ACCRETIONARY CLAST GENERATION DURING LARGE IMPACT EVENTS: NEW INSIGHTS FROM PROXIMAL CHICXULUB IMPACTITES AND IGNNIMBRITE DEPOSITS.

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Introduction: Aggregation processes have been extensively studied in the case of explosive volcanic eruptions. In contrast, the formation and emplacement mechanisms of asteroid impact-generated aggregates remain poorly understood [e.g., 1,2]. Particle aggregation consists of collision and adhesion of suspended particles in turbulent hot gas mixtures with a binding agent like water or electrostatic forces, e.g., in a phreatomagmatic ash plume or in co-ignimbrite clouds above pyroclastic density current [3]. Aggregation can influence ash dispersal, and needs to be considered for ash plume forecasting, modelling, and potential climatic effects in the case of significant injection into the atmosphere. Additionally, the study of impact-generated aggregates provides insights in the dynamics and emplacement processes of proximal impact ejecta blankets of large impact structures. Aggregates have been observed in proximal impact ejecta blankets of large impact structures on Earth, including Chicxulub (200-km-diameter, 66.05 Ma, Mexico, [e.g., 4,5]) and Sudbury (~250-km-diameter, 1.85 Ga, Canada [6]).

Methods: Detailed petrographic and geochemical investigations (including optical microscopy, micro-XRF major and trace element mapping, and SEM imaging combined with EDS analysis) were performed on impact-generated aggregates, later termed as accretionary clasts (ACs) found in two subaerially exposed Cretaceous–Paleogene (K–Pg) sites from the proximal continuous ejecta blanket of the Chicxulub impact structure: (1) Albion Formation, southeast Yucatán Peninsula, ~330–360 km from the Chicxulub crater center, and (2) El Guayal, Tabasco (Mexico), ~520 km southwest from the Chicxulub crater center. These ACs were compared with accretionary pellets/lapilli recovered in ignimbrite deposits produced by explosive (Plinian) volcanic eruptions at Tenerife (Canary Islands, Spain).

Results and Discussion: The ACs (also referred to as “pink spheroids”, 1–10 mm in diameter) of the Albion Formation occur in a ~2-m-thick bed at the base of the proximal ejecta deposit, between the Cretaceous Barton Creek dolomite Formation and ~8–10-m-thick diamictite [5]. The ACs are mainly composed of carbonate material (calcite and dolomite), as shown by high CaO contents (~72–98 wt%). They appear either as an angular lithic core surrounded by a fine-grained rim of accreted particles, or as aggregates without obvious core or internal structure. The ACs (~0.5–2 cm in diameter) from El Guayal occur as beds in a graded calcareous sandstone, above a carbonate-rich microbreccia. The ACs are composed of a core (ash, rock, or mineral, ~100–400 µm in size) surrounded by several millimeter-sized concentric laminations. The textures displayed are very similar to the accretionary pellets observed in ignimbrite deposits from Tenerife [1], suggesting a comparable formation process. These ACs are SiO2-rich (~85.0 wt%), whereas the adjacent host matrix is relatively SiO2-poor (~23.7 wt%) and CaO-rich (~52.4 wt%). Three main types of accretionary clasts can be identified within the proximal impact ejecta. The AC1 group consists of poorly structured aggregates, fine- (AC1a) or coarse-grained (AC1b). The AC2 type is described as aggregates with a core surrounded by several concentric laminations with grain-size variations. Finally, the AC3 group is composed of a lapilli-sized, angular lithic core, surrounded by a fine-grained rim. Interestingly, the AC3 type was only observed within the Albion Formation. This classification scheme can be used as a solid framework to describe ACs from impact ejecta deposits or impactites at impact structures other than Chicxulub.

Following these observations, different modes of formation are inferred between the Albion Formation and El Guayal ACs. Albion Formation ACs may have formed at the interface between the Barton Creek Formation, in a high-energy and high-density flow where shearing and rolling of clasts was intense, resulting in the electrostatic charging of fine particles, subsequently forming the ACs. At El Guayal, the energy of the density current likely decreases with increasing distance. Air and water from shallow sea is entrained inside the current, forming a co-ignimbrite-like ash cloud where ACs formed. This is similar to processes taking place at ignimbrite deposits on Tenerife [1], where accretionary lapilli started to form in the upper part of the plume, then dropped into the lower part of the pyroclastic density current plume, and accreted concentric laminations.

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