

INDICATIVE BASIC ISSUES ABOUT LUNAR DUST IN THE LUNAR ENVIRONMENT* B.J. O'Brien¹ and J.R. Gaier², ¹University of Western Australia, 35 Stirling Highway, Crawley, WA, Perth, Australia, brianjobrien@ozemail.com.au; ²NASA Glenn Research Center, 21000 Brookpark Road, Cleveland, OH 44135, USA, james.r.gaier@nasa.gov

Introduction: In 2009, while images of levitated lunar dust fascinate scientists, memories of clinging dust worry and bewilder engineers and astronauts. “Dust is the number one environmental problem on the moon.” And it is not coincidence that the Mars Human Precursor Science Steering Group (MHPSSG) identified dust as the number one operational and human issue for future Martian exploration as well.

Arguably, as a consequence, just as geology was the primary and dominant energising science before and during the Apollo era, lunar dust is becoming the principal and charismatic energising science for future lunar missions themselves and for applications of lunar findings to distant Mars.

Basic issues of lunar dust - including recent discoveries - so fundamental they affect a wide range of lunar research and exploration beyond their immediately obvious scientific disciplines, must be recognised as priorities instead of being often overlooked in scientific, engineering and operational aspects of lunar dust, itself the number one environmental problem on the Moon.

Examples include (i) adhesive and cohesive forces on dust on sensitive surfaces as well as in plasmas; (ii) transport of charged dust due to local and global environments; (iii) nano-dust; (iv) collateral dust; (v) differentiation between composition of surface lunar dust and collateral dust on elevated surfaces which may be carried into a habitat. The unexpected and/or unknown realities of such basic issues can be overlooked in focussed analyses without the consequences to expectations being fully appreciated. Such factors are vital for full successes with future robotic and human missions to the Moon and Mars.

Four Recommendations with high or very high priorities are given together with the minimum perceived outcome from each should it be implemented.

Recommendation #1: With very high priority, new experimental and theoretical programs should focus on lunar nanoparticles, their properties if they exist and reasons for their absence if they do not exist. The minimum outcome will complete a gap in knowledge of primeval cosmic and lunar dust size and composition. The knowledge is vital to the height and composition of a lunar exosphere, to understanding processes of uniquely powerful and toxic nano-dust – including those with abundances of nanophase

metallic iron (np-Fe⁰) [1] – and medical applications on earth. The information will fill a “missing link” in descriptions of the lunar environment.

Recommendation #2: Very high priority should be placed on understanding the relationship between surface and adhered lunar dust, with synergistic theoretical support to connect all relevant physical forces associated with charging, lofting, transport, and adhesion/cohesion of lunar dust. The outcomes of this would include strong theoretical and experimental basis for predicting surface adhered type, size distribution, charge and surface forces directly from measured and/or estimated lunar surface dust parameters; Predictability of behaviour in challenging lunar regions (e.g., polar) and during global events; Basis for rational engineering estimates and technology for dust management.

Recommendation #3: With high priority, a working group of space engineers and scientists should analyse lessons from the Apollo era, plus updated developments, to develop protocols to foster synergies between the two cultures. Minimum outcome will include optimised efficient flexibility in Suitcase Science Packages on the moon and in any other landings on a celestial body, particularly those deployed on human expeditions.

Recommendation #4: Programs such as LASER should continue to be given very high priority support recommended by SCEM. The outcome would be that recent peer-reviewed discoveries from revisited Apollo 12 data, although not funded by LASER, are proof of the importance of updated intensive analyses of significant Apollo data [2].

Concluding Comments:

The indicative “basics” in this white paper are examples of fundamental properties of lunar environments that are still little known, little explored and even unexpected by theories and models in 2009, 40 years after Apollo 11. Recommendations about such “basics” include measures that do not all deal directly with lunar science itself, but with the vitally important measures as to how such science should be explored.

References: [1] Liu, Y., et al., Planetary and Space Science (56) 2008, pp. 1517-1523. [2] O'Brien, B.J., Geophysical Research Letters **36** L09201, doi:10.1029/2009/GLO37116.

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