PALEOMAGNETIC POLE POSITION OF MARS REVISITED. Daniel Boutin and Jafar Arkani-Hamed, Earth & Planetary Sciences , McGill University , Montreal , Quebec , Canada.

Mars has become a one-plate planet since at 4 Gyr. ago, and no pervasive tectonic activities have occurred since, except for giant impact basins such as Hellas, Argyre and Isidis. Small impact craters have only modified upper portions of the crust. The large scale tectonics of Mars possibly occurred in the early history of the planet, before it became a one-plate planet, are more likely preserved in the areas far from the giant basins. These large scale features are expected to resemble the tectonics features of Earth in the Hadean and Early Archean which have been removed by the plate tectonics of the Earth. Studying the tectonic pattern of Mars may provide good information about that of the early Earth.

There is good evidence that the magnetic anomalies of Mars arise from deep seated magnetic source bodies. Some of the anomalies could be related to large scale tectonic features. The continental scale aeromagnetic maps of Earth provide good information about the regional tectonics. Distinct negative magnetic anomalies are associated with continent-continent collision zones. For example, the aeromagnetic map of the Canadian shield delineates the Thelon and Grenville suture zones as prominent negative magnetic areas. The Thelon suture is the zone of collision of Slave province and Superior province that occurred about 1.4 Gyr. ago, and the Grenville suture is that of Grenville province and Superior province occurred about 0.9 Gyr. ago. The continent-continent collision has thickened the crust and suppressed the highly magnetic lower crust into the mantle and thus thermally demagnetized it permanently. We upward continued the magnetic anomaly map of eastern Canada that includes the Grenville suture zone to different altitudes. The suture zone retains its prominent magnetic signature at 100-200 km altitudes, similar to the altitude of the aerobreaking and science phase magnetic data of Mars . But the magnetic signature is almost lost at 400 km altitude, which is the altitude of mapping phase magnetic data of Mars.

Before indulging in detailed modeling of the strong and complex magnetic anomalies of Mars, it is desirable to estimate the magnetization direction of their source bodies. The interpretation of the satellite magnetic anomalies of the Earth is facilitated because major magnetic anomalies arise from strong magnetic sources in the lower crust that are induced magnetized at the presence of the core field, and thus the direction of their magnetization is parallel to the core field. This is not, however, the case for Mars. The Martian magnetic source bodies carry remanent magnetization of unknown direction and intensity. The interpretation of the Martian magnetic anomalies is doubly non-unique. Attempts have been made to associate some of the radial magnetic anomalies of Mars with geological features assuming that the source bodies are vertically magnetized [Purucker et al.,2000; Raymond and Smrekar, 2001; Smrekar et al., 2002]. The magnetizing core field, however, was likely non-vertical over the majority of the Martian surface.

The independent modeling results support the possibility that the axis of the core field was considerably different from the present rotation axis. To estimate the direction of the Martian core field, Arkani-Hamed [2001a] modeled 10 isolated small magnetic anomalies using vertical prisms of elliptical cross sections. The anomalies were extracted from the 50-degree spherical harmonic model of the magnetic field [Arkani-Hamed, 2001b]. The strong and complex magnetic anomalies of Terra Cimmeria and Terra Sirenum were avoided because the large and complex satellite magnetic anomalies at high altitudes largely arise from combination of magnetic anomalies of many small and irregular bodies. The paleopole positions calculated from the magnetization of the source bodies were mainly clustered within a circle of 30 degree radius centered at 225E and 25N. One of the ten anomalies was also modeled by Hood and Zakharian [2001] using a completely different technique that resulted in a pole position very close to the one by Arkani-Hamed. Hood and Richmond [2002] modeled another anomaly at south latitudes and the related paleopole position again falls inside the circle.

We use the areobreaking and science phase data obtained within 100-200 km altitudes and the mapping data acquired at about 400 km altitude to reassess the paleomagnetic pole positions. Rather than extracting data from a spherical harmonic model, we use all three components of the orbital data and directly model them using vertical prisms of elliptical cross section, similar to the prisms used before. Many of the new pole positions agree, but not identically, with the previous results. We will discuss the method we used, and implications of the paleopole positions on the crustal magnetization and on the polar wandering of Mars.

References: [1] Arkani-Hamed, J., Geophys. Res. Lett., 28, 3409-3412, 2001a. [2] Arkani-Hamed J., J. Geophys. Res., in press, 2001b. [3] Hood, L.L., and N. Richmond , LPSC XXXIII, abstracts 1128, LPI, Houston, 2002. [4] Hood, L.L., and A. Zakharian, J. Geophys. Res., 106, 14601-14619, 2001. [4] Purucker, M., D. Ravat, H. Frey, C. Voorhies, T. Sabaka, and M. Acuna, Geophys. Res. Lett., 27, 2449-2452, 2000. [5] Raymond, C.A., and S. Smrekar, LPSC XXXII, abstracts 2178 , LPI, Houston, 2001. [6] Smrekar, S., C.A. Raymond, and G.E. McGill, LPSC XXXIII, abstracts 2065, LPI, Houston, 2002.