WETUMPKA RESURGE CHALK DEPOSITS – INSIGHTS FROM X-RAY COMPUTED TOMOGRAPHY. J. K. Markin[1], D. T. King, Jr.[1], and J. Ormö[2], [1]Geology Office, Auburn University, Auburn, Alabama 36849 [jkm0006@auburn.edu; kingdat@auburn.edu], [2]Centro de Astrobiologí a, INTA, 28850 Torrejón de Ardoz, Madrid, Spain [ormoj@cab.inta-csic.es].

Introduction: Wetumpka impact structure is a ~ 7.6-km diameter, Late Cretaceous feature of marine target origin [1, 2, 3]. The uppermost target formation at Wetumpka was the Mooreville Chalk, which occurs within the impact structure mainly as resurge deposits that fill topographically low areas of the intra- and extra-structure terrains [3]. This paper examines a 25-m section of resurge chalk in the upper part of core hole #09-03 (Baillif well), which was drilled in 2009 [4, 5]. For the location of this core, refer to [5]. Internal details of the resurge chalk were studied using CT technology.

X-ray computed tomography (CT) is a non-destructive, indirect technique that allows the true spatial, and geometric internal-features to be studied in a scanned object. From the measured amount of attenuation of a X-ray beam after passing though a scanned subject, internal algorithms within a X-ray CT scanner can reconstruct stacks of 2D visual cross-sections called 'slices' in which individual pixels represent the averaged attenuation coefficient of corresponding voxels in real matter [6]. Because attenuation coefficients by Beer's Law are functions of the porosity and atomic species (mineral phases) of scanned matter, the resulting gray scale images typically represent differing densities in which lighter values represent higher density or specific highly attenuating mineral phases [6]. X-ray CT is a proven application in the sedimentological characteristics of drill-core, particularly in fine-grained units [7]; therefore, X-ray CT has been used to elucidate the stratigraphic and sedimentological characteristics of the fine-grained Wetumpka resurge chalks, which have little visual contrast and do not lend themselves well to thin-section study.

Due to minimal core-loss in the #09-03 drill core, resurge interval, individual core-sections could be carefully re-fitted and therefore oriented relative to each other. Within the resurge interval, only at 3 points were there any uncertainties due to insufficient fitting or changes in drilling methods. Orientations across these points were made possible with trending, inclined-features in either or both visual and X-ray CT observations. Although true (absolute) azimuth orientation of #09-03 drill core is not known, the entire resurge-interval had a relative orientation and individual core sections were rotated clockwise in 90-degree increments when necessary to insure that inclination of features was parallel with CT slices.

At Auburn University College of Veterinary Medicine, a fourth-generation medical CT scanner was used to take 20 longitudinal (stratigraphic) slices per core section with the following scanning parameters: (1) x-ray beam energy at 100 keV in the upper 3.8 m and 120 keV below 3.8 m with 300 mA throughout, (2) scanning time at 2.0 sec per slice, and (3) 3-mm section width. Also, the field of view was a circular cross-section with a diameter of 47.9 cm for a scanned area of 1800 cm^2 within a resolution of 512 x 512 pixels. This creates an actual resolution of 0.69 mm per pixel. Because of the methodology utilized in this study, prominent noise and beam hardening artifacts are present; however, the CT images are still far superior to visual observation alone for both qualitative and limited quantitative analysis.

Results: Utilizing conjugate CT slices (moving between slices), impact-derived mud-chalk breccia can be discerned from resurge matrix by the following criteria: (1) a general lower attenuation coefficient for true impact-derived matrix relative to intact Mooreville Chalk breccia ranging from a differental of 100 Housnfield units (HU) to as high as 600 HU for chalky breccia which result in subtle to abrupt breccia-matrix boundaries; (2) discernable intact burrows which commonly are interpreted as *Planolites* but likely include *Teichichnus* and *Thallasinoides* (along with some burrows of indeterminable genus); and (3) intact internal laminations, which abruptly terminate at clast boundaries. Matrix-rich breccias dominate within the resurge; however clast- supported, poorly-graded breccias are prevalent within the middle of the 25-m resurge unit. Clasts and blocks also exhibit apparent imbrication or preferential alignment. Furthermore, resurge matrix exhibit inclined laminations of weak to strong expression that are predominately unidirectional with sparse, short reversals of unknown origin.

With the observed sedimentological features, the following basic resurge lithofacies are reported in stratigraphic order of first appearance:

Lithofacies 1 - Basal shear zone. The facies exhibits an underlying planar, well-sorted fine sands that are slightly intercalated with a muddy, glauconitic, sandy flame structure. Above the 'mixing zone' of the flame structure is a cross-laminated muddy, non-calcareous, glauconitic fine sand that fines upward and is gradational with lithofacies 2.

Lithofacies 2 - Matrix-dominated breccia. This is a glauconitic, calcareous shale that is sandy in parts with weakly-expressed inclined laminations, 'swirled' fabrics, generally sparse and small pebble-sized breccia, and possible boudinaged thick laminae of contrasting densities. This is the dominant lithofacies of the resurge unit, occurring between other lithofacies from the lithofacies 1 to the base of lithofacies 6.

Lithofacies 3 - Clast-dominated breccia. This lithofacies is of lesser occurrence than lithofacies 2, and although could be, in some cases, a fully disaggregated lithofacies 4, this facies is prevalent within the middle of the resurge unit. It is characterized as a normally graded unit of breccia that transitions from clast-supported to matrix supported (fig. 1b). Maximum thickness is 0.8 m with some apparent imbrications within one interval.

Lithofacies 4 - Transported Mooreville Chalk. When clast size exceeds the confines of the drill-core in the horizontal dimension, they are defined as "blocks." Such blocks are interpreted based on intact internal bedding, trace fossils, and other sedimentary structures (fig. 1c). Blocks range at a minimum size of 0.065 m to a maximal observed-minimum of 0.66 m. Orientation of blocks are commonly similarly aligned with matrix inclination trends. Lithology ranges from chalk to marl which are often caught 'frozen' in the process of disaggregation and dismemberment and exhibit wide matrix-filled fractures.

Lithofacies 5 - Polylithic-laminated matrix. This is an uncommon facies in which strongly expressed laminations of contrasting and alternating lithology resemble cross-beds and cross-lamination. Internally, they do not exhibit clasts but often have clasts resting on uppermost laminations accompanied with compaction features (fig. 1a).

Lithofacies 6 - Enigmatic chalk. This uppermost unit is a phosphatic chalk with modern diagenetic overprinting of caliche nodules that has been previously proposed as a secular deposit [4]. However, within the CT images subtle features such as internal, inclined lamination, burrows, and wide fractures could mean this is, in fact, lithofacies 4. Ongoing geochemical and thin-section petrographic studies will likely determine the origin of this unit.

Conclusions and discussion: Inclined features, basal shear, fine-grained, dominate matrix, 'frozen' sedimentary features, and boudinaged beds are all known sedimentary features of non-impact-derived, submarine mudflows [8]. Thus, the sedimentary features within the CT images are supportive of the mudflow interpretation of the Wetumpka resurge [9]. However, apparent imbrication, normal grading and preferential alignment of clasts and blocks are uncharacteristic of debris-flows, therefore this could reflect changing hydrodynamic conditions or interweaving flows of differing character. Ongoing sedimentological and stratigraphic research made possible by X-ray CT is anticipated to further understanding of the unique resurge of the Wetumpka marine-impact crater.

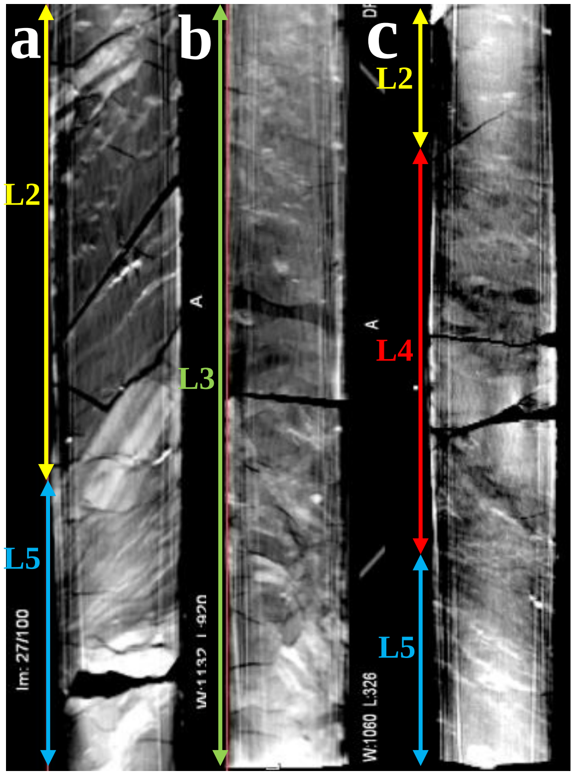

Fig. 1. Examples of CT slices of selected drill-core intervals with delineated lithofacies: **(a)** 9.49-9.81 m depth interval with lithofacies 2 (L2), L6 (lithofacies 6); **(b)** 11.82-12.23 m depth interval with a nearly whole lithofacies 3 (L3) with clasts of contrasting densities. **(c)** 19.80-20.14 depth interval with lithofacies 4 (L4) with L2 above and L5 below. Within L4, there are visible trace fossils, a thin, chalky bed, and 'frozen' brecciation.

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