EPSC Abstracts,
Vol. 2, EPSC2007-A-00270, 2007
European Planetary Science Congress 2007

The Smart 1 impact event: laboratory simulation and prediction of crater shape and size.

M.J. Burchell (1), R. Robin-Williams (1), B.H. Foing (2) and the Smart 1 Impact Campaign Team

(1) School of Physical Science, Univ. of Kent, Canterbury, Kent CT2 7NH, UK. (2) Space Science Dept., ESA - ESTEC, Postbus 229, 2200 AG Noordwijk, The Netherlands. (M.J.Burchell@kent.ac.uk / Phone +44 (0)1227 823248)

The ESA Smart 1 mission (1, 2, 3) to the Moon ended its life in a deliberate impact on the lunar surface. This controlled impact occurred on Sept. 3, 2006 at a speed of about 2 km/s and an inclination to the horizontal of about 1°. This thus represents a rare Solar System impact event whose impactor properties are known in advance. Unfortunately the resulting impact crater is too small to be seen from the ground. Nevertheless, the general size and shape of the crater can be predicted from laboratory experiments combined with scaling to the size of the Smart 1 impact event. This is done here based on a set of 14 impacts into sand using the two stage light gas gun of the University of Kent (4). A preliminary report on based on 8 impacts is given in (5).

The laboratory impacts were made using 2.03 mm dia. aluminium spheres impacting a sand target at angles of 1 - 10 degrees and at 2 km/s. Sand was used as it exhibits flow behaviour under impact that results in similar appearing craters to those observed on the lunar surface etc. which have resulted from high speed impacts of large objects. The craters resulting from the lab impacts were measured and their sizes will be reported. Two critical angles of incidence emerge; above 5 degrees the craters are still circular in plan view (to within 10%), at 2 degrees (and below) the main crater is not only significantly elongated along the direction of flight (projected onto the sand surface) but also a secondary crater begins to emerge from the main crater (again along the axis of flight). Thus at shallow angles of incidence the total crater length grows significantly (as reported previously by (6)). At 1 degree incidence the mass excavated from the resulting crater was approximately 75x the projectile mass. In all the impacts

the projectile ricocheted off the surface, intact and at a very shallow angle (not in general equal to the angle of incidence). The speed of the ricocheting projectiles was found to be 1.8 km/s, a substantial fraction of the original impact speed.

Scaling the results to the Smart 1 impact event is done in two ways. A naïve scaling can be done normalizing all crater dimensions to the projectile size and replacing the projectile dimensions by those of the Smart 1 spacecraft. A more sophisticated method is to use pi-scaling. Both methods are applied to the data and suggest that the resulting lunar crater is some 6 to 26 m long and 2 - 9 m wide. The shape of the Messier crater on the moon may be a good indicator of what to expect when the Smart 1 crater is finally imaged.

References (1) Foing B.H. et al., Earth, Moon and Planets 85-86, 523 - 531, 2001. (2) Foing B.H. et al., Adv. Space. Res. 31, 2323 - 2333, 2003. (3) Foing B.H. et al., Adv. Space Res. 37, 6 - 13, 2006. (4) Burchell et al., Meas. Sci. Technol. 10, 41 - 50, 1999. (5) Robin-Williams R. and Burchell M.J., 38th Lunar and Planetary Science Conf., Abstract 1651, 2007. (6) Gault D.E. and J.A. Wedekind, Proc. 9th Lunar and Planetary Science Conf., Pergamon, New York, pp. 3843 - 3875, 1978.