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Rock magnetic properties of drill core LOC-9 from the Lockne crater, Sweden

Irene Melero Asensio (1), Fátima Martín-Hernández (2), and Jens Ormö (1)
(1) Centro de Astrobiología (INTA-CSIC), Spain, (2) Universidad Complutense de Madrid, Spain (Avda. Complutense s/n)

: The Lockne crater is a 456 Ma old marine-target impact structure. It is concentric with a 7,5 km wide inner crater developed in the crystalline basement which is surrounded by a 3,5 km wide brim where the crater excavation removed most of sedimentary cover rocks before it was covered by the ejecta flap from the basement crater. The Lockne crater has been subject to several geological and geophysical studies including magnetic modeling based on aeromagnetic data. The magnetic modeling was restricted to the use of only measured values of the induced magnetization (i.e. magnetic susceptibility) for the geological bodies in consideration. Remanent magnetization as a contribution to the total signal was ignored for simplicity based on scientific argumentation.
Here, we provide a precise analysis of the rock magnetic properties, including characterization of the magnetic phases and identification of them for the different lithologies of the LOC-9 core. This is a 31,04m long and 42mm diameter core drilled into the crystalline crater brim and ejecta flap. Its location makes it ideal to study the features of the flap formation.
A visual core log was performed. This showed the ejecta flap at this location to be mainly a brecciated basaltic rock with some blending with dark shale just at the contact between the ejecta and the more intact granitic basement.
A complete rock magnetic characterization was carried out, including low-field magnetic susceptibility, hysteresis loops, isothermal remanent magnetization (IRM) acquisition curves, coercivity spectra derived from IRM acquisition curves, back field IRM demagnetization curves and thermomagnetic curves. Additionally, we made a compositional analysis from one magnetic extract by means of Scanning Electron Microscopy Energy-dispersive X-ray (SEM-EDX) in order to identify the dominant magnetic fraction of each mineral. For more mineralogical detail, thin sections from representative lithologies are currently being analyzed.
Low-field susceptibility values were obtained along the core by a portable SatisGeo KT-6 field kappameter. The values range between -0.1E-03[SI] and 58.2E-03[SI]. Negative susceptibility values correspond to diamagnetic minerals occurring in the crystalline basement below the flap. Most of the susceptibility values of the whole core fall in the interval between 0 and 1E-03[SI].Some sections of the basaltic ejecta have higher values. The susceptibility profile as a function of depth shows a significant increase in the interval between 11 and 14 m approximately.
Magnetite, titanomagnetite and goethite have been identified based on the thermomagnetic curves, the saturation magnetization measured in the hysteresis loops, and the IRM acquisition curves. Pyrite is indicated by the thermomagnetic curve of one sample. Additionally, the coercivity spectral analysis has shown one main magnetic component that dominates the magnetic signal in the depth level where the highest susceptibility values are observed. This suggests that the process of formation of the magnetic phases related with the highest magnetic values of the core is not post-depositional diagenesis, hydrothermal alteration or other rock metamorphism affecting the ejecta after its deposition. Instead, it suggests that the observed magnetic signal of the ejecta already existed before the ejecta emplacement.
The summary of the hysteresis parameters depending on the domain state for titanomagnetite particles is represented by Day plot. Some near surface parts of the ejecta basalt fall inside a theoretical pseudo-single domain zone. There is a downwards gradual increase to a multi-domain zone. The existence of pseudosingle domain particles that potentially can retain a stable remanent magnetization should be considered in any precise magnetic modeling of this section of the crater rim.