THE RELATIVE MASS FLUX OF MICROMETEORITES AND THE SOLAR WIND, D. S. Burnett and Carol Polanskey, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125.

Allowing for even modest improvements in analytical capabilities, it now appears feasible to consider the analysis of a large number of elements and isotopes in collector foils exposed to the solar wind in an analogus manner to the Apollo Solar Wind Composition measurements of He, Ne, Ar (1). The general mission requirements would be return of the collector materials to earth after a 1-2 year sun-oriented exposure outside the magnetosphere. A variety of super ultra-pure collector materials for different elements would be required, and these must be handled without contamination. This is clearly a challenging undertaking, but it does not appear impossible.

The micrometeorite flux is a potential source of background for a solar wind measurement. There are two principal issues: (a) can the micrometeorite mass flux be ignored compared to the solar wind? and (b) even if the micrometeorite flux is important, will a significant fraction stick to the collectors? As discussed below, the answer to (a) is probably no; thus (b) is an important issue. Intuitively, and by analogy with lunar microcraters, retention of projectile material during a hypervelocity impact in zero gravity would be expected to give insignificant retention. However, Hörz et al. (2) report 20-50% retention of projectile material for laboratory impacts of mg-sized silicate projectiles into Au and Cu for velocities up to 6.5 km/sec. This is a serious complication in that Au and other noble metals are a potentially important class of high-purity collector materials. However, more recent experiments (Hörz, private communication) show much less retention with micron-sized silicate particles, suggesting that, for all collector materials which quantitatively retain implanted solar wind ions, micrometeorite retention should be low.

We now discuss issue (a) above. The significant disparities in published micrometeorite fluxes have caused us to study the available data in detail, both from lunar microcraters and satellite detectors. Although a side issue to the major purpose for undertaking our study, it appears to us that the satellite mass fluxes are possibly distinctly higher than those inferred from microcrater diameter distributions, even when the well-documented anisotropy in the flux is considered. The anisotropy has previously been cited as causing an <u>apparent</u> difference in the satellite and micrometer fluxes (e.g. 3, 4, 5).

We have focused on satellite data from the Heidelberg instruments on the Heos (4) and Helios (6, 7) spacecraft, for events at 0.9-1.0 AU with measured masses greater than 10^{-12}g. With this mass restriction, complete velocity sensitivity should be obtained. There is some underestimation of measured masses in this range (7), but this should not affect the cumulative number flux significantly and would tend to suppress the differences noted above. A more serious complication is the lower heliocentric velocity of the Helios spacecraft at 1 AU (~20 km/sec; Grun, private communication) than that of the earth-moon system (~30 km/sec). Since most impact events appear to be due to the spacecraft overtaking micrometeorites, the Helios flux should be lower than that inferred from microcraters. Our point is that it seems to be higher. Heos had an eccentric polar earth orbit, and an increase in flux in the near-earth portions of the orbit was observed (4). Consequently, following Hoffman et al. (4), we considered only data from near apogee and from the earth-apex direction. We have adopted the microcrater rate vs. diameter curve of Morrison and Zinner (5) based on 12054. The Heos and Helios data indicate an average impact velocity of roughly 20 km/sec for the earth-moon system; consequently, we have used a pit diameter-mass conversion for 20 km/sec based on laboratory experiments (8); however, this conversion remains a major source of uncertainty.

FLUX OF MICROMETEORITES

Burnett, D.S. and Polanskey, C.

For comparison of satellite and microcrater fluxes, it is necessary to make consistent assumptions about the angular distribution of the micrometeorite flux. Even though not correct, for purposes of comparison, an isotropic flux can be assumed for simplicity. This is also justified since detailed information of the anisotropy is not available. Thus, we have taken the actual number of observed events and the published area-time-solid angle factors for Heos and Helios to calculate the satellite fluxes. When converted to 2π-steradians, these average fluxes can be fairly compared with that inferred from the microcrater production rate of Morrison and Zinner. For mass greater than 10^{-12} and for 2π geometry we calculate number fluxes of 1 and 0.3 event/cm^2-yr for Helios and Heos, respectively. A serious problem with our approach is that only a few events survive the selection criteria (2 for Heos and 5 for Helios). Thus, the two satellite fluxes are possibly consistent. However, the Helios flux is 6 times higher than the Morrison-Zinner 0.15/cm^2-yr microcrater flux.

The possibility should be considered that the flux of comets in the past few hundred years is significantly higher than that over the past 10^5 yr, as recorded by 12054. However, it is also possible that the above flux differences reflect errors in the exposure age of the 12054 glass surface or in the conversion between pit diameter and projectile mass.

To compare the micrometeorite and solar wind Si flux, we adopt the mass dependence indicated by the slope of the 12054 microcrater distribution but (to be conservative) increasing the absolute value by a factor of 6 to match the Helios datum. The slope of the mass distribution is sufficiently shallow that the area-averaged Si flux is determined by the largest impact events. The calculated integral micrometeorite Si flux is thus determined by the choice of upper mass limit of the integral. This choice was made as the micrometeorite mass for which there was a 10% probability of impact per year of exposure for the detector area of interest. Since this upper mass limit will increase with area, the micrometeorite background flux will increase with area analyzed for implanted solar wind. The smallest area is least subject to micrometorite background. We have calculated the relative micrometeorite to solar wind Si flux for areas of 0.1, 1 and 100 cm^2 (the latter is probably the maximum practical area which could be analyzed for solar wind). For an assumed solar wind Si atom flux of 3×10^{11}/cm^2-yr, the relative micrometeorite/solar wind Si fluxes are 0.04, 0.2 and 5 for the above areas. Assuming both fluxes have approximately chondritic composition, the same factors should hold for all nonvolatile elements. For an uncollimated sun-oriented solar wind collecter, the anisotropy on the micrometeorite flux will decrease these ratios by roughly a factor of 2. Given the large uncertainties in the micrometeorite flux, these factors are large, and the importance of the fractional retention of micrometeorite material is clear. To cause a 5% correction to the solar wind flux the required micrometeorite sticking percentages are 100%, 25% and 1% for 0.01, 1 and 100 cm^2, respectively. It appears that micrometeorite background would be important only for the analysis of large collector areas, and possibly not even then.

REFERENCES. (1) Geiss, J. et al. (1972) Apollo 16 Preliminary Science Report, NASA SP-315. (2) Hörz, F. et al. (1983) Proc. 14th Conf. (3) Fentig, H. et al. (1974) Proc. 5th Conf., 2463. (4) Hoffmann, H.J. et al. (1975) Plan. Sp. Sci. 23, 215. (5) Morrison, D. and Zinner, E. (1977) Proc. 8th Conf., 841. (6) Grün et al. (1980) Plan, Space, Sci, 28, 333. (7) Grün, E., Thesis, Heidelberg, (1981). (8) Mandeville, J.C. and Vedder, J.F. (1971) E.P.S.L., 11, 297.