**CARBONATE MELTS AND SEDIMENTARY IMPACTITE VARIATION AT CROOKED CREEK AND DECATURVILLE IMPACT CRATERS, MISSOURI, USA.** R. E. Beauford[1], [1]Arkansas Center for Space and Planetary Sciences, MUSE 202, University of Arkansas, Fayetteville, AR, 72701, USA. rbeaufor@uark.edu

The Crooked Creek and Decaturville, Missouri, impact craters offer an opportunity to understand variation in impactite lithologies in carbonate and mixed sedimentary environments. Interactions during impact mobilization created complex (figure 4) lithic impact breccias and clast-rich impact melt lithologies involving mixes of carbonates, sandstone, chert, and shale. Though investigative examination of several hundred impactite slices is in preliminary stages, several conclusions derive from early work: 1. Carbonate melts, previously reported from only 5 crater sites [2], are present in large quantities at both the Decaturville and Crooked Creek structures. 2. These recrystallized carbonates form the principal groundmass of most melts examined from both sites (figure 3). 3. The carbonate component of interbedded chert or sandstone and carbonate source rock frequently melts while the sandstone and chert does not. 4. Carbonate melts found throughout both sites have entrained clasts from these adjacent lithologies, but do not appreciably assimilate them. 5. The texture and composition of the resulting impactites is largely defined by this difference in melting energy and entrainment process. 6. Centimeter scale disruption of interbedded chert or sandstone within melted carbonates can create the illusion of clast transport in autochthonous clast-rich melt environments (figures 1 and 2).

**Introduction:** Crooked Creek is an impact crater of about 7 km in diameter and is located in southwest Crawford County, Missouri. Decaturville is a slightly smaller, 5.5 to 6 km, impact crater located about 115 km west of the Crooked Creek structure in central Missouri's Laclede and Camden Counties. Both impact craters are preserved in closely related sequences of Cambrian/Ordovician to Carboniferous marine sediments. Excepting a small exposure of Cambrian igneous rock that is exposed at the center of the Decaturville site, all of the surface exposures of both craters are composed of sedimentary carbonates, sandstone, chert, and minor shales. Though heavy forest cover is a hindrance, both sites are naturally dissected by steep sided karst valleys, providing access to crater cross sections and a variety of near surface and subsurface impactites.

*Carbonate and sedimentary impactites* have received some recent attention, but remain an understudied area of inquiry [2]. Carbonate impactites present interpretation and nomenclature challenges due to differences in melt recrystallization, compared to common silicates, and due to poor development of characteristic shock signatures [3]. This lack has been addressed, to some extent, by the work of Osinski and Grieve [1,2], but work to date has suffered from a lack of published field data. Osinski and Grieve point out that, though the majority of the world's impacts include sedimentary components in their target rocks, only 5 incidences of carbonate impact melts are reported and that direct study of any sedimentary impactites is sparse in the literature. The Crooked Creek and Decaturville locations contribute two more carbonate melt locations and a wide range of sedimentary target lithologies.

**Figure 1.** Multiple bands of relict bedding, composed of aligned shards of shattered chert can be seen through the entire upper half of this specimen.

**Figure 2.** A slice removed less than 5 centimeters from figure 1 shows no indication of relict banding below the broad swath of chert across the top of the slice, illustrating how little alteration is necessary in order to eliminate visual clues to in-situ brecciation.

**Methods of Investigation:** Initial investigation at these two locations has involved collection of multiple rock samples from 14 locations and the parting of these samples into several hundred slices for analysis.

**Figure 3.** An understanding of pre-impact bedding and an awareness of impactite positioning relative to crater geometry is necessary in order to discern local mixing versus larger scale clast transport. Clasts from multiple pre-impact rock groups, such as are found in this sample from a dike near the Decaturville crater rim, provide clues to transport timing and process.

**Figure 4.** Carbonate melt showing visible, directional flow features streams between fracturing chert (bottom) and sandstone (top), and entrains unmelted chert clasts, individual sand grains, and sandstone chips. Clasts may contribute to cooling as they are entrained [1] or may provide heat necessary to prolong fluidity.

**Discussion and Future Work:** The principle challenge in making sense of impactites in carbonate environments stems from the difficulty in distinguishing impact melted carbonates from unmelted rocks. Melted carbonates recrystallize as carbonates that are nearly indistinguishable from their pre-melt progenitors [1]. At both of these sites, macroscopic flow features assist melt identification.

Preliminary examination of specimens indicates large quantities of carbonate melt at both sites, consistent with other studies and model predictions [2]. The lower melting temperatures of carbonates, in comparison to surrounding or included sandstone or chert, proves to be the dominant control in defining post impact rock texture and composition. In virtually all of the samples thus far investigated, carbonates acted as the fluid media for entrainment, fracture, and mobilization of other, unmelted, interbedded rock types, and as a fluid carrier for entrained clasts of chert, grains of sand, sandstone clasts, and other higher temperature silicate materials.

Only small disruptions, at the centimeter scale or less, are necessary before interbedded materials take on the superficial character of allochthonous breccias and melts.

*Questions that need to be addressed* – Significant work remains to be done at these sites. Cooling rates of carbonate melts is unknown, as is melt viscosity and the nature of possible physical evidence for carbonate decomposition versus melting. Further questions also exist regarding exactly what minerals are involved. The timing of neither the impacts nor the dolomitization of regional carbonates has thus far been tightly constrained, meaning that it is uncertain whether these carbonates were limestone or dolostone at the time of the impacts. The pressure and temperature phase relationships for the unmelted and melted minerals has also not yet been constrained in the literature [2], but it is clear, that the melting temperatures of the carbonates are going to be substantially lower [1,2] than the relatively high melting temperatures and pressures of the relatively pure quartz represented in chert or the predominantly quartz arenite sandstones of the formations involved.

*Future work includes* the analysis of additional plates and thin sections in order to identifying textural and chemical changes in melted and unmelted carbonates from specific formations, melt and clast interactions in regards the assimilation of silicates, and the significance of vesicles as possible indicators of carbonate decomposition.

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**References:** [1] Osinski G. R. et al. (2008) *Meteoritics & Planet. Sci., 43*, Nr. 12, 1939-1954. [2] Osinski G. R. et al. (2008) *GSA Spec. Papers 437*, 1-18. [3] Stöffler D., Grieve R. A. F. (2007) *IUGS Subcommission on Metamorphic Rocks, Chapter 11*, Blackwell.