MAGNETIC DETECTION OF LARGE MAGNETIC FIELDS THAT OCCURRED DURING THE VREDEFORT IMPACT, IMPLICATIONS FOR MARS MAGNETIC ANOMALIES . G. Kletetschka[1,2,3], and T. Adachi[1,2], [1]Catholic University, Physics Department, Washington DC, USA, Kletetschka@nasa.gov, [2]GSFC/NASA, Code 691, Greenbelt, 20771, USA, [3]Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic.

Introduction: Margnetic anomalies on Mars generated interest about the impact related magnetization processes. Magnetic studdies on rock specimens from Vredefort crater revealed centimeter scale volumes with intense remanent magnetizations that were randomly oriented in respect to each other [1]. Magnetic grains carrying this magnetic remanence crystallized during the impact [1]. Random orientation causes an absence of large scale magnetic signature over the Vredefort crater and by analogy, may also be responsible for absence of magnetic anomalies on Mars inside the large impact craters opening the possibility for global magntic field on Mars during the formation of large impact craters [1]. We found that portions of these rocks are unusually strongly magnetized, reaching almost saturation level while other portions were virtually demagnetized compared to the magnetization expected from rock forming inside the geomagnetic field during the regular terrestrial rock forming processes. The unusual nature of the magnetization of these rock requires large magnetizing field. We performed magnetic scans over the surfaces of the rock specimens affected by the impact. Magnetic scans over the rock polished surfaces and/or thin sections under different fields gives not only information about the susceptibility distribution over the rock, separation of induced and remanent components of magnetizations, but also can map the magnetization efficency of various rock segments. Even-though the scans were performed with just a vertical component sensor, the nature of magnetization in the samples allows us to determine direction and amplitude of the magnetization volumes within the specimen.

Novel Technique: NASA Goddard Code 691 provided the Magnetic Properties lab previously used for magnetic testing and imaging of the microshutter arrays for James Web Space telescope. Imaging equipment is being used for the described Vredefort rock magnetic imaging.

We take advantage of the close proximity of a Hall sensor probe surface (0.125mm) allowing submilimeter resolution scans with sensitivity resolution better than 10 nT. The Hall sensor is brought into close proximity to the surface and laterally scanned. In order to test the new method we magnetically scan the central portion of the dollar bill (Figure 1). The first scan (A.) shown the natural magnetization and depicts an inverse image indicating original magnetization distribution. After the image was saturated with the field parallel to the positive sensor reading, the image acquired a positive appearance (Figure 1 B). The image resolution appears to be more than an order of magnitude better than similar magnetic scanning using giant magnetoresistance sensors. [2]

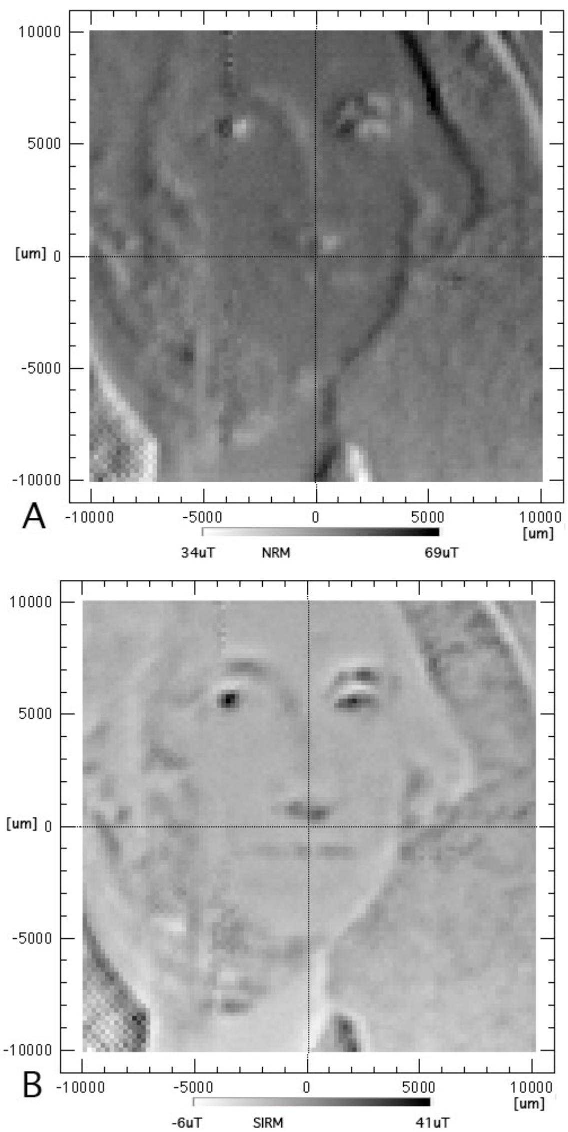

Figure 1: Novel magnetic scans of the central portion of the one dollar bill. Left: The one dollar bill contains natural remanent magnetization (NRM Middle: Magnetic scan image after we applied saturation magnetization (SIRM) to the bill parallel to the ambient field.

Results: Figure 2 shows magnetic scans over the Vredefort granite gneiss sample. The top image is representation of natural remanent magnetization (NRM) while the bottom image shows saturation isothermal remanent magneitzation (SIRM).

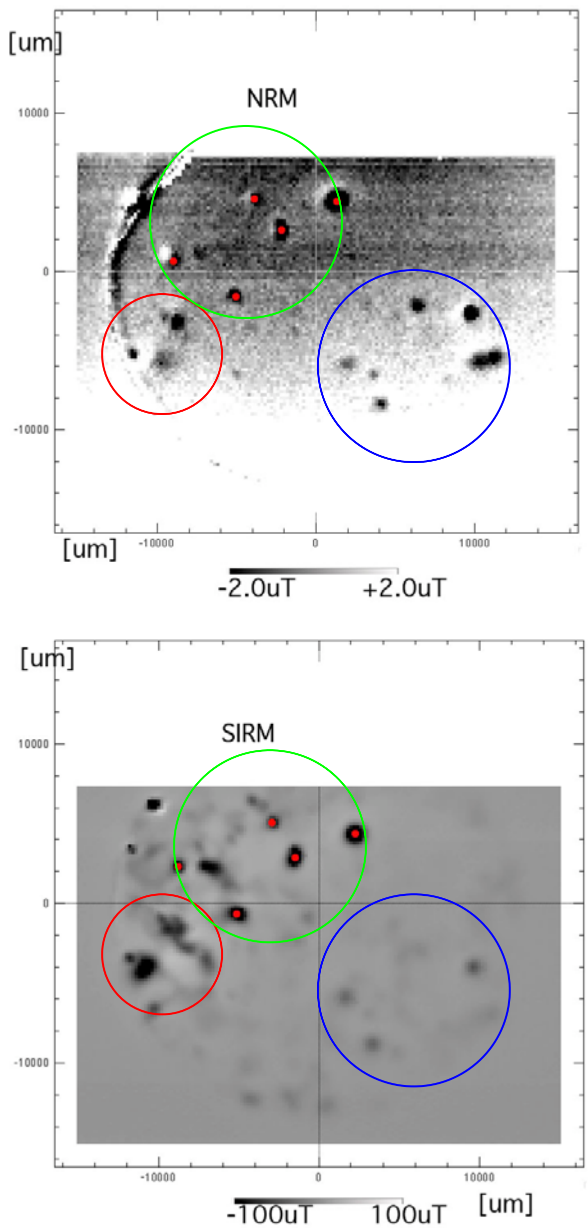

Figure 2: Magnetic scan over (0.2 mm) a flat section of the Vredefort granite gneiss specimen. Top: Vertical component of natural remanent magnetization (NRM), Bottom: Vertical component of saturation isothermal remanent magnetization (SIRM).

Note that the magnetic scale of the NRM scan is adjusted to be 2% of the magnetic scale of the SIRM image. This is because most of the rock that are formed within geomagnetic field acquire ~2% of their saturation remanence [3]. Therefore the similar magnetic intensities (dark color) on both images would correspond to the magnetic grains that formed similarly like magnetic grain in ordinary terrestrial rocks (green circles). However magnetic grains shown in the blue circle indicate that these grains were magnetized more efficiently that regular rocks and therefore may relate to strong magnetic fields that formed during the impact. Finaly the magnetic grain shown by red circles indicate magnetic grains with the original intensity smaller than expected and may represent demagnetization during the impact. The three distinctive regions are apart on cm scale, consistent with observation in [1].

Conclusions:

Novel method allows finding microscopic volumes that were magnetizaed with contrasting magnetic efficiency. The method depicts cm scale volumes of the granite gneiss that were magnetized during the Vredefort impact. Data suggest a presence of large cm-scale magnetic fields during the impact and large cm-scale currents associated with the impact.

Acknowledgement: We thank Robert Hart for providing the rock specimens (granite gneiss) from the outcrops inside the Vredefort crater.

References: [1] Carporzen L., Gilder S. A. and Hart R. G. (2005) *Nature, 435,* 198-201. [2] Uehara M.and Nakamura N. (2007) *Review of Scientific Instruments., 78,* 043708. [3] Kletetschka G. et al. (2003) *Meteoritic & Planetary Science*, 38(3), 399-406.