NUMERICAL MODELING OF TEKTITE ORIGIN IN VERTICAL IMPACTS.

V. V. Svetsov. Institute for Dynamics of Geospheres, Russian Academy of Sciences. E-mail: svetsov@idg.chph.ras.ru.

Introduction: Geochemical arguments show that tektites are derived from sedimentary layers at the earth surface [1–3]. Numerical simulations of ejecta motion after impacts [4] suggest that the Ries-moldavite strewn field could have been created by an oblique impact at angles 30–50º to the horizontal with a velocity of 20 km/s. In this case the melt of an upper 40 m thick layer is ejected downrange, moves through the atmosphere in a cloud of heated gas and lands at some distance from the crater as tektites. However, this is not the only way to explain the origin of tektites. It has been speculated that tektites can be produced in vertical impacts and move through a wake left by an impactor in the atmosphere [5]. Another possible mechanism (at least for layered Australasian tektites) is the melting of soils by radiant heating from aerial bursts [6]. In this study numerical simulations of ejecta motion were made for near-vertical impacts.

Numerical Approach: The modeling of impacts was based on hydrodynamic equations which were solved numerically by the SOVA method [7]. Tillotson equation of state was used for target materials and a tabulated equation of state for heated air. Tektites were treated as particles moving with melted materials after ejection from a growing crater and as small objects moving individually through the atmosphere at the later stage. The approach was in general similar to that used in [4]. It was assumed that the impact occurs at some small angle to the vertical but the flow was simulated approximately as axially symmetrical.

Results: The motion of a molten surface layer at relatively low impact velocities has some specific features. A sandy layer melts nearby the impact point and is ejected to the wake. The melt particles move at the top of a low-velocity (2-3 km/s) ejecta curtain along trajectories close to vertical. From altitudes above ~50 km they move ballistically through the wake filled by air heated to some thousands Kelvins and then through the upper atmosphere. This tektite-forming material spreads in the direction opposite to the impact direction (in contrast to oblique impacts) and lands in some area with a shape depending on the impact velocity and angle. Some selected impact parameters give the best fit to the size of the tektite strewn field and its distance from the Ries crater. The calculated mass of tektites is of the order of the mass obtained by geological estimates.

Conclusions: The simulations show that the moldavite strewn field could originate from impacts of asteroids about 1 km in size at angles 10–20º to the vertical with velocities from 11.2 km/s to about 13 km/s. Near-vertical impacts with higher velocities can produce more extensive tektite strewn fields.

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