WEAUBLEAU-OSCEOLA STRUCTURE, MISSOURI: DEFORMATION, EVENT STRATIFICATION, AND SHOCK METAMORPHISM OF A MID-CARBONIFEROUS IMPACT SITE. K. R. Evans, C. W. Rovey II, K. L. Mickus, J. F. Miller, T. G. Plymate, and K. C. Thomson, *Department of Geography, Geology, and Planning, Southwest Missouri State University, Springfield, MO 65804-0087 (email: kre787f@smsu.edu)*

Introduction: The Weaubleau-Osceola Structure in southwestern Missouri is a newly recognized 19-km-diameter circular feature that includes deformed Mississippian and older strata overlain by an event breccia and undeformed Pennsylvanian siliciclastic strata (Fig. 1). Recent discoveries of planar fractures and planar deformation features (pdf) in quartz from various breccia facies, variably oriented shatter-cone-like striae in deformed strata, and coincidence of a low-gravity anomaly support the idea that it is a meteorite impact site.

The Weaubleau structure *sensu* Beveridge [1] is one of several 38th parallel structures across mid-continental North America that have figured prominently in the endogenic-exogenic controversey [2-4], but since efforts during the 1950's and 1960's only reconnaissance-level geologic mapping studies have been initiated. Our new investigations follow the discovery of the large circular drainage basin and radial tributaries that are noticeable in a digital elevation model of the area surrounding the Weaubleau structure. Although it is much smaller, the drainage pattern bears striking resemblance to the Manicouagan impact of Quebec.

A New Name. The name "Weaubleau structure" originally referred to Weaubleau Creek, which runs through the middle of the structure, but because of the larger scope and paradigm shift in our understanding of its origin, we prefer to use the name "Weaubleau-Osceola structure. This structure is unique among the 38th parallel impacts because shortly after the event, the structure was buried near the feather edge of the Pennsylvanian, and it has been only partly exhumed by modern erosion. Consequently, it is remarkably well preserved, and a suitable candidate for precise relative age-dating based on fauna and geochemical signatures of the event bed and correlative strata in nearby areas.

Morphology: Based on existing mapping and drilling records, it is likely that the central 19-km circular feature marks the limits of the transient crater. Outside of this structure in two narrow areas, Mississippian strata have been eroded and Lower Ordovician strata have been uplifted and truncated at the base of the Pennsylvanian. We interpret these features as part of a relict crater rim, however, sub-Pennsylvanian karstification and channel cutting greatly modified the crater morphology.

Figure 1. Digital elevation model of the Weaubleau-Osceola structure shows a relict circular depression that outlines the transient crater. Although the uppermost target rocks are Mississippian carbonates, uplifted areas of Lower Ordovician dolomite that we interpret as relict parts of the crater flank the southwestern and northeastern margins and are beveled below the sub-Pennsylvanian unconformity.

Stratigraphy: The youngest highly deformed strata (target rock) exposed in the structure are the Burlington-Keokuk and Pierson formations undivided (Osagean); these units are dominantly crinoid grainstone to packstone interbedded with chert.

The Northview Formation (Kinderhookian), a green-gray siltstone unit, generally is found below the Pierson Formation in this region [5], but within the structure, it is partly missing. Underlying beds of the Sedalia and Compton formations (Kinderhookian) are dominantly mud-rich carbonates. All of these strata lie unconformably over the Lower Ordovician Jefferson City-Cotter Dolomite undivided. These rocks are the lowest rocks exposed in this area.

Structural Deformation: Three distinct structural domains in the Burlington-Keokuk-Pierson lithosome

are exposed in walls of the Ash Grove Aggregate Quarry near the center of the structure, 7 km southeast of Osceola. The uppermost level is so heavily fractured that it is difficult to determine bedding and offset along faults. A second middle-level domain consists of tight folds and thrust faults along thin shale and silt-rich decollement surfaces (Fig. 2). Shale and siltstone are rare in the Burlington-Keokuk-Pierson formations but fine siliciclastic material from underlying strata of the Northview Formation may have provided a ready source of lubrication of movement along faults. Discrete zones of mixed carbonate and siliciclastic injection breccia, with gray-green siltstone clasts commonly are intermingled with folded strata. The absence of Northview Formation to the southwest and common occurrence of siliciclastic material in the dominantly carbonate target strata suggests that the fluidization and injection of siliciclastic material was virtually instantaneous among the brittle and plastically deformed carbonates. Reconnaissance-level field studies of z-folds, recumbent folds, and imbricate thrusts indicate movement toward the north. Only the upper part of the lower domain is exposed in the quarry. These strata are gently folded carbonates. Thus, the intensity of deformation decreases downward, indicating that the deformation originated above the present bedrock surface.

Figure 2. Large, tight folds and thrust fault of the middle-level structural domain in quarry near Osceola, Missouri.

Event Stratification: A mixed carbonate and siliciclastic breccia overlies deformed carbonates. We informally refer to this unit as the "Weaubleau Breccia." It is a polymict breccia with carbonate mudstone matrix and pebble-sized and larger angular and red-discolored chert clasts and angular clasts of siltstone and shale. The unit is matrix supported, poorly sorted and grossly stratified in a massive bed. Submillimeter-scale octahedra of hematite and goethite (after magnetite?) are finely disseminated through the matrix. Locally, chert concretions are formed around larger siltstone clasts. The unit contains fauna and clasts ranging from at least Early Ordovician to Middle Mississippian.

Matrix support, lack of regular bedding, and the angular clasts of soft shale preclude fluvial transport of clasts. We interpret this unit as a fall-back impact breccia.

Shock Metamorphism: Mechanical twinning is ubiquitous in carbonate clasts in the breccia. A gradient exists between variably oriented stylolites to convergent pressure-solution striae that resemble horsetailing, however no definitive shatter cones have been found. Approximately 10% of the coarse quartz sand exhibit multiple sets of parallel fractures and pdf's that remain unindexed (Fig. 3). Shocked quartz grains commonly are "toasted" with a semi-opaque yellow-brown appearance.

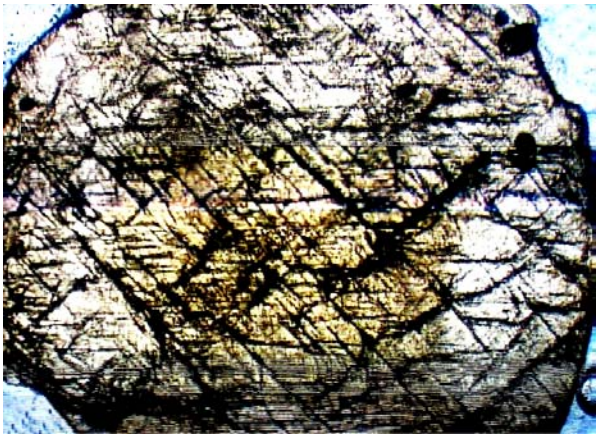

Figure 3. Photomicrograph shows planar fractures and faintly visible pdf's. Grain diameter is approximately 1.5 mm.

Conclusion: Based on available evidence, we consider that the Weaubleau-Osceola structure is an impact site. It tentatively appears to be terminal-Osagean in age, a biochronostratigraphic horizon that elsewhere marks the extinction of several echinoderm genera and species in North America.

References: [1] Beveridge T. R (1951) *Mo. Geol. Surv. Water Res., 32,2nd Ser.* 111 pp. [2] Snyder F. G. and Gerdemann P. E. (1965) *Am. Jour. Sci., 263(6),* 465-493. [3] Rampino M. R. and Volk T. (1996) *Geophy. Res. Let., 23,* 49-52. [4] Lusczaj J. (1998) *Geology, 26*, 295-298. [5] Thompson T. L. (1986) *Mo. Dept. Nat. Res. Div. Geol. And Land Surv., Rept. Inv. 70,* 182 pp.