EARTH's CRATER MAGNETIC ANOMALIES AND RECENT ADVANCES IN LUNAR AND MARTIAN MAGNETISM. M. Yu. Kuzmicheva[1], [1]Institute of Geospheres Dynamics RAS (Leninsky prospect 38, bld. 1, 119334 Moscow, Russia, kuzm@idg.chph.ras.ru, mukuzmgm@gmail.com).

Introduction: Recent years' mapping of orbit magnetic field observations of Mars and Moon from Mars Global Surveyor (MGS), Lunar Prospector and Kaguya provokes investigations of ancient core dynamos, ancient polar wanders, natures of crustal magnetic anomalies, its weathering and interaction with the solar wind [1, 2].

Martian crustal magnetism: Large impacts (> 300 km in diameter) alter the magnetization of the entire depth of the crust over an area comparable to the final size of the crater. Mars' lack of a global magnetic field and hence induced magnetization, thus remove a substantial complication from the interpretation of impact magnetic signatures. Mars does not currently possess a core dynamo- driven magnetic field, but evidence of strong crustal magnetization implies but such a field is certain to have existed in its early history comparable in strength to that at the Earth's surface. The oldest basins on Mars were magnetized and were deemed to have model ages between 4.1 and 4.3 Ga. Some of craters (with diameters >1000 km, Hellas, Utopia) are almost totally demagnetized in limits of their diameters, so the most likely scenario was a dynamo active when the oldest detectable basins formed, ceasing before Hellas and Utopia impacts after 4.1 Ga and not thereafter restarting. The Mars atmosphere was thereafter exposed directly to erosion by the solar wind, significantly altering the path of climate evolution, particularly fluvial erosion was altered by aerial erosion [3, 4].

Lunar crustal magnetism: Lunar crustal magnetic fields were detected by Apollo satellites and magnetometers on the surface. The Moon once had a long-lived global magnetic field with Earth-like field strengths. Magnetic sources of the moon crust are generally located at 10-20 km depths, where they could have formed in the presence of a core-generated magnetic field. The magnetic anomalies in the South Pole – Aitken basin are associated with magnetic sources close to the surface. The absence of near-surface magnetic sources is likely a result of impact-related shock demagnetization processes that occurred early in lunar evolution [5]. Thus, the impact-related shock de(re-)magnetization is an important process of a magnetic field history.

Impact-related magnetic processes: As known a crater-forming impact alters the magnetization of the crust by way of excavation and mixing of target material, by thermal demagnetization (and following re-magnetization if possible), by shock demagnetization. For ancient Mars shock demagnetization prevailes while a contribution from heat and excavation is less [4].

Heated in the impact, magnetic minerals in the crust cool below their Curie temperatures and acquire a thermo-remnant magnetization (TRM) with a magnitude proportional to the strength of the ambient magnetic field. Magnetic materials can be magnetized in an external magnetic field through shock remnant magnetization (SRM). Existing magnetization can be reduced or erased if the minerals are shocked in an ambient field too weak to induce a sufficient SRM. Post-impact hydrothermal system can lead to further TRM and/or the acquisition of chemical remnant magnetization (CRM).

Corresponding to the Earth: On the Earth impact sites show, in general, a negative magnetic anomaly [6], caused by a depletion of magnetic carriers in rocks, while melt sheets and melt-bearing breccia acquire an enhanced magnetization. Numerical simulations are quite successful reproducing the crater morphology, but it was not yet possible to model the negative anomaly [7]. Further investigation of excavation and post-impact processes should be performed.

References:

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