PRIMARY AND DIAGENETIC CHARACTERISTICS OF CHICXULUB IMPACT EJECTA SPHERULES IN THE NORTHWESTERN GULF OF MEXICO. R. N. Guillemette and T. E. Yancey, Department of Geology & Geophysics, Texas A&M University, College Station, TX 77843-3115 (guillemette@geo.tamu.edu; yancey@geo.tamu.edu)

Bubbly impact glass spherules and carbonate accretionary lapilli spherules are common components of basal Chicxulub impact deposits in marine settings along the northwestern margin of the Gulf of Mexico and are here examined from deposits at Mimbral in northeast Mexico and compared to Brazos River, Texas. This study documents the presence of distal carbonate accretionary lapilli at Mimbral, previously recorded at Brazos River, Texas and Bass River, New Jersey (Guillemette & Yancey, LPSC 2006). The Mimbral sample is from partly weathered surface exposures, providing material to document patterns of surficial alteration of spherules in arid climates as well as determine survivability of lapilli fabric during burial diagenesis. The Mimbral area has been affected by regional folding and some subaerial alteration of sample material is indicated by the presence of some pedogenic calcite and gypsum in and on the rock matrix. Microfabric and compositional data for lapilli at Mimbral are compared with lapilli at Brazos River. Unaltered accretionary lapilli contain multiple sizes of aggregates composed of 1-4 µm size low Mg calcite crystals with notable amounts of sulfur in association with low Fe content. Altered grains with pedogenic fabric contain minimal aggregational fabric, more uniform 4-10 µm size low Mg calcite crystals and low sulfur content. Despite greater alteration of many Mimbral lapilli compared to Brazos, many lapilli retain good preservation of primary fabric and composition (Figure 1). Of ten grains examined, there is a range from unaltered accretionary carbonate lapilli to completely pedogenic fabric, with a majority of grains being intermediate and retaining areas of remnant primary fabric and composition among areas of recrystallized carbonate.

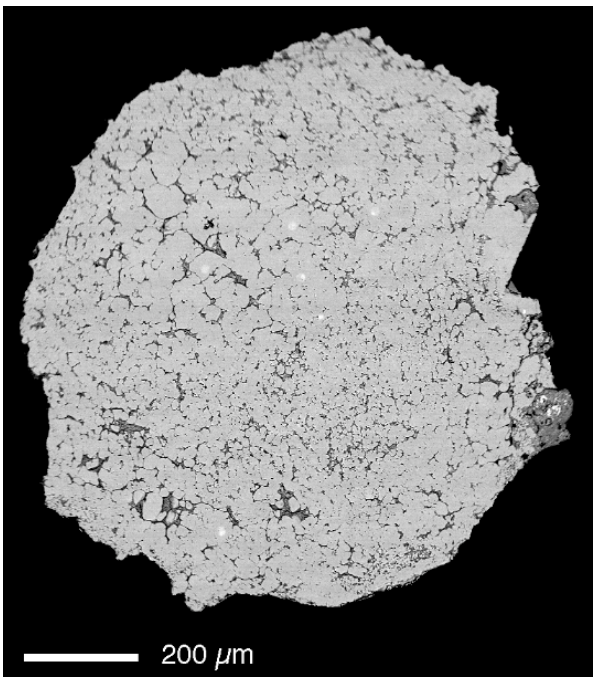

Figure 1: Partially recrystallized carbonate accretionary lapilli grain showing areas of small and coarser crystal size. Areas of small crystal size (just below center) retain a composition with elevated sulfur content. Areas of coarser crystal size are depleted in sulfur and are recrystallized. White spots show some of the analytical points.

Three of the ten grains are concretionary composite grains containing extra matrix cemented around lapilli, but in one grain the boundaries of lapilli are obscure and the grain was culled from compositional comparison because the origin of calcite in the grain (primary, recrystallized, diagenetic vein or modern pedogenic) could not be reliably inferred. Visual selection of grains by binocular microscope has to be supplemented by BSE imaging (best) or thin section examination to establish particle type in partly altered samples. Diagenetic alteration of Mimbral lapilli proceeds by size increase of the calcite crystals, causing altered lapilli to acquire the appearance of nodules of pedogenic calcite. With increase in crystal size, sulfur content decreases and sites of higher sulfur content are limited to areas of smaller crystal size. Patchiness in sulfur content occurs in lapilli with mixtures of remnant primary fabric and secondary recrystallization, showing that changes in fabric and composition tend to track each other during alteration and that original chemical composition can be recognized in grains with minor recrystallization.

The composition of Mimbral fine crystal size domains is close to that of the typical Brazos River carbonate accretionary lapilli (RB4B in Table 1) but lower in sulfur content than the most sulfur-rich Brazos Valley lapilli (RB2). The Al and Si content of the accretionary lapilli from both areas can be attributed to fine grained clays (altered glass) present between the 1-4 µm size calcite crystals; the 10 µm beam diameter used for the analyses spans several crystals and will occasionally hit a small amount of this intergranular clay.

	Mimbral (fine) (124 pts, 9 grains)	Mimbral (coarse) (41 pts, 7 grains)	Brazos RB2 (accr) (99 pts, 9 grains)	Brazos RB4B (accr) (34 pts, 6 grains)	Mimbral replaced Bubbly Glass (9 pts, 3 grains)
$CaCO_3$	98.7 *(1.4)*	99.8 *(1.1)*	94.0 *(2.8)*	96.5 *(1.8)*	98.6 *(1.2)*
$MgCO_3$	0.52 *(0.31)*	0.57 *(0.39)*	2.86 *(1.86)*	0.71 *(0.69)*	0.64 *(0.44)*
$FeCO_3$	0.20 *(0.15)*	0.34 *(0.20)*	0.13 *(0.09)*	0.81 *(0.93)*	0.49 *(0.24)*
$MnCO_3$	0.32 *(0.28)*	0.39 *(0.19)*	0.04 *(0.03)*	0.27 *(0.30)*	0.31 *(0.16)*
$SrCO_3$	< 0.20	< 0.20	0.09 *(0.04)*	0.12 *(0.04)*	< 0.20
SO_3	0.42 *(0.27)*	< 0.07	0.80 *(0.34)*	0.40 *(0.25)*	< 0.07
Na_2O	0.03 *(0.02)*	< 0.03	0.06 *(0.02)*	< 0.05	< 0.03
Al_2O_3	0.15 *(0.18)*	< 0.04	0.20 *(0.22)*	0.16 *(0.14)*	< 0.04
SiO_2	0.38 *(0.40)*	< 0.05	0.64 *(0.54)*	0.34 *(0.33)*	< 0.05
Total	100.8 *(1.0)*	101.3 *(1.0)*	98.8 *(0.9)*	99.4 *(0.7)*	100.2 *(0.7)*

Table 1: Compositional analyses of carbonate accretionary lapilli and bubbly glass spherules from surface rock exposure at Mimbral, Mexico, and carbonate accretionary lapilli from Brazos River, Texas. Values in table are the mean and standard deviation (in italics) in weight percent oxides. Mimbral fine and coarse crystal size domains determined from BSE images. Mimbral higher sulfur content is associated with smaller crystal size and low sulfur content with larger crystals, indicating recrystallization or replacement. Sparry replacement calcite of bubbly glass has low sulfur content.

Carbonate accretionary lapilli and bubbly impact glass occur in subequal amounts in the Mimbral sample. Although both may now be carbonate in composition, alteration of bubbly glass spherules to calcite at Mimbral is unlike alteration of carbonate lapilli and the two need not be confused when examining spherule deposits. Replacement calcite of bubbly impact glass is coarse spar and it contains very low levels of sulfur. Bubbly impact glass spherules are of similar size in Mimbral and Brazos River and the degree of alteration and the extent of preservation of original bubble fabric at Mimbral is similar to that at Brazos River. During replacement, the outer surface and bubble voids are often selectively lined with clay or microspar containing impurities that provide contrast with later generation calcite replacing glass, allowing recognition of the margins and bubble fabric in sparry replacement calcite. Sparse patchy coatings of minute crystals of titanium oxides or iron oxides may be present on growth surfaces of coarse sparry calcite replacing altered glass or filling voids. Margins of bubble voids are often fragmented and displaced in the interior of bubbly glass spherules, indicating selective dissolution instead of whole spherule dissolution during replacement. Bubbly impact glass spherules may be altered to clay or replaced with sparry calcite, but both indicate early diagenetic alteration of impact glass after burial. This contrasts with the more stable carbonate accretionary lapilli that alter more slowly and may experience partial recrystallizaton during burial diagenesis or during surface exposure to weathering.