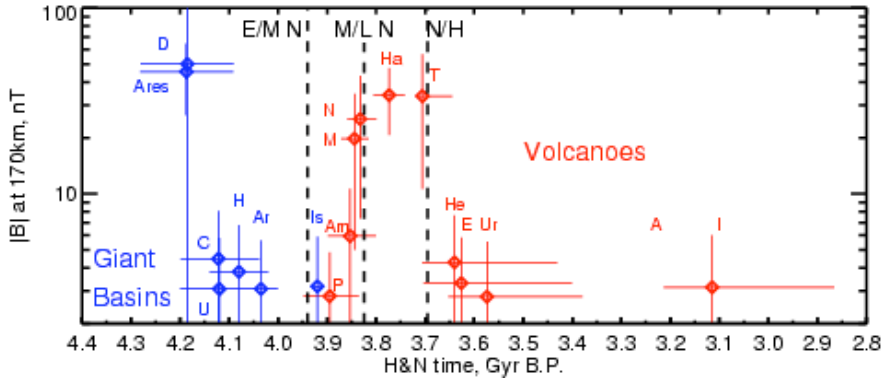

Figure 1: Magnetic signatures of 7 giant impact basins and the 10 oldest volcanoes plotted against Hartmann & Neukum age with crater-counting uncertainties. The implied second dynamo epoch occurs from ~3.85 to 3.7-3.45 Gyr ago.