

IMPACT HOLES AND IMPACT FLUX ON RETURNED SOLAR MAX LOUVER MATERIAL. R.A. Barrett¹, R.P. Bernhard¹, D.S. McKay²; ¹Lockheed-EMSCO, 2400 NASA Rd. 1, Houston, TX 77058, ²NASA-Johnson Space Center, Houston, TX 77058.

Introduction: Returned material from the Solar Maximum satellite contains many impact features on surfaces exposed to space for over 50 months [1,2,3,4]. The exposed aluminum louver material was scanned optically for impact features which were subsequently studied under a JEOL-35CF scanning electron microscope. The attitude control systems (ACS) box was covered by 84 louvers, each constructed of two layers of 125µm-thick aluminum separated by a 3mm-space supported by ribbing along the louver center. The total aluminum louver area is approximately 1.0m² and contains 65 impact holes [5]. Projectile material residue associated with the holes was studied chemically with a PGT System 4 energy dispersive x-ray analysis system (EDXA) including the use of a light element detector. Assignments of impact projectile origin are based on chemical compositions of material found intimately associated with, or melted into, the hole or resulting spray pattern.

Holes: The holes in the louver material range in size from 180 to 850µm. The distribution of the holes by size and category is shown in Figure 1. The holes typically have raised, overturned, circular rims on the front and back sides of the top layer, and are similar to those described for aluminum and gold foils subjected to hypervelocity impacts [6,7]. The bottom layer typically displays a spray pattern of pits and a radiating textured surface much larger in diameter than the hole in the top layer. Both layers may contain residue of projectile material. The residue on the top layer, when seen in large quantity, covers the inside wall of the hole and the surfaces of the overturned rims, both on the front side and on the back side of the layer. The residue occurs as globs and stringers of melted material and some particles on the surface of the aluminum. Projectile residue may also occur in second layer spray patterns. This residue occurs as tiny splatters, stringers, globs and particles.

Composition of Residue: Of the 65 holes detected by optical microscopy [5], 60 have been examined by SEM/EDXA. Analyses show that 6 of the holes are located in regions of high surface (and sub-surface) contamination, and projectile residues could not be separated from contamination. We were able to assign each of the 54 remaining holes to one of two categories: meteoritic or man-made debris. EDXA of projectile residue shows meteoritic material [8] to be present in 47 of the 54 holes. Most of the extraterrestrial residues are approximately chondritic in composition. Additionally, some residues are sulfide (containing primarily Fe, Ni, S) and some are mafic (primarily Mg, Si, Fe). Seven of the holes contain no detectable meteoritic residues but contain residue consisting of materials common in spacecraft thermal coatings. These thermal coatings, predominately paint, are defined by the presence of Ti, Si, Zn, C, and O in major amounts, with minor amounts of K, S, Cl, Fe and Al. [9].

Impact Flux: Fig. 2 shows cumulative flux of projectiles of both meteoritic and debris origin in the Solar Max satellite aluminum louvers. Flux of micrometeorites causing impact holes is similar to fluxes previously reported [10]. Fig. 2 present the first reported flux curve for the man-made orbital debris over this size range. Fig. 2 also contains new data for larger micrometeoritic impacts which extend the Solar Max-based flux curve in this size and mass range.

The number of orbital debris-derived holes is about a factor of 7 less than the number of micrometeorite-derived holes over the size range considered here (Fig. 1). However, if the hole sizes are converted to projectile mass using a mean velocity of 20 km/sec for micrometeorites and 10 km/sec for orbital debris using a scaling equation developed for aluminium foil perforations [11], then the true mass flux of the orbital debris is about a factor of 3 less than that for micrometeorites for this size range (Fig.2).

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Figure 1.

FLUX OF LOUVER HOLES

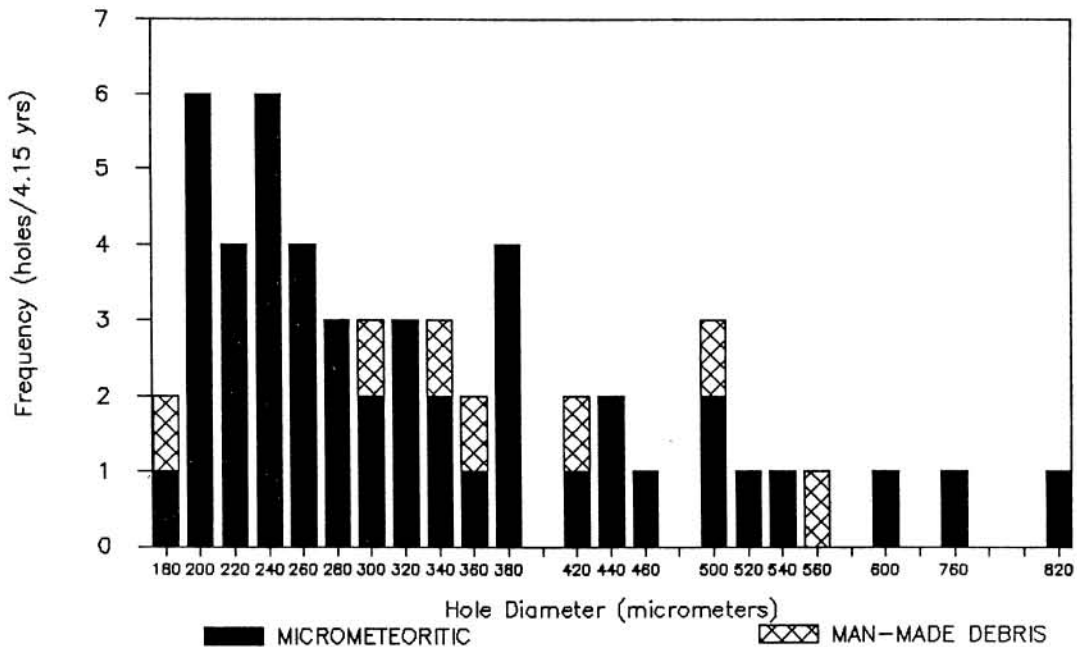


Figure 2.

CUMULATIVE FLUX OF LOUVER HOLES

