Paleomagnetic investigations of the Decaturville, MO and Sierra Madera, TX impact structures. S.A. Dulin[1], R. D. Elmore[1], Devin P. Dennie[2], Stacey C. Evans[1], Patrick Mulvany[3]. [1]University of Oklahoma, School of Geology and Geophysics, Norman, OK. [2] Devon Energy, Oklahoma City, OK. [3] Missouri Department of Natural Resources, Rolla, MO. Email: sdulin@ou.edu.

Introduction: Many age-dating techniques have failed to yield tightly constrained ages of impact events, and stratigraphic dating is often the only constraint used to determine the time of impact. In this study we are testing if a modified paleomagnetic conglomerate test on impact breccias, in conjunction with geochemical/petrographic studies, can be used to constrain the timing of the impacts and determine the origin of carbonate breccias. We report results from breccias at two impacts, the Decaturville structure in Missouri and the Sierra Madera structure in Texas.

The Decaturville impact structure is a documented impact crater 5.5km across and located ~15 miles south of Camdenton, Missouri. Stratigraphic constraints indicate that the impact occurred between the Pennsylvanian and Cretaceous [1]. A paleomagnetic study of breccias near the outer rim of the crater indicates that the breccias contain a chemical remanent magnetization (CRM) with southeasterly declinations and shallow inclinations that resides in magnetite and that the breccias fail the conglomerate test. The pole indicates that the impact can be no younger than Early Permian [2]. Recently the central uplift of the crater was made available for sampling. Thirteen paleomagnetic sites in fine-grained impact breccias as well as carbonate beds containing shatter cones were sampled and have undergone thermal demagnetization to isolate any remanent magnetizations present in the rocks. Sampling was undertaken in order to conduct a modified conglomerate test on the breccias, and to compare the results with the previous study [2] which was located ~2km to the east of the central uplift.

The Sierra Madera impact structure is a 13km diameter exhumed complex impact crater in Pecos County, Texas. The timing of the impact is stratigraphically constrained as < 100 Ma [3]. The impact deposits are composed of both monolithic and mixed carbonate/siliciclastic breccias. Paleomagnetic cores were taken in both breccias and impact-deformed country rock to understand timing and origin of the magnetizations in the structure. Similar to the Decaturville study, a modified conglomerate test was performed so that the timing of magnetization with respect to the impact can be determined.

Methods: New paleomagnetic **s**amples of the Decaturville breccias were collected (13 sites, 8-10 samples per site) as well as one bed of carbonate that displayed shattercones, all within the central uplift of the structure. Stepwise thermal demagnetization and rock magnetic studies to determine magnetic direction and magnetic carriers, respectively, are ongoing. Samples were taken of the impact breccias and the breccia matrix within the central uplift of the Sierra Madera crater. All samples were subjected to stepwise thermal demagnetization and rock magnetic analysis is currently being undertaken.

Results: Preliminary analysis of the new Decaturville specimens indicates that most specimens have a very weak natural remanent magnetization (NRM). A modern viscous remanent magnetization (VRM) is generally removed at low demagnetization temperatures (<250°C) but without stable decay at higher temperatures. Based on the preliminary analysis, only one site of the 13 collected within the central uplift shows a stable magnetization, with southerly declinations and shallow inclinations. This late Paleozoic magnetization should be considered preliminary, as more samples from that site must be thermally demagnetized. Petrographic and rock magnetic analysis is currently underway to determine if the other breccia samples do not contain magnetic minerals that could hold a magnetization.

The Sierra Madera breccias and matrix specimens contain two components after removal of the modern VRM. At high temperatures (580-680°C), the polymict and monomict breccias contain a ChRM with southerly declinations and steep negative inclinations or northerly declinations and steep down inclinations. The directions pass a reversal test. Since the breccias' clasts and matrix share the same ChRM, these breccias fail the conglomerate test and magnetization was acquired post-depositionally. The mean ChRM (dec 169.9°, inc -55.7°, $\alpha 95$=4.3, k=78.0) yields a pole position of 79.9N, 203.1E, ($\beta 95$=5.1, Dp=4.4, Dm=6.2). The error ellipse of this pole position overlaps the Cretaceous portion of the apparent polar wander path between 50-70 Ma.

The intermediate temperature component is removed by < 580°C and contains direction with northerly to northeasterly declinations and down inclinations or southerly to southwesterly declinations and negative inclinations. There is some overlap with the ChRM. The origin of the intermediate component is under investigation.

Rock Magnetism: Isothermal remanent magnetization experiments indicate that the Sierra Madera breccias contain both high- and low-coercivity mineral phases. The high temperature ChRM is interpreted to be held in hematite. Rock magnetic studies of the new Decaturville samples are currently underway.

Conclusions: Both the Decaturville and Sierra Madera breccias fail the modified conglomerate test since the ChRM is the same in both clasts and matrix, indicating post-depositional magnetizations. The new breccia samples from the central uplift region at Decaturville do not contain the same Permian magnetization as the rim breccias. The reason for this is currently under investigation. Petrographic and rock magnetic analysis will determine if magnetic minerals are present in the breccias. If they were present, they may have been demagnetized, perhaps as a result of the impact.

The presence of apparent glass with flow banding in the Sierra Madera breccias suggests that the ChRM could be a thermal remagnetization related to the impact. A chemical remagnetization due to hydrothermal fluids, driven by the impact or a later event is also possible. The pole for the Sierra Madera breccias indicates it can be no older than ~70Ma. If the ChRM at Sierra Madera is thermal in origin and related to the heat generated during the impact, the pole constrains the impact to between 50-70 Ma which is better than the the stratigraphic range of less than 100 Ma. Additional petrographic work as well as SEM analysis is needed to determine the origin of the ChRM at Sierra Madera.

References: [1] Offield T. W. and Pohn H. A. (1979) USGS Professional Paper 1042. [2] Elmore, R. D., and S. Dulin (2007), *Geophys. Res. Lett*., 34, L13308, doi:10.1029/2007GL030113. [3] Wilshire H. G. et al. (1972) *USGS Prof. Paper 599-H.*