VARIATION IN DISTAL IMPACT EJECTA WITH DISTANCE FROM THE SOURCE CRATER: A MODEL.

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Introduction: We have used information from six Phanerozoic ejecta/spherule layers to construct a model on how distal impact ejecta vary with distance from the source crater. The model appears to be consistent with theoretical studies of the cratering process and observational data from most Phanerozoic and late Precambrian distal ejecta layers, but not from older (>2.48 Ga), especially Archean spherule layers.

Impact Spherules: Distal impact ejecta layers consist primarily of spherules. There are two types of impact spherules: microtektites which do not contain primary crystallites and microkrystites which do. These two types combined with two mechanisms of formation (melt droplets versus condensate droplets) result in four possible categories of impact spherules: 1) microtektites produced as melt droplets, 2) microtektites formed as condensate droplets, 3) microkrystites formed as melt droplets, and 4) microkrystites formed as condensate droplets

The Model: As an ejecta layer thins away from the source crater, the average degree of shock metamorphism increases and therefore the percent melt (spherules) increases. Beyond ~10 crater diameters an ejecta layer consists primarily of spherules and beyond ~100 crater diameters an ejecta layer is essentially a spherule layer containing little, if any, unmelted ejecta >125 μm. Thus, an ejecta layer from a crater >~200 km in size will contain unmelted, as well as melted ejecta, globally. On average the petrographic and chemical homogeneity of melt-produced microtektites increases with distance from the source crater (i.e., the number of relict inclusions, vesicles, and schlieren decreases away from the source crater) [1]. The ratio of spherule fragments to whole spherules increases toward the source crater probably due to fragmentation caused by thermal stress as they land in water and/or to collisions between the microtektites in the atmosphere. The latter mechanism is supported by an increase in number of high-velocity impact pits per unit surface area on the microtektites toward the source crater [2]. The average size of the microtektites appears to increase toward the source crater beyond ~100 crater diameters, but closer in that trend reverses due to the increase in fragmentation. The maximum size of shocked-quartz grains increases toward the source crater, but the average degree of shock metamorphism, as indicated by the average number of sets of PDFs, increases away from the crater [3].

Precambrian Spherule Layers: Spherule layers from at least 11 impacts >2.4 Ga have been identified. The aggregate thicknesses of these layers are generally greater than the thicknesses of the Phanerozoic ejecta layers, but none of these older layers contain shocked-mineral grains except for trace amounts in 4 layers that were probably formed by just 2 impacts. Thus, these spherule layers do not fit the Phanerozoic model. This may be because the target rocks were mafic and/or because of much larger impact sizes as suggested by the large sizes of some of the spherules and the greater thicknesses of the spherule layers.

References: [1] Folco et al. 2010. *Geology* 38:211–214. [2] Prasad et al. 2010. *Meteoritics & Planetary Science* 45:990–1006. [3] Morgan et al. 2006. *Earth and Planetary Science Letters* 251:264–279.