Demagnetization of rock as an evidence of extraterrestrial impact (Acraman and Santa Fe impact structures)

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Introduction: Impact cratering is a unique energetical process that shapes solid planetary surfaces in our universe. Here on Earth the surfaces modified by impacts are quickly disappearing due to large surface mobility caused by weathering and erosion, driven by occurrence of life on Earth, precipitation, and plate tectonics. While there are many features on Earth surface that can be interpreted as due to an extraterrestrial impact, there are only few tools that allow providing a supporting evidence for terrestrial impact origin. These are PDFs (planar deformation features, mostly observed in quartz crystals), and shatter cone fabric (observed in outcrop scale). While there are additional potential observation features that are commonly associated impacts (microspherules [1], micro/nano diamonds [2], high temperature melting [3], gravity surface morphology [4]) these are not unique and may be related to processes other than impact. Recent work on Santa Fe structure has pointed out a potential novel feature, plasma assisted demagnetization, that may be considered as a unique terrestrial impact indicator [5].

Data and method: Acraman crater in South Australia is about 80 km in size and was reported to contain both PDFs and shatter cones. While it is considered to be deeply eroded, the Acraman crater has a clear expression of the crater center and crater's rim. Acraman crater center contains shattered granitic red rocks whose shattered pattern degrades with the distance from the crater center. Samples from the outcrops with shattered pattern were collected for paleomagnetic analysis.

Results: Samples that experienced an impact were fragmented by non-magnetic tools and prepared for paleomagnetic measurements. Samples' natural remanent magnetization (NRM) was measured and demagnetized. Than the samples were magnetically saturated in 2 T pulsed magnetic field and demagnetized in the same steps as samples' NRM. All shocked samples were originally magnetized to <1% of its saturation magnetization.

Discussion and conclusions: Acraman shocked samples showed a similar level of demagnetization as shocked rocks from Santa Fe impact structure [5]. This observation supports that at the time of shock and magnetic remanence destabilization, the rocks were shielded from the geomagnetic field exposure by inflating ionized plasma structure, expanding over the impact site, and producing electric currents that compensated the geomagnetic field. Acraman crater samples' demagnetization level supports an existence of new tool for extraterrestrial impact presence, this is that the demagnetization of rocks that experienced shock from an impact of extraterrestrial body can be used as a unique indicator of extraterrestrial impact.

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