FIRST RESULTS FROM LDEF'S MULTIPLE FOIL MICROABRASION PACKAGE

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The LDEF MAP Experiment

The Micro-Abrasion Package (MAP) aboard the Long Duration Exposure Facility (LDEF) is a micrometeoroid and space debris measurement experiment utilising the capture cell concept (1). The MAP experimental assemblies contain 2 foils covering a high purity substrate (2). Thinnest foils are of 1.5 micron aluminium, giving a limiting mass sensitivity for penetrating particles of less than 10^{-12} grammes at realistic velocities. The foils and substrates are mounted in trays whose orientation is constant with respect to the orbital velocity vector due to the gravity gradient and magnetic spin damped attitude stabilisation of LDEF. The orientations of the normals of 4 of the trays are designated North (D12), South (E6) , East (C9) and West (C3) , referenced to the 28.5 degree inclination of the LDEF orbital plane; and the fifth tray, always facing away from the Earth, is designated the space face. The five pointing directions are used to derive parameters of the orbital distribution of impacting particulates.

Orbital Considerations

LDEF's almost circular orbit, with a low altitude above the Earth when compared to the geocentric perihelion of orbital particles, implies very restricted and highly anisotropic access to five locations of LDEF's MAP experiment. The peripheral faces can be shown (3) to be accessed readily by orbital particles although the leading and trailing edges will differ markedly. To access the trailing edge a particle of high eccentricity but impacting at its perigee is required (i.e. overtaking LDEF) and even then its velocity will be relatively low; such particles are considerably less frequent than impacts on the leading edge which can be accessed by geocentric bound orbits of almost all inclinations and also by the interplanetary particulates. The north and south faces show symmetry to all distributions of bound orbits. The space end *cannot* be accessed by orbital particles at high speed, but is seen to be readily accessed by the interplanetary components; the mean solid angle exposure factor is twice that of the peripheral locations due to Earth shielding.

Analysis Priorities

Priorities for analysis of the MAP are:

1. Characterisation of the penetration size distribution in the thickest foils (30 μm) on the NSEW faces, followed by progressive analysis of thinner foils to 1.5 μm , including crater morphology studies.
2. Characterisation of impact perforation sites and residues on second surfaces
3. Characterisation of impact perforation sites and residues on the rear stop plate.
4. Spatial correlation of penetration data from 1) 2) and 3) above to determine trajectory impact angles, combined with crater morphology.

5. Chemical analysis via light element sensitive energy dispersive x-ray spectrometry of impact crater residues and capture cell residues on the second surface and stop plates.
6. Delineation of particle sources by both chemical and orbital characterisation e.g. cometary, asteroidal, interplanetary and/or space debris particulates.

Results

First results from the LDEF MAP will be presented at the Lunar and Planetary Science Conference.

LDEF MAP Co-Investigators

D.G. Ashworth, W.C. Carey, R.P. Flavill, R.C. Jennison.

References

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(2) J.A.M. McDonnell, D.G. Ashworth, W.C. Carey, R.P. Flavill, R.C. Jennison, The Long Duration Exposure Facility (LDEF) Mission 1 Experiments, (NASA SP-473, ed. Clark, Kinard, Carter and Jones, 117-120, 1984.

(3) D.I. Olsson-Steel and J.A.M. McDonnell, (in submission)

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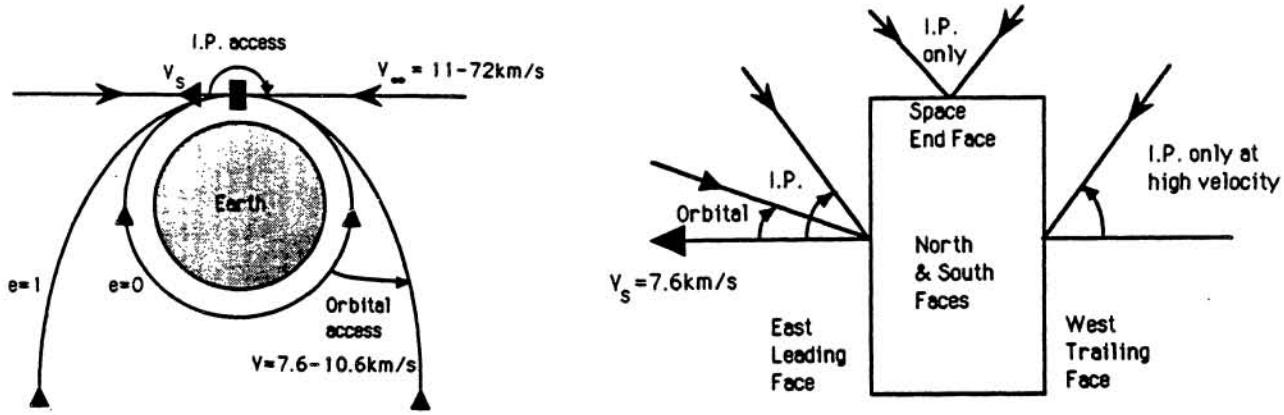

Figures 1(a) and 1(b). Schematic of LDEF orbit and access of orbital and interplanetary particulates (shown resolved in orbit plane). Orbital debris access is only to peripheral locations, and at low angles relative to the experiment normal. The space end is accessed only by interplanetary particulates which also access the peripheral trays but at angles from 0° to 90°.