INVESTIGATION OF CARBONATE-RICH BRECCIAS AND THEIR EMMPLACEMENT IN THE CENTRAL UPLIFT OF THE DECATURVILLE IMPACT STRUCTURE, MISSOURI. J. D. Newman¹ and G. R. Osinski². ¹Department of Earth Sciences & Centre for Planetary Science and Exploration/ ²Department of Physics and Astronomy, University of Western Ontario, London, ON, Canada.

Introduction: The Decaturville impact structure is a complex crater exposed in central Missouri on the dolostone-rich Ozark Plateau [1]. The impact structure is slightly elliptical with dimensions 6.3 km by 5.5 km and contains a central uplift, shatter cones, monomict and polymict breccias. Previous investigations of Decaturville include early geological studies [1], morphometry [2], paleomagnetic dating [3], mineralization [4], and presence of proposed carbonate melt [5].

Carbonates are present in about one third of known craters but how they react during the impact process is not yet fully understood [6]. This study characterized monomict and polymict breccias generated in a carbonate-rich target to understand and improve the knowledge regarding how carbonates respond to hypervelocity impact events.

Geologic setting. A 540 m thick Ordovician and Cambrian sedimentary sequence consisting primarily of dolostone with sandstone, shale, limestone, and chert underlies the impact structure down to the Precambrian basement of granite pegmatite and muscovite schist [1,4]. The oldest units are exposed at the center of the structure with younger units sequentially appearing outward to a normal ring fault, marking the extent of the structure [1]. Beyond the impact structure the Paleozoic sedimentary units are essentially flat lying within the Ozark Plateau [1,2]. Mississippi Valley-type (MVT) mineralization is present in sedimentary units from the Decaturville area. Marcasite, pyrite, galena, and sphalerite have been identified in the area and their deposition predates any brecciation caused by the impact event [1,3,4] so their presence is unrelated to the impact. Based on paleomagnetic constraints, the Decaturville impact structure has a Paleozoic age ranging from the Pennsylvanian to mid-Permian [3].

Drill cores have been collected throughout the impact structure, most notably near a sulfide pit and exposed pegmatite near the center of the structure [1]. The suite of samples in this study are from a drill site 530 m west of the central pegmatite within the central uplift and was drilled to a depth of 2396 feet (730 m).

Sample suite: Samples in this study consist of breccias and target rock from Decaturville core D77-1 (37.895°, -92.725°). Thirty-seven hand samples at varying depths within this core were available from which twenty-one thin sections were made; 17 breccia samples and 4 from target rocks.

Methods: Thin sections were examined petro-
not previously been reported from basement rocks within the structure or from the surrounding area.

Carbonate melt. Carbonate melt similar to the images presented in Beauford [5] was not observed in this sample suite. Detailed evidence of the proposed carbonate melt beyond the hand sample-scale – such as SEM or EPMA-level investigations [6] – was not provided by these authors.

In this study, we have documented evidence for localized melting in several breccia samples. The microtextures observed between calcite and quartz phases in these clasts display intricate rounded or elongate globules, reminiscent of immiscible-like textures (Fig. 1).

Flow features. Several breccia samples display clear indications of flow, these indicators include aligned clasts and smooth wave-like contours between areas of fine and coarse matrix. These flow features are most likely to be present in breccias that contain clasts larger than several cm. Flow features within breccias were also reported by [1].

Shock features. Decorated PDFs are rare and identified in quartz grains in a few samples. Some grains display up to three sets of PDFs. The rarity of PDFs corresponds with the low abundance of quartz grains throughout the sample suite. Shatter cones are present in the centre of the structure [1]. Muscovite kink bands are present in the Precambrian basement. The absence of PDFs or diaplectic glass in quartz and feldspar in the same basement sample rules out high shock pressures.

Vertical displacement within core. Based on clast and mineral assemblages present in the impact breccia samples, their stratigraphic source can be roughly assigned. This is possible since most units have at least one feature that differentiates it from the remaining units, or at least from an adjacent unit. Undisturbed target stratigraphy depths from [2] provides reference for the vertical displacement of units or the transport of material within the impact structure. At the D77-1 drill core location, Eminence Dolomite is exposed at the surface. The surface exposure of Eminence Dolomite indicates the target rocks have been uplifted by approximately 500 ft (152 m) compared to the undisturbed stratigraphy of the area [2].

Breccia samples from 71.2 to 219.4 ft depth indicate downward movement into the Eminence Dolomite unit. These breccias contain clasts from Jefferson City Dolomite, Roubidoux Formation, Gasconade Dolomite, and the Gunter Member; these units are all younger than the Eminence Dolomite. The greatest vertical displacement of 870 ft (265 m) is associated with the sample at 146.2 ft, a monomict sample of Derby-Doe Run Dolomite. Unlike the rest of the breccias within the 71.2 to 219.4 ft interval, the displacement of this sample was upward. This sample was recognized as Derby-Doe Run based on the presence of glauconite; Derby-Doe Run is the youngest unit to contain glauconite. A similar displacement of an exotic block of Derby-Doe Run was identified in a drill core 2.4 km east of D77-1 [1]; here the block of Derby-Doe Run rests on top of Jefferson City Dolomite.

Samples from 220.2 to 495.7 ft are predominantly monomict breccias from Eminence Dolomite. From 563.5 to 1841.0 ft, samples include target rocks from Derby-Doe Run Dolomite, Davis Formation, Bonnette Dolomite, and Lamotte Sandstone. The breccias near the bottom of the core at 2339.2 and 2341.4 ft from the Bonnette Dolomite were injected over 800 ft (244 m) downward into the Precambrian basement.

Conclusion: The drill core samples examined in this study show a wide visual range in impact breccias from the Decaturville impact structure as well as evidence for carbonate melt. This diversity coupled with the emplacement and transport of breccia and target rock show there was considerable movement creating complex relationships between breccia and target material during the formation of this structure. Impact breccias from Decaturville could be helpful in future comparisons with breccias from other carbonate-rich impact structures such as Crooked Creek, Sierra Madera, Flynn Creek, Haughton, or Tunnunik.