CHICXULUB TARGET STRATIGRAPHY AND EJECTA: INSIGHTS FROM NORTHERN BELIZE.

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Introduction: The undisturbed (pre-impact) Mesozoic stratigraphic section of the Chicxulub-target area in the Yucatan is not well known because of governmental policies in Mexico, Guatemala, and Belize regarding proprietary restrictions on subsurface data, and thus there is a dearth of published literature, related to this petroleum-producing region. Presently, the work of Ward et al. [1] stands out as one of the few openly published studies that examines Mexican (Yucatan) subsurface stratigraphy (age and lithology) of the target area. Stratigraphic and lithologic studies in adjacent Guatemala and Belize are informative in the absence of useful Mexican data. Guatemalan stratigraphic research in this regard is somewhat dated, and is best represented by the work of Vinson [2]. In recent years, Belize Mesozoic stratigraphy, both surficial and subsurface, has been investigated and reported openly (e.g. the work by Cornec [3], King et al. [4], and Gill et al. [5]). Figure 1 shows the area and key sites noted.

The Mesozoic stratigraphy of Belize includes formations that are the lateral equivalents of the target Yucatan Group (undivided) in Mexico and the Coban and Campur formations, respectively, of Guatemala. Belize stratigraphy of the northern (Corozal) basin includes four formations of interest, which lie above the trans-Yucatan crystalline basement. In age order, these are the Margaret Creek formation (red bed clastics; same as Todos Santos in Guatemala and Mexico), the Hill Bank formation (intercalated marginal marine clastics and shallow water carbonates and evaporites; same as the Todos Santos transition zone in Guatemala and Mexico), the Yalbac formation (shallow water dolostones and evaporties; same as Coban in Guatemala and the lower part of the Yucatan Group in Mexico), and the Barton Creek formation (shallow water dolostones; same as Campur in Guatemala and the upper part of the Yucatan Group of Mexico).

The Margaret Creek and Hill Bank of Belize are relatively thin units, together comprising less than a few 10s of meters in most places in the northern basin. For this reason, these units will not be described further here except to say that these units have been regarded historically as lowermost Cretaceous and uppermost Jurassic, but recent strontium-isotope analysis of carbonates in the Hill Bank suggest that these formations are likely all lowermost Jurassic and Upper Triassic strata [5]. The overlying Cretaceous Yalbac and Barton Creek formations, however, have substantial thickness in the northern Basin (at most ~ 975 m and ~ 700 m, respectively) and thus have greater relevance to cross-border correlation with the Yucatan Group of Mexico and to studies of carbonate ejecta components. These formations will be the focus of this report (Fig. 2).

Yalbac formation: This subsurface-only formation is a very thick accumulation of shallow water evaporates and dolostones (~ 200 to ~ 975 m), which thickens to the north across the Corozal basin of northern Belize [4]. Yalbac dolostones contain very few recognizable micro- or macrofossils owing to pervasive dolomitic diagenesis, dissolution, and subsequent recrystallization [5]. Thick intervals of dolomitic anhydrites and anhydritic dolostones also occur in the Yalbac. There are three informal members of the Yalbac, Y1, Y2, and Y3 (oldest). Most of the anyhdritic dolostone and all of the relatively rare, nearly pure anhydrite beds are found in Y1 and Y3, whereas Y2 is mainly dolostone. Deposition was mostly in shallow water, including sabkha, although some deeper water carbonates occur in the thicker parts of the stratigraphic section of northernmost Belize [4,5]. The Yalbac has historically been assigned to middle Lower to lower Upper Cretaceous (Hautervian to Cenomanian) based on equivocal biotic evidence, but recent strontium-isotope geochronology suggests numerical age solutions that range from Valanginian to mid-Turonian [5], and that there is a substantial (regional?) unconformity between the Yalbac and Hill Bank formations in northern Belize (and beyond?) with an hiatus that spans nearly 60 million years [5]. The Yalbac is organic rich and is a hydrocarbon source and reservoir rock that has been drilled extensively in northern Belize. Yalbac carbonate rock colors range from medium to dark brown and grey to nearly black.

Barton Creek formation: This surface and subsurface formation is a very thick accumulation of shallow water carbonates, mainly dolostones (~ 200 to ~ 700 m), which thicken to the north across the Corozal basin of northern Belize [4]. Barton Creek carbonates contain very few recognizable micro- or macrofossils (except for a few rudistid fragments, pelecypods, and snails [4,5]) owing to pervasive dolomitic diagenesis in most intervals, dissolution and subsequent recrystallization throughout, and karstic (freshwater) diagenesis [4,6]. Thick intervals of coarsely crystalline dolostones abound in the Barton Creek; and there are minor, mainly finely crystalline (micritic) limestones in the upper third of the formation. Deposition was mainly shallow water, including some carbonate grainstone shoals (but no recognizable reefs) [4]. The Barton Creek has historically been assigned to Upper Cretaceous (Cenomanian to Maastrichtian) based on scant and equivocal biotic evidence, but recent strontium-isotope

geochronology suggests numerical age of Barton Creek ranges from mid-Turonian to latest Maastrichtian [5,7], and deposition was conformable with the Yalbac. Unlike the Yalbac, the Barton Creek is not organic rich and is not a hydrocarbon source rock. Barton Creek rock colors range from light brown and grey to tan, pink, and brownish white (Fig. 3).

Relevance to Chicxulub: The Yalbac and Hill Bank formations' lateral equivalents in the adjacent Yucatan area of Mexico comprise the undivided Yucatan Group. Below the KPg interval, core from Pemex well Y1 in northern Quintana Roo contains a sequence of lithologies that are quite similar to the Belize sequence noted above (i.e., unit A of [1] = Margaret Creek, lower part of unit B of [1] = Hill Bank, upper part of unit B and unit C of [1] = Yalbac, and units D-F of [1] = Barton Creek).

The Yucatan Group's equivalent of the Barton Creek would have comprised the upper target of Chicxulub (i.e., the main spallation unit) and thus these lithologies would be expected to be strongly represented in the clast population among proximal ejecta. To test this hypothesis, we reviewed sedimentologic data of the ejecta at Albion Island in northern Belize [8], and this review indicates that 85-95 % of ejecta clasts over 5 cm in diameter possess lithologic characteristics similar to Barton Creek (Fig. 3). A similar review of data from central Belize ejecta deposits [9] indicates nearly all ejecta clasts and all re-worked ejecta clasts have Barton Creek-type litholiges.

With the lithologic differences between Yalbac and Barton Creek in mind, it may be useful to review extant compositional data on Chicxulub ejecta and crater-filling deposits of the Yucatan from areas that are closer to the crater than Belize and thus may have a different mixture of carbonate clasts coming from different depths in the Yucatan Group's target section. Further, in the virtual realm, the stratigraphic succession of lithologies, as suggested by this review of key Belize formations, may also assist in future modeling of Chicxulub impact processes and products.

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References: [1] Ward W.C. et al. (1995) *Geology, 23*, 873-876. [2] Vinson G.L. (1962) *Bull. Am. Assoc. Pet. Geol., 46*, 425-456. [3] Cornec J. (2015) *Geology map of Belize* (med.gov.bz). [4] King D.T. Jr. et al. (2004) *GCAGS Trans., 54*, 289-304. [5] Gill K.K. et al. (2018) *GCAGS Trans., 68*, 229-254. [6] King D.T. Jr. and L.W. Petruny (2014) *GCAGS Trans., 64*, 215-228. [7] Ocampo A.C. et al. (1996) *GSA Spec. Paper 307*, 75-88. [8] King D.T. Jr. and L.W. Petruny (2003) *Springer Impact Series*, 203-227. [9] King D.T. Jr. and L.W. Petruny (2015) *GCAGS Trans., 65*, 463-473.

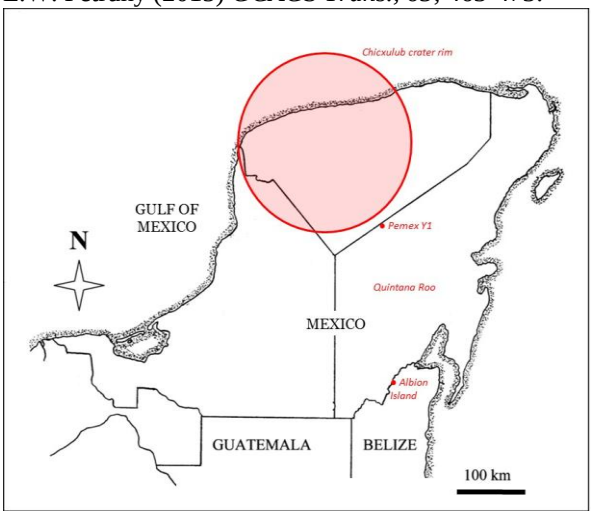

Figure 1. Location map with key features noted in text.

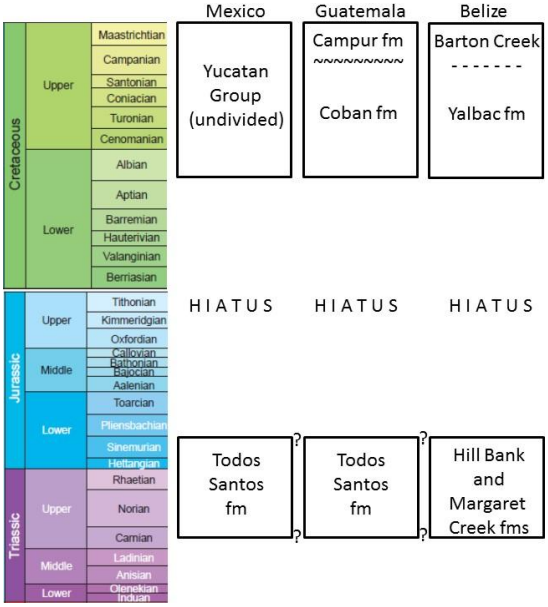

Figure 2. Target stratigraphy as noted in text above.

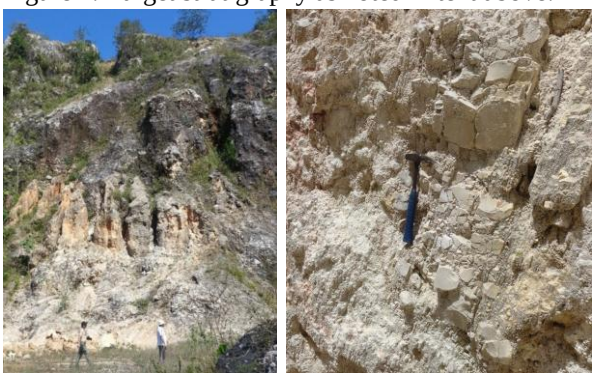

Figure 3. Left – Typical Barton Creek outcrop (height ~ 20 m); right – Barton Creek-type clasts in ejecta beds at Albion Island. Hammer for scale.