THE LARGEST METEORITES ON EARTH. N. A. Artemieva[1] and P. A. Bland[2], [1]Institute for Dynamics of Geospheres, Russian Academy of Sciences, Leninsky Prospect 38/6, Moscow, Russia 117939 (nata_art@mtu-net.ru); [2]Department of Earth Science and Engineering, South Kensington Campus, Imperial College London SW7 2AZ, UK (p.a.bland@imperial.ac.uk).

Introduction: Hoba is the largest known meteorite at ~6.10^4kg. But it is not clear that this represents an upper mass limit for meteorites on Earth. To define that limit it is necessary to model the interaction between small asteroids and the atmosphere. Artemieva et al. [1,2] have developed a model that calculates motion, aerodynamic loading, and ablation, for each particle in a disrupted impactor, providing a mass- velocity-distribution for fragments at the surface. Here we apply the separated fragments (SF) model to explore the upper mass limits for low velocity fragments (ie. meteorites).

Results and Discussion: We use the SF model to calculate the final mass- velocity-distribution of fragments from iron bolides with pre-entry masses of 10^7-10^{10}kg and low atmospheric entry angles (<15º): 'strong' impactors that experience substantial deceleration. The model input parameters (density, strength, ablation) are standard for iron bodies and are taken from Sikhote-Alin (e.g. [1]). We find that the mass of the largest low velocity (<2km/s) fragment on the surface depends on several factors. Varying pre-entry mass has a minimal effect: 10% increase in fragment size with a pre-entry mass increase of 2 orders of magnitude. Atmospheric entry velocity has a more substantial effect: for a 10^{10}kg pre-entry mass and a 10º entry angle we find largest surviving fragment masses of $2x10^4$, $8x10^4$, and $3x10^5$kg for entry velocities of 18, 14, and 11km/s respectively. But the strongest determinant on final fragment mass is initial entry angle. For the lowest impact velocity of 11km/s the increase is from $9x10^5$kg to $8x10^6$kg over the entry angle interval 8º-6.5º. So for maximum surviving fragment mass we require low entry velocity and low entry angle. The lower limit for pre-atmospheric velocity is 11km/s (Earth escape velocity), and the lowest entry angle (without ricochet off the atmosphere) is 6.5º (at 11km/s) and 10º (at 18km/s).

Encounters between the Earth and metallic asteroids with low velocity and low entry angle are rare, but they will occur. In the extreme case of 11km/s entry velocity and 6.5º entry angle we find that bodies >10^8kg all produce fragments at the surface with mass >7.10^6kg (>12m diameter). Iron bodies with pre-entry mass of 10^{10}kg and the above entry conditions produce showers of large fragments: 30-40 objects, each with final masses >10^7kg (up to $2.6x10^7$kg) ie. bodies 14-18m in diameter. Impact velocity for these fragments is 2-2.5km/s, and final impact angle 6-8º (total mass of <2.5km/s fragments on the ground is ~10^9kg). Although these velocities are higher than for typical meteorite falls, impact experiments have shown that low angles favour projectile survival [3]. We are currently investigating the survivability of projectile material in these types of impacts using numerical techniques.

Conclusions: That meteorites >$6x10^4$kg have not been discovered at the Earth's surface is not surprising. Given impact rates for irons with pre-entry mass 10^8-10^{10}kg [4], and the unusual entry conditions, low velocity fragments with mass ~10^7kg will arrive only every ~10Ma. But it is interesting that ~15m meteorites can occur. Whether they could be preserved and recovered is another issue.

References: [1] Artemieva N.A. and Shuvalov V.V. (2001) *J. Geophys. Res., 106,* 3297-3310. [2] Shuvalov V.V. et al. (2000) *Solar Syst. Res.* **34**, 49-60. [3] Schultz P. H. and Gault D. E. (1990) *Geol. Soc. Am. Spec. Paper, 247,* 239-261. [4] Bland P. A. and Artemieva N. A. (2003) to be presented at the *Third International Conference on Large Meteorite Impacts*, Nördlingen, August 5-7.