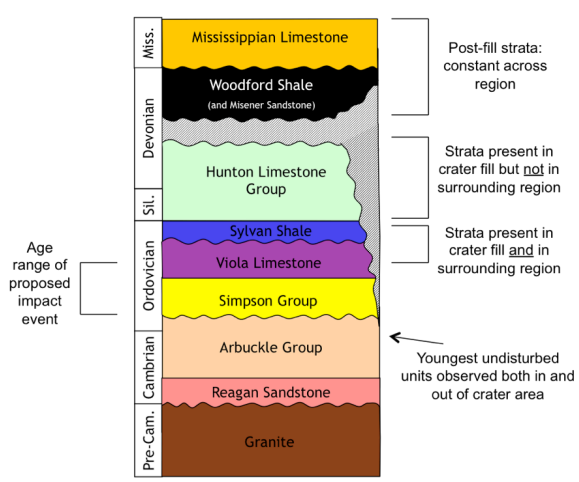
IMPACT AT INGALLS? EVIDENCE FOR A SUBSURFACE ORDOVICIAN METEORITE IMPACT NEAR INGALLS, OK. Benjamin C. Herrmann and Rhiannon G. Mayne, School of Geology, Energy and the Environment, Texas Christian University (ben.herrmann@tcu.edu).

Introduction: A structural anomaly has been discovered in the subsurface of north central Oklahoma. The feature is roughly circular in map view with a diameter of 2 km, and it is approximately 1100 m below the town of Ingalls in Payne County, OK. Initial mapping of the structure led to the suggestion that the site may be an impact structure. The feature is filled with sedimentary rocks of Ordovician and Silurian age, and deposition within the feature was complete by the end of the Devonian.

The aim of this study is to document the stratigraphic and petrographic aspects of the Ingalls feature in order to investigate the claim that it is a subsurface impact structure.

Stratigraphy and Structure: The rock units of the Ingalls feature lie beneath the Woodford Shale, a prominent stratigraphic marker marking the Upper Devonian and Lower Mississippian across most of Oklahoma [1]. Regionally, units below the Woodford dip to the southwest and are truncated erosionally to the northeast. The Hunton Limestone is one of these formations, with its regional truncation boundary lying more than 20 km to the west of Ingalls. Within the structure, however, there is as much as 60 m of Hunton Limestone present. Other stratigraphic irregularities at the site include increased bed thicknesses and the presence of additional units not present outside the structure. The increased thicknesses are interpreted as additional post-impact deposition, while the non-correlative units are interpreted as being impact generated.

Figure 1. Stratigraphic Column of Ingalls area. Highlights the rocks present regionally and within the proposed impact structure.



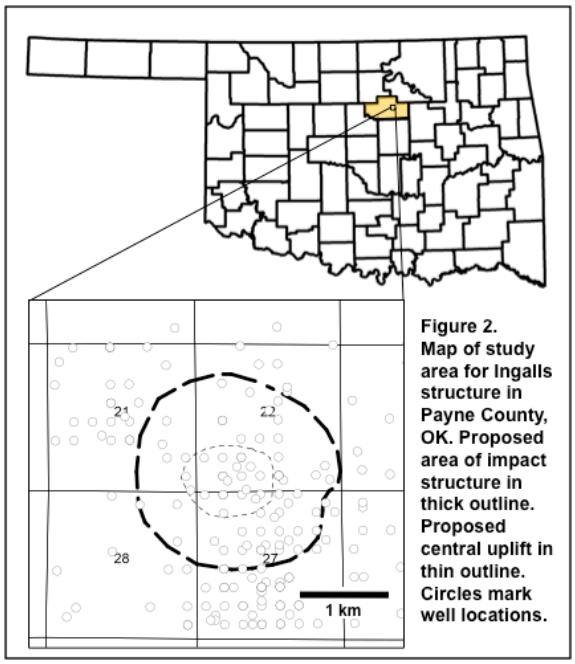


Figure 2. Map of study area for Ingalls structure in Payne County, OK. Proposed area of impact structure in thick outline. Proposed central uplift in thin outline. Circles mark well locations.

The shape of the structure is approximately that of a steep-sided, circular bowl. Maps of the structure indicate that the boundaries of the feature are very abrupt, with drastic changes in lithology indicative of fault planes. At the center of the feature lies an oblong elliptical spire of rock whose units are older than the surrounding crater fill. The composition of the this spire is interpreted to be a unit of the Simpson Group, and it lies as much as 150 m above the equivalent unit in the surrounding rocks. This is a very irregular pattern: regionally undisturbed rocks surrounding a circular suite of younger strata which further surround a spire of older and seemingly uplifted rocks. The spire is interpreted as the central uplift of a complex impact structure. Central uplifts occur in complex craters, which are formed from larger impacts and have flat floors as well as sharp, fault-like boundaries [2]. Complex craters generally have diameters greater than 4 km, but they occur in craters with diameters of around 2 km if the impactor strikes sedimentary rock instead of crystalline material [2]. Given that the structure at Ingalls has many characteristics which are aspects of complex craters, an impact origin seems to be the most reasonable explanation for the structure.

The precise age of the impact event is uncertain due to the limited well control within the structure. However, the Sylvan Shale of late-Ordovician age [1]

can be clearly identified within the structure, providing a minimum age of the impact event.

Petrographic Investigation: The only available rock samples from the Ingalls structure are well cuttings from oil and natural gas wells drilled into the structure. The majority of the wells penetrating the structure are very old, with many as old as the 1930s, leading to a limited amount of available data. There is no core for any of these wells, and only 7 of the wells had drill cuttings from formations within the structure. The most useful cuttings came from a well called the Rebound 1-22, drilled in 2008, which was drilled into the central uplift of the structure. There are extensive cuttings at regular intervals throughout the impact section, and quartz grains from selected intervals have been separated from the rest of the cuttings for petrographic investigation. The selection of intervals was based on position within the stratigraphic section of the well and the estimated age of impact.

The separated quartz grains are first placed in refractive index oil with RI = 1.54. The oil causes the grain to disappear, easing the identification of any potential shock features. Any quartz grains containing PDFs or other shock features are then isolated for further inspection. Grain mounts will be made with the isolated grains, and any PDFs will be indexed using a universal stage microscope.

Conclusion: Mapping of the feature at Ingalls suggests the presence of a 2 km subcircular structure with sharp edge boundaries and irregular stratigraphy that is non-correlative with the immediately surrounding rocks. This evidence combined, with the lack of regional context for the structure, leads to the suggestion that the feature is a complex impact structure; however, no conclusive evidence for an impact at the site has been found to date. Further investigation using petrographic techniques is required to obtain definitive evidence of an impact origin of the structure; for example, the presence of pdfs within quartz grains. These studies are ongoing at the time of submission.

References: [1] Amsden T. W. (1980) *Hunton group (late Ordovician, Silurian, and early Devonian) in the Arkoma Basin of Oklahoma. Okla. Geol. Surv. Bull. 129*. 136 pp. [2] French B. M. (1998) *Traces of Catastrophe. LPI contr. No. 954.* 120 pp.

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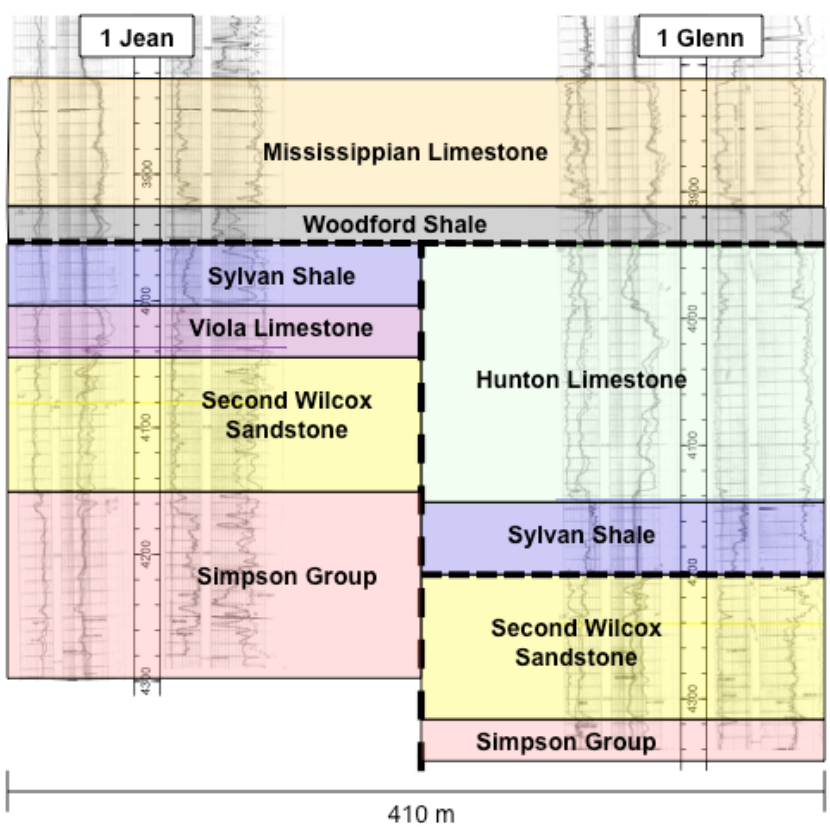

Figure 3. Well log cross section illustrating the structural and stratigraphic relationships that exist at the Ingalls structure. The two wells in the cross section are only 410 meters apart, yet their sections show marked differences, including tens of meters of offset and extra deposition. These irregularities are likely due to the Ingalls impact and subsequent deformation of the structure.