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Large impact demagnetization on Mars

B. Langlais (1), E. Thébault (2) and Y. Quesnel (3)

(1) UMR CNRS 6112, Laboratoire de Planétologie et de Géodynamique, Université de Nantes, 2 Rue de la Houssinière, 44000 Nantes, France; (2) CNRS UMR 7154, Laboratoire de Géomagnétisme et Paléomagnétisme, Institut de Physique du Globe de Paris, 4 Place Jussieu, 75005 Paris, France; (3) GeoForschungsZentrum, Potsdam, Germany

The largest Martian impact craters Hellas, Argyre, Isidis, Utopia are not associated with magnetic field signatures at spacecraft altitude. This is usually interpreted as locally non- or de-magnetized areas. Large impactors may reset the magnetization of the pre-impact material. It is thought that these impacts took place after magnetic dynamo had shut down, because post-impact material did not acquire a new magnetization. A careful analysis of the magnetization contrasts between large impact craters and their surrounding terrains should lead to a relative timing of when the Martian dynamo died out. The first step is to evaluate the impact demagnetization signatures. We assume the demagnetization to be restricted within the excavation area. Pre-impact lithosphere acquired its magnetization while cooling in the presence of a global, axial magnetic field. As a consequence, magnetization directions and intensity are not constant. Large craters, between 100 and 400 km diameter, are simulated at different locations. Depth-to-diameter ratio of the transient craters is set to 10%. Associated magnetic field signature is computed between 100 and 400 km altitude. For a single-impact event, the maximum magnetic field anomaly will be associated with a crater located over the magnetic pole. A 200-km diameter transient crater will have an 8 nT signature at 200 km altitude, while a 100-km diameter crater will be associated with a 3 nT signal at 150 km altitude. We compare these predictions to the 400-km altitude Mars Global Surveyor magnetic measurements. A complete low-altitude magnetic field mapping is needed, such as the one provided by ‘Mars Escape and Magnetic Orbiter’ (MEMO). These new data will allow such weak signatures to be better characterized; they will bring new constraints on the timing of the Martian dynamo and on Mars’ evolution.