SIMS CHEMICAL ANALYSIS OF EXTENDED IMPACTS ON THE LEADING AND TRAILING EDGES OF LDEF EXPERIMENT A0187-2. S. Amaril1, J. Foote1, C. Simon1, P. Swan1, R. M. Walker1, E. Zinner1, E. K. Jessberger2, G. Lange2, and F. Stadermann2. 1McDonnell Center for the Space Sciences and the Physics Department, Washington University, One Brookings Drive, St. Louis, MO 63130-4899. 2Max-Planck-Institut für Kernphysik, Postfach 103980, D-6900 Heidelberg, Germany.

Experiment AO 187-2 on LDEF consisted of 237 capture cells each 8.6 x 9.4 cm in size. Each cell consisted of four polished high purity Ge target plates, 42 x 39 x 0.5 mm, covered with a 2.5 μm thick mylar cover foil spaced 200 μm from the Ge plates. The mylar was coated with 1000 Å of Ta on the side facing the Ge to facilitate ion-probe analysis, and was coated with 100 Å of Au-Pd on the top (space-facing) side to inhibit space erosion of the plastic. 120 cells were mounted in a tray on the leading edge of the spacecraft and 117 cells were mounted in portions of two separate trays on the trailing edge. Following the return of LDEF to earth after a much longer mission than originally planned, it was found that most of the plastic cover foils had failed. All of the foils on the leading edge were gone and only twelve cells on the trailing edge were still intact.

However, optical microscope and SEM examination showed that many of the bare cells on both the leading and trailing edges possessed numerous "extended impacts" that must have been caused by the clouds of debris formed when incoming particles traversed foils that were still intact at the time of impact. Our initial efforts have focussed on the ion probe study of extended impacts on the trailing edge cells that had lost their plastic foils. As described in more detail in a paper presented at the First LDEF Post-Retrieval Symposium [1], some 53 candidate impacts were found by optical scanning of 116 cells on the trailing edge. Successful ion probe analyses using our modified CAMECA IMS 3f instrument have now been performed on 40 of these impacts. Lateral scanning profiles across these impacts were made by rastering an O+ primary ion beam of 1-2 nA over an area 40 μm x 40 μm and then stepping across the impact. Multi-element depth profiles were obtained at each analysis site by cycling through a series of isotopic masses. Individual depth profiles were then integrated from cycles 3 to 20 to obtain an integrated secondary ion count for each point in a lateral traverse. Although the ion signals did not match perfectly the appearance of the impacts as seen in the SEM, projectile debris material could be detected in almost every impact (see Fig. 1). We found that the ratios of different elements were somewhat variable across individual lateral traverses – either due to inhomogeneities in the projectiles themselves or to variable segregation of elements in the impact and collection processes. Rather than attempting to integrate the data across a single lateral traverse of a complex impact structure, we choose to report element ratios determined from the peak values seen in a traverse. Ion counts are converted to elemental ratios using the sensitivity factors previously determined on four glass standards [2].

Histograms of the ratios of Al, Fe, and Ti relative to Mg for 40 impacts are shown in Fig. 2. It can be seen that the distribution of values for the impact projectiles overlap those previously determined for IDPs [3] as well as average chondritic ratios. However, the average ratios for the LDEF impacts are systematically higher for the refractory elements Al, Ca, and Ti than those for either chondrites or IDPs. Conversely, the Fe/Mg ratios are systematically lower. Comparison of these data with earlier elemental fractionation trends obtained from studies of laboratory impacts of standard glasses [2] led us to suggest [1] that many of the apparent differences could be attributed to selective volatilization and redistribution of elements between the projectile as it existed in space and the deposits that are measured. The new data are consistent with the earlier results and can be similarly interpreted. However, it should be noted that the required elemental fractionation exceeds that previously measured (or extrapolated) for laboratory impacts and a difference between the interplanetary particles studied here and IDPs cannot be excluded. In particular we note that Ca depletions which have been observed for IDPs [4] do not seem to be reflected in the LDEF impacts.

Optical scanning of the bare leading edge cells also shows many extended impacts. Although this demonstrates that the cover foils remained intact for some time after the deployment.
of LDEF, further analysis will be required to assess the value of the leading edge cells for the study of cosmic dust and/or orbital debris. A preliminary analysis of 7 front side impacts suggests that most of them are due to space debris and not micrometeoroids. A new SIMS system for the analysis of impact material based on ion imaging of elements in the ion probe is currently under development.