MODELLING OF DISPERSAL AND DEPOSITION OF IMPACT GLASS SPHERULES FROM THE CRETACEOUS-TERTIARY BOUNDARY DEPOSIT; J.M. Espindola (Insituto de Geofisica, UNAM, Mexico), S. Carey and H. Sigurdsson (Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882).

The dispersal of glass spherules or tektites from a bolide impact with the Earth is modelled as ballistic trajectories in standard atmosphere. Ballistic dispersal of Cretaceous-Tertiary boundary impact glass spherules found in Haiti and Mimbral, Mexico requires a fireball radius in excess of 50 km but less than 100 km to account for the observed distribution.

Glass spherules from 1 and up to 8 mm in diameter have been found at the KT boundary at Beloc in Haiti [1], at Mimbral, Mexico [2], and at DSDP Sites 536 and 540 in the Gulf of Mexico [3], corresponding to paleodistances of 600 to 1000 km from the Chicxulub crater. In Haiti the basal and major glass-bearing unit at the KT boundary is attributed to fallout on basis of sedimentologic features [4]. When compared with theoretical and observed dispersal of volcanic ejecta, the grain size versus distance relationship of the KT boundary tektite fallout is extreme, and rules out a volcanic fallout origin. At a comparable distance from source, the KT impact glass spherules are more than an order of mangitude coarser than ejecta of the largest known volcanic events.

We model the dispersal of KT boundary impact glass spherules as ballistic ejecta from a fireball generated by the impact of a 10 km diameter bolide. Mass of ejecta in the fireball is taken as twice the bolide mass [5]. Melt droplets are accelerated by gas flow in the fireball cloud, and leave the fireball on ballistic trajectories within the atmosphere, subject to drag, depending on angle of ejection and altitude. The model for ballistic dispersal is based on equations of motion, drag and ablation for silicate spheres in standard atmosphere.

The ballistic transport range of particles is strongly dependent on decoupling radius, or the radius of the fireball when particles are no longer accelerated by the cloud and travel under their own inertia. Other factors that determine particle range are angle of ejection, particle diameter and initial velocity. Particle size is constrained by observations of the deposit [4], and initial velocity is evaluated from reasonable bolide mass and velocity [5]. Ablation is found to decrease particle radius by up to 10%. At decoupling radius <50 km the particles are severly affected by atmospheric drag and have low range. At higher decoupling radii the particle dispersal is in the range observed for KT boundary impact glass spherules (Fig. 1). Particles with high angle of ejection from the cloud and at high altitudes will travel with practically no drag and may obtain semi-orbital flight.

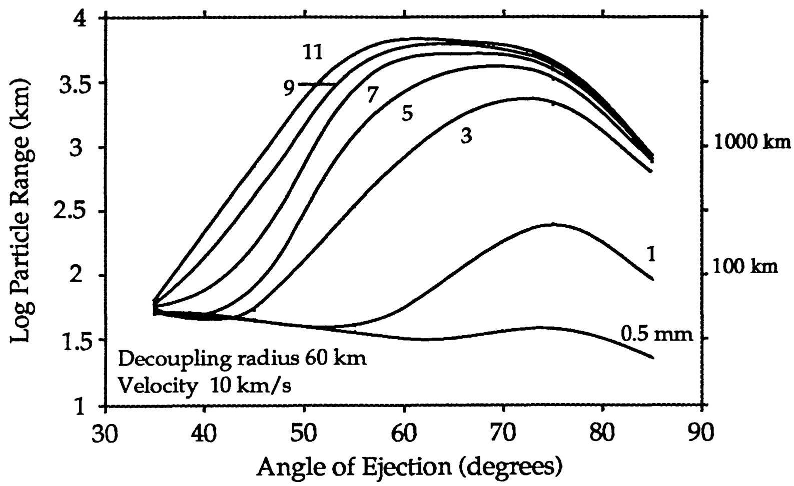

Fig. 1: Variation in the predicted transport range of particles (0.5 - 11 mm diam) as a function of ejection angle for fireball or decoupling radius of 60 km. Ballistic trajectory particle velocity at the decoupling stage is assumed 10 km/sec in all cases. This fireball radius satisfies the observed ~1000 km dispersal of glass spherules to Haiti and Mimbral, Mexico.

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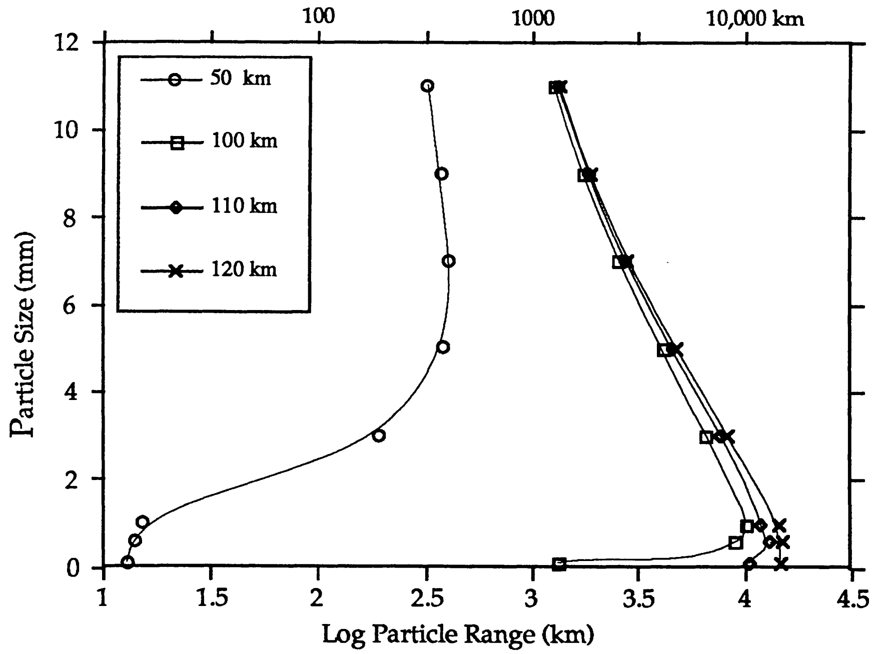

Fig. 2: Predicted maximum transport of particles from the impact of a 10 km diameter bolide at 20 km/sec. Modelling results are shown for decopuling radii or fireball of 50, 100, 110 and 120 km.

Maximum ballistic range as a function of particle size is shown in Fig.2, for decoupling radii from 50 to 120 km. The radius of 60 to 100 km required to account for the KT boundary dispersal indicates a fireball which would exceed the scale height of the Earth's atmosphere. Largest uncertainty in the ballistic model relates to the degree of melt droplet interaction with atmosphere. If atmospheric erosion is severe during impact [5], then ballistic dispersal may occur in near-vacuum conditions adjacent to the impact site. On the other hand, we model the extreme case of a standard atmosphere.

The model has also been used to estimate the thickness of the ballistic ejecta deposit, based on mass distribution in the fireball. For a 10 km diameter bolide at 20 km/sec, the axisymmetric ballistic model deposit has the same thickness/distance relation as the curve of Hildebrand and Stansberrry [6] in the far-field (>1000 km), but is significantly thinner in the proximal region.

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