NRM MEASUREMENTS OF SHATTER CONES AND RIM DEPOSITS FROM THE SIERRA MADERA IMPACT CRATER IN TEXAS, USA (Preliminary)

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10th Castle Meeting, Valtice, Czech Republic, Sept. 3-8, 2006

Demagnetization by shock?

Terrestrial rocks with Thermal Remanence Magnetization (TRM) and Chemical Remanence Magnetization (CRM) have the efficiency expressed by the ratio of Natural Remanent Magnetization (NRM) divided by Saturation Isothermal Remanent Magnetization (SIRM) called REM (ratio of efficiencies for remanence acquisitions), (Fig. 1) of between 0.01-0.02 proposed by *Wasilewski (1977)*, and *Kletetschka et al. (2003)*. *Dickinson & Wasilewski, (2000)* suggested creations and destructions of magnetic remanence by shock events in iron particle in extraterrestrial rocks.

Impact experiments on various minerals discussed by *Kletetschka et al. (2004)* suggested a significant reduction of initial magnetization in impact pressures as low as 1 GPa. Consequences of this demagnetization is a lower efficiency of REM. We show the initial data acquired from Sierra Madera Impact Crater shatter cone, impact breccia, and rim carbonate deposits that indicate the reduction/demagnetization of NRM in the shatter cone samples.

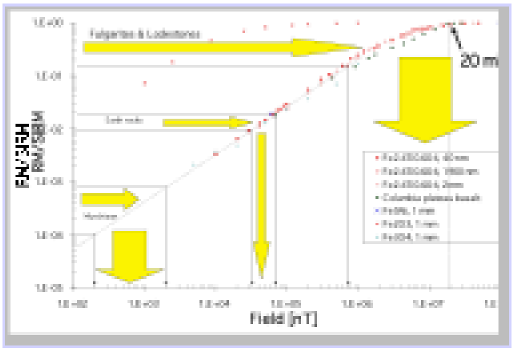
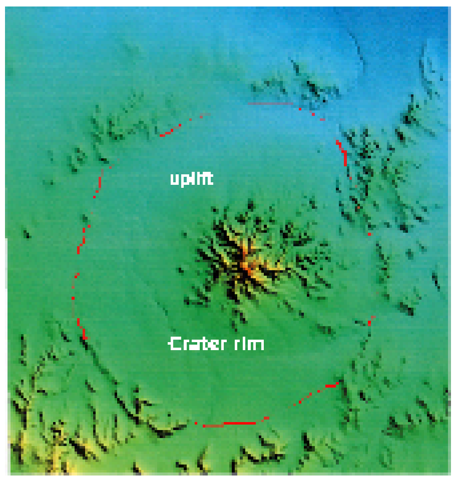


Fig. 1: Efficiency plot adopted from (*Kletetschka et al., 2003*) show the terrestrial efficiency of 0.01-0.02 correspond the geomagnetic filed.

Sierra Madera Impact crater, Texas, USA

The Sierra Madera Impact crater is located in Texas USA (Latitude: N 30 36', and W102 55'), and its diameter is 13 km, the target rocks are carbonates (calcite, dolomite, and carbonates breccia), and the age was estimated less than 100 Ma. The shatter cone, breccia, and rim samples were collected in the slope of central uplift, middle, and rim of the crater respectively.



Digital Elevation Model (DEM) of Sierra Madera impact structure showing central mountains and raised rim (red outline). Diameter of rim is 6 miles. Crest of the Central Uplift is 4583' above sea level. DEM compiled by Matthews from four 7.5' quadrangles. Adopted from: http://www.utep.edu/Geol/GeologicalResources/West_Texas_Geology/links/sierra_madera_azoo.htm

Method

Sub-samples were cut out from the collected rocks (Fig. 2A and B), and NRM was measured, and the samples were demagnetized by alternating field for 2, 4, 8, 15, 30, 60, 120, 240 mT. The demagnetization process was repeated after the samples were saturated for 2 T to obtain SIRM. Then the REM ratio was calculated and plotted (Fig. 3). During the measurements, the shatter cone axis were oriented parallel to the Z-axis to see for any trend, and the magnetization directions were plotted in equal area stereonet (Fig. 8 and 9)

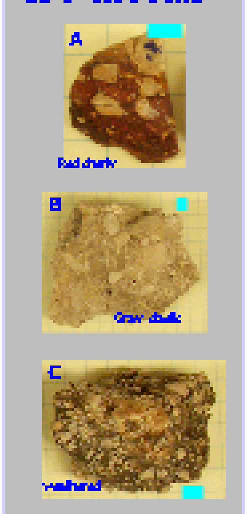
Fig. 2A: fine

Fig. 2B: coarse

Results

Our measurements of the shatter cone samples show the cone efficiency is 0.5% (Fig. 3A). These values are lower than the terrestrial efficiency (Fig. 7) and we interpret this to be demagnetization of the original remanence by impact. On the other hand, the impact breccia (Fig. 3C) show the typical terrestrial rock efficiency of 0.02 related to terrestrial magnetic acquisition. This 0.02 efficiency indicates a post magnetization as TRM/CRM the breccia acquired after the impact shock. The red cherty breccia CB4 show high REM values, this may associate with post or during shock alteration by heat and suggest TRM acquisition. Suite of rocks from Santa Fe shatter cone rocks (Fig. 6) are also metamorphosed granite, dyke, mica schist and gneiss, these samples show a different trend both in REM and direction (Fig. 3D and 9). The Fig. 7 show the low REM values for the limestones from various places, and that suggest careful analysis for determining the presence of shock demagnetization however.

Fig. 5: Sierra Madera Breccia



Scale bar: 5mm

Conclusion

Lower efficiency of REM (Fig. 3) and stable direction of magnetization (Fig. 8 & 9) of the rocks with shatter cone structure (A1, A2, A3, A5, B1, B7) indicate a shock demagnetization. The relatively unidirectional magnetization may correlate with the shatter cone axis, however this need more data to validate. The target rocks of Sierra Madera Impact Crater was a marine carbonate deposits and the lower efficiency may also suggest Depositional Remanence Magnetization (DRM), however the presence of the shatter cone structure will indicate the overprinted magnetization by the impact. Orientation in the rim calcite deposits was unknown, though when the rock was cracked open a shatter cone structure was observed. The anomalous behavior of the Santa Fe samples may indicate shock and different mineralogy (carbonate vs. alumino-silicates). Also notably remarks here is that very intricate shatter cone structures were observed in some samples, and this may contribute to the anomalous behavior.

Fig. 6. Santa Fe shatter cone structure in granite; A: large shatter cone structure, B: layers of shatter cone structure.

Fig. 3

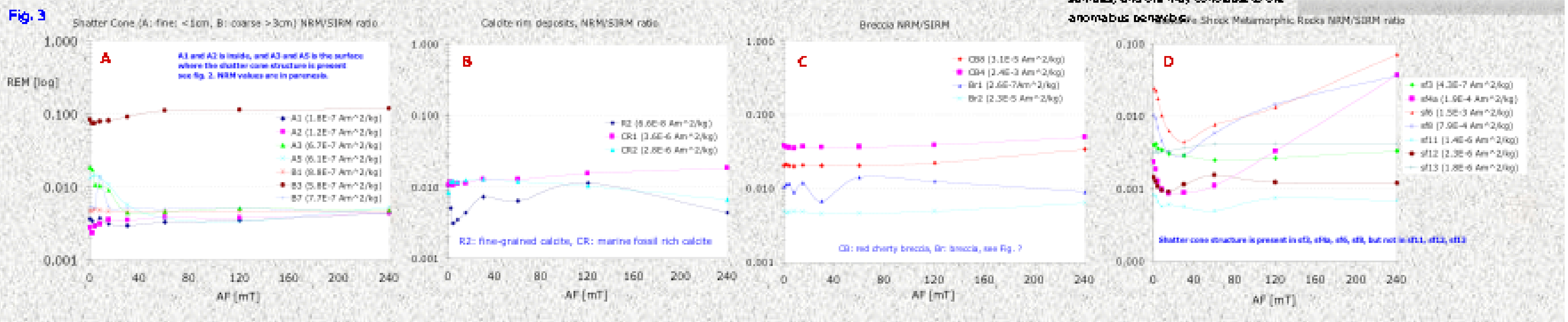
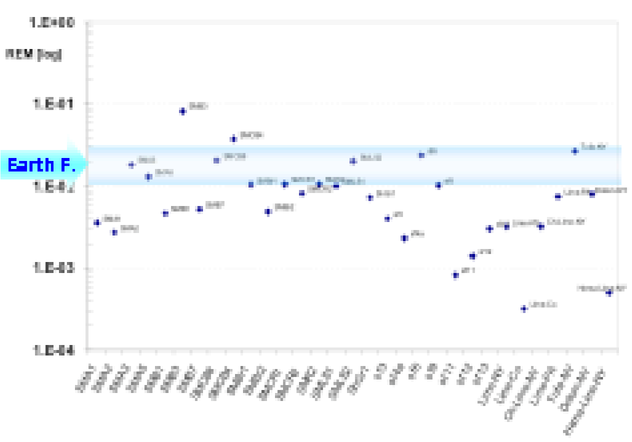


Fig. 7. REM values for our samples and other limestone



Stereonet Plots (Right): The magnetization direction plotted in Fig. 8 and 9 show the overprint of impact for shatter cone A, and some other samples. The unidirectional magnetization direction of the shatter cone samples also supports our interpretation for the impact demagnetization of shatter cone.

Fig. 8.: Magnetization direction plotted in stereogram

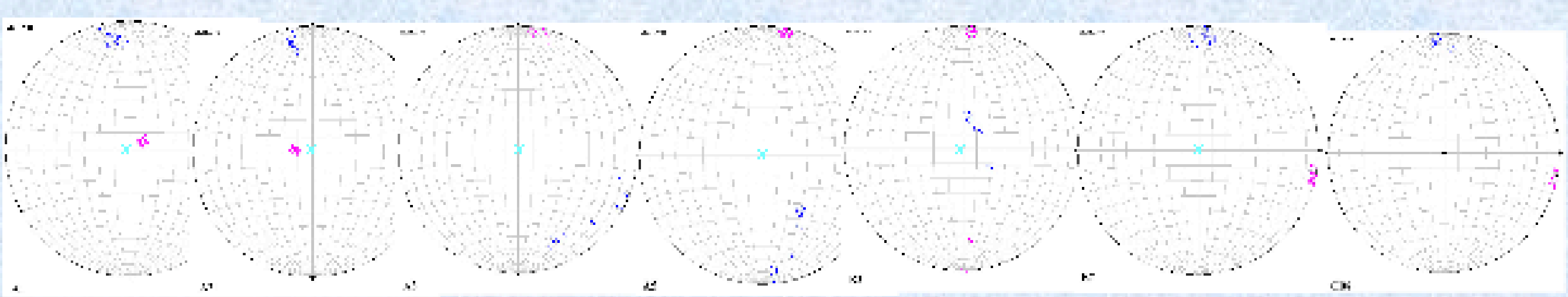
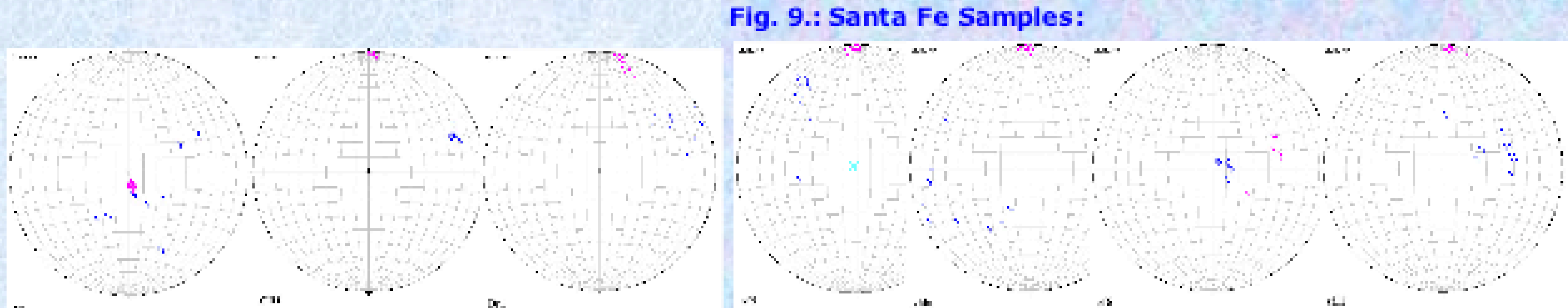


Fig. 9.: Santa Fe Samples:



X indicate the shatter cone axis parallel to Z-axis.

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Acknowledgements

We thank to Tomas Kohout for his help and discussion during the sample collection in Sierra Madera, TX and Santa Fe, NM sites.