THE ROCK ELM IMPACT STRUCTURE: MORPHOMETRY OF THE SOUTHERN FAULT BLOCK FROM SEISMIC REFRACTION SURVEYS. Nathan R. Rossman, and Jennifer L.B. Anderson, Winona State University, Winona, MN 55987 (NRRossma6723@winona.edu)

Introduction: The North American continent currently hosts 57 impact craters, 27 of which are found in exclusively sedimentary target rocks [1]. Often these craters are poorly exposed and their topographic signatures are minimal or non-existent, as is the case at the Rock Elm structure [2]. As the detailed geologic studies of the Rock Elm structure continue, geophysical techniques can also be used to provide insight into its three-dimensional structure. In particular, this is important because of the scarcity of well and drill cores and outcrops at this structure. Detailed studies of Rock Elm and other such craters may help to identify other craters that formed in sedimentary targets and/or in a shallow marine environment and illuminate the processes involved in their formation.

The Rock Elm structure located in western Wisconsin (described in depth in [2, 3]) is a nearly circular area of anomalously deformed rocks approximately 6.5 km in diameter (Figure 1). The impact occurred between ca. 460 and 410 Ma in flat-lying sandstones and carbonates that were deposited in a shallow marine continental-interior platform. Since then, this region has been eroded approximately 250-300 m.

The Rock Elm structure consists of several features: The *ring boundary fault* is a circular fracture zone separating the uplifted and deformed rocks of the structure from the normal stratigraphic sequence. The *central uplift*, composed of Mount Simon sandstone, has been uplifted 250-300 m above its normal stratigraphic position. After formation, the crater filled with mud and then sand, resulting in the deposition of the *Rock Elm shale* and *Washington Road sandstone*, respectively. In addition, deformed blocks of *Prairie du Chien Group dolostones*

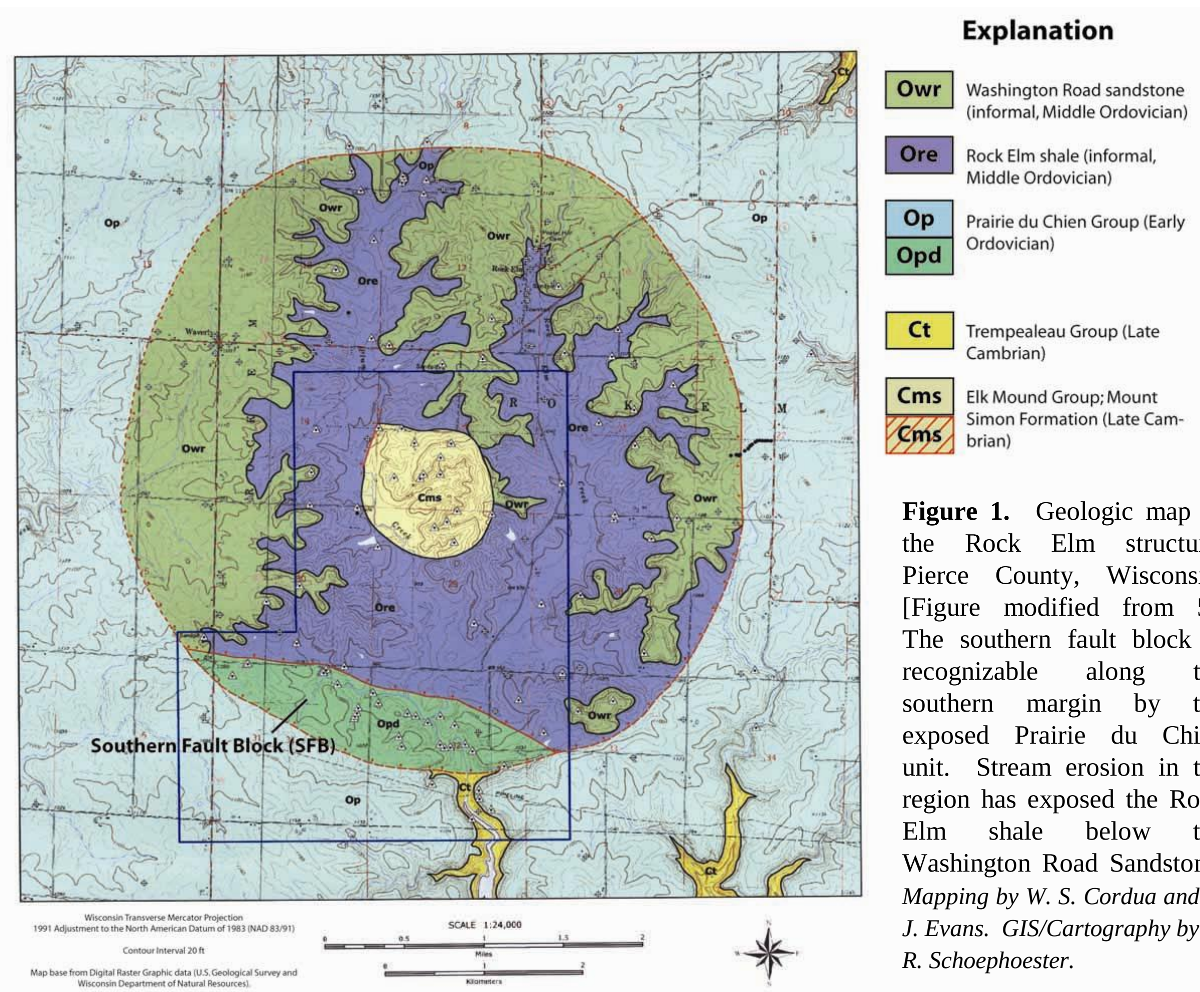

Figure 1. Geologic map of the Rock Elm structure, Pierce County, Wisconsin. [Figure modified from 5]. The southern fault block is recognizable along the southern margin by the exposed Prairie du Chien unit. Stream erosion in the region has exposed the Rock Elm shale below the Washington Road Sandstone. *Mapping by W. S. Cordua and T. J. Evans. GIS/Cartography by P. R. Schoephoester.*

outcrop along the margins of the structure. The largest of these is crescent-shaped, approximately 1.5 km in length, called the southern fault block (SFB) by [2, 3] (Figures 1 & 2). After its initial uplift due to the impact, it has been displaced downward at least 80 m (vertical component of movement) relative to the uplifted rocks outside of the structure [3]. The movement of the SFB is likely a consequence of gravitational collapse of the transient cavity during modification [4].

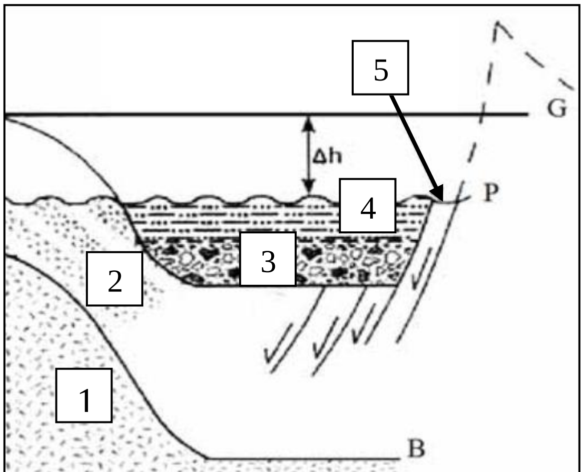

Figure 2. Schematic North-South cross-section of the southern half of the Rock Elm structure depicting: (1) Uplifted Precambrian basement rocks, (2) overlying Paleozoic sandstones and carbonates, (3) crater fill breccia, (4) crater fill sediments, and (5) the southern fault block. Lines indicate the original ground level (G); the original contact between the Precambrian basement and the overlying sediments (B); and the present erosion surface (P). The vertical amount of erosion of the target stratigraphy since the crater formed is labeled as Δh. [Figure modified from 6].

Methods: Emphasis of the current study has been, firstly, to determine the velocity structure of the soil and rock units that surround and make up the SFB, including the Rock Elm shale, and the Prairie du Chien Group within and outside of the ring boundary fault; secondly, characterize the three-dimensional geometry of the SFB by locating the faults that define its extent. The expected lithology and geometry of the subsurface was inferred from [5].

Seismic refraction profiles were produced with a 12-channel Geode™ seismograph and sledge hammer source. Travel-time data were analyzed with Microsoft Excel™ and Seisimager/2D™ refraction analysis software. In all, we have produced 11 seismic refraction profiles of the shallow subsurface within and outside of Rock Elm's expected rim focusing on the southern fault block and its vicinity.

Preliminary Results: Analysis is ongoing; however, some preliminary statements can be made about this region. Soil was found at each field location as indicated by low P-wave velocities ranging from 350-510 m/s. Initial P-wave velocities determined for the Rock Elm shale are considerably lower than expected [7, 8], ranging from 640-1250 m/s. Low values may be accounted for by the unit's highly friable nature and proximity to the surface. The P-wave velocities of the Prairie du Chien Group rocks "outside" of the structure range from 2080-2170 m/s. The P-wave velocities of the Prairie du Chien Group rocks within the structure (the SFB), range from 1110-3660 m/s, on the lower end of expected values for dolostones. These variations may be accounted for by laterally discontinuous porosity in the form of fractures and vugs, vertical lithology changes, and/or folding and brecciation.

Conclusions: If the P-wave velocities for the Prairie du Chien within and outside of the SFB indeed fall within the same range, this may imply that the SFB is larger in extent than currently thought. However, the question remains as to whether and how much the P-wave velocities are expected to differ on either side of a complex crater's rim.

Acknowledgments: The authors would like to thank Dr. W. S. Cordua, from the University of Wisconsin-River Falls, for his assistance with and expertise in the Rock Elm structure.

References:

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