NEW CORE-HOLE DRILLING AT WETUMPKA IMPACT STRUCTURE, ALABAMA – PRELIMINARY RESULTS. D. T. King, Jr.[1], J. Ormö [2], R. S. Harris[3], L. W. Petruny[1], and J. K. Markin[1] [1]Geology Office, Auburn University, Auburn, AL 36849 [kingdat@auburn.edu], [2]INTA Centro de Astrobiología, Madrid, Spain [ormo@inta.es], [3]Geosciences, Georgia State University, Atlanta, GA 30303 [rsharris@gsu.edu].

Introduction: The Wetumpka impact structure (near the town Wetumpka, Alabama) has a semi-circular crystalline rim that is approximately 5 km in diameter. The impact structure includes an interior structure-filling unit and an exterior disturbed terrain (located south and southwest, respectively, of the crystalline rim) [1, 2, 3]. The crystalline rim, central polymict breccia, interior marine chalk deposits and reworked glauconitic sands, and southern rim are the specific sites drilled during 2009 and reported on here.

Wetumpka, a Late Cretaceous marine-target impact structure in the inner Coastal Plain of Alabama, is characterized by a wide, horseshoe-shaped crystalline rim, an interior region of broken and disturbed sedimentary formations, and an exterior terrain on the south and south-west composed of structurally disturbed target formations [1, 2, 3]. The crater rim spans 270 degrees of arc and is open to the southwest, the same side as the structurally disturbed terrain.

The Wetumpka impact occurred in marine water just off the northern shore of the Late Cretaceous sea, which was precursor to today's northern Gulf of Mexico. The target water depth was very shallow and would have become shallower progressively toward the north, i.e., toward the coeval shoreline [1, 2]. In reverse stratigraphic order, the target consisted of marine water; poorly consolidated sediment (comprising 30 m of chalky ooze (Mooreville Chalk), 30 m of paralic marine sand (Eutaw Formation), and 60 m of terrestrial (fluvial) clayey sand and gravels (Tuscaloosa Group), and ultimately, weathered crystalline basement. The crystalline basement had a pre-existing southwest slope of about 10 m/km. The nature of the target and the slope of the basement are assumed to play a significant role in the cratering process, especially in crater modification [4]. In the following sections, we present preliminary interpretations from each of the four new core holes drilled in 2009.

Crystalline rim: Well #09-01was drilled in the northwestern quadrant of the crystalline rim and cored throughout. Well #09-01 penetrated approximately 78 m of fractured schist and gneiss before encountering a 10-m interval of highly brecciated metamorphic materials, which presented a technical problem for continued water circulation in the well-drilling process. This highly porous and permeable breccia zone was underlain by schist and gneiss that was much less fractured and displayed foliation consistent with the regional trend. Our interpretation of the rock relationships seen in well #09-01 is that the fractured schist above the breccia zone is representative of slightly upturned/tilted parts of the crystalline rim and that the relatively non-fractured schist and gneiss below is representative of deeper parts of the structurally uplifted local basement rock. The breccia zone may represent a surface of glide between the upturned rim and the basement and takes the same position as the sheared and highly deformed layer of Upper Cretaceous target sediments that have been observed at this level in other places. The absence of sediments in the drill core and in outcrops in the area gives further indication that the current erosional level of this section of the rim is below the overturned sedimentary section of the crater rim, or alternatively, some concentricity of the crater developed due to the thick, weak sediment layer. In this alternative scenario, the fractured shist may represent an overturned flap.

Central polymict breccia: The central polymict breccia occupies an area of less than one square km, and is located mainly along and near a residential street that encircles the central erosional high ground of Wetumpka impact structure. Along this road on the western side of the central high ground, blocks of schist, gneiss, and sandstone ranging in size from a few centimeters to 10 m crop out. These blocks are embedded in a matrix of fine to medium clayey sand, which contains shocked quartz. This breccia is not seen elsewhere within the Wetumpka structure-filling unit, and is interpreted as proximal ejecta, which was brought back into the crater bowl by the fluidized flow of slumped extra-crater material during early modification of the structure [3, 4, 5]. The alternative – fall-back ejecta – appears less likely as such unit is known only at depths of over 200 m in the structure fill [3, 6]. Quartz grains recovered from the matrix of breccias in this outcrop and reported that the quart-grain population is composed of 69 vol. % monocrystalline quartz, 12 vol. % polycrystalline quartz, 5 vol. % quartz with sweeping, undulatory extinction, and 14 vol. % quartz with planar microstructures and mosaic extinction [6].

Continuosly cored well #09-02 was drilled directly in front of the main outcrop of the central breccia. This well penetrated approximately 23.5 m, of which the upper 20 m was the central breccia. In this well, the central breccia rests directly upon sedimentary slump blocks (interior mega-blocks). Well #09-02 drill core penetrated a 3-m block of banded amphibolite gneiss, which was probably derived from the vicinity of the

southern rim (based on similarity of that block with amphibolite gneisses of the southern rim [7, 8]). Drilling well #09-02 supported the idea that proximal ejecta from the southern and/or southwestern reaches of the impact structure was transported back into the interior of the Wetumpka impact structure either by a water resurge or with the megablock slumping.

Interior chalk deposits: The interior Mooreville Chalk deposits at drill site #09-03 are composed of approximately 20 to 30 percent fossil plankton, including foraminifera, ostracodes, diatoms, radiolarians, and coccoliths. Megafossils have been found in outcrops near the drill site, including oysters, cephalopods, and shark teeth. Partially melted dinoflagellates, which are reported as an impact-damage effect in similar-appearing dinoflagellates from post-impact sediments of the Chesapeake Bay impact structure [9], have been recovered from a shallow pit at this drill site [10].

Well #09-03 recovered continuous core to a depth of approximately 90 m. The upper 6 m of the core is comprised of tan Mooreville Chalk, which is similar to the outcrop exposures adjacent to the drill site. Below the tan chalk is a unit, 18.5 m thick, which is composed of green-grey, glauconitic chalk, sand, and calcareous shale. This green-gray layer is provisionally interpreted – based on features shared with resurge deposits at the Lockne 11, 12], Tvären [13], and Chesapeake Bay craters [14, 15, 16] – as an aqueous resurge deposit of distal ejecta and ripped-up sediments, mainly derived from the coeval Mooreville Chalk. These sediments were washed back into the impact structure by returning sea water flow. However, the nearly homogenous nature of this unit, compared with the generally graded resurge deposits at the aforementioned craters, indicates a relatively shallow target water depth at Wetumpka. Underlying this green-grey unit is a section of 65.6 m of tan-brown medium to coarse sand. This impactite sand contains intervals of disaggregated sand that is structureless and intervals of sand with intact sedimentary structures and burrows. In the latter, the burrow *Ophiomorpha* is particularly abundant. Because this burrow is locally indicative of the Eutaw Formation, the Eutaw is thought to be the main source for the impactite sands in the lower part of this well.

Southern rim: Well #09-04 penetrated approximately 218 m and continuous drill core was obtained. In this well, the upper 38 m penetrated the Tuscaloosa Formation. The underlying 18 m penetrated Eutaw Formation, which included a section near the center of the Eutaw Formation that showed deformed and vertical bedding planes. The section below the Eutaw Formation, approximately 27 m thick, was again Tuscaloosa Formation. We interpret this relationship to be the outer flanks of an overturned flap, which has slumped intact into the transient crater and where the more proximal parts (i.e., the "hinge") containing more crystalline ejecta travelled all the way to the crater center. Below the interpreted impact-crater rim section, well #09-04 penetrated 135 m of impactite sands, which contained relatively intact megablocks derived from both the Tuscaloosa and Eutaw Formations, which were dispersed within the impactite sand.

Summary: Each of the four drill sites displays rock types and physical relationships that reveal information about the probable physical processes during excavation and modification of Wetumpka impact structure, including their relative timing. In the crystalline rim (particularly in well #09-01 in the northwestern quadrant), there is good evidence of excavation-phase overturning of a crystalline flap. During early modification, sedimentary megablocks were emplaced by gravity sliding into the transient crater bowl (e.g., interior megablocks in the lower parts of wells #09-03 and 09-04). This megablock movement was attended by slumping of less stable rim materials (collapse of sedimentary units comprising the southern rim seen in the upper part of well #09-04). We have interpret that these early modification-related events were coeval with the development of the exterior disturbed terrain [4]. The foregoing events were followed by modification-stage aqueous resurge, which emplaced units like the green-grey chalk and calcareous shale drilled at site #09-03 and the crystalline block-bearing polymict breccia (in well #09-02, located in the central breccia area). Late modification events are not well-preserved at Wetumpka, but there are post-impact sediments consisting of a thin veneer of Mooreville Chalk, which is preserved in the upper 2 m of well #09-03.

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