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Operation

ROLLER COASTER

DEFENSE NUCLEAR AGENCY
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PROJECT OFFICERS REPORT—PROJECT 2.6c

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SPECIAL PARTICULATE CHARACTERISTICS

C.D. Dunn, Project Officer

R.L. Bersin, Manager
Research and Development

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Richmond, California

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ABSTRACT

The procedures developed and used in obtaining data on individual particles resulting from the four events of Operation Roller Coaster are presented with discussions of their accuracy and reliability. A very large amount of data on particle size, shape, color, and plutonium content was obtained. Less extensive data on uranium content was obtained by standard fluorometry. Special techniques for obtaining the density of irregular particles, identifying submicron radioactive particles, and observing the elemental distribution quantitatively in inidividual particles were investigated in depth; recommendations on further development of these techniques are included.

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CHAPTER 1

INTRODUCTION

1.1 OVERALL OBJECTIVES

The objective of Project 2.6c, Special Particulate Characteristics, was to investigate those characteristics of plutonium-uranium-bearing particulates formed during a one-point detonation of a nuclear weapon which are pertinent to evaluation and prediction of the effectiveness of various storage configurations in minimizing the hazard resulting from accidental non-nuclear detonation.

1.1.1 Specific Objectives of Individual Analytical Tasks

Optical Microscopy:

1. To determine size distribution input data for analyzing and predicting atmospheric dispersion, fallout patterns, and hazard arising from inhalation and ingestion of particles.

2. To provide knowledge relative to particle-formation mechanisms and the role of background materials (e.g. cover soil) in determining the observed characteristics of the particles.

Alpha Counting of Unaltered Particulates:

1. To provide indication of the plutonium content, and thus alpha activity, of the particulate debris.

Although for particles above a given size range (~10 microns) self-absorption of alpha rays may be significant, measurements were to be performed on large as well as small particles in anticipation that particle characteristics in the main would be sufficiently uniform to allow utilization of appropriate calibration curves. The relative simplicity of such gross counting allows for the accumulation of extensive data for meaningful statistical analysis of activity distributions in the particulate debris.

Precision Alpha Counting:

1. To determine the true plutonium content of individual particulates.

2. To seek the relationship between true plutonium content, particle physical characteristics (size, color, morphology), and gross alpha count of individual particles.

Density of Individual Particles:

1. To provide requisite density data for fallout analysis studies.

2. To provide input data for interpretation of alpha counting data on unaltered particles.

Fluorometric Uranium Analysis:

1. To investigate the distribution of uranium and plutonium within particles for fractionation effects and possible correlation of such observations with other particulate characteristics.

Electron Microscopy:

1. To investigate utilization of the electron microscope for extending the input data on particulate size distributions into the domain of submicron particles.

Electron Diffraction:

1. To investigate the utilization of electron-diffraction pattern analyses towards determination of the matrix composition of individual particles to provide input data for developing understanding of the observed physical and radiological characteristics of the particulates analyzed.

2. To provide means for identifying fallout particles in the submicron size range.

Electron Probe Microanalysis:

1. To investigate the utilization of electron-probe microanalysis for the determination of matrix composition of individual particles to provide input data for developing understanding of the observed physical and radiological characteristics of the particulates analyzed.

1.2 THEORY

A major portion of the theories behind the physical and nuclear analytical techniques utilized to obtain the special particulate characteristics is extensively descril ed in the literature. The procedures for utilization of these techniques for the analyses associated with Project 2. 6c. however, were in many instances unique.

We shall thus confine the theoretical discussions within this chapter to a brief review, indicating the points of particular interest to the reader who may be unfamiliar with the analytical methods employed, citing references to more extensive discussions. The significance of these theoretical considerations will be expanded upon in the following chapter, where their relation to the experimental and analytical procedures employed will be emphasized.

1.2.1 Optical Microscopy. Optical microscopy is an effective technique for studying the size, color, and morphology of particles larger than 2 microns. The image of an object formed by spherical lenses is never identical with that object but suffers from the five monochromatic Seidel (third order) aberrations; the two primary chromatic aberrations; the usually ignored fifth and higher order aberrations; and the often ignored tertiary chromatic aberrations. Certain nonlinear effects present are unimportant in the present application.

The most important effect of these aberrations is to reduce the sharpness of the image and to make its true color somewhat difficult to determine. Microscopic equipment is designed with the assumption of a two-dimensional object and the restriction of a fixed geometrical relationship between light source, condenser, object, objective lens combination, and ocular lens combination, which permits three of the five monochromatic aberrations to be brought to zero at the expense of a highly curved field with some distortion. The curved field is of small importance because of the accommodation of the eye and the focal depth of the camera, and residual distortion is unimportant for small measurements near the center of the field. The most perfect system ordinarily obtainable uses Kohler illumination, an aplanatic-achromatic condenser, apochromatic objectives with correction collars, and compensating oculars.

The procedures employed at Tracerlab, the resolution limits and aberrational considerations associated with these procedures, are described in Chapter 2. Reference 1 contains a comprehensive theoretical dissertation on optical microscopy.

1.2.2 <u>Alpha Counting of Unaltered Particles.</u> Sample particles in the micron-size range containing alpha-emitting plutonium can be directly counted for alpha emission. This counting is performed in a counter producing an output pulse which is roughly proportional to the residual energy of the alpha particle after leaving the sample particle matrix. The theory of operation of such counters (2π proportional flow counters) is well described in the literature (see Reference 2) and will not be discussed here.

Of prime concern is the effect of loss of alpha-particle energy within the sample particle matrix, or self shielding. The alpha particles from Pu-239 have an energy of 5.15 Mev and a range of 5.6 mg/cm^2. If the density of the matrix material is ρ $grams/cm^3$, it is easily shown that the alpha particle range in microns, R, is approximately given by:

$$R = \frac{56}{\rho} \text{ microns}$$

For a sample particle of diameter d, and for a homogeneous uniform distribution of plutonium within the matrix, the relation between observed counts per minute in the counter, CPM, and sample diameter d will be:

1. for $d \ll R$, CPM αd^3, since self shielding is negligible

2. for $d \gg R$, CPM αd^2, since the countable sample can be considered to have a surface equal to that of the sample, of thickness infinite in relation to the alpha range, R.

In general, then, for a given matrix material and a given volumetric distribution of plutonium, D,

$$\text{CPM } \alpha D d^n \quad (2 \leq n \leq 3)$$

Now the total plutonium content of the particle is given by:

$$[Pu] = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3 D$$

Thus the relation between observed CPM and true Pu content is given by:

$$\frac{CPM}{[Pu]} \propto \frac{d^n}{d^3}, \quad 2 \leq n \leq 3$$

1.2.3 Precision Alpha Counting. Precision alpha counting is employed to determine the true plutonium content of the sample, without dependence upon matrix composition or self absorption. The technique utilized for precision alpha counting relies on the fact that the alpha particles from radioisotopes are emitted at discrete energies. A detector with sufficient energy resolution is thus capable of differentiating between the alpha radiations from different isotopes.

The preparation of samples for analysis requires chemical separation of the plutonium, with subsequent preparation of the sample for counting. During this process, a portion of the sample may be lost. Since it is required to determine the true total plutonium content of the initial sample, means must be available to account for such losses. This is accomplished by adding a known quantity of a tracer of a plutonium isotope not present in the initial sample, this tracer being equilibrated with the dissolved sample before chemical separation is initiated.

In addition, the detector must be capable of independently measuring the quantity of tracer and sample isotopes in the final sample. This is accomplished through identification of the isotopes by the energy of their emitted alpha particles.

Utilizing this approach, the means are available for precise determination of the total plutonium content of the initial sample.

1.2.4 Density of Individual Particles. Information on the density of the fallout particles is of interest for understanding fallout characteristics and to provide input data for interpreting the results of gross alpha counting.

Principle of the Technique Utilized. The density of spherical particles down to 10 microns has been measured with ease and accuracy by the application of Stokes' law for terminal velocities (see Reference 3). The particle is immersed into and allowed to fall slowly (with respect to the speed of sound in the medium) through an incompressible, viscous fluid infinite in extent with relation to the particle size. The particle accelerates until a terminal velocity is approached, at which time the bouyant force is equal to the drag force. For spheres a simple relationship was derived by Stokes in 1847 between the terminal velocity, diameter of the sphere, the densities of sphere and fluid, and the viscosity of the fluid useful for a Reynolds Number up to around 1.2. For irregular particles, the two unknown quantities are the density of the particle and a geometrical factor. If the terminal velocity is measured independently in two different fluids, both the density and geometrical form factor can be obtained by simultaneous solution of the equations. Given these, the terminal velocity in any medium can be predicted.

Experimental Considerations. The small size of the particulate samples studied required that special techniques be utilized for observing the particle rate of fall. If a collimated beam of light is passed axially through a column of liquid in a darkened room, the only visible light will be the glow from the liquid itself due to the Tyndall effect. The scattering of light will render any extraneous matter, with a diameter larger than a few microns, visible to the naked eye. The intensity of the scattered light will depend on the strength of the illuminating source and the size and reflectivity of the particle. By means of this principle of light scattering, a 20-micron particle can easily be observed at a distance of one meter, and even a 5-micron particle can be visually followed. This allows replicate measurements of a single particle to be made during its fall and permits the use of a fluid with a comparatively low variation of viscosity with temperature.

A large diameter for the liquid-filled tube compared with that of the particle eliminates the effect of drag exerted by the tube wall on the falling particle. Faxen (see Reference 3) has shown that the reduction of particle velocity due to interaction with the cylinder wall is less than one percent when the ratio of particle diameter to cylinder diameter is 0.01.

The apparatus used consisted of two highly polished, concentric, 35 cm-long borosilicate glass cylinders with inside diameters of 2.5 cm and 0.5 cm. A calibrated linear scale is etched on the surface of the outer cylinder. Both tubes are filled with trichloroethylene. As this liquid has essentially the same index of refraction as borosilicate glass, reflections from the wall of the inner tube are eliminated; and, in effect, the inner tube is invisible. The liquid in the outer tube also serves to stabilize thermally the fluid in the inner tube.

1.2.5 Fluorometric Uranium Analysis. Quantitative measurement of nanogram quantities of uranium was required to determine uranium content of individual fallout particles.

Melts obtained by fusing uranium salts with sodium fluoride fluoresce a brilliant yellow green when illuminated by long-wave (3650Å) ultraviolet light. The intensity of fluorescence is directly proportional to the total uranium content and is measured with commercially available apparatus. Although the test is specific (niobium causes weak fluorescence but at shorter wavelength) several elements including platinum quench the fluorescence if present in sufficient concentration; other elements may enhance the fluorescence or shift its wavelength. In the analysis of submicrogram particles, these effects can be ignored. The fluorescence of the melt is dependent on its thermal history, so one must be careful to prepare all samples in the same manner. The molten NaF (with 5% LiF to lower melting point and adhesion to the crucible) is extremely corrosive and will attack the platinum dish if heating is prolonged. No chemical pretreatment of the particle is required (see Reference 4).

1.2.6 Electron Microscopy. Interest in studying particle-size distributions below the limits of optical microscopy (~2 microns) prompted consideration of electron microscopy.

Electron microscopy is quite analogous to optical microscopy except that the wavelength associated with a 100-Kev electron is so small that the resolution and ultimate magnification is limited only by the perfection of the magnetic lenses, stability of currents and voltages, and the thinness of specimens. This resolution ranges from 3 millimicrons in simple instruments used for training and preliminary inspection to 0.2 millimicron in the finest research instruments. The principal limitations on electron microscopy are that the specimen or mounting film must be not more than 20 millimicrons thick and capable of withstanding several amps/cm^2 of 100-Kev electrons in a vacuum below 10^{-5} Torr. In thicker films (or lesser vacua) the fraction of electrons in the beam undergoing scattering becomes sufficient to impair resolution and reduce contrast.

The contrast between small, low-density particles and most substrates tends to be poor but can be improved by heavy element shadowing if the particles lie on the supporting film. If the particles are inside the film, shadowing is impossible.

1.2.7 Electron Diffraction. The Roller Coaster particles were expected to consist of a fairly pure, if complex, oxide of uranium, plutonium, and silicon. It was thus anticipated that identification of submicron-fallout particles by their diffraction pattern would be possible.

The wavelength of 50-Kev electrons is the order of the distance between atoms in a crystal, so the Bragg condition can be satisfied and diffraction patterns form. e.g., Laue spots for single crystals or Debye rings for strongly polycrystalline materials, and even Kikuchi patterns for unusually perfect crystals. The diffraction pattern is determined by the crystalline structure of the substance and usually identifies it uniquely; extensive tabulations of patterns are available.

The low penetrating power of electrons limits this technique to clean particles with thin edges. The electron diffraction pattern is formed in the electron microscope by bringing the magnification to zero.

1.2.8 Electron Microprobe. The matrix composition of the individual fallout particles is of interest for correlation with other physical and radiological characteristics observed.

The electron microprobe represents a development of the science of X-ray fluorescence spectroscopy in which the fluorescence of the specimen is excited directly by an electron beam rather than by an X-ray source. The electron beam can be focussed to a micron diameter spot or less, but due to scattering in the specimen, the effective spot size is not less than 2 microns. Thus a very small region of the specimen may be selected for analysis, or the specimen may be scanned to produce an analysis as a function of location. The energy of the beam is under control and one may select to some extent which lines will be excited and to what degree. The fluorescence is analyzed by a standard X-ray spectrometer, and by monitoring the intensity of a particular line as a function of beam position, a map or line profile can be built up showing the distribution of a given element in the specimen.

CHAPTER 2

EXPERIMENTAL AND ANALYTICAL PROCEDURES, DATA RELIABILITY AND ERRORS

The material presented in this chapter is an outline of techniques utilized for sample analysis, treatment of data, and estimate of errors. The customary section on operations is omitted because no on-site participation by Project 2. 6c was required.

Particulate samples consisting of five-stage Anderson impactors, four-stage Casella impactors, total air samplers, and sticky cylinders were available. The samples to be analyzed were selected by the Scientific Director's staff, which also specified the samples upon which composition analyses were to be performed. Before leaving the experimental site, the samples were processed by Project 5. 1a. sent first to the Naval Ammunition Depot, Concord, California, and then dispatched for particulate studies.

The first two stages of the impactors and the total air samples were analyzed only for particles larger than two microns; the latter stages of the impactors were analyzed for submicron particles. The first two stages were combined in a single sample and the latter three (Anderson) or two (Casella) stages were combined in a second sample as specified by the scientific director. The exit filters were considered a part of the second sample but were not combined with it because of the different handling procedure required. No sticky cylinders were analyzed by Project 2.6c.

All chemicals are of reagent grade; acids and bases are concentrated but not fuming, unless otherwise noted.

2.1 OPTICAL MICROSCOPY

2.1.1 Procedures, Experimental

Sample Preparation:

Impactor Slides, Stages 1 and 2:

1. Remove the samples from their containers in a clean glove box lined with absorbent paper with clean gloves and clean glassware, etc.

2. Wash the sticky surface off into an evaporating dish, using a minimum quantity of amyl acetate. Use a rubber policeman to make sure all material is removed.

3. Add a small amount of collodion flexible to make about a 10% mixture.

4. Pour carefully onto microscope slides and set aside to dry.

5. Remove from glove box and label.

Impactor Slides, Latter Stages:

1. Proceed as in Steps 1 and 2, above.

2. Pour into a small bottle.

3. Extreme care must be exercised to insure cleanness, since this solution will be used to make electron microscope grids.

Total Air Samplers:

1. Under the Safelight in the darkroom, place a sheet of Kodak No-Screen X-ray film in an exposure folder and cover with a very thin sheet of polyethylene, mylar, or something similar.

2. Place the filters on the sheet and puncture each sheet and the film in two places for orientation.

3. Carefully close the folder and expose for 24 hours. If over or underexposure results, vary the time.

4. Develop as in Radioautography Procedure for Individual Slides (see next section).

5. Match the filter to the film and punch out the radioactive sites.

6. Place the punched out filter paper on a slide and tease apart in a few drops of amyl acetate.

7. Add a drop of collodion flexible and spread over the slide.

8. Autoradiograph the slide as in Radioautography Procedure for Individual Slides and examine microscopically for the particle. If necessary, tease the paper further and re-autoradiograph.

9. Repeat until the particle can be isolated.

Radioautography Procedure for Individual Slides:

1. Under the Series 1 Safelight in the darkroom, cut 8- by 10-inch sheets of Kodak No-Screen X-ray Film into one-inch strips.

2. Fit the film to the microscope slides carrying the particles and cut the film to the appropriate length.

3. Fix the film to the slide at the end with a hinge of masking tape. This will register the particle.

4. Lay the slide in an X-ray Exposure Folder.

5. Repeat Steps 2 to 4 for the remaining slides.

6. Close the exposure folder and allow the exposure to continue for 24 hours. (If the first slides developed are either underexposed or overexposed, vary the exposure time for the best radioautography.)

7. Open the folder under the Safelight, bend the film back from the slide at the tape and place the film in the developer (Eastman Kodak X-ray Developer) for one minute (being careful not to wet the slide) by draping the slide over the edge of the tank.

8. Dip the film in the wash water for around 10 seconds, remove, and place the film in the fixer (Eastman Kodak X-ray Fixer) for five minutes.

9. Remove and place the film in the wash water for 30 minutes.

10. Place the film on the drying rack and leave until dry. Care must be taken in each step to avoid wetting the slide.

Particle Separation Procedure:

1. Take the radioautographed slide and make a small hole through each black spot where a particle is to be separated.

2. Bend the film back down to the slide and place it under the microscope.

3. Locate a punched hole under the microscope. Look through the hole to locate the particle under it.

4. Bend the film away from the slide and relocate the particle.

5. With a steel rod sharpened to a 20-micron radius, cut the collodion around the particle in the shape of an eye with two cuts.

6. Pick up the cut-out with the steel rod and place it on a microscope coverslide.

7. Fix the particle to the coverslide with a drop of 1-percent collodion solution.

8. Write the particle identification on an identification tag and fix the tag to the coverslide.

9. Place the coverslide in a sample can.

Particle Size Measurement Procedure:

1. Tape the coverslide containing the (single) particle to be measured under the optical microscope (Type A066), using lowest illumination and blue filter.

2. Locate the particle under 100X magnification. Close field diaphragm and focus condenser. If necessary, make adjustment of alignment.

3. Position the appropriate objective (10X for particles >100 microns; 43X for particles >30 microns; and 97X for particles <30 microns).

4. Focus the microscope with the fine focus adjustment. Check for proper numerical aperture on condenser.

5. Set the filar micrometer eyepiece on one edge of the particle and read the micrometer. Always approach the particle from the same side.

6. Carefully screw the filar across the particle to the other edge. Read the micrometer and subtract the previous reading. Write the result in the notebook.

7. Rotate the micrometer eyepiece 60^{o} and repeat Steps 5 and 6. Then rotate it another 60^{o} and again repeat Steps 5 and 6. (Note: With irregular particles measure the maximum dimension, the minimum dimension, and the best visual average dimension.

8. If the particle is transparent, record its color, using the filterless position. If the particle is opaque, transfer to the microscope with the vertical illuminator.

9. Calculate the particle volume. The true particle diameter is the apparent diameter less the resolving power of the microscope.

Microphotography Procedure:

1. Place the camera and microscope attachment on a microscope with an Ortho Illuminator.

2. Check that the microscope and illuminator have been properly adjusted. If not, adjust them according to the Procedure for Initial Photomicrographic Adjustment.

3. Place the particle to be photographed under the microscope and locate it with the objective to be used.

4. Set the color filter to green for a black and white exposure and to daylight for a color exposure.

5. Focus the particle through the ocular of the microscope attachment.

6. Set the light intensity at medium or high for the 10X objective, depending on the darkness of the subject; set it at high or ultra high for 43X; and set it at ultra high for 97X.

7. Set the exposure at 1/10 second.

8. Load the Polaroid camera carefully with Polaroid P/N film.

9. Take the picture.

10. Remove the particle from the microscope.

Carbon Film Coating:

1. Place the coverslide on a wire screen support directly under the electrodes.

2. Evacuate to at least 10^{-5}mm.

3. Strike an arc and hold for five seconds.

4. Examine coverslide with a flashlight through the porthole. If a just-visible coat of carbon has not formed, repeat Step 3.

2.1.2 Analytical Procedures and Data Reliability

Particle Diameter and Volume. Table 2.1 presents information on field depth and resolution for the various combinations of objective and ocular utilized for these analyses. Size measurements were with an achromatic objective using a positive Ramsden ocular with a movable hairline to scan the image. Microphotographs were with achromatic objectives and negative Huygenian oculars except at the highest magnification where an apochromatic objective with compensating ocular was employed. The high-power objectives were immersed in cedarwood oil, and the condenser was also oiled in this case.

The resolution limits reported in the table indicate the minimum possible error in particle diameter determination. The optical system employed depended upon the particle size being measured, as indicated in Table 2.2.

For spherical particles, the error in diameter can be taken as the resolution. It should be noted that the fractional error in the reported volume is three times that of the reported particle diameter.

For non-spherical irregular particles, a mean diameter is determined as described in the procedure. The reported volume is computed utilizing this mean diameter.

The error in such a determination is, in general, difficult to establish. It is reasonable to assume, however, that the number of particles whose volume is overestimated will be comparable to the number underestimated, given a random variation in shape and orientation on the microscope slide.

The accumulation of data on a large number of particles should then result in a measured mean size (volume) distribution representative of the true one, although the dispersion may be anomalous. It should be noted that specific activity distributions, which are also related to particle volume, are subject to the same argument.

Since the errors associated with irregular particles are related to geometrical considerations, no bias with particle size is to be anticipated.

As an indication of the validity of this hypothesis, studies of specific activity distributions for the irregular particles and the spherical particles for a given sample were performed. This material is discussed in Chapter 3, Section 3.2, where it is shown that the distributions observed with irregular particles are indistinguishable from those based upon spherical particles, since the observed activity dispersion in the spherical particles was exceedingly large.

2.2 ALPHA COUNTING OF UNALTERED PARTICLES

2.2.1 Experimental Procedure for Using 2π Flow Counter

1. Place the planchet containing the particle on a cover-slide and carbon coated to be counted in the ready chamber of the 2π flow counter.

2. Secure the chamber cover and rotate the sample wheel to position the particle in the counting chamber.

3. Flush the counting chamber with gas for one minute and return the gas flow switch to "Operate."

4. Start the counter and count for 1,000 counts or 100 minutes, whichever will occur first.

5. Stop the count and rotate the sample so as to position the particle in the ready chamber once again. Open the chamber and remove the planchet.

Note: Any particle having less than 100 counts in 100 minutes should be returned to be counted by radioautography methods.

2.2.2 Analytical Procedures and Data Reliability

Geometrical Considerations. As discussed in Section 1.2.2, the measurements performed on gross alpha activity of unaltered particles are influenced by absorption of alpha particle energy within the particle matrix.

The counters employed are individually calibrated with an infinitely thin (no self absorption) standard alpha source, resulting in a standard factor which relates observed counting rate for such a source to true DPM. Because of the 2π geometry, the efficiency of the counter is slightly under 50%, and the standard factors for the counters utilized vary between 1.940 and 1.950 .

The sensitivity of these counters is such that the dissipation of greater than 0.5-Mev energy within the counting chamber results in a pulse of sufficient magnitude to be recorded. Since the energy of Pu^{239} alpha particles is 5.15 Mev, an alpha particle can lose up to 90% of its initial energy within the sample and still be recorded.

For sample particles of diameter d microns satisfying the condition:

$$d \ll \frac{56}{\rho} \quad \text{(see Section 1.2.2)} \qquad (2.1)$$

where ρ is the density of the sample matrix, the standard factor defined above can be directly applied to obtain true DPM within the sample. Allowing for the energy discrimination (0.5 Mev) cited above, this condition will actually hold provided:

$$d \leq (0.9) \frac{56}{\rho} \qquad (2.2)$$

$$\simeq \frac{50}{\rho}$$

Thus we see that the low discrimination level of the counters reduces the stringency of Equation 2.1 to that of Equation 2.2, the application of the standard factor now being appropriate for particles satisfying Equation 2.2.

For sample particles violating Equation 2.2, the correlation between DPM and observed CPM is altered by two effects: (1) self absorption within the particle matrix becomes significant, and (2) the standard factor for the detector (which is fundamentally a geometrical parameter) becomes inapplicable.

The latter effect is more readily understood by reference to Figure 2.1. In Region I, the original standard factor applies, whereas for Region II a significantly larger standard factor would be applicable. Thus for larger particles, the relation

$$\text{CPM} \propto d^n \quad (2 \leq n \leq 3)$$

discussed in Section 1.2.2 becomes questionable and places further emphasis upon the desirability of obtaining a calibration curve which relates true DPM to observed CPM for larger particles, which is only possible through the technique of precision counting described elsewhere.

Statistical Considerations. The precision of the observed CPM values can be considered independently of the question of accuracy of conversion of CPM to DPM of the sample. The statistical error in the CPM measurement is determined as follows:

Let S = total sample counts accumulated

B = total background counts accumulated

t = accumulation time in minutes

N = total counts accumulated

then $N = (S + B) \pm \sqrt{N}$ counts

and $\frac{N}{t} = \frac{(S + B)}{t} + \frac{\sqrt{N}}{t}$ counts/minute

Let B_t = background counting rate of the counter

ΔB_t = error in the background counting rate of the counter

then: $$\frac{S}{t} = \left(\frac{N}{t} - B_t\right) \pm \sqrt{\left(\frac{\sqrt{N}}{t}\right)^2 + (\Delta B_t)^2} \quad \text{CPM} \qquad (2.3)$$

For all counters utilized, the maximum value of ΔB_t was ± 0.02 CPM, as determined by 800-minute background measurements. The counting criteria cited in Section 2. 2. 1, however, indicate a maximum value of t of 100 minutes, and a minimum value of N of 100 counts.

Thus:

$$\left(\frac{\sqrt{N}}{t}\right)_{min.} = \frac{10}{100} = 0.1 \quad \text{CPM}$$

while $$(\Delta B_t)_{max.} = 0.02 \text{ CPM}$$

Referring to Equation 2.3, we see, then, that the statistical error in determination of the sample CPM is thus always predominantly determined by the error in the sample measurement, and the error in the background of the counter contributes insignificantly.

For the lowest activity sample reported, then, the statistical uncertainties will be ± 0.1 CPM, for a sample counting 1 CPM.

For samples measuring R CPM ($R > 1$) the counting error will be:

$$E \leq (\sqrt{R})\ (0.1)\ \text{CPM} \tag{2.4}$$

(Note: For high activity samples 100-minute counting time was not required, hence the $\leq$)

For all samples measuring in excess of 1 CPM, the statistical error is thus always less than 10%; the actual error can be determined from Equation 2.4.

For those isolated instances where (R) <1 CPM, a lower limit for error will be ±0.02 CPM, that of the counter.

2.3 PRECISION ALPHA COUNTING

2.3.1 Experimental Procedure

Particle Dissolution:

1. Place coverglass containing particle mounted in collodion (or the fluorometry bead) in a glass beaker.

2. Add a quantity of Pu^{236} tracer equal to the disintegration rate of the particle determined by gross counting.

3. Add concentrated HNO_3, a small amount of perchloric acid, and a few drops of H_2SO_4.

4. Evaporate to perchloric acid fumes.

5. Transfer to a teflon beaker.

6. Add concentrated HF.

7. Evaporate to perchloric acid fumes.

8. Repeat Steps 6 and 7.

9. Proceed to decontamination.

Plutonium Electroplating Procedure:

1. Evaporate the solution containing the heavy element tracer and activity to approximately 1 ml. Add 1 ml HNO_3 and 1 ml HCl. Evaporate to wet dryness. Repeat the HNO_3-HCl treatment twice.

2. Pick up in 1 ml HCl and take to dryness. Do not bake. Rotate the beaker to insure complete dryness. Add 2 ml HCl, boil to 1 ml and transfer to a prepared electroplating cell. Rinse the beaker with two 1/2-ml HCl washes and one 1/2-ml water wash. Transfer each wash to the plating cell. (Use a fresh platinum disc free from dents or scratches.)

> The platinum disc and anode must be freed of any grease film by rinsing several times with acetone and alcohol. Write the sample identification on the back of the disc. Ignite to red heat in a Fisher burner flame. The electroplating cell must be clean and free of any foreign material. Check for leakage before use.
>
> Keep the plating solution at minimum volume during this transfer and also during the titration.

3. Add 1 drop methyl red indicator. Add NH_4OH dropwise until the indicator shows the solution to be basic (yellow). Add 2$\underline{N}$ HCl dropwise until solution is just acid. Add 1 drop in excess.

4. Place the sample on the Sargent-Sloman electroplater. Adjust the anode to approximately 1/4-inch above the platinum disc. Plate for 10 minutes at a starting current of 2.5 amps and about 5 volts. The current may fluctuate during the plating period. Check occasionally and adjust the current to maintain 2.6 amps throughout the plating period.

5. At the end of the electroplating period, add 1 ml NH_4OH. Stir for 15 seconds. Turn off the current and stirrer. Remove the anode from plating solution.

6. Immediately transfer the plating solution into the beaker used for evaporation. Rinse the inside of the plating cell 3 times with water washes. Combine the washes with the plating solution in the beaker.

7. Dismantle the plating cell and remove the platinum disc. Rinse with alcohol and ignite the disc to red heat; cool. Check yield on laboratory alpha counter before submitting sample to the counting room.

8. Place sample in a lined and labeled tin box and submit for counting analysis.

2.3.2 Analytical Procedures and Data Reliability. The plutonium samples were analyzed in Tracerlab Frisch Grid Chambers, a detector which produces an output pulse of magnitude directly related to the energy of the alpha particle detected (most meaningful if source is infinitely thin to eliminate self absorption effects). A tracer (Pu^{236}) was added to each sample to allow correction for yield in the radiochemical separation and electroplating procedures.

The detector completely resolves the alpha rays from Pu^{236} and Pu^{239}, as shown in Figure 2.2, which is a recorded spectrum for an electroplated standard sample. The total quantity of Pu^{239} in the initial particle sample is determined as follows:

1. A short run of a calibrated plutonium standard source is made both before and after the analysis of an unknown plutonium sample. This procedure gives an evaluation of the counting geometry and resolution of the instrument in this interval of time.

After counting a sample, a Pulse Height Graph sheet is used to make a graphical plot of the data. Channel counts on the ordinate are plotted versus channel number and/or energy on the abscissa. From this graph, together with the data tape, an analysis of the isotope peaks is carried out utilizing a Calculation Sheet.

In selecting the group of channels representing each isotope peak, the following points are considered:

Width of Isotope Peak Base. Since each isotope peak which represents a single alpha particle energy is theoretically of the same contour, its base will cover the same number of channels with only the height of the peak differing in each case. The peak contour may be represented approximately by a Gaussian distribution curve.

Low Energy Tail. The low energy tail of each isotope peak will continue down to zero energy. However, no counts less than 1% of the peak height are added to the totalized peak count. The totalized count of the calibrated plutonium standard source is evaluated in the same manner.

Background. On low counting samples, it is necessary to correct for background. This correction is compiled from a statistical summation of consecutive background determinations. It may be applied if it does not distort the peak contour. Background may also be subtracted empirically, from a knowledge of the isotopes present, and of their peak contour.

Peak Resolution. The resolution is determined by the width of the peak contour and will determine the possibility of detecting isotope peaks in close proximity. Resolution may be mathematically denoted as the peak width at its mid-height divided by the peak energy, each value expressed in the same energy units. The resolutions for each analysis are calculated in order to determine the amount of instrument drift. A value of 1.5% is considered as an optimum resolution.

2. Determination of Geometry. A geometry factor is used to convert the observed counting rate of the unknown sample to absolute disintegrations per minute (DPM).

The geometry factor is defined as the observed corrected counting rate divided by the absolute disintegration rate of the calibrated plutonium standard source.

The observed counting rate of the sample always contains the following inherent losses.

2π Geometry. The geometry is restricted to 2π steradians by virtue of a flat disk mounting.

Collimation Loss. A collimating ring is used with the sample disk to obtain an ideal peak contour by decreasing the relative amount of degraded alpha particles and thereby further reducing the counting rate.

3. Computation of Pu^{239} in Sample:

Tracer Yield. Pu-236 is used as a tracer to establish the procedure yield. The corrected DPM of this isotope is divided by the amount of tracer originally introduced.

$$\text{Tracer Yield} = \frac{\text{DPM of recovered 236}}{(\text{DPM of added 236})\ (\text{Decay factor from standardization})}$$

Total Sample DPM. A summation is made of counts under all isotope peaks present. These counts are corrected for low energy tail, background, peak resolution, and Section 3 as follows:

This corrected count is divided by the counting time, the geometry factor and the tracer yield.

$$\text{Total DPM} = \frac{\text{Total corrected counts}}{\text{Total counting time x geometry factor x tracer yield}}$$

4. Errors. The errors in the Pu^{239}-Pu^{240} analyses arise fundamentally from the statistics associated with the sample counts accumulated. The background of the detectors is less than 0.01 counts/min under the Pu^{236} and the $Pu^{239-240}$ peaks and is therefore negligible.

The reported errors represent the statistical sum of the fractional error in the tracer yield (or equivalently the Pu^{236} DPM) and the Pu^{239}-Pu^{240} count and are reported as percent errors in the data tables.

2.4 DENSITY OF INDIVIDUAL PARTICLES

2.4.1 Experimental Procedures for Measuring Spherical Particle Density by Constant Density Column

1. Place the particle to be measured under the microscope (100X) and locate the particle. Turn off the room lights.

2. Place a drop of acetone near the particle but not on the collodion.

3. Cut the particle out with the steel rod as in the particle separation procedure.

4. Place the eye-shaped piece of collodion in the acetone and locate it under the microscope. Slurry the particle in the acetone to remove the collodion.

5. Remove the particle with the steel rod. If any collodion remains, repeat Step 4.

6. Have the Stokes' law density column set up in advance, that is, fill the column with trichloroethylene and allow to settle for several hours. Position the light source 6 inches above the column and shining directly down it. Fix the centimeter scale to the back of the column. Position the electric stopwatch conveniently. Calibrate the liquid by dropping several measured aluminum and steel microspheres through the apparatus individually and measure their terminal velocity. The latter is done by timing their fall through given centimeter lines. Several measurements may be taken during the fall of each particle. Choose only particles in the size range 30 to 100 for calibration.

7. Place the end of the steel rod with the particle attached to it into the trichloroethylene, and the particle will fall free.

8. Time the fall of the particle as it passes the centimeter lines. Measure the particle's fall as many times as possible

during its single fall consistent with maintaining accuracy in judging when the particle passes the centimeter lines.

9. Calculate the density ρ from Stokes' law:

$\rho = 4.5 \; g\eta/(a^2 v) \; \rho'$ (Particles down to 10 microns may be readily measured by this technique.)

where ρ' = density of trichloroethylene = gm/cc

g = acceleration of gravity = 980 cm/sec/sec

η = viscosity of trichloroethylene

a = radius of particle

v = terminal velocity

2.4.2 Data Reliability and Errors. A comprehensive analysis of the errors associated with this particular apparatus and technique appears in Reference 4. Based upon the measurement of 23 spherical stainless steel particles, the observed deviation was ±2.0%, at a mean density of 8.04 grams/cm^3. For the spherical particles reported here, this error is applied.

For the measurement of irregular particles, the unknown shape factor can be eliminated through measurement with two different fluids of known densities and/or viscosities. (Note: It was not possible to locate a satisfactory second fluid (trichloroethylene being the first) for these measurements. It is thus difficult to objectively assign an error factor to the irregular particles. However, the observed density variation among the spherical particles can be compared with that of the irregular particles, from which a meaningful error estimate for the latter can be made. This is discussed more extensively in Section 3.4, where the results of the experimental measurements are considered.)

2.5 URANIUM FLUOROMETRY

[redacted]

1. Dissolve particle in a drop of HNO_3 in a platinum fluorometry dish.

2. Evaporate over a hot plate using the special rack made for this purpose.

3. Add a predetermined amount of NaF-LiF flux.

4. Fuse this mixture on a Fisher burner using an air-gas mixture for about 2 minutes.

5. Let sample cool for about 15 minutes and read on the Jarrell-Ash fluorometer.

2.5.2 Analytical Procedures and Data Reliability. On each day that measurements were taken, a calibration curve for the fluorometer was measured utilizing a blank, a 4.24-nanogram sample, and a 123.6-nanogram sample. The latter two were prepared from standard solutions.

The fluorometer calibration curve for each day was plotted as ordinate intercept provides an estimate of the average blank for the calibration samples employed.

The slope of the line, $\frac{\Delta y}{\Delta x}$, provides a measurement of the gain of the amplifier system for the day in question. Since the amplifier gain was found to display daily variation, the total uranium content of the samples was determined by reference to the appropriate calibration for the day of the measurement.

Twenty two separate calibrations were taken, each resulting in a measured average blank value by extrapolation as described above. The average value for the blank based upon 22 measurements was 2.0 ± 1.8 nanograms. This value was subtracted from the total uranium measurement of all samples to determine the net uranium content of the particles.

The error in the blank, ±1.8 nanograms, greatly exceeded the error in total uranium determination. Thus, ±1.8 nanograms is taken to be the uncertainty in uranium content for all samples (or ±3.6 nanograms for 95% confidence). In Table 3.5, a dash indicates a total uranium content less than 1.8 nanograms.

2.6 ELECTRON MICROSCOPY

2.6.1 Experimental Procedures. The analysis of fallout particles in the submicron range utilizing the electron microscope required the following:

1. Samples must be mounted on the electron microscope grid 3 mm in diameter.

2. Material covering the sample must be minimal in thickness to avoid excessive electron scattering.

3. Means must be available for differentiating between true fallout particles and extraneous material in the sample.

The large amount of background material in the samples, coupled with difficulties in removing the organic substrate, combined to make meaningful collection of electron microscope data impracticable.

A brief review of the techniques investigated is presented below.

Sample Preparation. The first sample was prepared by washing Stages 3 and 4 of Casella impactors and Stages 3, 4, and 6 of Anderson impactors with a small amount of amyl acetate, adding a small amount of collodion, and transferring drops of the mixture to fresh electron microscope grids. After the grids evaporated to dryness they were individually examined in the electron microscope. The exit filter was not processed at this point.

The particles which resembled the larger particles (visible in the optical microscope) in general morphology and showed high opacity to the 100-kilovolt electron beam were tentatively identified as the fallout particles. All such particles, and no others, were found enshrouded by a low density material 790 Ångstrom units thick (0.079 micron). Particles believed to be radioactive were rarely found singly but usually in clumps of up to one hundred, apparently held together by the same low density material. The fallout was thinly dispersed through large amounts of background material. The size of the aliquot on each grid was increased in an attempt to facilitate the location of fallout particles; the resulting thick films gave poor resolution or contrast.

The low-density shroud was tentatively identified as radiation-polymerized Canadian balsam and an attempt was made to remove it with solvents. Various esters, alcohols, ketones, chain and cyclic hydrocarbons, ethers, and sulfoxides were unsuccessful. Aliquots of samples were then placed on copper electron microscope bar grids with silicon monoxide films and electroashed for a few minutes on each side, at low power to avoid excess recombination heating on the copper.

The low density material was reduced to ash, as were all other organic materials. It also appeared that there had been a thin, uniform film of residual Canadian balsam which had ashed into clumps of fairly high opacity. The quantity of ash in relation to the number of fallout particles was still excessive.

Aliquots of the samples were electroashed on microscope slides, slurried in amyl acetate, and transferred to a centrifuge cone. The cone was taken to dryness and a few milliliters of acetylene bromide (1, 1, 2, 2 tetrabromo-ethane) were added. This liquid has a high specific gravity (2.96), and it was expected that the ash, sand, and other background material would rise to the surface while the plutonium-bearing particles would settle, due to their high density. This also was unsuccessful, however, in that everything settled.

Most of the ash seemed to be due to organic background, so centrifugation in acetylene bromide prior to mounting and/or ashing was attempted.

Centrifugation after ashing had produced no improvement because the ash of organics was heavier than the fluid; centrifugation before ashing often caused a large amount of olive green or brown material to separate out. The surface film contained no activity and appeared organic. A large amount of background material settled along with the activity so that the ratio of fallout to background remained very low.

Conclusion. The very low amount of fallout available made it necessary to spend excessive time scanning grids to locate a single particle which appeared to be fallout, and when a particle was found it had to be photographed individually because of lack of other such particles in the field. A size standard then had to be photographed for accuracy in measurement. Thus the burden of particles on the grid was so low that it would be necessary to photograph each particle separately rather than simply size a number of particles seen in one electron micrograph. The cost of so doing appeared prohibitive, and further electron microscope studies were not undertaken.

2.7 ELECTRON DIFFRACTION

Electron diffraction measurements were performed on a number of particles thought to be fallout, utilizing specimens prepared as previously described. The results of these measurements are presented in Chapter 3, Section 3.7.

2.8 ELECTRON PROBE MICROANALYSIS

2.8.1 Sample Preparation

1. Remove the particle from its collodion mount and wash it briefly under the microscope in a drop of amyl acetate.

2. Pick the particle out of the amyl acetate and place it in freshly prepared Quickmount (the closer to the surface, the better).

3. When the Quickmount has hardened, prepare the polishing wheel with No. 400 boron carbide and cut the block down to the particle very carefully. Use an optical microscope to determine progress. Exercising extreme caution, cut the particle approximately in half.

4. Prepare the polishing wheel with 6-micron diamond paste. Remove all large scratches as determined under the 10X objective.

5. Prepare the polishing wheel with 1-micron diamond paste. Remove all scratches as determined under the 43X objective.

6. Prepare the polishing wheel with 1/4-micron diamond paste and polish the particle.

7. Cut the particle out of the block with a particle pick and remove the Quickmount with solvent.

8. Place the particle flat side up on a polished beryllium disk which has been marked with a grid. Note the position of the particle in the grid.

9. Place the beryllium disk in the carbon evaporator when the desired number of particles have been placed on the disk. Evaporate carbon onto the disk until it starts to become opaque. The disk is ready for analysis.

2.8.2 Analytical Procedures and Data Evaluation. The techniques for analysis of electron microprobe data are extensively described elsewhere (see Reference 5) and will not be repeated here. The analysis of a number of 316 stainless steel microspheres was performed* as an indication for accuracy of the technique. The results for a single particle are presented in Table 2.3. This data provides an indication of the accuracy obtainable from measurement of a single particle. For an unknown particle irregular in shape or non-uniform in composition, the results are considerably more qualitative.

* Materials Analysis Company

TABLE 2.1 VISUAL DEPTH OF FIELD AND RESOLUTION IN GREEN LIGHT (5000Å)

Ocular Power	Objective Power	Total Magnification	Visual Depth (micron)	Numerical Aperture	Resolution (micron)
12.5	97	1212.5[a]	0.2-0.3	1.25	0.2
12.5	43	537.5[a]	0.9-1.7	.66	0.4
12.5	10	125[a]	0.16-32	.25	1.0
15	90	1350[b]	0.1-0.2	1.25	0.2

a) Ramsden ocular and achromatic objective.
b) Compensating ocular and apochromatic objective.

TABLE 2.2 OPTICAL RESOLUTION

Particle Size Range	Optical Systems Resolution
d > 100 microns	1.0 micron
30 microns < d < 100 microns	0.4 micron
d < 30 microns	0.2 micron

TABLE 2.3 ELECTRON PROBE MICROANALYSIS OF SINGLE STAINLESS STEEL MICROSPHERES

Element	Composition of 316 Stainless Steel From Handbook of Chemistry and Physics	Single Particle Analysis
Fe	69.0	62.5
Mn	2.00	1.69
Si	1.00	0.34
Cr	16.00	18.64
Ni	10.00	14.7
Mo	2.00	2.18

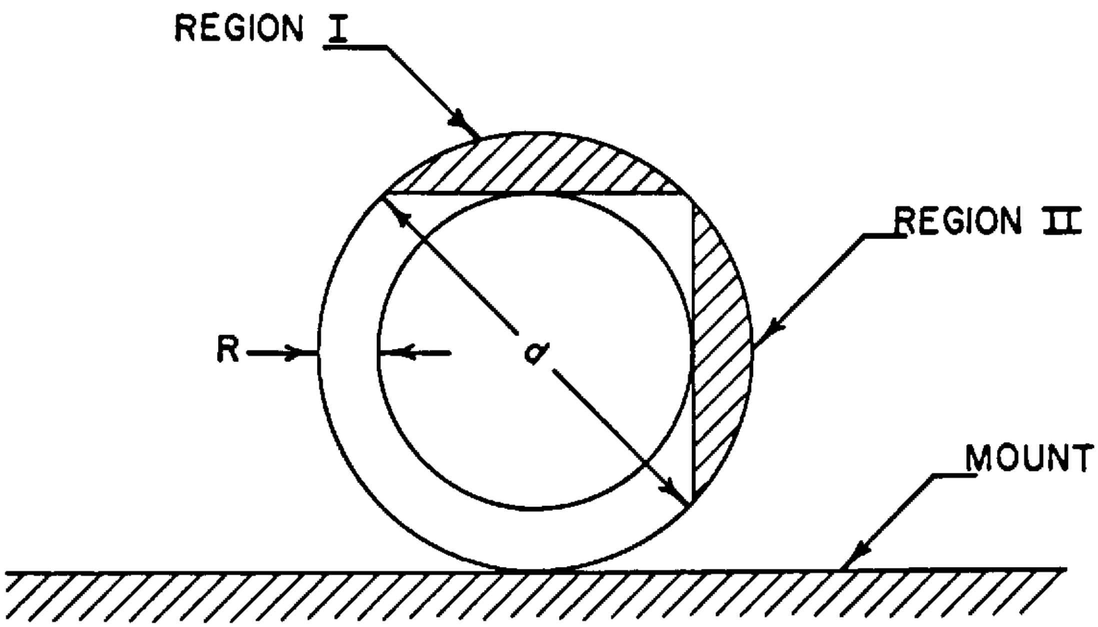

Figure 2.1 Geometrical presentation of 2π alpha counter standard factor variation for large particles.

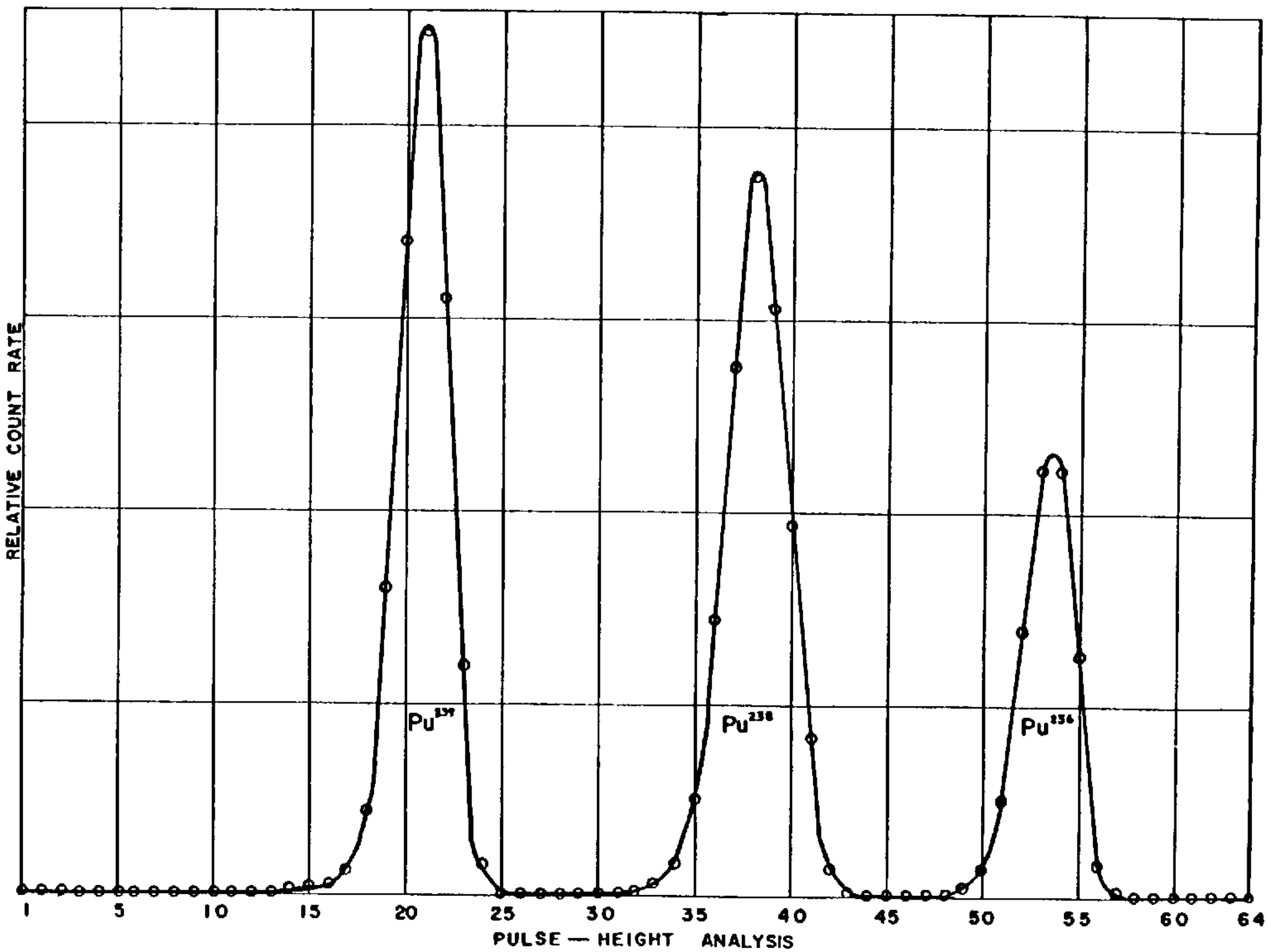

Figure 2.2 Alpha particle spectrum from Tracerlab Frisch Grid chamber.

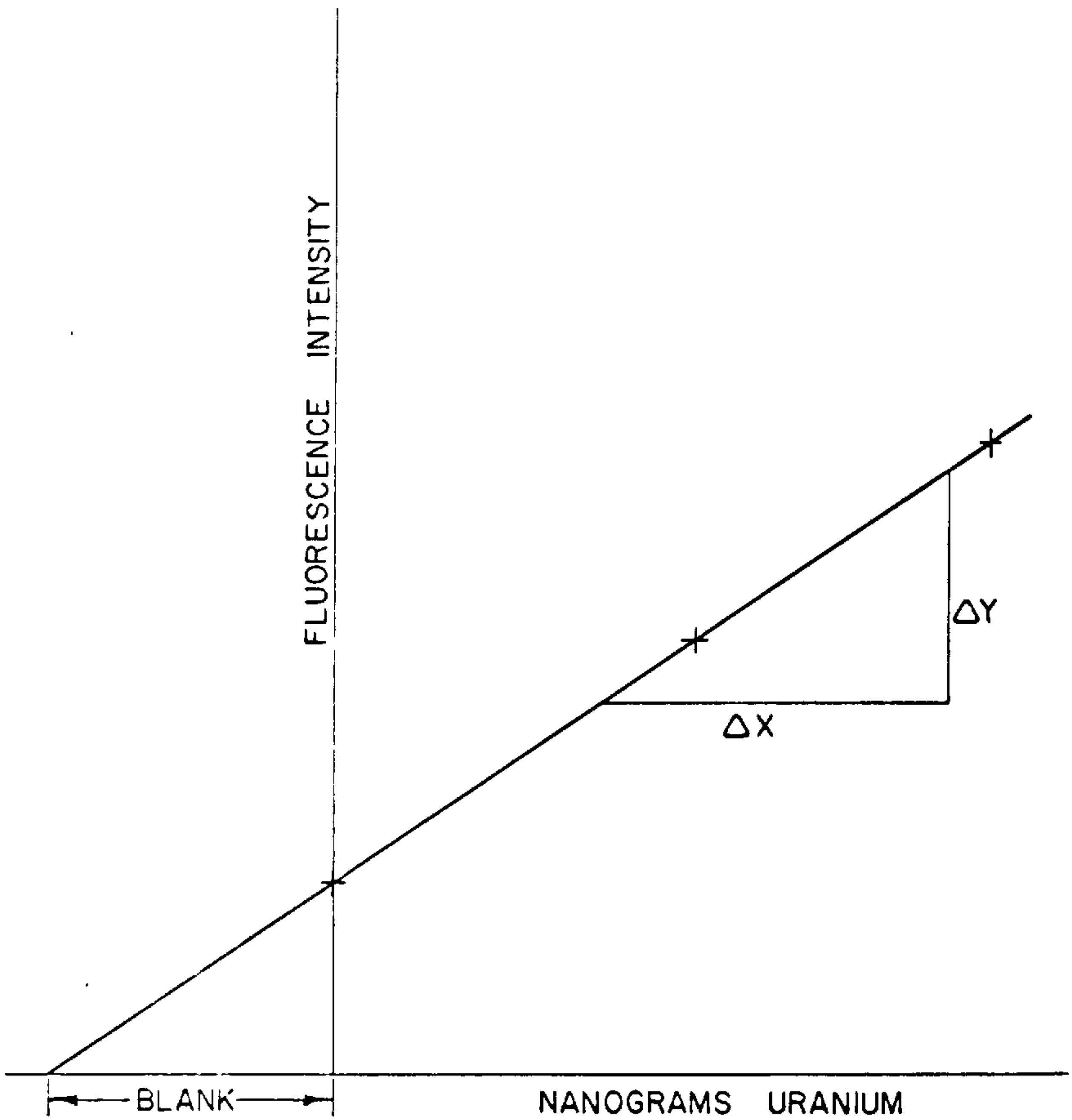

Figure 2.3 Uranium fluorometer calibration curve.

CHAPTER 3

PRESENTATION OF RESULTS

A summary of all samples processed by Project 2.6C is presented in Table 3.1. All data appears in the tables following, which are individually discussed.

As will be shown below, the precision and accuracy of the techniques utilized for characterizing the particulate debris are sufficient to allow meaningful interpretation of the resultant data in terms of true particle characteristics. The various modes of analysis lead to self consistent conclusions and provide meaningful information for evaluation.

Interpretation of the accumulated data has been performed only in so far as was required to establish the validity of the experimental measurements, to facilitate proper utilization of the reported data by the evaluation team.

3.1 OPTICAL MICROSCOPY

The following parameters were determined by optical microscopy:

Particle Diameter, hence Volume

Particle Color

Particle Shape

These characteristics are tabulated in Table 3.2, which presents the data on all particles studied.

3.1.1 Accomplishment of Stated Objectives. The objectives of the optical microscopy are re-stated below:

1. To determine size distribution input data for analyzing and predicting atmospheric dispersion, fallout patterns, and hazard arising from inhalation and ingestion of particles.

2. To provide knowledge relative to particle formation mechanisms and the role of background materials (e.g. cover soil) in determining the observed characteristics of the particles.

The size distribution data is of particular interest. We have already shown that for spherical particles the error in diameter is sufficiently small ($\sim$0.2 micron) to assure that reported sizes for such particles are precise. However, a large fraction of the collected particles were irregular in shape, and we are interested in the accuracy of the reported size distributions for these particles. Photomicrographs of typical spherical and irregular particles appear in Figures 3.1, 3.2, and 3.3.

It has been postulated (Section 2.1) that the method for determining irregular particle diameters is expected to lead to a true measure of the average size distribution but with a possible anomalous dispersion. This has been examined as follows:

For a given species of particulate material, the total particle activity is a sensitive function of particle volume. Thus, a comparison of the activity versus size distribution for spherical and irregular particles from a given sample should reveal:

1. Comparison in composition between the two particle classes

2. Bias (if present) in the recording of the diameter for irregular particles.

Figures 3.4, 3.5, 3.6 and 3.7 represent activity versus diameter distributions for four samples ranging from small particles of high Pu content material serially to large particles of lower Pu content material. The irregular particles are distinguished by the symbol (⊡) while the spherical or spheroidal particles by (⊙). Reference to these figures indicates that the spherical and irregular particle activity distributions are indistinguishable.

Thus, it is concluded that the variation in true particle characteristics is such that no detectable bias is introduced by the irregular particle diameter determinations, and that the dispersion in the irregular particle characteristics is no greater than that for spherical particles.

It is also concluded that irregular particles are indistinguishable from spherical particles from a given sample regarding plutonium content.

3.1.2 Conclusions. Size distributions reported are equally valid for spherical and irregular particles.

Plutonium content of irregular particles is indistinguishable from that of spherical particles for a given sample, regardless of the alpha activity content of the particles.

3.2 ALPHA COUNTING OF UNALTERED PARTICLES

The alpha count (CPM) of all particles is also presented in Table 3.2. In this instance the standard factors for the alpha counters have been utilized (see Section 2.2). However, since the particles do not simulate an infinitely thin electroplated source, self absorption and geometry effects are present for the larger particles, hence the use of CPM rather than DPM in the tables.

3.2.1 Accomplishment of Stated Objective. The objective of alpha counting of unaltered particles was stated as:

> To provide indication of the plutonium cont ent, and thus alpha activity, of the particulate debris.

In Section 2.2 we have discussed the influence of geometry and self-absorption on the count-rate obtained with unaltered particles, and the degree to which such a measurement can be employed to indicate true Pu content.

For particles of dimension $d \leq \frac{50}{\rho}$ microns (reference Section 2.2) the alpha count is expected to provide a true measure of Pu content. Figure 3.4 shows that the gross alpha count for particles below 6-microns diameter follows a cubic relation with diameter, indicating that: (1) particle composition is uniform, (2) on the average, the particle density falls below 8 grams/cm^3, and (3) gross alpha count is a true measure of Pu content for particles of this size.

For succeedingly larger particles, we note from Figures 3.5, 3.6 and 3.7, that the mean count rate qualitatively appears to approach the squared relation with diameter (reference Section 2.2) indicating again that on the average the particles appear homogeneous in composition, and that the gross alpha count rate can be related to true Pu content in a known manner.

However, we note that the larger particles display an extremely wide dispersion in their measured CPM, and we are faced with the question as to whether this dispersion represents true variation in Pu content, or is related to some factor which influences the ability of gross counting techniques to determine Pu content. The possible causes for this wide dispersion are: (1) true variation in total Pu content, (2) density variations between particles, and (3) non-homogeneous Pu distribution within the particles.

Let us initially assume that all particles contain Pu homogeneously distributed throughout their volume. If R is the Pu alpha particle range in the particle, and r the particle radius, it is readily shown that the fraction of total plutonium which falls in the outer spherical shell of thickness R is given by:

$$F = \frac{3R}{r} - 3\left(\frac{R}{r}\right)^2 + \left(\frac{R}{r}\right)^3$$

i. e. the ratio of the volume of the outer shell of thickness R to the total particle volume.

Since the fraction F represents that fraction of the particle plutonium which is potentially countable, (F^{-1}) should be related to a correlation factor which corrects observed CPM to true total DPM of the particle.

Figure 3.8 shows the variation in the factor (F^{-1}) which occurs for variation of r/R over 5:1; and it is noted that even for r/R = 5, the correction factor is only 2.0.

Thus if $\frac{r}{R} \leq 5$, (or since $R = \frac{50}{P}$, $r \leq 250$)

for a particle 25 microns in radius or less, density variations between 1 and 10 grams/cm^3 would produce no greater than a factor of 2.0 variation in gross counts.

3.2.2 <u>Conclusion.</u> If the particles are indeed homogeneous, then it would appear that for particles under 50 microns diameter dispersions in gross alpha CPM greater than the order of 100 percent must be attributable to true total plutonium content variation.

Dispersions considerably greater than this were indeed observed (see Figures 3.4, 3.5, 3.6, and 3.7).

3.3 PRECISION ALPHA COUNTING

The results of precision alpha counting are presented in Table 3.3, which includes the fractional standard deviation of the measurements. It is seen that the measurement errors are well under the fractional dispersion in gross alpha count indicated in Figures 3.4, 3.5, 3.6 and 3.7, even for the Double Tracks event which displayed the smallest dispersion.

3.3.1 Accomplishment of Stated Objectives. The objectives of precision alpha counting were as follows:

1. To determine the true plutonium content of individual particulates.

2. To seek the relationship between true plutonium content, particle physical characteristics (size, color, morphology), and gross alpha count of individual particles.

It is evident that objective 1 was well satisfied for those particles measured. We shall then direct our attention to objective 2.

The observed correction factor, $\left(\frac{DPM}{CPM}\right)$, for the particles analyzed is shown plotted in Figure 3.9 as a function of particle diameter, for particles up to 70 microns diameter. Comparison between Figure 3.8 and Figure 3.9 shows remarkable similarity, and it would appear that for particles in this size range the observed variations in this factor could be attributed to density variations among the particles precision counted which contain Pu homogeneously distributed. Thus, it would appear that deviations in excess of 50% from the mean gross count for a given particle size cannot be attributed to density variations. It should also be noted that the curves correlate quite well when ($r/R = 1$) corresponds to a particle diameter of 14 microns, or a radius of 7 microns. Thus for average material, $R = 7$ microns. Since $R = \frac{50}{\rho}$ (see Section 2.3) an average particle density of 7 grams/cm^3 is indicated. In Section 3.4 it is shown that a mean particle density of 5.5 grams/cm^3 was measured, based upon measurement of 9 particles. Thus, the manifested correction factors for particles under 70 microns may be somewhat greater than the mean density of 5.5 would predict; a fact which may indicate a slight increase in the required standard factor for the counter as particle size increases.

Attention is now called to particles 2369-24 and 3466-27 in Table 3.3, which displayed anomalously high correction factors. Non-homogeneity in the Pu distribution was evident in these particles from microscopic observation of small inclusions.

Thus, deviations exceeding 50 percent from the mear gross count can in some instances be explained by non-uniformity of plutonium distribution. However, it should be noted that such inhomogeneity can only produce anomalously low gross counts, since from Figure 3.9 we see that correction factors less than 1 are not physically manifested and indeed would be difficult to explain on physical grounds.

Reference to Figures 3.4, 3.5, 3.6, 3.7, however, reveals that anomalous dispersions (i.e. in excess of 50% from the mean line) are in general distributed equally above and below the mean line, leading to the tentative conclusion that the observed dispersion primarily indicates variation in actual plutonium content of the particles, with the exception that a few anomalously low points may be attributable to non-homogeneity in the Pu^{239} distribution.

3.3.2 Conclusions

1. The gross alpha counting data displays a mean correlation between observed counts and particle size which is compatible with the hypothesis of homogeneity in Pu distribution within the particles.

2. The conversion of mean observed CPM to true Pu DPM within the particles can be accomplished utilizing a calibration curve based upon precision counting, the corrections for which are consistent with the the hypothesis of homogeneous Pu distribution within the particles, self-absorption, and detector standard factor variation with particle size.

3. In a few isolated instances non-homogeneity in plutonium distribution leads to anomalous gross counting results, but these occasions are rare.

4. Large dispersions (>50 percent) observed in gross CPM are attributable to true variations in plutonium content for particles smaller than 70 microns. Density variations can at most produce a factor of 2 uncertainty in this size range. Observed density variations based on 9 particles are discussed in Section 3.4.

3.3.3 Recommendations. It is recommended that size distributions and activity distributions be determined for all samples and correlated with test parameters such as location of sample collection relative to ground zero. Correlation of these results with activity-versus-size distribution on all samples will provide substantiation or rejection of the hypotheses herein presented, which is relevant to appropriate procedures for determining ultimate fate of the weapon plutonium, overall mass balance, and hazard evaluation.

3.3.4 Americium Precision Counting Data. Radiochemical separation and precision counting for americium were determined for a few particles. This data is presented at the end of Table 3.3. The observed DPM of americium are shown plotted against the observed Pu gross alpha count in Figure 3.10, where it is seen that, although based upon a very small sample, correlation between observed particle content for Pu and Am appears to exist.

3.4 DENSITY OF INDIVIDUAL PARTICLES

Table 3.4 presents the results of density determination of 9 individual particles.

3.4.1 Accomplishment of Stated Objectives. The objectives of the density determination were:

1. To provide requisite density data for fallout analysis studies.

2. To provide input data for interpretation of alpha counting data on unaltered particles.

The densities reported for spherical particles can be taken as true density measurements. For irregular particles this is not the case. Within the context of objective 1, however, the rate-of-fall characteristics of irregular particles are determined precisely, which for fallout and dispersion analyses are the requisite information.

Within the limits of the small number of particles analyzed, it appears that the rate of fall characteristics (as indicated by their reported densities) for irregular particles will be indistinguishable from those of spherical particles; i.e. the true variation in spherical particle density produces a variation in rate of fall for a given particle size which compares with the observed dispersion in rate of fall of irregular particles.

For a given spherical particle size, the fall rate in air is linearly related to density (ρ air $<<\rho$ particle). In Figure 3.11 relative fall rates for given diameter of spherical and irregular particles are shown. Two spherical particles displayed anomalously high densities. Unfortunately sufficient data is not available to establish whether these particles are unique, or do indeed represent a significant fraction of the particle population.

In relation to objective 2, it has been shown that the effects of density variation on alpha counting results are to introduce dispersions into the data but that the observed dispersions in counting characteristics exceed those anticipated by reasonable density variations and are thus attributed to true Pu content variation. On the other hand, the experimentally determined correction curve for CPM to DPM conversion (Figure 3.9) reflects the average density characteristic of the particles which were precision counted, and thus the possibility of introducing a bias to the data exists if this average density characteristic is significantly different from the average density characteristic of the particular sample in question.

In view of the large density variations observed for particles from a given sample, however, and the fact that the calibration curve is based upon a composite of particles from all events, it is felt that any bias so introduced would not exceed the dispersion in true particle plutonium content already observed.

3.4.2 Conclusions

1. For fallout analysis and dispersion studies, the rate-of-fall characteristics for irregular particles appears to compare with that of spherical particles of the same size.

2. Observed density variations in individual particles are not sufficient to explain the wide dispersion observed in gross alpha count of particles.

3.4.3 Recommendations. Analysis of spherical versus irregular particle abundances in varied samples for a given event should serve to confirm or negate the initial conclusion regarding identity of dispersion properties for both particle types for a given particle size. In particular, analysis of samples from locations subject to different wind conditions (e.g. at different altitudes, and upwind and downwind) should reveal the presence of any significant differences in dispersive patterns for a given size range.

3.5 URANIUM FLUOROMETRIC ANALYSIS

The results of the uranium fluorometric analyses are presented in Table 3.5. Significant quantities of uranium were found in a number of particles.

3.5.1 Accomplishment of Stated Objective. The stated objective was:

1. To investigate the distribution of uranium and plutonium

within particles for fractionation effects and possible correlation of such observations with other particulate characteristics.

The results obtained in Table 3.5 are plotted in Figure 3.12, which shows uranium nanogram content plotted against Pu DPM. For the Double Tracks particles, no apparent correlation exists. The Clean Slate samples, however, do indicate the presence of correlation between the abundance of both elements. It should be noted that the plutonium CPM dispersion previously observed for a given particle size range will be reflected in the U/Pu correlation; and indeed the dispersion about the mean correlation line is compatible with the Pu variations indicated in Figures 3.5, 3.6, and 3.7 for particles within the same size range.

3.5.2 Conclusions. For the Clean Slate samples analyzed, correlation between U and Pu particle content appears to exist and displays a dispersion comparable with that observed for individual particle plutonium content.

3.6 ELECTRON MICROSCOPY

The electron microscope studies failed to yield quantitative results. The basic reasons for this are summarized below:

1. Optical microscopy studies revealed the fact that large quantities of background (non-active) debris were collected with the samples. This required the establishment of means for identifying any submicron particles observed as true fallout rather than inactive debris.

2. The non-crystalline nature of the particles made their identification as fallout by electron diffraction unfeasible.

3. The samples were collected on organic media which could not be adequately separated from the particulates to permit satisfactory electron micrographs to be prepared. This is illustrated in Figures 3.13, 3.14, and 3.15, where typical electron micrographs are presented.

4. The number of fallout particles collected per unit area was extremely low. Thus to obtain reasonably sized samples for meaningful size distribution analysis, concentration of sample collected over relatively large collection area onto a single electron microscope grid (3-mm diameter) was required. The resultant accumulation of organic collection media onto a single electron microscope grid produced prohibitively large quantities of background material for satisfactory electron micrographs to be prepared.

3.6.1 Recommendations. For future programs, where electron microscopic analysis of collected debris is desired, the following procedures are recommended:

1. Satisfactory collection media must be utilized. It is recommended that electron microscope grids be utilized directly for such collections, thereby avoiding the necessity of transference and handling of the sample, with associated accumulation of interfering material.

2. Electron-microscope samples should only be collected at those sites where it is expected that the ratio of active collected material to background debris (e.g. sand) will be high.

3.7 ELECTRON DIFFRACTION ANALYSIS

Electron diffraction studies revealed that the fraction of material which produced identifiable patterns, and could therefore be identified as true fallout material, was impractically small. Over 500 possible samples of fallout material were investigated for diffraction, from which 6 positive identifications were made. These results are presented in Table 3.6.

Electron diffraction studies were conducted only on microscope grids which indicated alpha activity, with a lower limit set at 1 CPM. Using highly active particles as a norm (see Figure 3.4), approximately 200 particles of 0.3-micron diameter would produce this activity level. For lower specific activity debris, or a smaller particle size, more fallout particles would be required.

Approximately 25% of the total grid area was scanned per sample. Thus, it is reasonable to assume that a significant fraction of the material analyzed was actual debris. However, since only six particles out of 500 displayed diffraction patterns, it is concluded that the fraction of submicron fallout material which was crystalline was indeed low. Figures 3.13, 3.14, and 3.15

illustrate the nature of the material observed; those objects which displayed identifiable diffraction patterns cannot be physically distinguished from non-diffracting material.

3.7.1 Conclusion. The major portion of the submicron debris was indeed not diffracting and could not be identified.

3.8 ELECTRON PROBE MICROANALYSIS

The objective of electron probe microanalysis was to determine the matrix composition of fallout particles.

3.8.1 Analysis of Double Tracks Particle 9698-17. This particle was analyzed first with the ARL microprobe at Sandia - Albuquerque. The particle was mounted unpolished on copper paste. It was found to contain irregular distributions of aluminum, silicon, iron, uranium, and plutonium but no detectable amounts of barium, zirconium, or thorium. An aluminum-rich region appeared to correspond to a black inclusion in the otherwise transparent amber particle. Line profile pictures are on file at Sandia-Albuquerque.

A rough polish was then put on the particle, the black inclusion now becoming exposed, and it was analyzed with the MAC 400 microprobe at Materials Analysis Company, Palo Alto. The details of the analysis are reported in their Analytical Report No. 647B which is hereby incorporated by reference.

In summary it was found that the particle contained detectable quantities of aluminum, silicon, potassium, calcium, titanium, iron, uranium, and plutonium, with calcium predominating. The black inclusion was highly enriched in aluminum. The U/Pu ratio (not absolutely determined) varied by a factor of 6.6 from one place to another. The uranium content was approximately 8 to 9 percent by weight.

3.8.2 Analysis of Clean Slate I Particle 3038-28. This particle was analyzed with the ARL microprobe at Sandia-Albuquerque. The unpolished particle was mounted on copper paste. The analysis showed aluminum, silicon, and uranium but no detectable iron or plutonium. The elements were fairly uniform in distribution. Line profile pictures are on file at Sandia-Albuquerque.

3.8.3 Conclusions. The multiplicity of elements detected in these particles is compatible with the variability in density and plutonium content observed in other large particles.

TABLE 3.1 SAMPLES PROCESSED BY PROJECT 2.6c

Event & Location	Tracerlab No.	No. of Stages	Sampler Type
DOUBLE TRACKS			
A-066	2526	5	Casella
D-064	2920	6	Andersen
D-068	2922	5	Casella
E-058	9624	5	Casella
E-058	9698	5	Casella
E-058	9699	1	Tas D
G-058	9660	5	Casella
G-058	9661	1	TAS D
G-064	9656	5	Casella
H-060	2723	5	Casella
I-059	9691	1	TAS D
I-061	9668	5	Casella
I-061	9669	1	TAS D
J-058	2812	6	Andersen
N-068	2837	5	Casella
R-054	2946	5	Casella
R-082	2934	6	Andersen
B,L5,P17	2907	5	Casella
B,L7,P9	2443	1	TAS I
B,L8,P21	2151	5	Casella
J,L6,P13	2482	5	Casella
CLEAN SLATE I			
L18,P21	3449	5	Casella
L19,P9	3013	1	TAS I
L25,P9	3038	1	TAS I
L29,P9	3466	5	Casella
CLEAN SLATE II			
BM-07	4082	1	TAS D
TB-P2	2305	5	Casella

TABLE 3.1 CONTINUED

Event & Location	Tracerlab No.	No. of Stages	Sampler Type
BB1-01	2366	5	Casella
A-036	4116	1	TAS D
A-054	2286	5	Casella
B-044	2371	5	Casella
B-054	4812	1	TAS II
B-060	2370	5	Casella
B-068	2369	5	Casella
L1,P17	4022	1	TAS I
L3,P9	2312	5	Casella
L4,P21	4024	1	TAS I
L7,P9	4011	1	TAS I
D-030	4163	1	TAS II
D-034	3182	6	Andersen
DM-Pos. 12	2272	5	Casella
CLEAN SLATE III			
BM-06	4987	6	Andersen
BM-07	5184	1	TAS D
BM-10	4973	5	Casella
A-030	4974	6	Andersen
A-102	4964	5	Casella
A-108	5162	1	TAS D

TABLE 3.2 PARTICLE SIZE, GROSS ALPHA ACTIVITY, AND MORPHOLOGY

Double Tracks Arc A Station 066 Casella 2526

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	4.4	18.2	45	Opaque	Irregular
2	3.4	7.3	21	Opaque	Egg Shaped
3	5.1	22.7	69	Opaque	Sphere
4	3.3	3.3	19	Opaque	Irregular
5	3.4	9.6	21	Brown	Spheroid
6	3.7	9.9	27	Opaque	Sphere
7	3.0	2.9	9.9	-	-
7A	2.6	-	9.2	Orange Brown	Sphere
7B	1.1	-	0.7	Orange Brown	Sphere
8	2.6	3.3	9.2	Opaque	Spheroid
9	3.6	12.5	24	Opaque	Sphere
10	4.0	14.9	34	Opaque	Sphere
11	4.6	19.5	51	Opaque	Spheroid
12	4.1	22.4	36	Opaque	Spheroid
13	3.8	10.7	29	Opaque	Sphere
14	3.6	10.5	24	Opaque	Sphere
Note:	Appears to be attached to piece of collodion.				
15	5.4	14.6	82	Opaque	Spheroid
16	3.8	13.6	29	Opaque	Irregular
17	6.6	47.4	151	Opaque	Irregular
18	3.6	23.2	24	Red Orange	Sphere
19	4.4	18.0	45	Opaque	Sphere
20	3.1	7.1	16	Opaque	Irregular
21	6.4	16.4	137	Brown Orange	Sphere
22	4.0	12.6	34	Opaque	Spheroid
23	2.2	1.9	56	T. Brown	Sphere
24	10.5	11.4	606	Yellow Brown	Irregular
25	3.4	6.2	11.8	-	-
25A	2.6	-	9.2	Opaque	Sphere
25B	1.7	-	2.6	Orange	Hemisphere
26	2.9	4.9	13	Opaque	Sphere
27	3.0	2.0		-	-
27A	2.4	-	7.2	Opaque	Sphere
27B	1.6	-	2.1	Opaque	Irregular
28	2.4	3.4	7.2	Opaque	Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc A Station 066 Casella Continued

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
29	3.4	6.5	12	-	-
29A	2.7	-	10	Opaque	Sphere
29B	1.6	-	2.1	Brown Orange	Hemisphere
30	3.9	20.6	31	Opaque	Sphere
31	3.3	5.0	13	-	-
31A	2.8	-	11	Brown Orange	Spheroid
31B	1.6	-	2.1	Brown Orange	Sphere
32	2.8	6.7	11	Opaque	Sphere
33	3.2	9.8	17	Opaque	Sphere
34	5.0	31.4	65	Opaque	Sphere
Note: Combined vertical and substage illumination begins here.					
35	3.5	2.5	15	-	-
35A	2.5	-	8.2	Opaque Brown	Sphere
35B	2.3	-	6.4	Opaque Brown	Irregular
36	2.4	3.4	7.2	Orange Brown	Sphere
37	6.7	30.5	98	-	-
37A	5.5	-	87	Opaque Black	Spheroid
37B	2.8	-	11	Opaque Black	Spheroid
38	3.5	3.8	22	Opaque Brown	Irregular
39	4.6	18.6	24	-	-
39A	3.3	-	19	Opaque Black	Sphere
39B	2.1	-	4.8	Brown	Lobe
39C	0.8	-	0.3	Opaque Black?	Sphere
40	8.9	5.2	369	Yellow Brown	Spheroid
41	3.5	5.8	22	Opaque Black	Spheroid
42	2.8	6.8	11	Opaque Brown	Serrated Sphere
43	5.2	9.1	74	Yellowish	Spheroid
44	3.1	6.5	16	Opaque Black	Spheroid
45	2.8	4.1	6.2	-	-
45A	2.1	-	4.8	Orange Brown	Sphere
45B	1.4	-	1.4	Orange Brown	Sphere
46	3.2	4.3	17	Opaque Black	Sphere
47	4.3	1.6	42	Clear, Orange & Black	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc A Station 066 Casella Continued 2526

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
48	2.3	3.7	6.4	Opaque Brown	Sphere
49	2.8	7.7	11	Orange Brown	Spheroid
50	2.3	2.9	6.4	Orange Brown	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc B Balloon Line 5 Position 17 Casella 2907

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	16.6	74.3	2,395	Opaque	Grainy Irregular
2	12.0	56.1	905	Opaque & Clear	Irregular
3	21.1	277.5	4,919	Opaque	Grainy Spheroid
4	18.5	10.3	3,315	Opaque	Irregular
5	13.0	9.0	1,150	Opaque & Clear	Irregular
6	9.3	19.7	421	Opaque	Spheroid
7	6.3	8.9	131	Yellow	Irregular
8	8.6	43.3	330	Opaque	Spheroid
9	17.5	174.8	2,806	Opaque & Clear	Spheroid
10	7.4	43.6	173	-	-
10A	6.9	-	172	Opaque	Grainy Spheroid
10B	1.4	-	1.4	Clear	Sphere
11	21.4	142.0	5,131	Opaque & Clear	Irregular
12	18.4	113.4	3,262	Opaque & Clear	Rectangular
13	11.0	80.4	8,824	Opaque	Rectangular
14	7.7	10.7	239	Clear Yellow	Spheroid
15	4.3	4.6	42	Opaque & Clear	Irregular
16	8.4	114.5	310	Opaque	Sphere
17	10.9	38.6	678	Opaque & Clear	Irregular
18	12.8	59.9	735	-	-
18A	10.1	-	540	Dark Amber	Spheroid
18B	7.2	-	195	Dark Amber	Spheroid
19	24.6	302.9	7,794	Opaque	Irregular
20	8.1	65.2	278	Opaque	Sphere
21	27.2	364.8	10,540	Opaque & Clear	Irregular
22	5.2	6.5	74	Part Opaque	Irregular
23	5.2	4.2	74	Mostly Opaque	Irregular
24	4.7	5.2	54	Opaque & Clear	Irregular
25	7.7	22.5	239	Opaque	Irregular
26	10.0	15.7	524	Opaque & Yellow	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc B Balloon Line 5 Position 17 Casella 2907

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
27	6.0	9.9	113	Opaque & Clear	Irregular
28	10.7	32.4	641	Opaque & Clear	Irregular
29	2.7	4.9	10	Opaque	Sphere
30	14.3	109.7	1,531	Opaque & Clear	Irregular
31	5.7	5.9	97	Opaque & Clear	Triangular
32	17.5	84.4	2,806	Opaque	Spheroid
33	6.9	5.6	172	Opaque	Irregular
34	18.9	569.8	3,535	Opaque & Brown	Spheroid
35	7.9	12.9	258	Opaque & Yellow	Spheroid
36	9.5	93.2	216	-	-
36A	6.1	-	119	Opaque	Spheroid
36B	5.7	-	97	Opaque	Spheroid
37	22.4	5.8	5,884	Opaque	Star Polyhedron
38	15.0	2.6	1,767	Opaque	Irregular
39	6.3	5.4	131	Yellow & Red	Irregular
40	12.2	49.7	951	Yellow	Irregular
41	12.4	99.7	9,980	Opaque	Spheroid
42	6.2	7.1	125	Opaque & Yellow	Irregular
43	9.9	113.4	508	Opaque	Spheroid
44	3.1	12.0	16	Opaque	Spheroid
45	8.5	7.2	322	Clear & Opaque	Irregular
46	10.4	120.1	589	Opaque	Sphere
47	2.5	1.9	8.2	Opaque	Sphere
48	10.6	1.6	624	Dark Green & Violet	Irregular
49	7.1	11.2	187	Opaque & Clear	Irregular
50	9.6	124.6	463	Opaque	Sphere

Double Tracks Arc B Balloon Line 7 Position 9 TAS I 2443

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	1.9	2.0	3.6	Brown	Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc B Balbon Line 8 Position 21 Casella

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	12.8	5.8	1,098	Opaque & Purple	Hexagonal
2	12.2	152.2	625	-	-
2A	9.3	-	421	Opaque	Spheroid
2B	7.3	-	204	Opaque	Spheroid
3	24.0	321.0	7,238	Opaque	Angular
4	21.9	515.9	4,608	-	-
4A	20.5	-	4,511	Opaque	Sphere
4B	5.7	-	97	Opaque	Sphere
5	42.9	866.8	41,340	Opaque	Hexagon
6	20.7	238.9	4,644	Brown Orange & Opaque	Irregular
7	15.0	218.3	1,767	Opaque	Spheroid
8	15.8	322.2	2,065	Opaque & Orange	Irregular
9	15.2	294.7	1,839	Opaque	Irregular
10	14.4	54.9	1,563	Yellow Brown	Irregular
11	15.5	75.4	1,950	Yellow Brown	Irregular
12	15.7	67.1	2,026	Part Opaque	Spheroid
13	12.5	19.1	1,023	Opaque	Irregular
14	8.6	102.8	333	Opaque	Irregular
15	14.3	151.6	1,531	Opaque	Spheroid
16	10.2	93.5	556	Opaque	Irregular
17	12.8	66.2	1,098	Yellow Brown	Irregular
18	8.7	51.9	345	Opaque	Spheroid
19	10.5	120.4	606	Part Opaque	Spheroid
20	12.2	88.8	951	Gold-Orange	Irregular
21	9.5	67.4	449	Opaque	Sphere
22	11.6	81.0	817	Opaque	Irregular
23	12.4	76.1	998	Opaque	Irregular
24	17.1	35.1	2,618	Opaque	Spheroid
25	12.9	83.7	1,124	Opaque	Spheroid
26	8.2	36.9	289	Opaque	Spheroid
27	9.0	76.4	382	Opaque	Spheroid
28	6.1	54.3	119	Opaque	Spheroid
29	18.3	82.7	3,209	Opaque	Sphere
30	8.0	18.7	268	Part Opaque	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc B Balloon Line 8 Position 21 Casella **Continued** 2151

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
31	8.9	27.3	369	Opaque	Spheroid
32	10.9	18.4	678	Yellow Grey	Sphere
33	8.6	20.4	333	Part Yellow Brown	Irregular
34	9.7	55.4	478	Opaque, Clear Edge	Spheroid
35	9.9	21.7	508	Part Opaque	Spheroid
36	9.1	31.7	299	-	-
36A	7.9	-	258	Opaque	Spheroid
36B	3.7	-	27	Opaque	Spheroid
36C	2.2	-	5.6	Clear	Spheroid
36D	2.5	-	8.2	Clear	Spheroid
37	8.4	100.0	310	Opaque	Irregular
38	10.3	52.2	572	Opaque	Sphere
39	14.9	121.4	1,684	-	-
39A	14.7	-	1,665	Opaque	Sphere
39B	3.3	-	19	Opaque & Clear	Spheroid
40	6.2	19.7	125	Opaque	Sphere
41	6.5	19.4	144	Opaque	Spheroid
42	5.9	20.8	108	Opaque	Spheroid
43	11.2	10.6	582	-	-
43A	5.4	-	82	Opaque	Sphere
43B	3.5	-	22	Opaque	Sphere
43C	9.7	-	478	Yellowish	Irregular
Note:	Parts A and B appear to be inside part C.				
44	6.3	20.4	131	Opaque & Clear	Egg
45	11.9	13.3	882	Brownish & Opaque	Spheroid
46	6.7	20.0	158	Yellow	Spheroid
47	4.5	14.3	48	Opaque	Spheroid
48	6.8	8.6	165	Yellow-Brown	Irregular
49	3.5	8.7	22	Opaque	Sphere
50	8.5	8.1	321	Yellow & Opaque	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc D Station 064 Anderson 2920

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	1.8	8.6	3.1	Opaque & Clear	Spheroid
2	3.1	8.7	15	Opaque	Spheroid
Note: Combined Vertical & Substage illumination begins here.					
3	3.9	6.0	31	Yellow & Black	Spheroid
4	2.6	3.7	9.2	Orange Brown	Sphere
5	2.5	4.2	8.2	Dark Brown	Spheroid
6	7.4	4.1	212	Opaque	Irregular
7	9.9	1.5	508	Shiny T. Yellow	Irregular
7A	6.4	-	137	Black Inclusion	Irregular
8	5.8	1.0	102	Black	Irregular
9	1.4	1.9	1.4	T. Red Brown	Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc D Station 068 Casella

2922

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	3.7	17.4	27	Opaque	Spheroid
2	18.1	141.6	3,105	Opaque	Spheroid
3	3.5	9.8	22	Opaque	Oval
4	6.4	65.2	137	Opaque	Spheroid
5	4.6	9.8	51	Brown Orange	Sphere
6	6.8	2.9	165	Opaque	Spheroid
7	5.5	16.7	87	Opaque	Prolate
8	5.7	46.5	97	Opaque	Spheroid
9	4.1	12.6	36	Opaque	Irregular
10	4.8	0.3	~26	-	-
10A	~2.9	-	~13	Opaque	Spheroid
10B	~2.9	-	~13	Opaque	Spheroid
11	36.8	625.1	26,090	Opaque	Irregular
12	29.7	44.7	13,720	Opaque	Irregular
13	4.7	18.3	54	Opaque	Irregular
14	5.7	24.2	97	Opaque	Oval
15	16.6	34.9	2,395	Opaque	Rectangular
16	20.7	262.9	4,644	Opaque	Irregular
17	6.5	37.0	144	Opaque	Spheroid
18	14.7	2.0	1,665	Opaque	Irregular
19	20.2	185.1	4,316	Opaque	Spheroid
20	6.4	65.5	137	Opaque	Spheroid
21	24.3	3.2	7,513	Brown	Spheroid

Note: This particle displays an unusually rough surface.

TABLE 3.2 CONTINUED

Double Tracks Arc D Station 068 Casella (Continued) 2922

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
22	5.1	14.9	67	-	-
22A	5.0	-	65	Opaque	Sphere
22B	1.6	-	2.1	Brown-Orange	Sphere
23	6.9	24.3	172	Amber	Sphere
24	6.1	42.1	40	-	-
24A	3.5	-	22	Opaque	Spheroid
24B	2.8	-	11	Opaque	Spheroid
24C	2.4	-	7.2	Opaque	Spheroid
25	3.7	10.3	27	Opaque	Spheroid
26	17.1	22.6	2,618	Opaque	Irregular
27	24.4	227.1	5,212	-	-
27A	21.0	-	4,849	Opaque	Irregular
27B	9.5	-	463	Opaque	Irregular
28	3.6	11.0	24	Opaque	Sphere
29	7.2	47.3	204	-	-
29A	7.2	-	195	Opaque	Sphere
29B	1.3	-	1.2	Clear	Sphere
29C	2.5	-	8.2	Clear	Sphere
30	3.0	4.7	14	T. Brown	Irregular
31	1.3	2.3	1.2	Shiny Black	Irregular
32	5.1	15.2	58	-	-
32A	2.9	-	13	T. Brown Orange	Irregular
32B	4.4	-	45	Black	Spheroid
33	6.4	29.0	137	Black	Sphere
34	3.4	5.0	10	-	-
34A	2.4	-	7.2	T. Dark Grey	Sphere
34B	1.6	-	2.1	T. Grey	Sphere
34C	1.1	-	.70	T. Grey	Sphere
35	3.8	3.7	29	T. Orange Brown	Spheroid
36	3.3	3.6	19	Shiny Grey	Sphere
37	5.3	5.1	78	T. Grey Yellow	Spheroid
37A	1.9	-	3.6	Black	Sphere
Note: 'A' appears surrounded by the main body.					
38	3.7	6.6	27	Dull Brown	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc D Station 068 Casella (Continued) 2922

Particle Number	Average Diameter (u)	Count Rate (cpm)	Volume (u^3)	Color	Morphology
39	12.4	9.2	100	T. Dark Brown	Irregular
40	2.5	3.3	8.2	Very Shiny Yellow	Spheroid
41	3.0	5.5	14	T. Orange Brown	Spheroid
42	2.5	4.0	8.2	T. Orange Brown	Sphere
43	6.2	10.7	125	T. Orange	Irregular
44	4.3	5.9	42	Shiny T. Orange	Sphere
45	3.6	3.9	16	-	-
45A	2.9	-	13	T. Orange Brown	Sphere
45B	1.7	-	2.6	T. Orange Brown	Sphere
46	6.7	9.7	158	Black & T. Orange	Irregular
47	3.2	0.7	17	Brown	Irregular
48	5.0	8.6	65	T. Yellow	Spheroid
49	3.9	16.4	31	Yellow	Irregular
50	6.1	39.3	119	Yellow & Clear	Irregular

Double Tracks Arc E Station 058 Casella, Resin/Cellulose 9624

Three radioactive sites were observed on 48-hour autoradiograph but appear to have been lost in trying to isolate them. The observed activity was 332 dpm.

TABLE 3.2 CONTINUED

Double Tracks Arc E Station 058 Casella 9698

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	36.0	274.2	24,430	Greenish & Opaque	Irregular
2	17.7	5.3	2,903	Opaque	Fuzzy Ball
3	12.7	6.6	1,073	Opaque & Clear	Irregular
4	10.0	21.3	· 524	Gold	Sphere
5	11.6	52.9	410	-	-
5A	8.9	-	369	Dark Yellowish	Spheroid
5B	3.2	-	17	Dark Yellowish	Spheroid
5C	3.6	-	24	Ruddy	Irregular
6	5.3	3.2	78	-	-
6A	5.3	-	78	Opaque	Sphere
6B	0.8	-	0.3	Opaque	Sphere
Note: Surrounded by a yellowish tinge 11.5μ across, irregular shape.					
7	11.4	26.0	658	-	-
7A	9.6	-	463	Opaque	Spheroid
7B	7.2	-	195	Very Transparent Yellowish	Irregular
8	5.7	11.3	97	Opaque & Clear	Irregular
9	35.6	82.0	23,620	Opaque	Irregular
10	17.3	16.0	2,711	Opaque & Clear	Irregular
11	8.0	8.6	240	-	-
11A	7.7	-	239	Deep Amber	Sphere
11B	1.0	-	0.5	Opaque	Sphere
12	15.0	34.6	1,767	Part Opaque	Irregular
13	7.8	4.4	248	Dark Orange	Irregular
14	11.2	6.4	736	Part Opaque	Irregular
15	9.0	18.5	299	-	-
15A	7.8	-	248	Opaque	Spheroid
15B	4.6	-	51	Clear	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc E Station 058 Casella 9698

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
16	5.4	10.4	63	-	-
16A	4.9	-	62	Opaque	Spheroid
16B	1.3	-	1.2	Opaque	Spheroid
17	75.5	1881	225,400	Amber	Sphere
Note: Particle shows very intricate structure.					
18	12.6	8.1	1,049	Transparent	Irregular
19	3.8	12.2	24	-	-
19A	3.6	-	24	Opaque	Irregular
19B	0.3	-	0.01	Opaque	Sphere
Note: Six opaque submicron particles are also in the field.					
20	5.0	6.4	65	Opaque & Clear	Irregular
21	-	6.9	124	-	-
21A	5.9	-	108	Opaque & Yellow	Irregular
21B	3.1	-	16	Opaque & Yellow	Irregular
Note: Two particles about 15μ apart.					
22	12.2	23.0	951	Opaque & Yellow	Irregular
23	5.1	8.9	69	Opaque & Clear	Spheroid
24	6.7	4.2	158	Part Opaque	Irregular
25	15.7	59.1	2,026	Opaque & Clear	Irregular
26	11.0	16.3	697	Opaque	Irregular
27	6.2	2.7	125	Part Opaque	Spheroid
28	2.9	9.1	13	Bright Orange	Hexagonal
29	2.1	3.9	4.8	Deep Red Orange	Sphere
30	23.9	155.5	7,148	Opaque, Clear Edges	Grainy Spheroid
31	8.4	14.2	310	Opaque & Clear	Irregular
32	11.3	28.5	756	Opaque & Clear	Irregular
33	12.2	4.0	951	Clear	Irregular
33A	5.4	-	82	Opaque	Spheroid
33B	4.6	-	51	Opaque	Irregular
Note: A and B are inclusions.					
34	6.2	2.2	125	Brown Black	Irregular
35	4.9	3.4	62	Brown	Irregular
36	4.2	21.2	39	Opaque	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc E Station 058 TAS D 9699

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	3.2	6.5	17	Black	Spheroid
2	4.6	11.9	27	-	-
2A	3.6	-	24	Red-Yellow	Spheroid
2B	1.8	-	3.1	Dark Yellow	Spheroid
3	2.3	2.0	6.4	Brown and Clear	Irregular

Double Tracks Arc G Station 058 Casella 9660

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	6.1	0.06	12	Opaque	Sphere
2	12.7	214.5	1,073	Opaque	Spheroid
3	30.8	376.1	1,530	Opaque	Irregular
4	10.6	117.0	624	Opaque	Sphere
5	11.4	95.8	775	Opaque	Spheroid
6	16.5	228.4	2,352	Opaque	Sphere
7	7.5	2.6	22	Opaque	Sphere
8	5.8	31.8	102	Opaque	Sphere
9	5.6	3.4	92	Opaque & Clear	Irregular
10	5.3	1.6	78	Opaque	Irregular
Note: Four more particles < 2μ in field.					
11	8.9	3.3	369	T. Pale Yellow	Irregular
11A	1.1	-	.70	Black	Spheroid
11B	2.6	-	9.2	Black	Dumbell
12	2.0	1.8	4.2	Brown	Triangle
13	8.4	15.6	310	T. Yellow	Irregular
14	1.8	2.1	3.1	T. Orange Brown	Spheroid
15	2.2	2.3	5.6	T. Orange Brown	Spheroid
16	3.0	2.6	14	T. Yellow Brown	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc G Station 058 TAS D 9661

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	4.4	6.7	45	Opaque & Yellow	Irregular
Note: Appears to be attached to piece of collection media.					
2	16.2	173.9	1,342	-	-
2A	11.2	-	736	Opaque	Sphere
2B	10.5	-	606	Opaque & Gold	Irregular
3	4.2	7.4	39	Yellow	Sphere
4	7.7	50.5	239	Yellow	Spheroid
5	3.0	6.5	14	Gray Yellow	Spheroid
6	3.4	5.9	21		Sphere
7	5.6	2.2	92	Yellow	Irregular
8	4.6	13.7	51	Black	Spheroid
9	6.2	12.2	125	Black, T. Brown, Clear	Irregular
10	9.1	11.8	395	Yellow	Spheroid
11	2.7	3.9	10	Black	Spheroid
12	3.2	2.3	17	Yellow	Spheroid
13	5.6	8.0	79	-	-
13A	3.0	-	14	Black	Spheroid
13B	5.0	-	65	T. Orange Brown	Spheroid
14	4.2	11.3	39	Yellow	Spheroid
15	9.1	9.5	395	T. Yellow	Spheroid
16	7.0	4.0	180	Clear, Orange, Black	Irregular
17	4.1	5.2	36	Black & T. Gray	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc G Station 064 Casella 9656

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	-	8.2	84	-	-
1A	5.4	-	82	Yellow	Rough Sphere
1B	1.6	-	2.1	Opaque	Sphere
Note:	Particles are completely detached about 2μ apart.				
2	10.6	8.4	624	Part Opaque	Sphere
3	15.0	430.1	1,767	Opaque	Sphere
4	11.2	72.6	736	Opaque	Spheroid
5	8.5	144.4	322	Opaque	Bullet Shape
6	13.0	73.2	1,150	Opaque	Sphere
7	7.4	90.2	212	Opaque	Sphere
8	3.1	14.3	16	Yellowish	Irregular
9	17.6	30.0	2,855	Opaque	Spheroid
10	5.2	21.1	66	-	-
10A	4.9	-	62	Opaque	Sphere
10B	1.4	-	1.4	Dark Orange	Hemisphere
10C	1.6	-	2.1	Orange	Sphere
Note:	Part C completely detached about 1.5μ away.				
11	8.5	51.8	322	Opaque	Sphere
12	13.9	63.6	1,407	Opaque	Irregular
13	8.0	13.8	177	-	-
13A	6.6	-	150	Opaque	Irregular
13B	3.5	-	22	Clear	Spheroid
13C	2.1	-	4.8	Opaque	Spheroid
14	8.1	19.5	278	Opaque	Sphere w/tail
15	5.6	27.1	92	Opaque & Orange	Irregular
16	10.7	126.2	641	Opaque	Sphere
17	4.7	10.9	54	Orange	Sphere
18	4.6	19.9	51	Opaque & Dark Orange	Spheroid
19	4.8	22.7	58	Opaque & Clear	Spheroid
20	6.4	37.2	137	Opaque & Clear	Spheroid
21	3.5	5.5	22	Opaque	Irregular
22	5.1	32.8	69	Opaque	Sphere
23	3.7	6.9	17	-	-
23A	2.9	-	13	Opaque	Irregular
23B	2.0	-	4.2	Dark Orange	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc G Station 064 Casella

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
24	2.4	3.2	7.2	Dark Orange	Spheroid
25	3.7	6.1	27	Opaque & Dark Orange	Irregular
26	9.8	2.8	493	Yellow Orange	Sphere
27	3.2	4.0	17	Opaque & Grey Orange	Irregular
Note:	Two particles, 1.2 and 1.1μ, also in field.				
28	3.8	9.1	21	-	-
28A	3.0	-	14	Opaque & Dark Orange	Spheroid
28B	2.3	-	6.4	Opaque & Dark Orange	Bar Shape
28C	0.9	-	0.4	Opaque	Sphere
29	3.4	8.2	21	Dark Brown	Ellipsoid
30	3.2	8.1	17	Opaque	Spheroid
31	2.6	5.3	9.2	Opaque	Spheroid
Note:	Five submicron particles in field.				
32	3.5	7.7	22	Opaque & Orange	Spheroid
33	29.4	35.0	13,310	Opaque & Yellow	Sphere
Note:	Particle is cleaved in half.				
34	16.1	59.6	2,185	Opaque & Yellow	Irregular
35	7.8	74.3	248	Opaque & Yellow	Irregular
36	6.5	99.9	144	Opaque	Sphere
37	16.5	80.5	2,352	Opaque & Grey	Spheroid
38	11.6	34.7	636	-	-
38A	10.6	-	624	Opaque	Spheroid
38B	1.6	-	2.1	Opaque	Spheroid
38C	2.7	-	10	Opaque	Irregular
39	15.0	175.0	904	-	-
39A	11.6	-	817	Opaque	Irregular
39B	5.5	-	87	Opaque	Sphere
40	4.7	26.3	54	Opaque	Spheroid
41	5.7	8.9	97	Opaque & Clear	Spheroid
42	10.9	20.7	678	Opaque & Clear	Irregular
43	4.6	6.2	51	Opaque	Sphere
[illegible]	4.5	8.1	48	Red Brown	Sphere
45	10.1	17.1	540	Opaque	Irregular
46	3.7	12.7	27	Opaque	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc G Station 064 Casella 9656

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
47	4.8	9.9	58	Clear Yellow	Sphere
48	10.4	12.5	589	Opaque & Clear	Irregular
49	3.9	10.9	31	Opaque	Spheroid
50	3.2	8.4	17	Opaque	Sphere
51	4.4	13.8	45	Opaque	Irregular

Double Tracks Arc H Station 060 Casella 2723

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	11.9	147.4	882	Opaque	Irregular
2	6.7	42.3	115	-	-
2A	5.9	-	108	Opaque	Spheroid
2B	2.4	-	7.2	Opaque	Spheroid
3	4.5	7.3	18		
3A	2.5	-	8.1	Opaque	Sphere
3B	2.7	-	10	Part Opaque	Sphere
4	7.3	28.6	204	Opaque	Spheroid
5		1.9	~8	-	-
5A		-	~4	Opaque	Sphere
5B		-	~4	Opaque	Sphere
6	33.4	15.5	19,520	Opaque	Triangular
7	2.5	3.4	8.2	Opaque	Irregular
8	4.0	56.4	34	Amber & Black	Spheroid
9	13.2	130.1	1,204	Opaque	Spheroid
10	3.2	78.1	17	Opaque	Spheroid
11	7.6	32.7	230	Opaque	Spheroid

Note: Two clear attachments are probably air bubbles.

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 059 TAS D

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	2.8	2.9	14	Orange Brown	Irregular
2	17.2	182.8	2,664	Opaque Yellow	Spheroid
3	2.4	4.3	7.2	Opaque Yellow	Spheroid
--	5.7	23.9	75	-	-
4A	5.2	-	74	Opaque Yellow	Sphere
4B	1.3	-	1.2	Opaque Yellow	Sphere
5	4.8	11.9	58	Opaque Brown	Sphere
6	4.1	20.5	36	Opaque Black	Sphere
7	2.3	2.6	6.4	Brown	Irregular
8	2.7	3.3	10	Orange Brown	Irregular
9	4.2	5.8	39	Opaque Brown	Spheroid
10	10.3	39.6	572	Part Opaque	Crescent
11	4.6	10.7	51	Opaque Brown	Sphere
12	2.8	4.3	11	Dark Orange Brown	Egg
13	2.8	0.1	11	Opaque Orange Brown	Irregular
14	2.9	4.9	13	Opaque Brown	Irregular
15	4.9	14.6	62	Opaque Brown	Sphere
16	2.6	4.1	9.2	Dark Brown	Sphere
17	22.3	239.7	2,057	-	-
17A	13.9	-	1,407	Dull Black	Sphere
17B	5.4	-	82	Shiny Orange	Spheroid
17C	6.6	-	151	Yellow	Irregular
17D	9.2	-	408	Yellow	Irregular
17E	2.6	-	9.2	Yellow	Irregular
18	8.7	20.1	345	Black	Spheroid
19	10.2	27.3	556	Black	Irregular
20	19.1	20.8	1,475	-	-
20A	7.7	-	239	Black	Spheroid
20B	8.0	-	268	Black	Irregular
20C	11.3	-	756	Black	Irregular
20D	7.4	-	212	Black	Spheroid
21	7.4	9.6	212	Shiny Black	Blistered Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 059 TAS D (Continued) 9691

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
22	10.2	120.8	556	Shiny Black	Spheroid
23	2.7	2.6	10	T. Orange Gold	Spheroid
24	4.8	6.8	58	Shiny Brown	Irregular
25	2.7	1.0	10	T. Dark Brown	Irregular
26	3.2	2.2	10	-	-
26A	2.6	-	9.2	T. Light Brown	Spheroid
26B	1.3	-	1.2	T. Light Brown	Spheroid
27	3.5	5.7	22	Dull Black	Sphere
28	6.2	9.2	125	Black	Spheroid
29	9.3	8.5	421	Black	Irregular
30	23.6	11.9	6,832	Yellow	Irregular
31	3.8	5.6	29	Shiny T. Orange	Spheroid
32	3.4	3.2	21	V. Shiny Black	Irregular
33	3.4	3.1	10	-	-
33A	2.0	-	4.2	T. Orange Brown	Spheroid
33B	2.1	-	4.8	T. Orange Brown	Spheroid
33C	1.0	-	0.52	T. Orange Brown	Spheroid
33D	1.0	-	0.52	T. Orange Brown	Spheroid
34	2.6	0.8	9.2	Yellow	Spheroid
35	3.5	3.0	22	Shiny T. Orange Brown & Black	Spheroid
36	3.1	5.6	16	Shiny Brown	Spheroid
37	2.2	1.0	5.6	T. Orange Brown	Irregular
38	1.8	0.4	3.1	T. Orange Brown	Irregular
39	2.8	1.6	11	T. Red Brown	Spheroid
40	3.1	1.0	16	T. Gray Brown	Spheroid
41	11.0	3.0	697	T. Gray	Irregular
42	4.4	0.5	45	Yellow	Irregular
43	2.4	1.7	7.2	T. Orange Gray	Sphere
44	2.6	3.0	9.2	T. Dark Gray	Irregular
45	2.6	3.5	9.2	Shiny Yellow	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 059 TAS D 9691

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
46	2.6	5.9	16	-	-
46A	2.6	-	9.2	Brown	Sphere
46B	1.1	-	6.7	Brown	Sphere
47	2.0	3.0	4.2	T. Orange	Sphere
48	2.7	2.6	10	Opaque	Sphere
49	3.2	1.7	5.4	-	-
49A	1.6	-	2.1	T. Gray	Sphere
49B	1.8	-	3.1	Black	Irregular
49C	0.6	-	0.1	T. Gray	Spheroid
49D	0.4	-	0.04	T. Gray	Pear Shaped
49E	0.5	-	0.07	Black & Clear	Oval
50	4.8	30.7	58	Black	Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 061 TAS D 9669

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	5.9	5.4	108	Black & T. Yellow	Spheroid
2	11.2	70.7	736	Brown	Spheroid
3	3.9	12.0	31	T. Brown	Irregular
4	3.4	4.3	13	-	-
4A	2.6	-	9.2	Black	Spheroid
4B	1.9	-	3.6	T. Brown	Sphere
5	5.5	25.5	87	Black	Spheroid
6	7.9	69.0	258	T. Dark Brown	Spheroid
7	5.5	31.0	87	Black	Sphere
8	1.6	2.5	2.1	T. Orange	Spheroid
9	3.6	2.6	24	T. Dark Brown	Spheroid
10	3.6	10.6	24	Shiny Black	Egg Shape
11	3.3	7.0	19	Black	Irregular
12	6.4	6.4	137	Black to Clear	Sphere
13	3.4	4.2	21	Brown	Spheroid
14	8.1	65.9	278	Brown	Sphere
15	2.7	2.5	10	T. Brown	Spheroid
16	4.9	21.0	62	Shiny Black	Sphere
17	7.9	8.7	258	Black & T. Yellow	Spheroid
18	4.0	9.1	34	Black	Irregular
19	4.9	13.7	62	Black	Sphere w/tail
20	7.0	23.3	180	Black	Spheroid
21	2.6	3.7	9.2	T. Red Brown	Spheroid
22	3.2	5.1	17	T. Dark Brown	Sphere
23	-	2.9	7.5	-	-
23A	2.3	-	6.4	T. Orange	Sphere
23B	1.2	-	0.90	T. Orange	Sphere
23C	0.6	-	0.1	T. Orange	Sphere
23D	1.0	-	0.52	T. Orange	Sphere
Note: Parts C and D are completely detached.					
24	4.7	20.5	54	Shiny Black	Sphere
25	3.5	1.4	22	Black	Very Irregular
26	3.9	7.2	31	Black	Sphere
27	8.8	5.5	357	T. Gray Yellow	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 061 TAS D

9669

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
28	2.9	4.6	13	T. Dark Brown	Sphere
29	5.0	20.1	65	T. Dark Brown, Shiny	Sphere
30	8.9	16.5	269	-	-
30A	4.2	-	39	Black	Spheroid
30B	7.6	-	230	Clear	Irregular
31	2.8	16.8	11	T. Orange Brown, Shiny	Sphere
32	2.8	2.3	11	T. Orange Brown	Sphere
33	-	5.9	22	-	-
33A	2.6	-	9.2	T. Dark Grey	Irregular
33B	2.9	-	13	T. Orange Yellow	Irregular
Note: Parts A and B became detached.					
34	2.5	4.0	8.2	Yellow	Spheroid
35	5.5	9.9	87	T. Dark Brown	Spheroid
36	1.9	2.4	3.6	T. Orange Brown	Sphere
37	2.0	3.6	4.2	Bright Yellow	Sphere
38	9.0	75.2	303	-	-
38A	8.3	-	299	T. Dark Yellow	Sphere
38B	2.0	-	4.2	T. Yellow	Sphere
39	4.9	29.4	62	Yellow	Egg Shape
40	2.4	2.7	7.2	Yellow	Spheroid
41	3.3	2.5	19	Yellow	Irregular
42	3.3	5.6	19	Yellow	Irregular
43	3.8	4.5	29	Red-Yellow	Sphere
44	3.2	8.0	17	Brown	Irregular
45	2.1	2.6	4.8	Yellow	Irregular
46	7.4	13.6	212	Black & Clear	Irregular
47	2.6	4.1	9.2	Brown	Sphere
48	2.6	2.0	9.2	Black & Clear	Spheroid
49	3.1	4.2	5.8	Black & T. Gray	Very Irregular
50	9.6	76.8	463	Black	Bubbly Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 061 Casella 9668

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	9.6	15.9	478	Opaque & Yellow	Irregular
2	6.7	22.9	172	Opaque	Irregular
3	3.2	6.6	17	Opaque	Irregular
4	5.9	5.1	108	Part Opaque	Spheroid
5	2.9	5.7	13	Opaque	Spheroid
6	4.7	4.0	54	Part Opaque	Irregular
7	5.1	5.6	69	Grey	Irregular
8	14.6	36.6	1,262	-	-
8A	13.2	-	1,204	Opaque	Sphere
8B	4.8	-	58	Clear	Hemisphere
9	11.5	78.3	796	Opaque & Clear	Very Irregular
10	13.4	360.6	1,260	Opaque	Spheroid
11	9.9	95.3	508	Opaque	Spheroid
12	19.6	282.1	2,965	-	-
12A	16.3	-	2,268	Opaque	Sphere
12B	11.0	-	697	Dirty Yellow	Irregular
13	3.0	8.2	14	Opaque	Sphere
14	6.3	30.5	131	Opaque	Irregular
15*	3.2	8.0	17	Opaque & Clear	Spheroid
16	2.9	7.1	13	Opaque & Clear	Spheroid
17	1.8	15.1	3.1	Opaque	Irregular
18	3.5	0.1	22	Clear	Spheroid
19	3.7	8.5	27	Clear	Sphere
20	3.5	11.4	22	Opaque	Sphere
21	3.5	10.3	22	Opaque	Sphere
22	3.0	2.9	14	Pale Green & Yellow	Sphere

Note: This particle shows internal structure like bubbles.

23	5.5	40.5	87	Opaque	Sphere
24	2.8	5.4	11	Opaque	Sphere
25	4.6	4.2	51	Opaque & Clear	Spheroid
26	2.3	3.2	6.4	Yellow Grey	Sphere
27	2.6	3.2	9.2	Dark Red Brown	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc I Station 061 Casella Continued 9668

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
28	3.6	7.1	24	Brown	Spheroid
29	3.2	4.1	17	Brown Orange	Irregular
30	2.0	2.0	4.2	Brown	Sphere
31	2.5	1.9	8.2	Brown	Sphere
32	3.3	4.0	19	Amber	Irregular
33	5.6	2.9	92	Yellow Brown	Irregular
34	3.1	7.5	16	Dark Amber	Irregular
35	2.7	4.1	10	Dark Brown	Spheroid
36	2.8	3.1	11	Amber	Irregular
37	8.4	60.7	310	Dark Brown	Sphere
38	2.6	3.8	9.2	Opaque	Sphere
39	10.4	29.4	589	Opaque & Yellow	Irregular
40	9.7	17.8	478	Opaque & Yellow	Irregular
41	6.7	6.7	158	Opaque & Yellow	Irregular
42	5.8	4.8	65	-	-
42A	4.0	-	34	Opaque & Clear	Irregular
42B	3.9	-	31	Opaque & Clear	Irregular
43	2.9	7.2	13	Opaque	Sphere
44	3.3	6.6	19	Opaque	Irregular
45	2.2	2.1	5.6	T. Orange Brown	Spheroid
46	2.1	2.3	4.2	Opaque	Spheroid
47	2.5	4.7	8.2	T. Orange	Sphere
48	2.5	1.6	8.2	T. Orange, Shiny	Sphere
49	16.2	7.6	988	-	-
49A	10.5	-	606	Shiny Yellow	Irregular
49B	9.0	-	382	T. Pale Yellow	Irregular
50	4.3	1.8	42	Yellow	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc J Balloon Line 6 Position 13 Casella 2482

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	6.0	0.06	113	Opaque & Clear	Spheroid
2	18.4	0.4	3,262	Opaque & Clear	Lumpy
3	4.8	19.9	58	Opaque & Clear	Ellipsoid
4	4.8	3.7	28	-	-
4A	3.4	-	21	Opaque & Clear	Irregular
4B	2.4	-	7.2	Opaque & Clear	Irregular
5	1.9	0.1	3.6	Opaque	Crystalline
6	10.2	4.1	556	Opaque & Clear	Irregular
7	9.2	24.5	408	Opaque & Clear	Spheroid
8	7.2	17.2	111	-	-
8A	5.5	-	87	Opaque	Irregular
8B	3.6	-	24	Opaque	Irregular
9	5.2	11.8	45	-	-
9A	4.3	-	42	Opaque	Sphere
9B	1.7	-	2.6	Yellow	Sphere
10	2.5	5.1	8.2	Brown	Sphere
11	9.4	17.7	147	-	-
11A	6.1	-	119	Opaque & Clear	Spheroid
11B	1.6	-	2.1	Opaque	Irregular
11C	1.9	-	3.6	Opaque	Sphere
11D	3.5	-	22	Opaque	Sphere
12	4.9	12.5	62	Opaque	Sphere
13	9.3	51.2	120	-	-
13A	5.7	-	97	Orange Brown	Irregular
13B	7.6	-	23	Opaque	Sphere
14	2.5	3.3	8.2	Dark Orange Brown	Sphere
15	1.8	1.5	3.1	Brown Orange	Sphere
16	2.4	2.8	7.2	Brown Orange	Sphere
17	3.4	1.5	21	Part Opaque Black	Sphere
18	2.5	1.1	8.2	Part Opaque Black	Spheroid
19	2.3	1.1	6.4	Shiny Opaque Black	Irregular
20	1.6	1.6	2.1	Transparent	Sphere
21	2.8	3.5	11	Brown	Sphere
22	2.7	2.5	10	Opaque Brown	Triangle
23	4.2	3.0	39	Grey Yellow	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc J Balloon Line 6 Position 13 Casella (Continued) 2482

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
24	2.1	1.5	4.8	T. Grey	Spheroid
25	33.9		20,400	T. Yellow	Irregular
25A	2.1	-	4.8	Black	Sphere
Note:	Part A is an inclusion.				
26	3.8	4.6	29	T. Grey Brown	Irregular
27	3.3	5.8	17	T. Brown, Shiny	Spheroid
28	2.3	1.5	6.4	Dark Grey	Spheroid
29	2.8	7.6	11	Black	Sphere
30	7.0	1.5	180	T. Red Orange	Irregular
31	2.0	2.4	4.2	T. Dark Gray	Irregular
32	2.1	2.5	4.8	T. Dark Gray	Sphere
33	6.9	10.0	172	T. Pale Yellow	Spheroid
34	2.5	3.8	8.2	T. Orange Brown	Spheroid
35	5.9	1.6	108	T. Orange Brown	Irregular
36	2.3	2.2	6.4	T. Brown	Irregular
37	1.9	0.9	3.6	T. Orange & Clear	Sphere
38	1.9	1.2	3.6	Opaque	Sphere
39	13.1	16.4	1150	Opaque & T. Yellow	Irregular

TABLE 3.2 CONTINUED

Double Tracks Arc J Station 058 Anderson 2812

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	12.7	158.0	1,073	Opaque	Diamond
2	5.7	36.6	970	Opaque	Sphere
3	10.6	10.6	813	-	-
3A	5.7	-	97	Opaque	Spheroid
3B	5.6	-	92	Opaque	Spheroid
3C	10.6	-	624	Yellow	Irregular
4	2.9	8.7	13	Opaque	Sphere
5	4.1	14.4	36	Opaque	Irregular
6	2.8	5.5	11	Opaque	Sphere
7	5.7	16.4	97	Opaque	Irregular
8	13.7	8.9	1,346	Yellow Green	Sphere
Note:	This particle shows a complex internal structure.				
9	7.0	3.0	180	Opaque	Irregular
10	3.5	5.9	22	T. Dark Brown	Spheroid
11	23.7	1.4	6,965	T. Pale Yellow	Irregular
11A	9.6	-	463	Black	Irregular
12	3.8	3.0	17	-	-
12A	3.0	-	14	T. Brown Orange	Spheroid
12B	1.7	-	2.6	T. Brown Orange	Spheroid
13	3.6	2.6	24	T. Orange	Spheroid
13A	2.9	-	13	Black	Irregular
14	2.2	1.6	5.6	T. Dark Brown	Sphere
15	2.6	4.2	9.2	Dull Brown	Spheroid
16	6.5	26.3	144	Black	Spheroid
17	3.5	5.2	13	-	-
17A	2.7	-	10	T. Dark Brown	Spheroid
17B	1.7	-	2.6	T. Dark Brown	Spheroid
18	4.1	4.2	36	T. Brown	Sphere

TABLE 3.2 CONTINUED

Double Tracks Arc N Station 068 Casella 2837

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology

This sample yielded only particles under two microns in diameter. The observed activity was 732 dpm.

Double Tracks Arc R Station 054 Casella 2946

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	2.7	8.6	10	Opaque	Sphere
2	2.9	6.1	6.3	-	-
2A	2.2	-	5.6	Dark Amber	Sphere
2B	1.1	-	.7	Opaque	Sphere
3	2.5	2.9	8.1	Opaque	Sphere
4	16.9	75.5	2,527	Opaque	Spheroid
5	3.2	9.1	17	Brownish Red	Sphere
6	2.8	1.2	11	Orange Tan	Sphere
7	15.3	65.1	708	-	-
7A	10.0	-	527	Opaque	Irregular
7B	5.5	-	87	Opaque	Spheroid
7C	5.7	-	97	Opaque	Sphere
8	2.8	6.0	11	Opaque	Spheroid
9	12.6	55.7	1,049	Opaque	Sphere
10	11.6	85.9	817	Dark Brown	Sphere
11	2.3	3.1	6.4	Reddish	Spherical
Note: This appears to be a mass of $\lesssim$ 0.2μ particles					
12	3.3	6.8	19	Opaque	Sphere
13	6.0	1.9	113	Opaque	Sphere
14	2.1	2.4	4.8	Opaque	Irregular
15	2.5	1.4	8.2	Opaque	Sphere
16	2.9	1.8	13	T. Dark Brown	Spheroid

TABLE 3.2 CONTINUED

Double Tracks Arc R Station 082 Anderson **2934**

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology

No particles were found. The observed activity was 373 dpm.

Clean Slate I Arc B Balloon Line 16 Position 21 Costella 3449

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	141	61.6	1,465,000	Gray	Irregular
1A	31.5	-	16,840	Black	''
1B	31.6	-	16,520	Black	''
2	10.9	2.9	678	Yellow	''
3	2.8	1.8	11	T. Drk. Gray Yellow	Sphere
4	9.5	13.2	493	Amber	Irregular
5	11.0	17.5	697	Orange Brown	''
6	13.1	9.4	1,177	T. Yellow Gray	Sphere
7	7.2	2.9	195	T. Gray Yellow	Spheroid
8	30.8	5.4	15,300	Brown	Irregular
9	9.0	7.2	382	-	-
9A	4.9	-	62	Gray Yellow	Spheroid
9B	6.3	-	131	Gray Yellow	Spheroid
10	28.9	47.6	12 640	T. Yellow Green	Sphere
11	11.2	19.3	736	Gray Yellow	Spheroid
12	86.5	43.8	338,900	T Gray Yellow	Sphere
13	24.0	16.0	7,235	Yellow	Spheroid
14	18.5	52.0	3,3.5	Gray	Irregular
15	3.6	3.8	24	Yellow	Spheroid
16	4.6	3.2	51	Black & T. Yellow	Sphere
17	5.3	15.2	78	T. Orange Gray	Spheroid
18	6.8	4.4	165	T. Brownish Gray	Irregular
19	9.1	7.6	395	Yellowish Gray	
20	9.6	2.8	463	Clear	Sphere
21	6.5	7.1	144	Yellow Gray	Sphere

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 18 Position 21 Casella

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
22	10.0	4.6	524	Yellow Gray	Irregular
23	12.8	13.2	1,098	T. Yellow	Spheroid
24	7.2	4.0	195	Black	"
25	117	54.3	838,600	T. Yellow	Sphere
26	10.7	9.2	641	T. Yellow Gray	Spheroid
27	5.7	6.2	97	Brown	"
28	20.3	2.3	4,380	-	-
28A	17.4	-	2,758	Yellow	"
28B	10.2	-	556	T. Gray	"
29	5.7	1.4	97	Yellow	Irregular
30	12.5	1.5	1,023	Green	Spheroid
31	13.8	1.1	1,376	-	-
31A	12.5	-	1,023	T. Yellow	"
31B	4.9	-	62	T. Yellow	"
32	14.2	1.4	1,497	Yellow Gray	Irregular
33	7.6	0.8	230	T. Yellow	"
34	8.0	0.6	268	T. Yellow	"
35	5.6	1.0	92	T. Gray	"
36	20.2	3.3	4,316	T. Yellow Gray	Sphere
37	17.4	1.5	2,758	Brown	Spheroid
38	4.2	2.0	39	T. Gray Yellow	Sphere
39	72.8	109.5	202,000	-	-
39A	69.7	-	177,300	Black	Irregular
39B	8.1	-	278	Black	Spheroid
40	11.5	0.7	796	Shiny White Metallic	Irregular
41	27.6	1.8	11,010	T. Yellow	Spheroid
42	17.3	1.5	2,711	T. Yellow, Grainy	Irregular
43	4.7	2.1	54	T. Gray Yellow	"
44	5.0	1.0	65	Black	Spheroid
45	7.3	1.4	204	Yellow	Irregular
46	18.0	2.4	3,054	T. Yellow Gray & Orange	"
47	13.3	2.5	1,232	Yellow	"
48	13.7	0.7	1,346	Yellow	"
49	2.2	0.9	5.6	Clear & T. Gray Orange	Spheroid
50	5.6	0.8	92	Yellow	"

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 19 Position 9 TAS I 3013

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	6.3	16.2	131	Black	Spheroid
2	15.8	41.6	2065	Black	Sphere
3	17.7	35.4	2903	T. Dirty Yellow	Sphere
4	14.3	120.2	1531	T. Yellow & Orange	Sphere
5	8.5	26.4	321	Black	Grainy Sphere
6	6.9	5.4	172	Black	Oval
7	8.7	13.0	345	Black	Triangle
8	9.5	3.5	449	Black	Spheroid
9	11.1	31.0	716	Black & Clear	Spheroid
10	26.1	240.6	9309	Black & Clear	Spheroid
11	31.1	80.7	15,750	T. Yellow & Black	Sphere
12	9.6	37.1	463	Black & Clear	Spheroid
13	16.5	33.2	2352	T. Yellow & Black	Spheroid
14	19.3	48.4	3764	T. Yellow & Black	Irregular
15	29.8	200.9	13,860	Black & Clear	Irregular
16	17.5	122.4	2806	Black	Spheroid
17	17.9	89.7	3003	Black & Clear	Crescent
18	21.4	48.1	7752	Black	Spheroid
19	18.3	124.3	3209	Black	Irregular
20	29.8	85.5	13,860	Dark T. Yellow Gray	Sphere
21	8.6	9.9	333	Black	Spheroid
22	11.6	27.7	817	Black & Clear	Irregular
23	17.3	108.8	2414	-	-
23A	16.6	-	2395	Black	Spheroid
23B	3.3	-	19	T. Orange	Spheroid
24	13.6	31.6	1317	Black	Irregular
25	15.1	30.4	1803	Black	Sphere
26	13.6	93.0	1317	Black	Oval
27	40.6	197.3	35,040	Black	Irregular
28	18.1	62.1	3105	Black & T. Yellow	Irregular
29	28.0	128.3	11,490	Black	Sphere
30	11.6	66.5	817	T. Orange	Spheroid
31	12.5	12.5	1023	Black & T. Yellow	Crescent

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 19 Position 9 TAS I (Continued) 3013

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
32	6.4	16.4	137	Black & Clear	Irregular
33	16.6	27.4	2395	Black	Irregular
34	7.2	17.1	1954	Black	Egg
35	10.3	56.1	572	Black	Spheroid
36	84.6	147.4	317,000	T. Yellow	Sphere
37	10.2	8.4	556	Black & Clear	Irregular
38	6.3	5.2	131	T. Orange Yellow	Ellipse
39	25.4	3.7	8580	T. Yellow Green	Spheroid
40	30.2	22.1	10164	-	-
40A	18.6	-	3369	Black	Irregular
40B	23.5	-	6795	Black	Lumpy
41	6.5	4.4	144	Black & Clear	Irregular
42	5.4	4.1	82	T. Dark Brown	Spheroid
43	26.1	280.5	9203	Black	Hemisphere
44	13.5	173.2	1288	Black	Sphere
45	21.9	101.2	5499	Loose Cluster of 11 Black Spheres	
46	16.2	51.7	2226	T. Orange	Sphere
47	12.4	21.0	9980	Black	Irregular
48	15.7	29.5	2026	Black	Spheroid
49	11.5	97.4	796	Black	Sphere
50	4.3	2.8	42	T. Gray	Square

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 25 Position 9 TAS I 3038

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	43.0	170.2	41,630	Black	Irregular
2	12.0	63.2	905	Black	Irregular
3	27.6	214.7	11,010	Black	Grainy Ball
4	10.8	51.8	660	Black	Pitted Spheroid
5	14.8	50.9	1,697	Dull & Shiny Black	Spheroid
6	17.1	32.9	2,618	Black	Grainy Irregular
7	72.0	180.3	191,391	-	-
7A	10.6	-	624	Black	Sphere
7B	15.0	-	1,767	Yellowish	Spheroid
7C	71.2	-	189,000	Yellowish	Irregular
8	36.8	48.5	10,964	-	-
8A	23.3	-	6,623	Black	Spheroid
8B	16.4	-	2,310	Yellowish	Spheroid
8C	13.8	-	1,376	Yellowish	Irregular
8D	3.5	-	22	Dark Yellowish	Spheroid ?
8E	7.1	-	187	Clear	Hemisphere ?
8F	9.1	-	395	Yellowish	Spheroid ?
8G	4.6	-	51	Black	Spheroid ?
9	51.4	8.1	44,316	-	-
9A	43.3	-	42,460	Dark Orange	Spheroid
9B	12.0	-	905	T. Yellow Orange	Spheroid
9C	12.2	-	951	Dark Orange	Irregular
10	13.9	45.7	1,407	Brown	Irregular
11	10.6	5.1	624	T. Yellow Brown	Irregular
12	11.5	75.3	796	Brown & Clear	Irregular
13	15.2	18.0	1,803	Brown & Clear	Irregular
14	24.2	45.2	7,420	Yellow	Irregular
15	16.7	13.3	2,439	Black	Irregular
16	8.8	9.1	357	Brown	Irregular
17	20.5	89.2	4,511	Yellow Brown	Spheroid
18	16.1	49.9	2,185	Shiny Black	Irregular
19	55.5	60.7	72,543	-	-
19A	51.5	-	71,520	Black & T. Yellow	Sphere
19B	12.5	-	1,023	Black	Sphere
20	91.7	571.3	403,700	Black & Orange	Sphere with Warts

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 25 Position 9 TAS I (Continued) 3038

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
21	39.3	75.7	29,420	T. Yellow	Sphere
22	11.6	44.4	817	Black	Spheroid
23	27.9	55.8	11,370	Dull Black	Sphere
24	15.7	91.8	2,026	Black	Spheroid
25	15.2	57.8	1,839	Shiny Black	Sphere
26	30.7	81.4	15,150	Black	Grainy Irregular
27	11.0	61.6	697	Shiny Black	Egg
28	105.2	248.6	609,600	T. Shiny Orange	Sphere
29	11.6	9.8	817	Shiny Yellow Grey	Sphere
30	14.5	2.9	697	-	-
30A	10.7	-	641	Black & Clear	Spheroid
30B	4.7	-	54	T. Yellow	Sphere
30C	1.6	-	2.1	Black	Sphere
31	58.4	1611.2	77,328	-	-
31A	52.3	-	74,900	Black	Irregular
31B	15.7	-	2,026	T. Yellow	Spheroid
31C	6.5	-	144	Black	Sphere
31D	7.9	-	258	Black	Sphere
32	21.5	44.2	2,591	-	-
32A	15.5	-	1,950	Black	Irregular
32B	10.5	-	606	T. Yellow	Spheroid
32C	3.9	-	31	T. Yellow	Irregular
32D	2.0	-	4.2	Black	Sphere
33	20.5	56.0	4,511	Yellow	Rough Irregular
34	26.9	95.2	10,190	Black	Irregular
35	13.3	83.0	854	-	-
35A	11.5	-	796	Black	Spheroid
35B	4.8	-	58	T. Yellow	Sphere
36	59.8	76.8	112,000	T. Grey Yellow	Pitted Sphere
37	17.4	44.4	2,758	Black	Irregular
38	14.0	46.6	1,437	Black	Irregular
39	19.6	10.2	3,942	Brown	Grainy Irregular
40	6.9	9.2	172	Black	Irregular

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 25 Position 9 TAS I (Continued) 3038

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
41	19.8	102.7	3857	-	-
41A	19.4	-	3823	Yellow	Spheroid
41B	4.0	-	34	T. Yellow	Spheroid
42	30.6	245	15,000	Black	Irregular
43	54.5	25.2	84,760	Black & T. Yellow	Irregular
44	54.8	70.6	86,170	T. Yellow	Sphere
45	18.8	42.2	3479	T. Yellow	Irregular
46	43.7	161.4	43,700	Black	Spheroid
47	15.0	86.3	1767	Yellow & Clear	Irregular
48	40.3	82.5	34,270	Black	Spheroid
49	30.9	105.0	15,450	Black	Sphere
50	33.5	33.0	19,680	T. Yellow	Sphere

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 29 Position 9 Casella 3466

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	33.8	407.9	10,337	-	-
1A	24.8	-	7,986	Black	Sphere
1B	16.2	-	2,226	T. Yellow	Spheroid
1C	6.2	-	125	T. Yellow	Hemisphere
2	14.6	190.4	1,629	Black	Irregular
3	215	337.5	5,203,000	Clear, Black Specks	Spheroid
4	11.9	8.2	882	Black	Irregular
5	25.6	15.2	8,784	Black	Sphere
6	21.3	8.5	5,060	Shiny Brown Black	Sphere
7	20.3	9.6	4,380	Black & Clear	Irregular
8	89.7	192.0	111,400	-	-
8A	57.8	-	101,100	Black	Spheroid
8B	59.5	-	110,300	Black	Spheroid
9	32.3	10.6	17,640	Black to Clear	Irregular
10	55.4	10.3	89,030	T. Yellow	Sphere with Blisters
11	11.5	6.2	796	Shiny Black	Oval
12	25.0	8.4	8,181	Black	Irregular
13	19.7	5.0	4,003	Shiny Black	Spheroid
14	14.8	27.8	1,697	Black & Clear	Irregular
15	19.0	20.4	3,591	Brown	Spheroid
16	22.0	12.5	5,575	Very Shiny Black	Spheroid
17	67.7	46.8	162,500	T. Yellow	Square with Inclusions
17A	8.5	-	321	Black	Sphere
Note:	Part A is apparently inside the mass.				
18	205	8.4	4,511,000	Dirty Yellow	Irregular
19	47.5	10.2	56,120	Yellow Brown	Spheroid
20	67.3	400.7	159,600	Black	Sphere with Tail
21	30.3	308.8	14,570	Black & Clear	Irregular
22	48.3	10.7	59,000	Clear	Irregular w. Inclusion
22A	6.3	-	131	Black	Sphere
23	15.6	4.2	1,988	Black	Sphere
24	20.3	6.1	3,393	-	-
24A	18.5	-	3,315	Dirty Yellow	Sphere
24B	5.3	-	78	Dirty Yellow	Sphere

TABLE 3.2 CONTINUED

Clean Slate I Arc B Balloon Line 29 Position 9 Casella (Continued) 3466

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
25	66.0	21.1	150,500	Black & T. Yellow	Irregular
26	14.9	23.5	1,732	Dark Brown	Spheroid
27	26.7	0.08	9,966	Clear	Spheroid w. Inclusion
27A	15.6	-	1,988	T. Yellow	Spheroid
28	44.8	19.1	47,080	Clear	Sphere w. Inclusion
28A	6.9	-	172	Black	Sphere
29	40.7	14.0	35,300	Clear w. Black Specks	Irregular
30	20.5	5.7	4,511	T. Yellow to Amber Center	Sphere
31	34.6	6.4	21,690	Black & Clear	Irregular
32	11.7	5.5	519	-	-
32A	8.2	-	289	Clear to T. Yellow	Spheroid
32B	7.6	-	230	Clear to T. Yellow	Irregular
33	19.7	26.5	4003	Black	Irregular
34	85.6	38.6		Black & Clear	Irregular
35	18.0	40.0	3054	Black	Irregular
36	7.4	8.8	145	-	-
36A	5.5	-	87	Black	Spheroid
36B	4.8	-	58	T. Brown	Spheroid
37	226.0	13.5	6,044,000	Clear	Irregular
38	117.4	73.7	838,600	Black & Clear	Irregular
39	26.0	20.0	9203	Clear	Irregular
40	40.0	40.0	33,510	Clear Yellow	Sphere
40A	5.4	-	82	Black	Sphere
41	26.2	92.7	9417	Black	Sphere
42	7.0	12.1	180	T. Dark Yellow	Sphere
43	83.0	98.9	299,400	Clear	Sphere
44	66.8	177.3	156,100	Black	Irregular
45	31.1	12.0	15,750	Black	Spheroid
46	49.1	97.0	61,980	Black	Irregular
47	112.5	156.5	745,600	Black	Irregular
48	10.0	70.1	5236	Black	Spheroid
49	36.4	3.9	25,250	Black & T. Yellow	Cylinder
50	51.2	14.0	702,800	T. Yellow & D. Yellow	Spheroid

TABLE 3.2 CONTINUED

Clean Slate II BM-07 TAS D 4082

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	42.8	6.2	41,050	T. Yellow & Black	Irregular
2	24.2	11.8	7,420	T. Yellow & Black	Rectangle
3	28.7	71.4	12,380	Black	Irregular
4	41.2	52.6	33,620	T. Yellow & Black	Irregular
5	29.1	17.6	12,900	T. Yellow	Irregular
6	28.2	28.3	11,740	T. Yellow-Brown	Irregular
7	22.8	34.2	6,206	Black	Irregular
8	20.1	22.0	4,252	T. Dark Brown Orange	Irregular
9	20.8	55.6	4,712	T. Orange Brown	Irregular
10	21.5	42.9	5,203	Black	Irregular
11	27.0	30.0	10,310	Black	Irregular
12	21.8	22.2	5,424	T. Orange, Yellow, Black	Irregular
13	14.7	20.3	1,665	Black	Spheroid
14	40.6	19.3	35,040	Black	Irregular
15	19.0	14.6	3,591	T. Orange Brown & Clear	Irregular
16	28.0	40.9	11,490	T. Dark Orange	Irregular
17	59.0	67.0	107,500	Black & Clear	Irregular
18	21.8	28.4	5,424	Black	Irregular
19	22.6	26.4	6,044	Black & T. Yellow	Irregular
20	61.6	397.2	122,400	Black	Irregular
21	24.3	14.7	7,513	Black & T. Yellow	Irregular
22	23.3	14.8	6,623	Black & T. Yellow	Irregular
23	34.9	57.7	22,260	Black	Irregular
24	22.1	51.2	5,651	Black	Spheroid
25	42.1	196.8	39,070	Black	Irregular
26	29.0	77.5	12,770	Black & T. Yellow	Irregular
27	34.0	19.4	20,580	Black & Clear	Irregular
28	42.3	63.5	39,630	Black	Very Irregular
29	25.5	0.04	8,681	T. Orange Brown	Irregular
30	19.5	24.7	3,882	Black & T. Orange	Irregular
31	28.5	33.4	12,130	T. Yellow Orange	Irregular
32	28.7	37.4	12,380	T. Orange & Brown	Irregular
33	19.4	28.4	3,823	Black & Clear Yellow	Irregular

TABLE 3.2 CONTINUED

Clean Slate II BM-07 TAS D (Continued) 4082

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
34	23.7	14.5	6,965	T. Yellow & Clear	Irregular
35	40.8	18.5	35,560	Black	Irregular
36	21.7	27.6	5,350	Black & T. Orange	Irregular
37	30.9	32.0	15,450	Black & T. Orange	Irregular
38	13.2	3.9	1,204	T. Orange Brown	Irregular
39	25.8	20.6	8,991	Black & Clear	Irregular
40	14.6	11.8	1,629	T. Dark Brown	Rectangle
41	9.5	3.9	449	Black	Irregular
42	21.8	7.8	5,424	T. Orange & Clear	Irregular
42A	11.7	-	839	Black	Irregular
43	17.4	13.8	2,758	T. Dark Orange	Irregular
44	17.0	21.3	2,572	T. Yellow	Irregular
45	17.2	6.0	2,664	T. Dark Orange	Irregular
46	17.0	13.5	2,572	Black	Oval
47	156.7	105.4	2,026,000	Black	Irregular
48	53.4	214.6	79,730	Black & T. Orange	Irregular
49	10.4	3.7	589	Black, T. Orange, Clear	Irregular
50	24.8	41.1	7,986	Black	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Tower B Position 2 Casella

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	52.0	111.6	73,620	T. Dark Brown	Irregular
2	386.2	217.7	30,110,000	T. Gray	Irregular
3	63.2	35.2	82,120	-	-
3A	51.9	-	73,200	T. Gray	Irregular
3B	24.3	-	7,513	Black	Sphere
3C	13.9	-	1,407	T. Gray	Hemisphere
4	120.4	26.3	904,800	T. Dark Gray	Irregular
5	46.9	37.1	54,010	T. Gray	Irregular
5A	18.7	-	3,424	Black	Spheroid
5B	16.4	-	2,310	Black	Spheroid
Note: A and B are partially embedded.					
6	137.7	15.4	137,600	T. Gray	Irregular
7	55.4	9.1	89,030	T. Dark Brown Orange	Frothy Sphere
8	45.9	136.5	50,630	Brown & Clear	Spheroid
9	55.0	47.9	87,110	Black & T. Yellow	Spheroid
10	558.7	814.3	91,430,000	Black	Irregular
11	46.3	10.1	51,970	Clear to T. Yellow	Spheroid
12	605.8	342.6	116,500,000	Black, Clear, T. Yellow	Irregular
13	52.4	15.6	75,330	Black	Sphere
14	107.6	56.7	533,050	-	-
14A	99.6	-	517,300	T. Mottled Gray	Irregular
14B	31.1	-	15,750	Black	Spheroid
15	35.9	21.1	24,230	T. Gray & T. Yellow	Spheroid
16	113.0	39.7	115,000	Black & T. Yellow	Irregular
17	38.9	58.4	30,820	Black & T. Yellow	Irregular
18	44.3	29.1	45,260	Black, Clear Edges	Spheroid
19	94.2	82.4	437,700	Black	Sphere
20	253.9	138.9	8,580,000	T. Dark Brown	Spheroid
21	59.1	20.2	63,090	-	-
21A	38.4	-	29,680	Black	Irregular
21B	40.2	-	34,010	T. Yellow	Irregular
22	53.8	42.2	81,530	Black & Clear	Irregular
23	332.5	209.2	19,160,000	Black	Spheroid
24	69.2	4.0	173,500	Clear	Sphere

TABLE 3.2 CONTINUED

Clean Slate II Tower B Position 2 Casella (Continued) 2305

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
24A	52.4	-	75,330	Black	Spheroid
25	27.8	35.7	11,250	Black	Spheroid
26	24.3	26.0	7,513	Black & Clear	Irregular
27	38.9	295.2	30,820	Black	Irregular
28	73.9	15.0	211,300	Black	Spheroid
29	120.1	25.4	904,800	T. Dark Gray	Spheroid
30	192.0	54.6	3,706,000	Black	Irregular
31	50.1	40.4	65,840	Black & T. Yellow	Very Irregular
32	38.0	26.1	28,730	Black	Spheroid
33	47.7	25.1	56,830	Clear	Spheroid
34	148.2	106.6	1,697,000	Black	Spheroid
35	34.5	49.2	21,500	Black	Irregular
36	161.2	38.1	2,185,000	T. Yellow	Irregular
37	44.5	67.4	46,140	Black	Square
38	238.5	117.1	7,058,000	Black	Irregular
39	133.7	31.6	1,260,000	Gray	Spheroid
40	144.0	47.9	1,563,000	Black & Clear	Irregular
41	171.5	143.8	2,618,000	T. Gray Yellow	Irregular
42	158.1	69.9	2,065,000	T. Mottled Gray	Irregular
43	107.8	32.2	6,596,000	T. Gray Yellow	Irregular
44	59.3	240.7	109,200	Black	Egg
45	292.1	43.3	13,040,000	T. Yellow Gray	Irregular
46	122.8	20.7	974,400	T. Gray Yellow	Irregular
47	77.5	31.2	243,700	Black	Irregular
48	270.6	159.4	10,420,000	T. Yellow Gray	Spheroid
49	135.2	47.8	1,288,000	T. Yellow Gray	Irregular
50	34.2	31.8	20,940	Black & Clear	Irregular

TABLE 3.2 CONTINUED

Clean Slate II British Balloon 1 Position 01 Casella 2366

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	26.6	6.3	9854	T. Orange & Black	Irregular
2	63.5	28.3	134,100	Black	Irregular
3	48.8	134.7	60,850	Black	Irregular
4	40.2	62.6	34,010	Black	Irregular
5	51.7	67.1	72,360	Black	Irregular
6	66.3	180.8	152,600	T. Yellow Gray	Sphere
7	9.5	2.5	449	Black	Irregular
8	4.3	0.7	42	T. Orange & Black	Irregular

Clean Slate II Arc A Station 036 TAS D 4116

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	86.3	112.8	336,500	Black	Heart Shaped
2	35.1	37.0	22,640	Black & Clear	Very Irregular
3	77.9	261.2	247,500	Black	Irregular
4	16.2	10.8	2,226	Black & T. Orange	Irregular
5	105.1	553.0	394,700	-	-
5A	74.6	-	217,400	Black	Irregular
5B	69.7	-	177,300	T. Pale Yellow	Irregular
6	31.2	45.9	15,900	Black	Irregular
7	20.2	13.6	4,316	T. Orange & Black	Irregular
8	12.2	9.4	951	Dark Brown	Spheroid
9	19.4	38.3	29,420	T. Yellow & Clear	Irregular
10	18.6	19.4	3,823	Black & T. Orange	Irregular
11	16.8	12.1	2,483	Black & T. Yellow	Irregular
12	17.6	22.5	2,855	Yellow Orange	Spheroid
13	21.7	13.0	5,350	Black	Irregular
14	18.1	39.4	3,105	Black & T. Orange	Irregular
15	48.2	22.2	58,630	Black & T. Yellow	Irregular
16	17.3	11.1	2,711	Black	Irregular
17	108.4	32.6	659,600	Black & Clear	Irregular
18	15.9	21.0	2,104	Yellow Orange	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc A Station 036 TAS D (Continued) 4116

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
19	12.9	10.8	1,124	Black & T. Yellow	Irregular
20	16.2	12.4	2,226	Black & T. Orange	Irregular
21	147.6	25.2	1,665,000	T. Gray	Irregular
21A	28.1	-	11,620	Black	Sphere
Part A is partly embedded.					
22	41.6	36.2	37,690	Black	Irregular
23	16.2	16.0	2,226	Black	Irregular
24	135.9	29.0	1,288,000	Black	Irregular
25	27.4	41.5	10,770	Black	Sphere
26	18.3	33.0	3,209	Black & T. Orange	Irregular
27	38.7	64.3	30,350	Black & T. Orange	Irregular
28	24.0	32.8	7,238	Black & T. Orange	Irregular
29	18.9	9.0	3,535	T. Yellow	Irregular
30	30.0	48.8	14,140	T. Yellow & Gray	Crescent
31	107.9	3.7	659,600	Orange	Sphere
32	99.2	74.1	511,100	Black	Lumpy
33	29.5	32.9	13,440	Black & T. Orange	Irregular
34	12.3	9.2	9,744	T. Yellow	Irregular
35	21.8	9.3	5,424	Black, Clear Edges	Irregular
36	23.5	17.7	6,795	Black	Irregular
37	20.4	21.8	4,445	Black & T. Orange	Irregular
38	23.3	36.5	6,623	Black & T. Orange	Irregular
39	52.9	37.8	77,510	T. Yellow	Sphere
39A	43.0	-	41,630	Black	Irregular
40	20.1	24.7	4,252	Black	Irregular
41	68.8	30.8	170,500	Black	Sphere
42	33.4	57.1	19,520	T. Brown-Orange	Irregular
43	23.1	19.2	6,454	Black & T. Orange	Irregular
44	16.2	15.6	2,185	Black & T. Yellow Orange	Irregular
45	19.8	14.4	4,064	Black & T. Yellow	Irregular
46	19.8	10.8	4,064	Black	Key Shaped
47	28.3	8.1	11,870	Black, Clear Edges	Irregular
48	14.7	9.7	1,665	Black	Irregular
49	28.3	18.5	11,870	Black & Clear	Irregular
50	17.2	15.9	2,664	Black	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc A Station 054 Casella 2286

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	55.8	78.9	90,970	Black & T. Orange	Irregular
2	19.3	12.9	3,764	T. Orange & Black	Irregular
3	20.3	13.1	4,380	Black	Irregular
4	15.4	6.8	1,912	Black	Irregular
5	15.2	1.7	1,839	T. Orange Yellow	Irregular
6	29.5	11.5	13,440	T. Yellow & Black	Very Irregular
7	57.4	67.1	99,020	Black, T. Orange Edges	Crescent
8	16.9	13.1	2,527	T. Orange Brown	Irregular
9	37.6	21.5	27,830	T. Gray	Irregular
10	25.4	18.4	4,633	-	-
10A	18.9	-	3,535	Black & Clear	Irregular
10B	12.8	-	1,098	Clear	Irregular
11	19.7	25.5	4,003	Black & T. Dark Orange	Irregular
12	19.6	12.1	3.942	Black	Irregular
13	33.3	24.3	19,330	Black	Rough Rectangle
14	23.7	11.0	6,965	T. Yellow Brown	Very Irregular
15	24.7	9.8	7,890	T. Yellow	Irregular
16	35.6	139.8	23,620	Black	Irregular
17	17.0	14.4	2,572	Black & T. Orange	Irregular
18	13.2	10.5	1,204	Black & Clear	Irregular
19	24.6	15.7	7,794	Black	Irregular
20	37.9	51.2	28,500	Black & Clear	Irregular
21	20.8	33.2	4,712	T. Dark Orange Brown	Irregular
22	33.5	71.5	19,680	Black	Irregular
23	44.0	23.2	44,600	Clear	Sphere
23A	8.9	-	369	Black	Spheroid
23B	3.3	-	19	Black	Sphere
Note:	Parts A and B are inclusions.				
24	26.2	11.5	9,417	Black & T. Orange Yellow	Very Irregular
25	29.4	34.7	1,331	Black & T. Orange	Irregular
26	38.6	31.4	30,110	T. Yellow Brown	Irregular
27	61.1	40.8	119,400	Black	Irregular
28	55.3	27.2	88,550	Black	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc A Station 054 Casella (Continued) 2286

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
29	27.9	78.1	11,370	Black	Irregular
30	33.6	27.9	19,860	Black, Clear Edges	Irregular
31	26.5	21.5	9,744	Black	Irregular
32	19.9	21.1	4,126	T. Yellow	Irregular
33	88.5	71.8	362,900	Black & Clear	Irregular
34	67.2	32.0	158,900	Black & Clear	Irregular
35	31.7	12.9	16,680	Black	Irregular
36	47.2	27.8	55,060	T. Yellow	Sphere
36A	28.0	-	11,490	Black	Spheroid
Note:	Part A is partially embedded.				
37	39.4	67.9	32,020	Black	Irregular
38	71.5	44.3	191,400	Black & Clear	Irregular
39	20.1	11.4	4,252	Black & T. Orange	Irregular
40	14.9	9.7	1,732	Black & Orange	Spheroid
41	14.2	7.4	1,499	Black & T. Orange	Irregular
42	24.5	18.6	7,700	T. Yellow	Irregular
43	53.5	51.2	80,180	Black & Clear	Irregular
44	25.8	81.6	8,991	T. Yellow	Irregular
45	30.2	49.1	14,420	Black & Clear	Irregular
46	33.4	28.9	19,520	Black	Irregular
47	33.3	74.2	19,330	Black & T. Orange	Irregular
48	32.2	59.8	17,480	Black, Clear Edges	Irregular
49	27.2	7.7	10,540	Black	Irregular
50	23.4	13.2	6,709	Black, Clear Edges	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 044 Casella 2371

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	35.9	30.5	24,230	Black	Irregular
2	23.6	24.3	6,882	Black	ˈˈ
3	49.7	24.4	64,280	T. Gray	ˈˈ
4	15.8	4.0	2,065	Black & T. Orange	ˈˈ
5	13.8	4.0	1,376	T. Yellow & Yellow	ˈˈ
6	14.1	4.3	1,468	T. Orange & Clear	ˈˈ
7	36.9	17.5	26,310	Mottled Black & Clear	ˈˈ
8	8.7	2.9	345	T. Orange Yellow	ˈˈ
9	24.7	15.7	7,890	T. Yellow	ˈˈ
10	30.8	47.8	15,300	Black	ˈˈ
11	12.8	14.4	1,098	Yellow	ˈˈ
12	26.0	13.8	9,203	Black	ˈˈ
13	20.6	19.6	4,577	Yellow	ˈˈ
14	13.4	4.0	1,260	Yellow	ˈˈ
15	44.6	72.3	46,450	Gray	ˈˈ
16	49.6	38.9	63,890	Black	ˈˈ
17	14.7	5.3	1,665	Yellow, Clear Edges	ˈˈ
18	29.5	4.9	13,440	Black	ˈˈ
19	36.4	6.8	25,250	Black	ˈˈ
20	16.1	11.1	2,185	T. Yellow	ˈˈ
21	23.2	6.9	6,538	T. Yellow & Yellow	ˈˈ
22	7.5	5.2	221	Yellow	ˈˈ
23	10.5	2.8	606	Mottled O. & T. Orange	ˈˈ
24	11.4	6.0	775	Dark Yellow	ˈˈ
25	13.9	3.2	1,407	O. & T. Orange	ˈˈ
26	8.0	1.2	268	T. Gray	Spheroid
27	12.6	2.7	1,049	Orange Brown	Irregular
28	10.7	3.9	641	T. Brown Orange	Irregular
29	11.8	1.5	863	T. Orange Brown & Black	Irregular
30	19.8	6.0	4,064	Clear w/Black Specks	Sphere
31	15.8	7.2	2,065	Black	Irregular
32	8.0	0.5	268	T. Yellow	ˈˈ
33	19.1	4.1	3,648	T. Yellow	ˈˈ
34	10.6	4.5	624	T. Orange Yellow	ˈˈ

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 044 Casella 2371

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
35	7.1	1.2	187	T. Orange & T. Yellow	Irregular
36	13.5	2.1	1,288	T. Orange	''
37	7.3	2.1	204	Black	''
38	18.8	1.7	3,479	Black & T. Yellow	''
39	24.1	4.4	7,326	T. Dark Gray	''
40	6.3	0.5	131	Black	''
41	7.5	1.2	221	T. Yellow	''
42	17.4	3.3	2,758	T. Yellow & T. Orange	''
43*	42.0	3.1	38,790	Black	''
44	10.2	1.3	556	T. Orange & T. Yellow	''
45	6.5	2.4	144	T. Yellow	''
46*	57.5	15.4	99,540	Black	''
47	8.5	1.9	321	T. Yellow	''
48	28.4	6.7	11,990	Black	''
49	36.9	2.7	26,310	Clear	''
50	16.8	9.9	2,483	Black	''

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 054 TAS II 4812

Particle No.	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	26.2	15.9	9,417	Black	Spheroid
2	16.7	8.8	2,439	T. Yellow Brown & Black	Irregular
3	16.5	19.7	2,352	T. Orange Brown	''
4	40.8	36.8	3,556	Black	''
5	17.3	12.4	2,711	Yellow	''
6	9.5	5.6	449	T. Yellow, Blue Specks	''
7	17.8	4.2	2,953	T. Yellow Gray	''
8	17.3	6.6	2,711	Gold	''
9	15.4	10.5	1,912	Yellow	''
10	17.8	3.8	2,953	Yellow	''
11	48.3	7.4	59,000	T. Yellow	Sphere
12	14.8	3.9	1,697	Mottled T. Yellow-Gray	Irregular
13	28.8	3.0	12,510	Black	''
14	14.2	2.6	1,499	Orange & Clear	''
15	25.3	5.1	8,479	Black	''
16	12.8	2.8	1,098	Yellow	''
17	12.3	5.4	974	Yellow	''
18	71.2	4.6	189,000	Black	''
19	31.0	9.6	15,600	Mottled Clear & Black	''
20	13.8	4.6	1,376	T. Yellow Orange	''
21	9.6	9.5	463	T. Dark Yellow	''
22	8.5	3.4	321	T. Dark Orange	Spheroid
23	13.9	3.8	1,407	White-Yellow	Irregular
24	13.0	5.2	1,150	T. & O. Yellow	''
25	13.6	2.5	1,317	T. Orange	''
26	26.2	5.2	9,417	Yellowish White	Irregular
27	12.9	3.6	1,124	Yellow	''
28	29.6	3.9	13,580	Mottled Black & Clear	''
29	8.6	3.3	333	T. Orange Brown	''
30	10.9	2.7	678	T. & O. Yellow Orange	''
31	11.6	1.9	817	T. Yellow	''
31A	1.5	-	1.8	Yellow	Sphere
32	12.7	4.1	1,073	Clear w/Bubbles	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 054 TAS II (Continued) 4812

Particle No.	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
33	22.0	6.8	5,575	Mottled Black & Clear	Irregular
34	13.6	3.9	1,317	T. Dirty Yellow	' '
35	17.8	2.9	2,953	Yellow	' '
36	13.6	2.4	1,317	T. Gray	' '
37	25.1	1.3	8,299	Black	' '
38A	21.6	0.5	5,276	T. & O. Yellow	' '
38B	7.1	-	187	T. & O. Yellow	' '
39	14.5	11.5	1,596	Orange	Spheroid
40	33.5	14.1	1,968	Black & Clear	Irregular
41	54.0	12.4	82,450	Dark Gray	' '
42	30.8	12.3	1,530	T. Brown Gray	' '
43	24.9	8.9	8,083	Dark Brown	' '
44	24.6	4.0	7,794	Brown	' '
45	6.9	0.9	172	Clear	Spheroid
46	8.2	3.0	289	Orange	Irregular
47	6.1	0.4	119	T. Orange Yellow	' '
48	8.2	1.0	289	T. Yellow Orange	' '
49	29.4	0.1	13,310	Gray	' '
50	15.9	4.8	2,104	Gray	' '

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 060 Casella 2370

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	38.0	53.7	28,730	Black	Irregular
2	15.2	46.3	1,839	T. Gray Yellow	''
3	46.0	25.6	50,960	Black & Clear	''
4	24.6	14.2	7,794	Clear, Black Specks	''
5	16.5	3.0	2,352	Clear, Black Spots	''
6	14.4	9.3	1,563	T. Yellow	''
7	27.9	30.7	11,370	T. Orange	''
8	23.6	16.0	6,862	Black	''
9	61.6	14.9	122,400	Black	''
10	45.5	23.8	49,320	Black	''
11	30.1	64.5	14,280	Black	''
12	45.5	6.9	49,320	Mottled Black & Clear	''
13	27.1	8.8	10,420	T. Gray Yellow	''
14	19.5	5.4	3,882	Black	''
15	13.7	26.3	1,340	O. & T. Orange	''
16	18.5	27.7	3,315	T. Yellow Gray	''
17	29.2	12.4	13,040	Clear, Black Spots	''
18	16.6	8.8	2,395	O. & T. Yellow	''
19	17.8	9.0	2,953	Black	''
20	15.5	4.2	1,950	T. Pale Yellow	''
21	12.3	7.7	974	T. Yellow Mottled Black	''
22	18.5	4.8	3,315	T. Yellow	''
23	21.0	4.9	4,849	T. Yellow Mottled Black	''
24	15.8	4.3	2,065	T. Gray	''
25	16.3	7.6	2,268	Black & T. Dark Orange	''
26	35.7	5.1	23,820	T. Gray	''
27	29.0	13.2	12,770	T. Yellow	Sphere
28	31.2	14.6	15,900	Black	Irregular
29	30.1	27.2	14,280	Black	''
30	14.9	4.5	1,732	T. Yellow	''
31	24.9	14.7	8,083	Black	Spheroid
32	21.1	23.9	4,919	Black & Clear	Irregular
33	29.5	18.6	13,440	Black	''
34	11.2	5.5	736	T. Yellow	''

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 060 Casella 2370

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
35	14.5	10.5	1,596	Black	Spheroid
36	10.3	6.1	572	Yellow	Irregular
37	18.5	10.5	3,315	O. & T. Yellow	"
38	38.3	113.2	29,420	Black	"
39	16.4	6.2	2,310	Clear	"
40	16.8	8.3	2,483	T. Dark Orange	"
41	28.7	7.5	12,380	Black & Clear	"
42	13.1	7.4	1,177	T. Yellow Orange	"
43	45.2	68.0	48,350	Black	"
44	16.0	13.7	2,145	Dark Orange	"
45	13.5	3.6	1,288	Black	"
46	13.2	5.4	1,204	T. Orange	"
47	16.3	3.8	2,268	Orange, Clear Edges	"
48	13.8	3.0	1,376	T. Orange	"
49	13.9	3.1	1,407	O. & T. Orange	"
50	13.0	3.0	1,150	Clear	"

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 068 Casella 2369

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	39.3	52.3	31,780	Black, Clear Spot	Irregular
2	15.0	17.9	1,767	Black, T. Orange Spot	Irregular
3	26.8	40.9	10,080	Shiny Yellow	Irregular
4	15.4	24.2	1,912	Black	Irregular
5	15.0	13.7	1,767	Black & T. Orange	Spheroid
6	20.3	36.6	4,380	Yellow	Irregular
7	25.1	76.6	8,299	T. Yellow	"
8	26.2	22.4	9,417	T. Dark Yellow	"
9	51.1	24.3	69,860	Black, Clear Edge	"
10	21.7	6.5	5,350	Clear to Pale Yellow	"
11	40.0	20.0	33,510	Black	"
12	15.9	21.8	2,104	Black	"
13	23.1	27.7	6,454	Black	"
14	31.9	17.5	17,000	Black, Orange Spot	"
15	13.1	12.7	1,177	Yellow	"
16	12.2	2.0	951	Black & Clear	"
17	15.4	8.0	1,912	Black	"
18	13.2	13.5	1,204	T. Yellow	"
19	33.2	76.0	1,916	Black	"
20	10.1	2.2	540	T. Yellow Mottled	"
21	17.3	3.7	2,711	Black & Clear	"
22	21.0	8.0	4,849	Black & T. Orange	"
23	35.0	46.9	2,245	Black	"
24	12.5	3.4	1,023	Black & Clear	"
25	16.3	5.3	2,268	T. Orange, Mottled	"
26	17.2	14.6	2,664	T. Orange & Clear	"
27	22.4	15.2	5,884	Black	"
28	14.2	6.7	1,499	T. Orange & Black	"
29	39.6	39.5	32,510	Black	"
30	27.7	5.2	11,130	Black	"
31	9.6	4.2	463	Clear	Spheroid
31A	4.0	-	34	T. Purple	"
32	27.9	28.4	11,370	Black	Irregular
33	26.4	11.6	9,634	Black	"
34	18.4	13.8	3,262	T. Orange	"

TABLE 3.2 CONTINUED

Clean Slate II Arc B Station 068 Casella 2369

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
34A	4.8	-	58	Black	Irregular
35	43.9	216.7	42,300	Black	"
36	11.9	10.4	882	T. Dark Brown	Spheroid
37	16.0	10.0	2,145	Gray & Clear	Irregular
38	15.7	3.8	2,026	T. Dark Brown	Spheroid
39	21.1	27.1	4,919	Black	Irregular
40	24.5	17.5	7,700	Black & T. Orange	"
41	16.8	11.0	2,483	T. Dark Brown	"
42	31.0	4.9	15,600	Black, Clear Edges	"
43	22.6	7.6	6,044	Clear	Sphere
44	25.0	28.3	8.181	Orange, Clear Edges	Irregular
45	20.1	19.6	4,252	T. Orange Yellow	"
46	28.1	10.4	11,620	T. Orange Gray	"
47	22.9	28.0	6,288	Clear Mottled Orange	"
48	49.4	6.5	34,260	-	-
48A	29.8	-	13,860	T. Yellow	Spheroid
48B	33.9	-	20,400	T. Gray	"
49	14.7	10.4	1,665	T. Orange	Irregular
50	20.7	16.6	4,644	Black	"

Clean Slate II Arc B Balloon Line 1 Position 17 Tas I 4022

Autoradiographic exposures of 24, 48, 96, and 120 hours revealed no radioactive sites.

TABLE 3.2 CONTINUED

Clean Slate II Arc B Balloon Line 3 Position 9 Casella 2312

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	25.5	6.0	8,681	Yellow	Irregular
2	23.8	5.2	7,058	T. Yellow	''
3	15.1	14.5	1,803	Yellow	''
4	47.5	58.5	56,120	Black	''
5	58.7	6.0	105,900	T. Yellow	''
6	45.0	51.2	47,710	Black & Clear	''
7	32.6	20.8	18,140	Black	''
8	24.2	95.8	7,420	Black	''
9	46.8	17.9	53,670	Black	''
10	21.4	16.0	5,131	Yellow	Spheroid
11	85.9	13.0	212,870	-	-
11A	57.0	-	96,970	T. Gray	Spheroid
11B	58.7	-	105,900	T. Gray	Spheroid
12	46.7	34.4	45,830	-	-
12A	42.8	-	41,050	Black	Spheroid
12B	20.9	-	4,780	Black	Hemisphere
13	25.2	15.3	8,378	Black & Clear	Irregular
14	74.3	30.6	214,800	Black	''
15	40.1	99.0	337,600	Black	Spheroid
16	45.5	102.2	49,320	Black	''
17	42.1	11.2	39,070	Mottled Black & Clear	Irregular
18	51.8	25.8	72,770	Yellow	Sphere
19	53.7	21.2	81,080	Black	Irregular
20	34.9	84.0	22,260	Black	''
21	15.2	18.6	1,839	Brown	''
22	41.4	14.8	37,150	Black	Irregular
23	23.7	7.7	6,965	Black & T. Yellow	Spheroid
24	60.2	11.9	114,200	Yellow Gray	Blistered Spher
25	16.2	6.5	2,226	Yellow	Irregular
26	22.1	5.9	5,651	Mottled Black & Clear	''
27	30.9	8.6	15,450	Yellow	''
28	42.0	86.5	38,790	Black	''
29	28.4	9.5	11,990	T. Yellow	''
30	19.6	8.6	3,942	White	''

TABLE 3.2 CONTINUED

Clean Slate II Arc B Balloon Line 3 Position 9 Casella 2312

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
31	71.4	32.6		-	-
31A	51.9	-	73,200	T. Yellow	Spheroid
31B	25.8	-	8,991	Black	"
31C	18.1	-	3,105	Black	"
31D	15.7	-	2,026	T. Yellow	"
32	24.6	9.1	7,794	T. Pale Yellow	Sphere
33	31.6	5.3	16,520	Clear & Yellow	Spheroid
34	62.6	82.8	128,400	Black & T. Gray	Irregular
35	34.1	14.1	20,760	Black	"
36	18.4	13.9	3,262	T. Gray Yellow	Spheroid
37	49.4	13.7	63,120	T. Yellow	Irregular
38	53.2	23.2	78,840	Mottled Black & Clear	"
39	44.0	50.6	44,600	Black	"
40	42.5	9.0	40,190	Clear	"
41	40.0	51.5	33,510	Black	Spheroid
42	22.4	12.7	5,884	Black	"
43	50.0	9.4	65,400	T. Yellow	Sphere
44	35.2	13.8	22,840	Black	Irregular
45	20.3	8.5	4,380	Black	"
46	33.2	14.8	19,160	T. Yellow	Sphere
47	15.8	6.4	20,650	T. Orange Brown	Irregular
48	20.7	6.2	4,644	T. Orange Brown	"
49	8.6	4.4	333	T. Gray	Spheroid
50	16.9	9.4	2,527	T. Yellow Brown	Irregular

TABLE 3.2 CONTINUED

Clean Slate II Arc B Balloon Line 4 Position 21 TAS I 4024

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	17.1	3.2	2,618	T. Orange	Irregular
2	15.9	3.0	2,104	T. Yellow Brown	''
3	21.5	11.8	5,203	T. Yellow	''
4	31.3	6.6	16,040	Black	''
5	33.8	27.6	20,220	Black	''
6	29.5	4.2	13,440	Clear	Sphere
7	17.5	3.2	2,806	Clear	Irregular
7A	13.1	-	1,177	T. Orange	''
8	22.2	13.4	5,728	T. Orange	''
9	20.7	23.1	4,644	Black	''
10	13.5	2.1	1,288	T. Yellow	''
11	45.4	12.8	48,720	Black	''
12	6.5	4.7	144	Orange	''
13	17.5	6.3	2,806	Black	''
14	14.0	6.5	1,437	T. Yellow	''
15	26.1	11.6	9,309	Black	''
16	12.5	3.0	1,023	Orange	''
17	13.6	3.6	1,317	O. & T. Orange	''
18	13.6	8.8	1,317	T. Orange	''
19	15.8	5.0	2,065	T. Yellow Brown	''
20	9.4	3.2	435	Gray	Spheroid
21	14.8	3.5	1,697	T. Yellow Gray	Irregular
21A	1.7	-	2.6	Black	Spheroid
21B	2.7	-	10	Black	Irregular
22	18.0	5.0	3,054	Yellow	''
22A	14.2	-	1,499	Clear	''
23	23.6	1.8	6,882	Black	''
24	9.3	1.9	421	T. Orange	''
25	11.6	9.4	817	Yellow Brown	''
26	12.4	1.6	998	T. Yellow	''
27	8.4	6.2	310	T. Orange	''
28	9.2	2.5	408	T. Yellow	''
29	24.8	17.1	7,986	Black	''
30	15.5	7.5	1,950	T. Yellow	''

TABLE 3.2 CONTINUED

Clean Slate II Arc B Balloon Line 4 Position 21 TAS I Continued 4024

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
31	10.3	2.8	572	T. Orange Brown	Irregular
32	11.2	3.3	736	Black & T. Orange	"
33	27.9	5.3	1,137	Clear	"
33A	12.7	-	1,073	Yellow	Spheroid
34	19.9	0.7	4,126	T. Yellow	Irregular
34A	4.8	-	58	Black	"
35	18.0	4.5	3,054	T. Yellow Gray	"
36	15.1	2.2	1,803	T. Dirty Yellow	"
36A	2.3	-	6.4	Black	"
36B	2.4	-	7.2	Black	"
37	9.5	11.0	449	T. Dark Orange Red	Spheroid
38	10.0	3.8	524	T. Orange	Irregular
38A	2.7	-	10	Black	"
39	27.2	6.5	1,054	T. & O. Gray	"
40	11.5	5.2	796	Mottled T. & O. Yellow	"
41	10.4	1.2	589	T. Yellow	"
42	12.6	8.9	1,049	Brown	"
43	7.3	4.9	204	T. Gray	Sphere
44	22.9	5.9	6,288	T. Gray & Mottled Black	Irregular
45	9.4	1.1	435	T. Orange	"
46	13.7	3.6	1,346	T. Orange	"
47	10.2	0.7		T. Yellow & Gray	"
48	10.5	2.1		Yellow	"
49	13.0	0		Yellow	"
50	9.2	1.4		Orange	"

TABLE 3.2 CONTINUED

Clean Slate II Arc B Balloon Line 7 Position 9 TAS I 4011

Particle Number	Average Diameter (micron)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	8.3		299	T. Yellow	Spheroid
2	9.3		421	O. & T. Yellow	Irregular
3	27.1		10,420	Yellow	Irregular
4	16.4		2,310	T. Yellow	Sphere
5	6.7		158	T. Grey	Grainy Sphere
6	11.3		756	Grey Yellow	Spheroid
7	15.6		1,988	T. Yellow	Spheroid
8	11.0		697	T. Yellow	Spheroid

Clean Slate II Arc D Station 034 Anderson 3182

Autoradiographic exposures up to 120 hours reveal no particles.

TABLE 3.2 CONTINUED

Clean Slate II Arc D Mobile Position 12 Casella 2272

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	26.6	8.3	9,854	Black & Clear	Irregular
2	22.1	9.8	5,651	Black	''
3	31.5	8.2	16,370	Clear	Hemisphere
4	26.0	22.9	9,203	Black	Irregular
5	48.6	3.1	60,111	T. Yellow	Irregular
6	39.5	5.9	3,227	Black & Clear	Irregular
7	14.9	2.3	1,732	Black & Clear	''
8	44.6	11.0	46,450	T. Green & Clear	''
9	39.1	6.4	31,300	Black, Clear, T. Orange	''
10	39.4	17.5	32,020	Black	''
11	44.4	9.8	45,830	Black	''
12	12.5	3.9	1,023	T. Pale Yellow	''
13	31.8	.02	16,840	Black	''
14	14.9	6.0	1,732	T. Pale Yellow Orange	''
15	10.8	2.7	6,596	T. Pale Orange	''
16	30.2	6.1	14,420	T. Yellow	''
17	51.6	30.0	71,930	Black	''
18	4.4	3.9	45	Yellow	''
19	31.0	4.3	15,600	T. Yellow	''
19A	2.9	-	13	Black	Spheroid
20	24.2	9.6	7,420	Black	Irregular
21	15.4	2.8	1,912	T. Orange	''
22	21.6	3.0	5,276	Clear Mottled Gray	''
23	39.0	12.5	31,060	Brown	Irregular
24	31.2	50.7	15,900	Black	''
25	20.1	9.8	4,252	Black	''
26	30.4	18.1	14,710	Gray	''
27	24.2	5.5	7,420	Black	''
28	31.4	35.6	16,210	Black	''
29	32.6	9.2	18,140	Clear & T. Yellow	''
30	27.1	41.0	10,420	Black	''
31	24.3	25.6	7,513	Black	''

TABLE 3.2 CONTINUED

Clean Slate II Arc D Mobile Position 12 Casella 2272

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
32	32.2	7.0	17,480	Black	Irregular
33	60.4	?	115,400	T. Gray Yellow	"
34	42.2	36.2	39,350	Black	"
35	17.1	7.6	2,618	T. Orange, Black Spots	"
36	21.6	1.4	5,276	Black	"
37	31.6	4.4	16,520	Clear Mottled Black	"
38	28.1	6.0	11,620	T. Dark Gray & Clear	"
39	13.3	6.2	1,232	T. Orange	"
40	14.2	4.5	1,499	Clear	"
40A	4.8	–	58	Black	"
41	32.4	8.4	17,810	Clear	"
41A	24.7	–	7,890	Black	"
42	24.8	70.4	7,986	Orange	"
43	16.9	12.2	2,527	T. Yellow	Sphere
44	19.2	49.5	3,706	T. Yellow	Irregular
45	13.8	141.1	1,376	Yellow	"
46	20.6	7.9	4,577	T. Yellow	Irregular
47	13.1	2.02	1,177	T. Dark Brown	"
48	24.2	20.7	7,420	Black	"
49	46.1	10.4	5,130	Black	"
50	13.8	3.6	1,376	T. Orange	"

TABLE 3.2 CONTINUED

Clean Slate III BM-06 Andersen 4987

Particle Number	Average Diameter (micron)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	18.8	5.7	3,480	O. & T. Yellow	Irregular
2	16.3	3.2	2,260	O. & T. Yellow	"
3	23.5	26.2	6,840	Yellow w. T. edges	"
4	38.8	66.7	30,500	Black & Clear	"
5	38.1	35.4	29,000	Black	"
6	25.7	18.6	8,900	T. Grey Yellow	"
7	97.9	19.2	492,000	Black	"
8	22.7	5.7	6,140	Yellow	"
9	14.7	65.1	1,660	Yellow	"
10	144.8	6.8		T. Dark Grey	"
11	18.3	7.3	3,200	Yellow w. T. edges	"
12	17.6	7.1	2,860	Brown & Clear	"
13	50.6	16.1	68,200	Black	"
14	17.9	1.7	2,990	T. Yellow	"
14A	3.3	-	18.8	Yellow	"
15	10.2	2.0	558	T. Dk. Brown Orange	"
16	6.6	2.1	151	T. Yellow Grey	"
17	12.6	2.3	1,050	T. Yellow	"
18	8.6	4.4	332	T. Yellow Grey	Sphere
19	9.4	1.9	425	T. Orange Brown	Irregular
20	25.3	2.1	8,480	Yellow	"
21	10.1	3.1	540	T. Yellow	"
22	10.2	1.0	558	Grey	"
23	7.8	2.1	248	T. & O. Yellow	"
24	5.9	1.1	108	T. Yellow Brown	"
25	18.2	2.9	3,140	Grey	Irregular
26	8.6	0.7	332	T. Dk. Yellowish Grey	"
27	12.1	0.7	925	T. & O. Yellow	"
28	8.6	1.2	332	T. Yellow	"
29	10.7	1.3	643	T. Brown Orange	Spheroid
30	7.7	0.4	238	T. Grey	Irregular
31	10.7	0.9	643	Clear, Bubbles	"
32	17.4	1.8	2,760	Yellow	"
33	19.1	4.4	3,640	Yellow	"
34	23.7	27.9	6,970	Yellow & Clear	"
35	45.7	1.6	49,700	Clear	Spheroid
36	11.6	1.1	820	Clear	Sphere
37	4.1		36.0	T. Yellow Grey	Spheroid
38	5.2		73.5	Yellow	Irregular
39	23.2		6,560	Yellow	"
40	5.3		77.9	T. Greyish Yellow	"
41	19.9		4,130	T. Dark Grey	"
42	25.8		8,960	T. Grey & Clear	"
43	7.7		238	-	--
43A	4.3	-	41.5	Yellow	"
43B	7.3	-	204	T. Yellow	"
44	12.4		1,000	Yellow	"

TABLE 3.2 CONTINUED

Clean Slate III BM-07 TAS D 5184

Particle Number	Average Diameter (micron)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	21.4	4.9	5,120	Black	Irregular
2	16.4	5.3	2,310	Yellow Orange	"
3	14.1	9.1	1,470	T. Yellow w. O. spots	"
4	39.4	29.5	32,000	Black	"
5	48.0	13.2	57,600	Black & Clear	"
6	32.5	14.3	18,000	Black	"
7	10.2	16.7	558	T. Yellow	"
8	11.6	3.6	820	T. Yellow Brown	"
9	16.1	2.1	2,180	T. Dk. to Lt. Grey	"
10	8.7	13.2	344	T. Dk. Orange Red	"
11	14.4	6.0	1,560	Yellow	"
12	5.5	4.4	87	T. Dk. Orange Red	"
13	15.5	22.8	1,950	O. &. T. Orange Red	"
14	35.3	37.8	23,000	Black	"
15	42.5	37.0	40,300	Mottled T. Grey & Clear	"
16	18.5	6.4	3,310	Yellow w. T. edges	"
17	17.6	3.1	2,850	Yellow	Spheroid
18	7.3	4.7	204	Yellow	Irregular
19	19.9	1.5	4,130	T. Yellow	"
20	294.3	13.4		Yellow	"
21	16.2	10.0	2,220	O. &. T. Yellow	"
22	12.8	2.2	1,100	T. Yellow	"
23	26.0	20.3	9,200	Yellow	"
24	15.6	12.1	1,980	Yellow	"
25	14.6	1.3	1,630	Yellow	"
26	3.5	3.4	22.4	Yellow	Irregular
27	7.1	1.5	187	T. &. O. Grey	"
28	6.6	0.6	151	T. Yellow	"
29	6.3	0.6	131	T. Yellow	"
30	11.3	5.4	755	T. Yellow	"
31	4.8	0.8	58.2	Brown	"
32	18.3	3.4	3,200	Yellow	"
33	9.1	0.7	394	T. Yellow	"
33A	1.9	-	3.6	Yellow	Spheroid
34	18.8	5.0	3,480	Yellow	Irregular
35	5.7	1.0	96.9	Dk. Grey	"
36	15.3	1.3	1,870	T. Orange & Clear	"
37	9.5	0.9	450	O. & T. Yellow	"
38	15.0	6.0	1,770	O. & T. Yellow	"
39	5.7	0.9	96.9	T. Yellow	"
40	16.1	2.8	2,180	O. & T. Yellow	"
41	10.8	3.1	659	Yellow	"
42	13.4	1.1	1,260	T. Yellow	"
43	15.5	0.9	1,950	Yellow	"
44	14.2	0.7	1,500	Yellow	"
45	15.9	0.8	2,100	Yellow & T. Orange	"
46	3.5	0.04	22.5	Silver	"
47	9.0	0.6	382	T. Yellowish	"
48	6.6	6.6	151	T. Red Orange & Black	"
49	23.5	0.7	6,840	T. & O. Yellow	"
50	9.8	7.0		T. Orange Yellow	"

TABLE 3.2 CONTINUED

Clean Slate III BM-10Casella 4973

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	36.8	156.4	26,090	Black	Irregular
2	39.5	17.5	32,270	T. Gray	Sphere
3	33.0	31.6	18,820	Black	Irregular
4	51.8	29.2	72,770	Black	Spheroid
5	91.7	93.6	403,700	Black	Irregular
6	74.8	26.3	219,100	Yellow	''
7	10.9	11.4	678	Black	''
8	28.9	4.3	12,640	Black	''
9	33.3	31.3	19,330	Black	''
10	33.9	23.2	20,400	Black	''
11	22.7	10.0	6,124	Black	''
12	35.5	18.5	23,420	Black	''
13	81.8	74.2	28,660	Black	''
14	43.9	8.7	42,300	Black	''
15	22.6	7.1	6,044	Black	''
16	9.8	9.8	493	Yellow	Spheroid
17	38.6	6.2	30,110	Black	Irregular
18	64.4	41.9	139,800	Gray	''
19	23.2	12.1	6,538	Black	''
20	20.1	9.2	4,252	Black	''
21	26.3	9.0	9,524	Black	''
22	28.6	29.4	12,250	T. & O. Yellow	Spheroid
23	58.9	4.3	107,000	Mottled Gray & Clear	Irregular
24	40.1	23.0	33,760	Black	''
25	10.2	13.2	556	Dark Yellow	''
26	10.3	6.3	572	T. Dark Orange	Spheroid
27	29.5	4.2	13,440	T. Gray	''
28	38.0	10.2	28,730	T. Drk-Lt Gray	Irregular
29	21.7	5.5	5,350	Black	''
30	125	42.0	1,023,000	T. Gray	''
31	56.3	43.5	93,440	Black	''

TABLE 3.2 CONTINUED

Clean Slate III BM-10 Casella (Continued) 4973

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
31	56.3	43.5	93,440	Black	Irregular
32	19.3	17.3	3,764	Black	"
33	20.4	7.5	4,445	Clear	Sphere
34	30.4	15.7	14,710	T. Gray	Irregular
35	47.0	37.8	54,360	Black	Irregular
36	31.8	16.8	16.840	Black	"
37	27.2	18.7	10,540	Black	"
38	126	4.3	1,049,000	T. Light Gray	"
39	26.8	5.6	100,800	T. Gray Yellow	Sphere
40	16.4	7.1	2,310	Yellow	Irregular
41	52.2	2.6	74,470	Clear & Black	"
42	36.3	6.4	25,040	Clear & Black	"
43	12.4	3.5	998	Orange	"
44	23.6	5.2	6,882	Black	"
45	68.3	3.6	166,800	Black	"
46	30.3	2.8	14,570	T. Gray	Spheroid
47	38.3	6.6	29,420	Black & T. Gray	Irregular
48	53.8	4.5	81,530	Black	"
49	17.3	4.7	2,711	Yellow Gray	"
50	44.2	8.0	45,210	Black & Clear	"

TABLE 3.2 CONTINUED

Clean Slate III Arc A Station 030 Andersen 4974

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	41.4	19.5	37,150	Black	Irregular
2	21.0	4.2	4,849	T. Mottled Gray	''
3	25.4	5.1	8,580	Black	''
4	93.3	1.8	425,200	Black & Clear	''
5	93.4	10.5	426,600	Black	''
6	13.5	2.9	1,288	T. Orange Yellow	''
7	19.3	11.7	3,764	T. Orange	''
8	21.0	2.7	4,849	Black	''
9	30.2	8.6	14,420	Black	''
10	34.2	17.6	20,940	Black	''
11	13.9	4.9	1,407	Dark Yellow	''
12	46.2	145.8	51,630	Black	''
13	16.3	3.8	2,268	T. Orange	''
14	15.4	9.9	1,912	T. Yellow	''
14A	2.4	-	7.2	Yellow	''
14B	2.1	-	4.8	Yellow	''
15	34.1	32.1	20,760	Black	''
16	18.6	6.7	3,369	Black	''
17	21.6	9.7	5,276	T. Yellow	''
18	40.8	109.4	35,560	Black	''
19	11.1	4.4	716	Orange Yellow & clear	''
20	51.9	20.0	73,200	Black	''
21	28.4	6.9	11,990	Black	''
22	14.5	2.3	1,596	T. Yellow	''
23	34.7	8.5	21,880	Black	''
24	35.1	18.7	22,640	O. & T. Gray	''
25	122	15.4	950,800	Black & Clear	''
26	14.9	1.0	1,732	Gray	''
27	32.1	1.3	17,320	Black	''
28	15.9	0.7	2,104	Gray	''
29	35.2	7.1	22,840	Brown	''
30	10.5	1.2	606	Gray	''
31	17.9	4.4	3,003	T. Orange, Grainey	''

TABLE 3.2 CONTINUED

Clean Slate III Arc A Station 030 Andersen 4974

Particle Number	Average Diameter (μ)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
32	11.9	4.8	882	T. Orange & Clear	Irregular
33	42.2	7.8	39,350	T. Brown	"
34	9.4	6.9	435	Orange	"
35	17.2	3.1	2,664	Yellow	"
36	37.9	4.2	2,850	Black & Clear	"
37	11.0	4.6	697	Yellow	"
38	13.4	1.3	1,260	Clear with Black Specks	"
39	9.6	1.9	463	Yellow	"
40	31.4	2.9	16,210	Black	"
41	10.1	2.7	540	T. Orange Yellow	"
42	15.0	5.7	1,767	T. Yellow	"
43	13.1	3.1	1,177	Orange	"
44	47.4	9.3	55,760	Gray & Clear	"
45	36.2	21.6	24,840	Black	"
46	20.0	4.3	4,189	Black	"
47	14.1	3.1	1,468	Brown-Yellow	"
48	46.8	28.9	53,670	Black	"
49	49.7	1.9	64,280	Black	"
50	12.7	0.3	1,073	T. Gray	"

TABLE 3.2 CONTINUED

Clean Slate III Arc A Station 102 Casella

Particle Number	Average Diameter (micron)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	18.2	1.3	3,140	Yellow	Irregular
2	35.9	10.5	24,400	Black	"
3	39.1	16.6	31,200	Grey	"
4	30.3	8.4	14,600	Black	"
5	27.4	5.4	10,700	Black	"
6	49.0	8.6	61,500	Grey	"
7	29.3	7.8	13,200	Black	"
8	14.5	3.1	1,600	Grey	"
9	33.7	16.5	20,000	Black	"
10	49.5	20.4	63,500	Black	"
11	23.5	9.4	6,740	-	-
11A	11.7	-	835	Orange	"
11B	19.6	-	3,840	Clear	"
12	72.5	8.9	200,000	Grey	"
13	29.8	6.0	13,800	T. Yellow	Spheroid
14	28.7	2.9	12,400	Clear/Specks	"
15	66.5	70.7	154,000	Black	Irregular
16	15.5	1.7	1,950	Yellow	"
17	27.0	15.5	10,300	Black	"
18	36.1	8.6	24,600	Clear & D. T. Yellow	"
19	8.6	1.6	332	Yellow	Spheroid
20	16.6	3.8	2,400	Dk. Yellow	Irregular
21	15.3	15.2	1,880	T. Yellow	"
22	52.9	2.7	77,400	Black	"
23	12.3	1.6	975	Orange	Irregular
24	24.4	12.2	7,610	Black	"
25	32.9	10.5	18,600	Black	"
26	59.7	10.6	111,000	Black	"
27	34.6	4.1	21,600	Black & Clear	"
28	62.2	6.8	126,000	Black & Clear	"
29	16.8	9.6	2,480	Clear	"
30	37.0	5.3	26,500	T. Yellow	"
31	11.3	2.0	755	Black & T. Yellow	"
32	9.6	3.2	462	Yellow	Spheroid
33	15.2	2.1	1,840	Yellow	Irregular
34	16.4	3.0	2,300	T. Yellow	"
35	11.0	4.4	696	T. Yellow-Orange	"
36	11.2	3.0	735	Yellow	"
37	20.7	1.9	4,640	T. Yellow	"
38	17.5	1.3	2,800	T. Grey	"
39	13.7	2.2	1,350	Yellow	"
40	20.4	2.2	4,450	Yellow	"
41	12.0	0.8	909	T. Grey & T. Yellowish	"
42	10.4	3.4	590	Clear	Sphere
43	16.8	3.2	2,480	Orange Yellow	Irregular
44	18.6	2.0	3,360	Grey	"
45	10.2	2.0	556	Grey	"
46	22.2	1.6	5,730	O. & T. Yellow	"
47	13.6	1.2	1,320	T. Yellow	"
48	21.3	1.3	5,050	Orange	Irregular
49	8.0	2.4	268	T. Orange Brown	"
50	21.2	1.2	5,000	Grey Yellow	"

TABLE 3.2 CONTINUED

Clean Slate III Arc A Station 108 TAS D

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Particle Number	Average Diameter (micron)	Count Rate (cpm)	Volume (μ^3)	Color	Morphology
1	20.4	29.7	4,450	Yellow	Irregular
2	25.6	7.2	8,750	Grey & White	"
3	31.6	6.4	16,500	Black	"
4	34.8	13.9	22,000	Black	"
5	20.1	7.4	4,250	Black	"
6	37.5	2.8	2,760	Mottled Black & Clear	"
7	66.0	22.5	150,000	Black	"
8	20.8	6.8	4,700	T. Yellow	"
9	27.5	5.2	10,900	Yellow	Spheroid
10	11.5	9.9	800	T. Orange	Irregular
11	35.5	91.6	23,400	O. & T. Yellow	"
12	19.7	8.2	4,000	Yellow	"
13	28.1	4.7	11,600	T. Brown	"
14	35.6	8.4	23,600	Mottled Black & Clear	"
15	4.2	2.3	38.8	Silver, Yellow, Red	"
16	22.4	2.7	5,860	Yellow	"
17	27.0	44.6	10,300	Yellow	"
18	46.0	2.2	50,800	Black	"
19	13.5	3.2	1,290	Orange	"
20	16.2	2.0	2,220	T. & O. Orange	"
21	19.4	3.2	3,810	Yellow	"
22	24.5	5.0	7,700	Yellow	"
23	31.8	0.3	16,800	Black	"
24	24.0	2.8	7,240	Yellow	"
25	11.2	1.1	735	Yellow Orange	"
26	19.3	2.7	3,760	Brown Yellow	"
27	11.6	2.4	820	T. Dk. Orange	"
28	26.9	7.1	10,200	Brown & Clear	"
29	16.8	4.5	2,480	T. Brown Grey	"
30	17.4	3.2	2,760	Yellow	"
31	10.7	3.9	643	Yellow	"
32	55.2	1.8	88,300	Black	"
33	6.7	1.0	157	T. Yellow Grey	"
34	10.4	3.7	590	T. Yellow	"
35	23.8	1.6	7,070	Yellow Orange/T. Edges	"
36	16.5	3.4	2,360	Yellow	"
37	8.1	2.0	278	Bright Yellow Orange	"
38	10.2	8.2	556	T. Grey Yellow	"
39	28.0	1.3	11,500	Black	"
40	20.1	2.8	4,250	Yellow	"
41	11.1	2.1	716	Black & T. Grey	"
42	7.7	2.1	238	T. Grey Yellow	"
43	11.8	1.4	861	Yellow	"
44	19.9	2.0	4,120	T. Yellow	"
45	13.3	3.6	1,230	Yellow	"
46	21.5	1.5	5,210	Yellow	"
47	23.2	9.4	6,560	T. Brown	"
48	17.9	3.7	3,000	Yellow	"
49	5.0	1.1	65.7	T. Brown Yellow	"
50	-	1.2		-	-
50A	6.6	-	151	Orange	"
50B	2.3	-	6.4	Orange	"

TABLE 3.3 PRECISION ALPHA COUNTING, PLUTONIUM, AND AMERICIUM

Sample No.	Particle No.	Location	Average Diameter (micron)	Gross Count Rate (cpm)	$Pu^{239+240}$ Content (dpm)	Error (Percent)	Correction Factor	Class*
EVENT DOUBLE TRACKS (Plutonium)								
9668	17	I061	1.8	15.1	15.5	2.5	1.03	III 0
2812	5	J058	4.1	14.4	14.3	2.4	.993	III 0
9699	1	E058	3.2	6.5	8.2	4.4	1.3	II 0
2443	1	BL7P9	1.9	2.0	1.4	10.5	.70	I T
EVENT CLEAN SLATE I (Plutonium								
3038	21	BL25P9	39.3	75.7	121.3	2.3	1.60	I T
3013	39	BL19P9	25.4	3.7	4.5	5.5	1.2	II T
3466	27	BL29P9	26.7	0.08	94.9		1000	II P
EVENT CLEAN SLATE II (Plutonium)								
4082	8	BM-07	20.1	22.0	29.1	3.0	1.32	III T
2305	24	TB, P2	69.2	4.0	8.4	4.1	2.1	I T
2366	1	BB1-01	26.6	6.3	6.3	5.4	1.0	III P
2370	12	B-060	45.5	6.9	8.7	3.4	1.3	III P
2371	43	B-044	42.0	3.1	4.5	4.8	1.4	III 0
2369	24	B-068	12.5	3.4	60.0	3.2	18	III P
2312	14	B, L3, P9	74.3	30.6	56.7	3.0	1.85	III 0

* Class I - Sphere; Class II - Spheroid; Class III - Irregular
0 - Opaque; P - Part Opaque; T - Translucent

TABLE 3.3 CONTINUED

Sample No.	Particle No.	Location	Average Diameter	Gross Count Rate	$Pu^{239+240}$ Content	Error (Percent)	Correction Factor	Class*
			(micron)	(cpm)	(dpm)			
EVENT CLEAN SLATE II (Plutonium)								
2272	39	DM Pos. 12	13.3	6.2	7.2	5.0	1.2	III T
2286	37	A-054	39.4	67.9	54.3	3.6	0.800	III 0
4116	22	A-036	41.6	36.2	55.3	3.5	1.53	III 0
4812	5	B-054	17.3	12.4	12.6	5.2	1.015	III 0
EVENT CLEAN SLATE III (Plutonium)								
4964	10	A-102	49.5	2.1	34.5	3.8	16	III 0
4973	13	BM-10	81.8	74.2	126	2.3	1.698	III 0
EVENT DOUBLE TRACKS (Americium)					Am^{241} Content (dpm)			
2151	12			67.1	0.956	7.5		
2526	18			23.2	0.166	24		
2723	10			78.1	0.392	130		
2812	5			14.4	0.095	80		
9656	34			59.6	0.990	10		
9668	17			15.1	0.085	425		
EVENT CLEAN SLATE I (Americium)								
3038	21			75.7	1.82	5		

TABLE 3.4 PARTICLE DENSITY MEASUREMENTS

Location	Tracerlab No.	Diameter (micron)	Density (gm/cc)	Description	
EVENT DOUBLE TRACKS					
BL8P21	2151-32	10.9	15.46	Trans. Yellow-Gray	Sphere
	2151-38	10.3	4.26	Opaque	Sphere
E058	9698-9	35.6	2.19	Opaque	Irregular
G064	9656-6	13.0	11.65	Opaque	Sphere
	9656-2	10.6	3.83	Part Opaque	Sphere
EVENT CLEAN SLATE II					
BM07	4082-14	40.6	4.58	Black	Irregular
TBP2	2305-38	238.5	1.66	Black	Irregular
	2305-15	35.9	2.64	Trans. Gray & Yellow	Spheroid
	2305-35	34.5	3.37	Black	Irregular

TABLE 3.5 FLUOROMETRIC URANIUM ASSAY

Sample Number	Particle Number	Location	Average Diameter (micron)	Count Rate (cpm)	Uranium Content (nanogm)	Class*
EVENT DOUBLE TRACKS						
2907	8	B, L5, P17	8.6	43.3	4.9	II 0
	12		18.4	113.4	4.3	III P
2922	15	D068	16.6	34.9	6.7	III 0
	19		20.2	185.1	4.2	II 0
9660	2	G058	12.7	214.5	-	II 0
2723	1	H060	11.9	147.4	-	III 0
	6		33.4	15.5	-	III 0
	9		13.2	130.1	3.3	II 0
2812	1	J058	12.7	158.0	-	III 0
	2		5.7	36.6	-	I 0
	8		13.7	8.9	-	I T
	9		7.0	3.0	-	III 0
2946	4	R054	16.9	75.5	5.3	II 0
	7		15.3	65.1	4.7	Aggregate
	9		12.6	558.6	5.3	I 0
	10		11.6	85.9	2.8	I T
2526	43	A066	5.2	9.1	-	II T
	21		6.4	16.4	-	I T
	40		8.9	5.2	-	II T
	24		10.5	11.4	-	III T
9656	23	G064	3.7	6.9	-	Aggregate
	11		8.5	51.8	-	I 0
	18		4.6	19.9	-	II P
	45		10.1	17.1	-	III 0
9656	48	E058	10.4	12.5	-	III P
9698	12	E058	15.0	34.6	-	III P
	18		12.6	8.1	-	III T
	10		17.3	16.0	-	III P
9668	10	I061	13.4	360.6	-	II 0
	1		9.6	15.9	-	III P
2151	31	B, L5, P21	8.9	27.3	-	II 0
2482	7	J, L6, P13	11.4	26.0	-	Aggregate

* Class I - Sphere 0 - Opaque
Class II - Spheroid P - Part Opaque
Class III - Irregular T - Translucent

- indicates a total uranium content less than 1.8 nanograms.

TABLE 3.5 CONTINUED

Sample Number	Particle Number	Location	Average Diameter (micron)	Count Rate (cpm)	Uranium Content (nanogm)	Class*
EVENT CLEAN SLATE I						
3038	48	B, L25, P9	40.3	(82.5)	46.8	II 0
	45		18.8	42.2	-	III T
3013	15	B, L19, P9	29.8	200.9	20.7	III P
	47		12.4	21.0	-	III 0
	25		15.1	30.4	2.2	I 0
	44		13.5	173.2	-	I 0
3466	33	B, L29, P9	19.7	26.5	4.5	III 0
	49		36.4	3.9	2.4	III P
	21		30.3	308.2	-	III P
	47		112.5	(156.5)	40.2	III 0
3449	19	B, L18, P21	9.1	7.6	-	III 0
	34		8.0	0.6	-	III T
	40		11.5	0.7	-	III 0
	45		7.3	1.4	-	III 0
EVENT CLEAN SLATE II						
2366	2	BB1-01	63.5	(28.3)	38.4	III 0
	3		48.8	(134.7)	30.0	III 0
	4		40.2	(62.6)	18.4	III 0
	5		51.7	(67.1)	33.8	III 0
2286	32	A-054	19.9	21.1	-	III T
	43		53.5	(51.2)	8.1	III P
	48		32.2	59.8	3.5	III P
	46		33.4	28.9	5.9	III 0
4082	48	BM-07	53.4	(214.6)	58.9	III P
	17		59.0	(67.0)	13.4	III P
	23		34.9	57.7	18.8	III 0
	49		10.4	3.7	-	III P
2305	29	TB-P2	120.1	(25.4)	38.0	II P
	32		38.0	26.1	18.7	II 0
	33		47.7	(25.1)	5..0	II T
	50		34.2	31.8	29.4	III P
4116	11	A-036	16.8	12.1	-	III P
	31		107.9	(3.7)	53.2	I T
	35		21.8	9.3	-	III P
	44		16.2	15.6	-	III P
2370	21	B-060	12.3	7.7	-	III T
	37		18.5	10.5	-	III P
	43		45.2	(68.0)	3.2	III 0
	49		13.9	3.0	-	III T

TABLE 3.5 CONTINUED

Sample Number	Particle Number	Location	Average Diameter (micron)	Count Rate (cpm)	Uranium Content (nanogm)	Class*
EVENT CLEAN SLATE II (Contd.)						
2312	5	B, L3, P9	58.7	(6.0)	15.4	III T
	14		74.3	(30.6)	30.3	III 0
	24		60.2	(11.9)	27.6	I S
	45		20.3	8.5	3.1	III 0
2272	14	D Mob. Pos. 12	14.9	6.0	-	III T
	25		20.1	9.8	2.2	III 0
	39		13.3	6.2	-	III T
	48		24.2	20.7	-	III 0
4812	31	B-054	15.8	7.2	-	III 0
	34		10.6	4.5	-	III T
	35		7.1	1.2	-	III T
	48		28.4	6.7	-	III 0
4024	13	B, L, 4, P21	17.5	6.3	3.2	III 0
	17		13.6	3.6	-	III P
	29		24.8	17.1	5.7	III 0
	46		13.7	3.6	-	III T
2369	11	B-068	40.0	(20.0)	9.4	III 0
	40		24.5	17.5	2.4	III P
	45		20.1	19.6	-	III P
	47		22.9	28.0	-	III T
EVENT CLEAN SLATE III						
4973	17	BM-10	38.6	6.2	-	III 0
	34		30.4	15.7	4.8	III T
	35		47.0	(37.8)	15.8	III 0
	48		53.8	(4.5)	12.3	III 0
4964	5	A-102	27.4	27.6	-	III 0
	23		12.3	1.8	-	III 0
	42		10.4	8.9	-	I T
	49		8.0	1.6	-	II T
4974	11	A-030	13.9	4.9	-	III 0
	19		11.1	4.4	-	III P
	28		15.9	0.7	1.9	III 0
	38		13.4	1.3	-	III P

TABLE 3.6 PARTICLE CONTENTS IDENTIFIED BY ELECTRON DIFFRACTION

Sample No.	Size (microns)	Identity
EVENT DOUBLE TRACKS		
9624	1.1	PuC
	6.4	SiO_2 (cristobalite)
	1.6	U_3O_8
	2.3	U_3Si_2
CLEAN SLATE I		
3038	0.5	U_3Si_2
CLEAN SLATE II		
2286	1.3	U_3Si_2

Figure 3.1 Photomicrograph of debris particles.

Figure 3.2 Photomicrograph of debris particles.

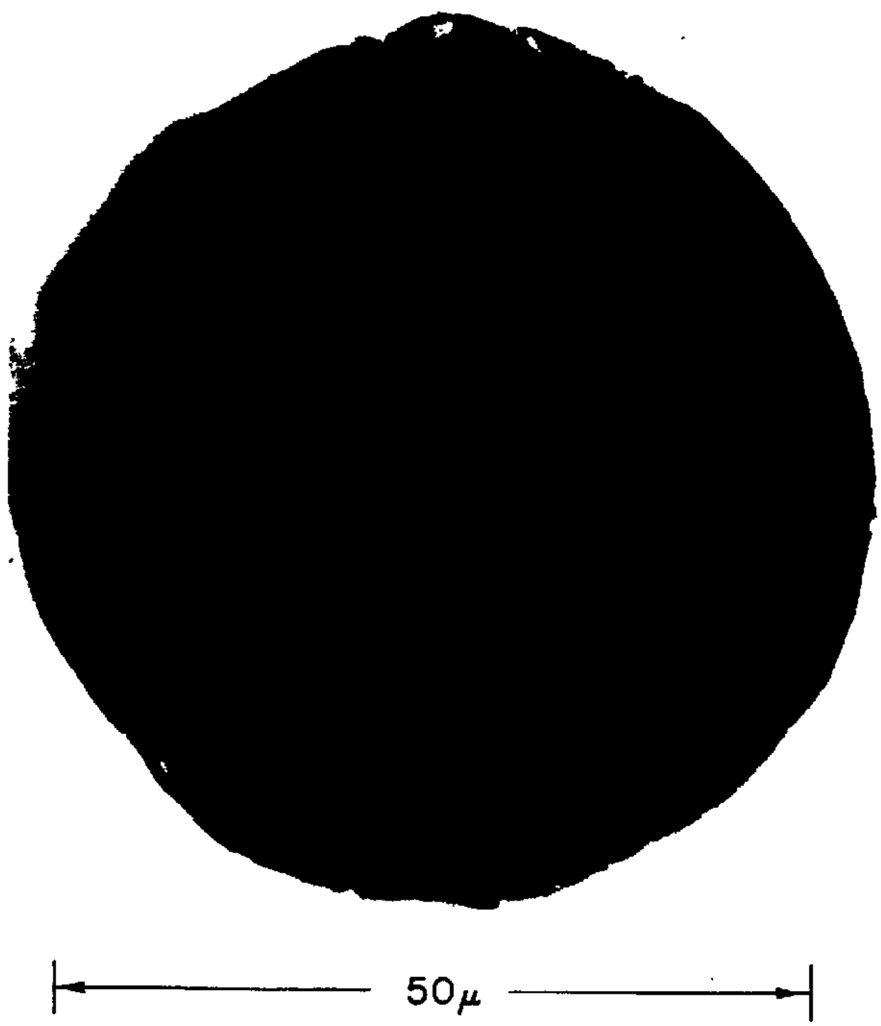

Figure 3.3 Photomicrograph of debris particles.

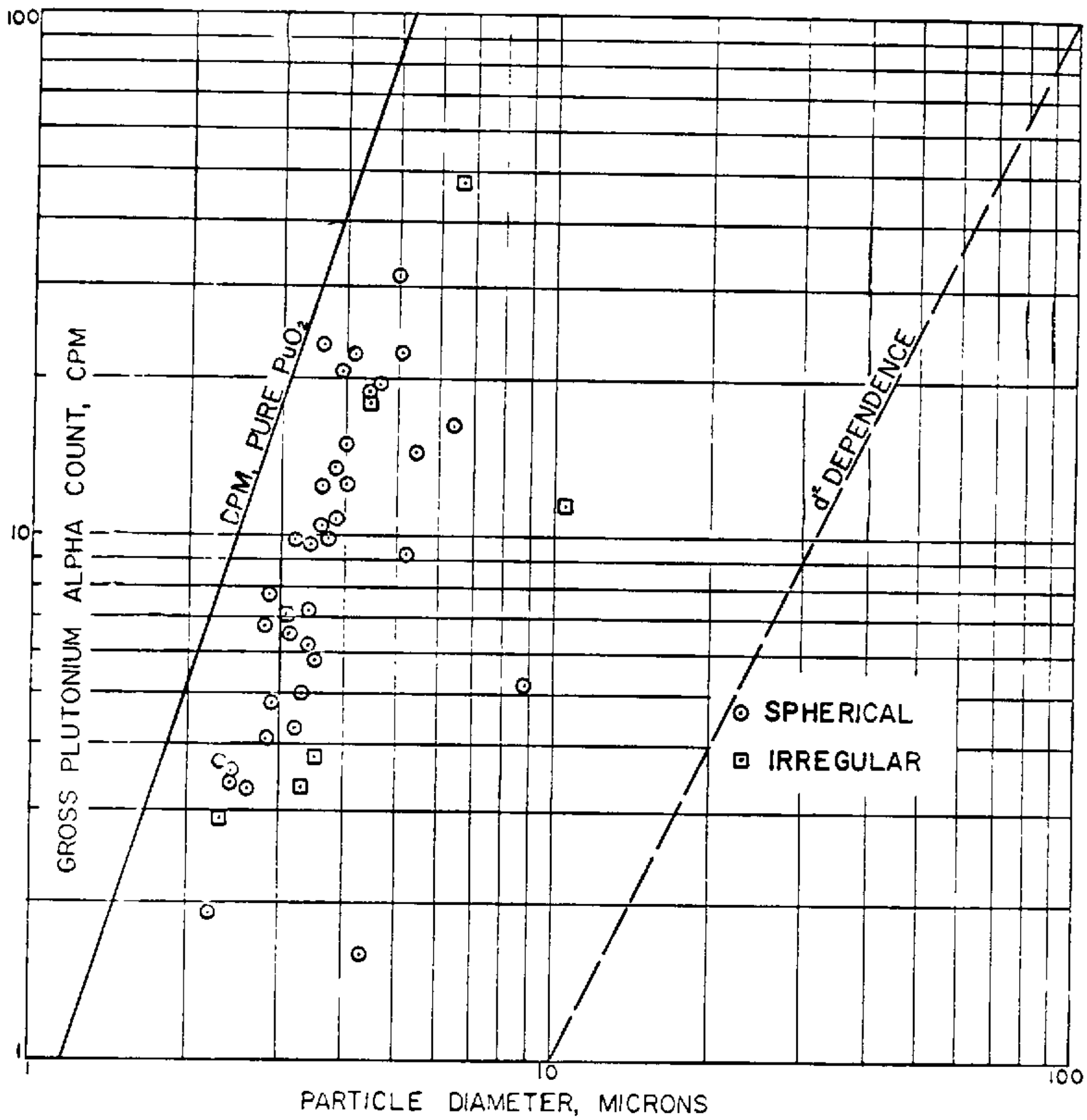

Figure 3.4 Activity-size distribution for Sample DT A-066.

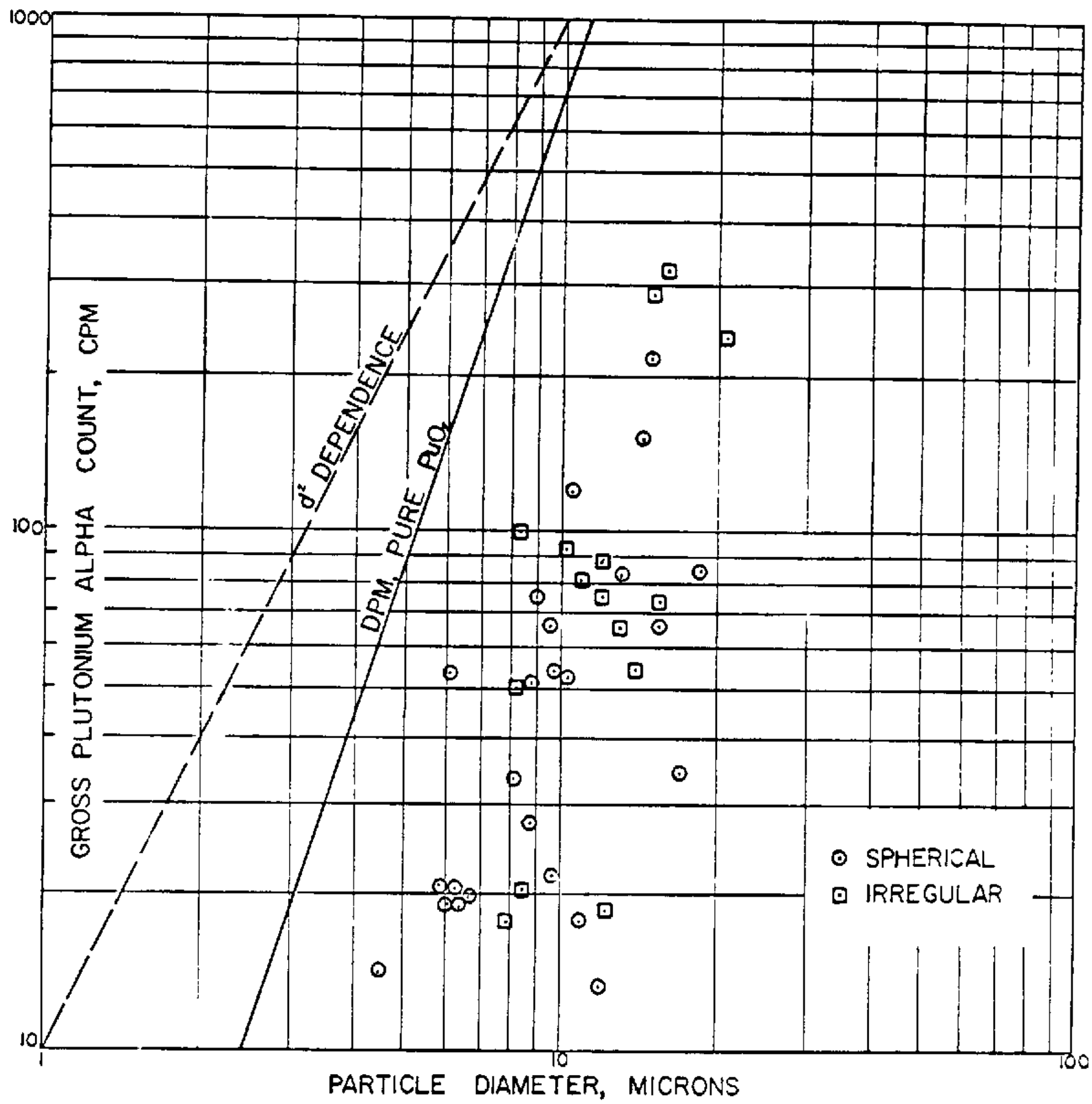

Figure 3.5 Activity-size distribution for Sample DT Arc B, L8, P21.

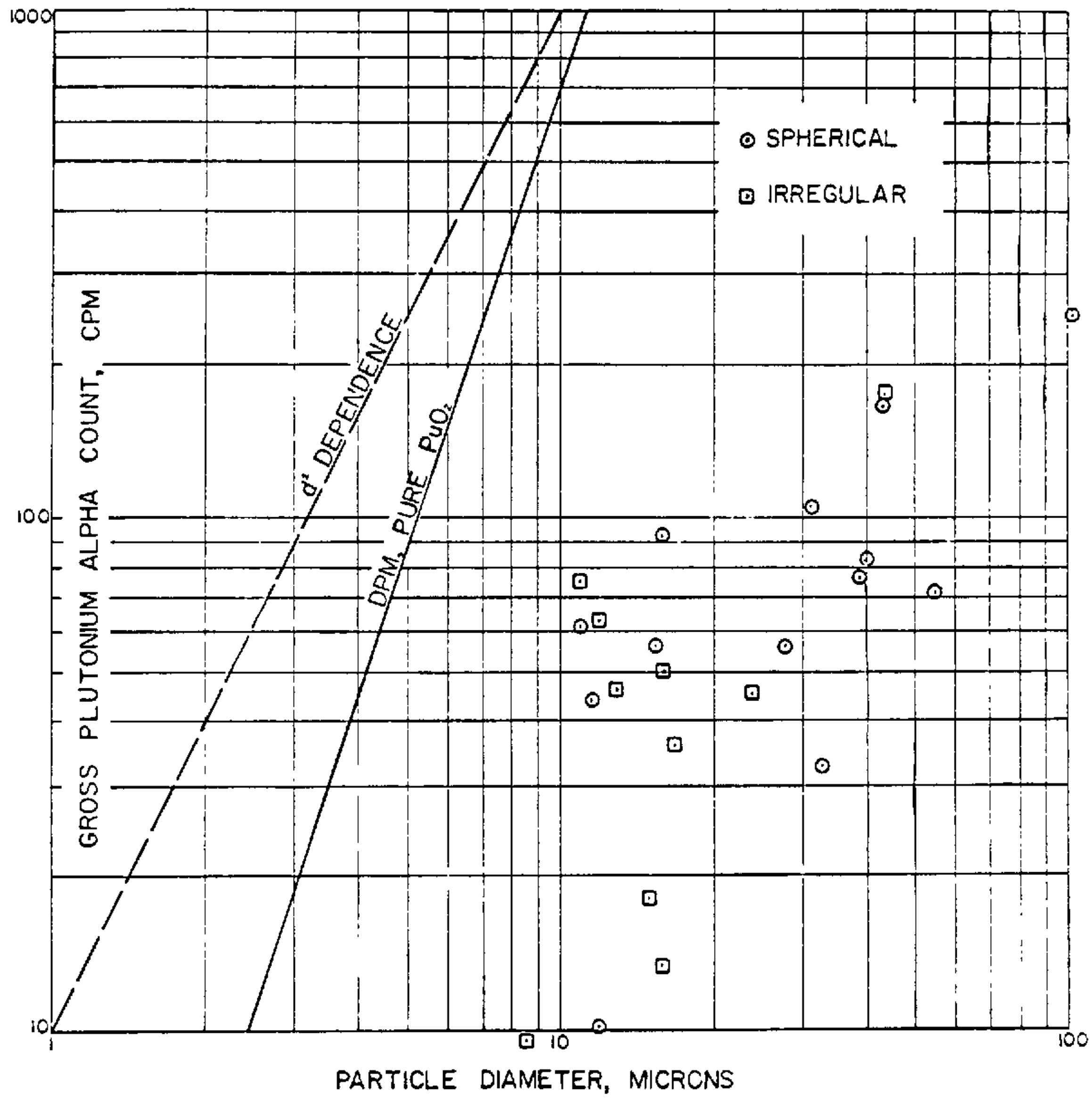

Figure 3.6 Activity-size distribution for Sample CSI L25, P9.

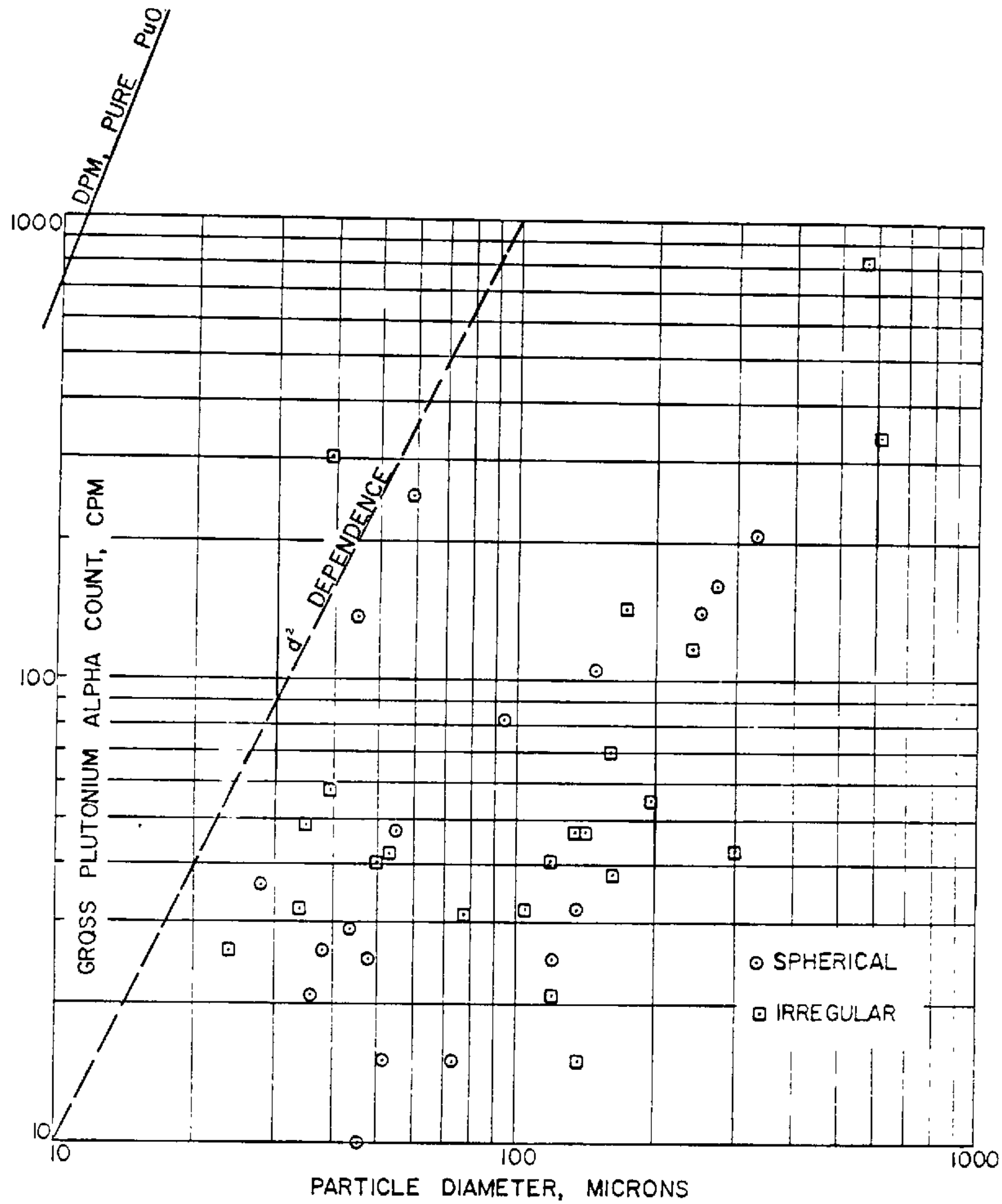

Figure 3.7 Activity-size distribution for Sample CSII TB-P2.

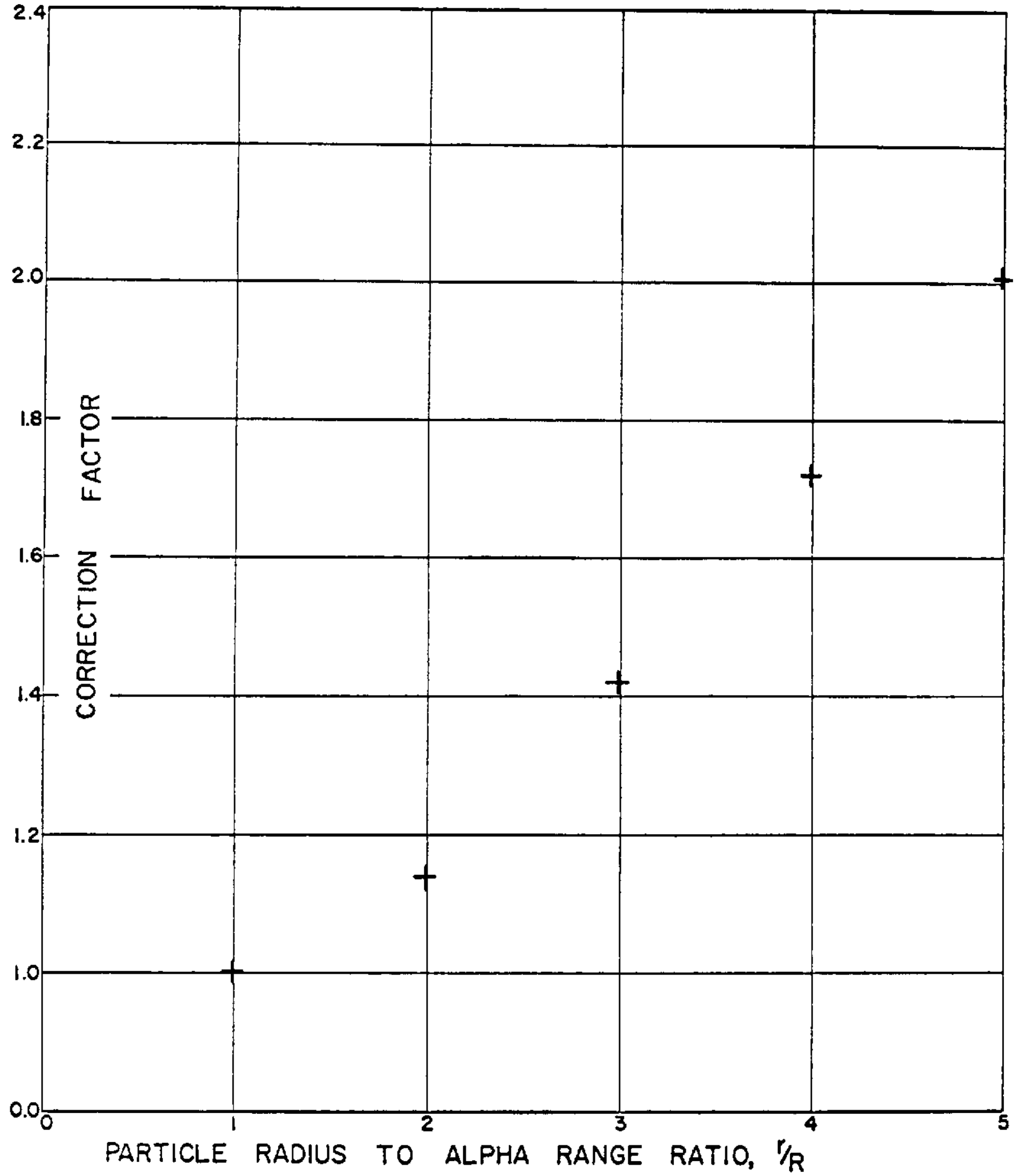

Figure 3.8 Theoretical precision counting/gross counting correction factors based on particle self absorption.

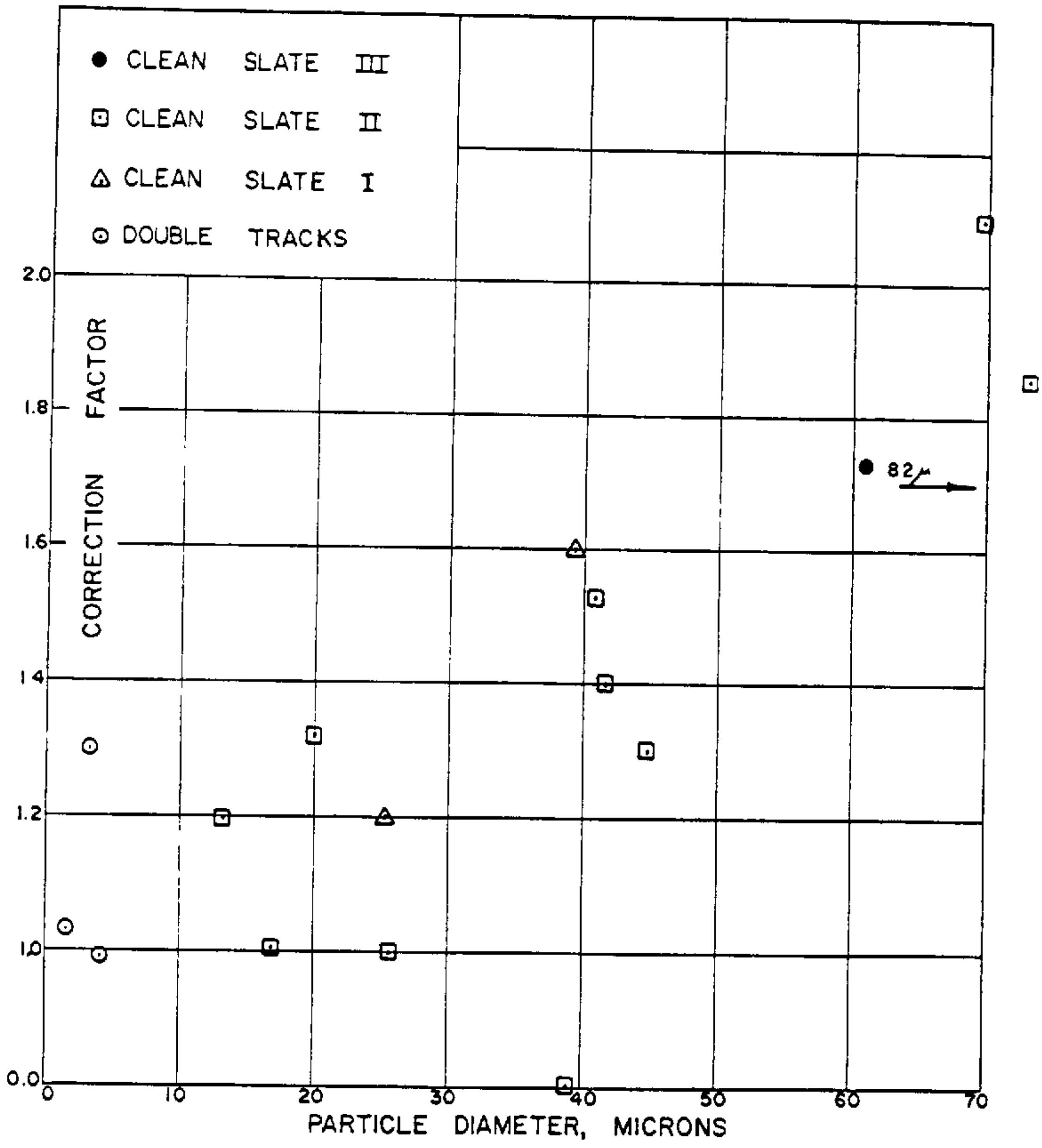

Figure 3.9 Precision counting/gross counting correction factors based on precision alpha counting.

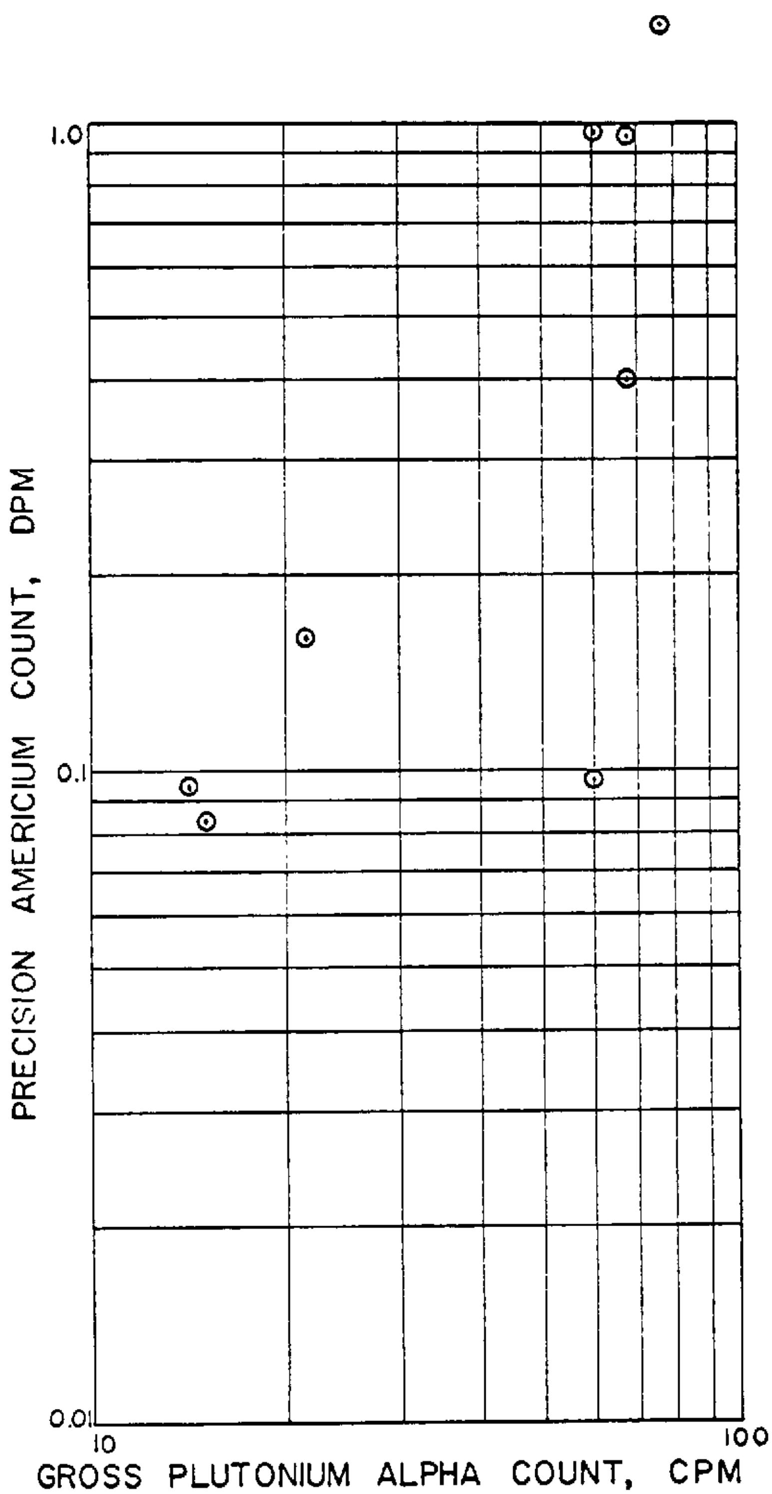

Figure 3.10 Correlation between pu cpm and am dpm.

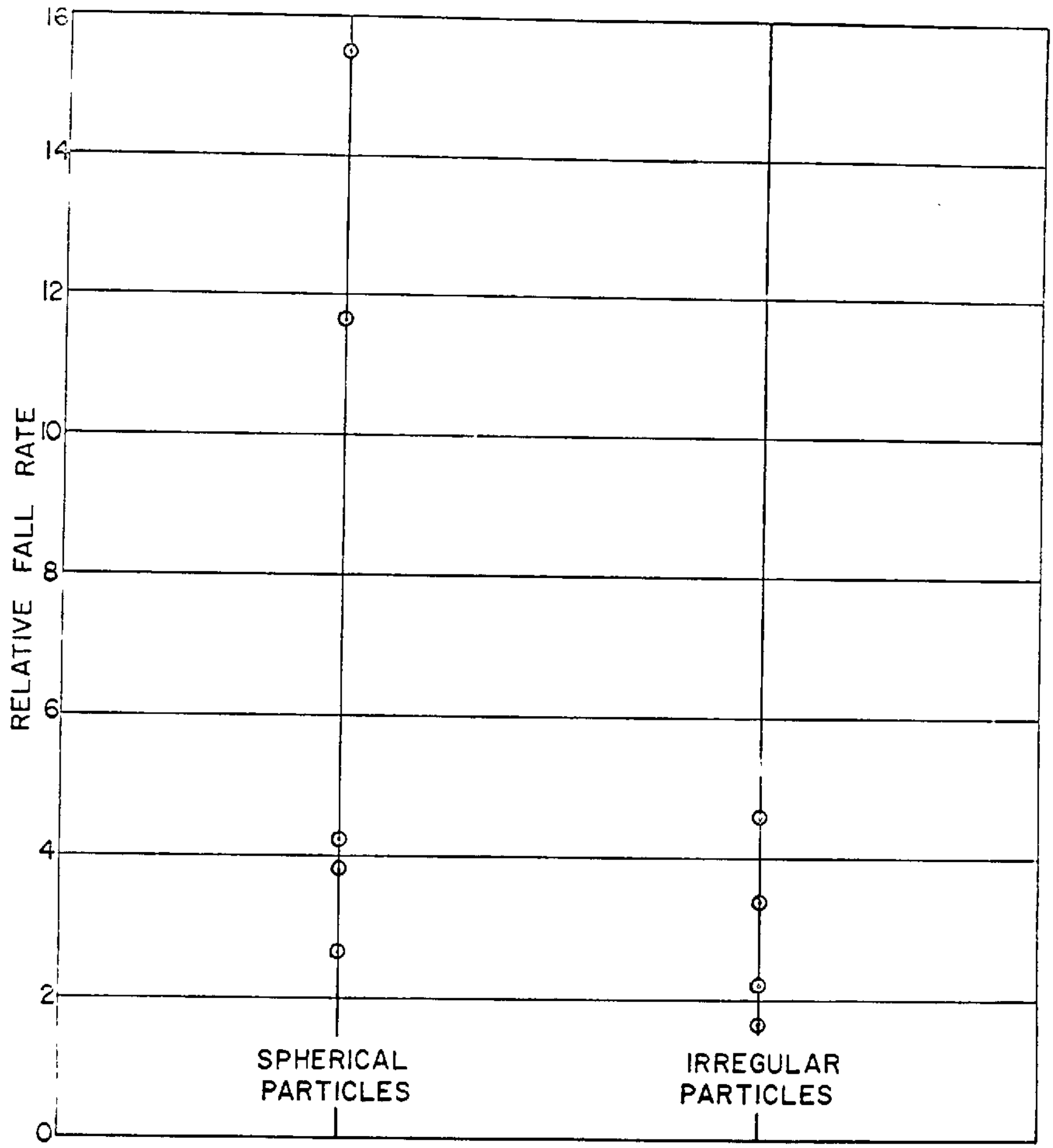

Figure 3.11 Measured relative fall rates for spherical and irregular particles.

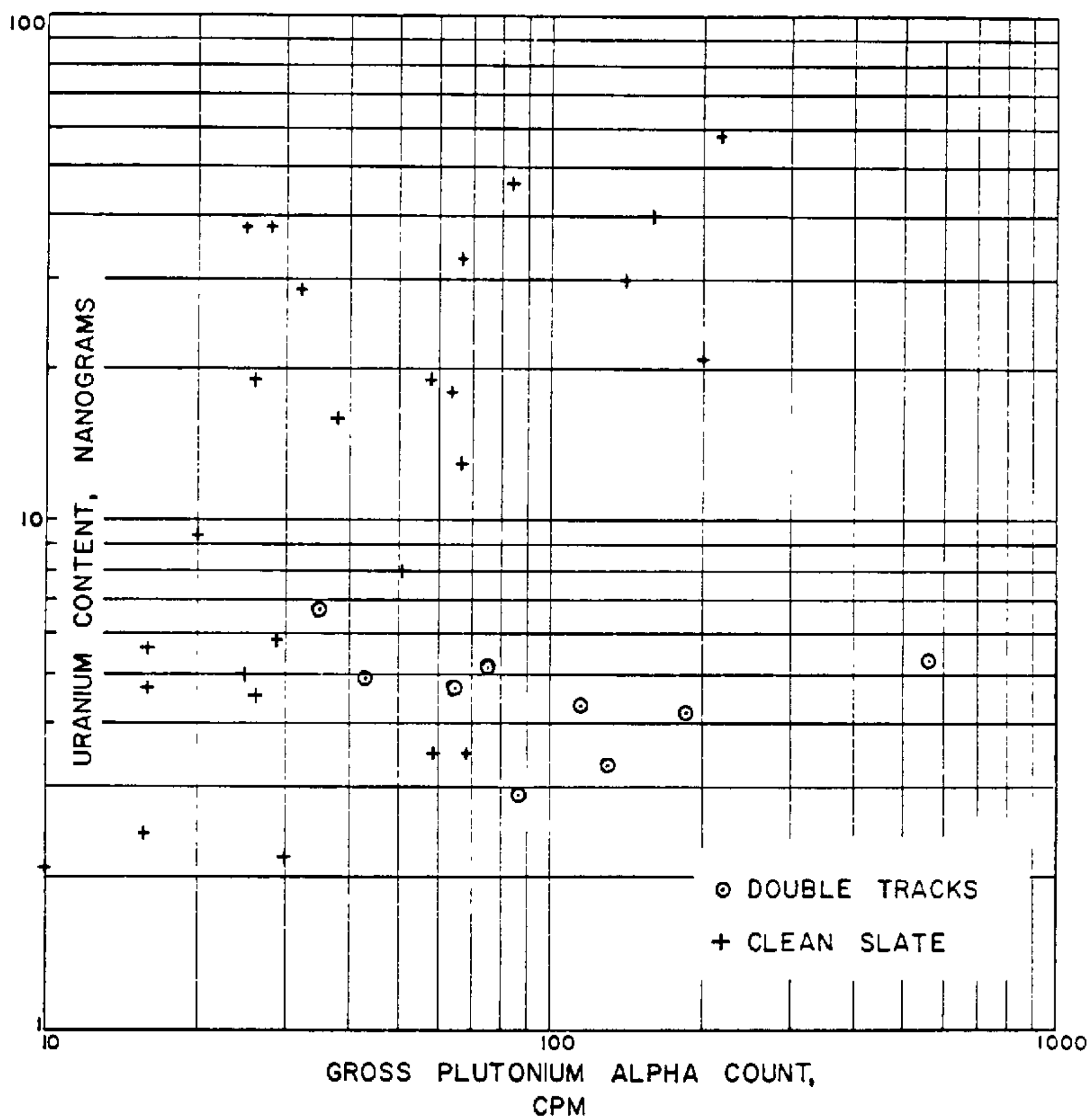

Figure 3.12 Correlation between particle uranium content and particle plutonium content.

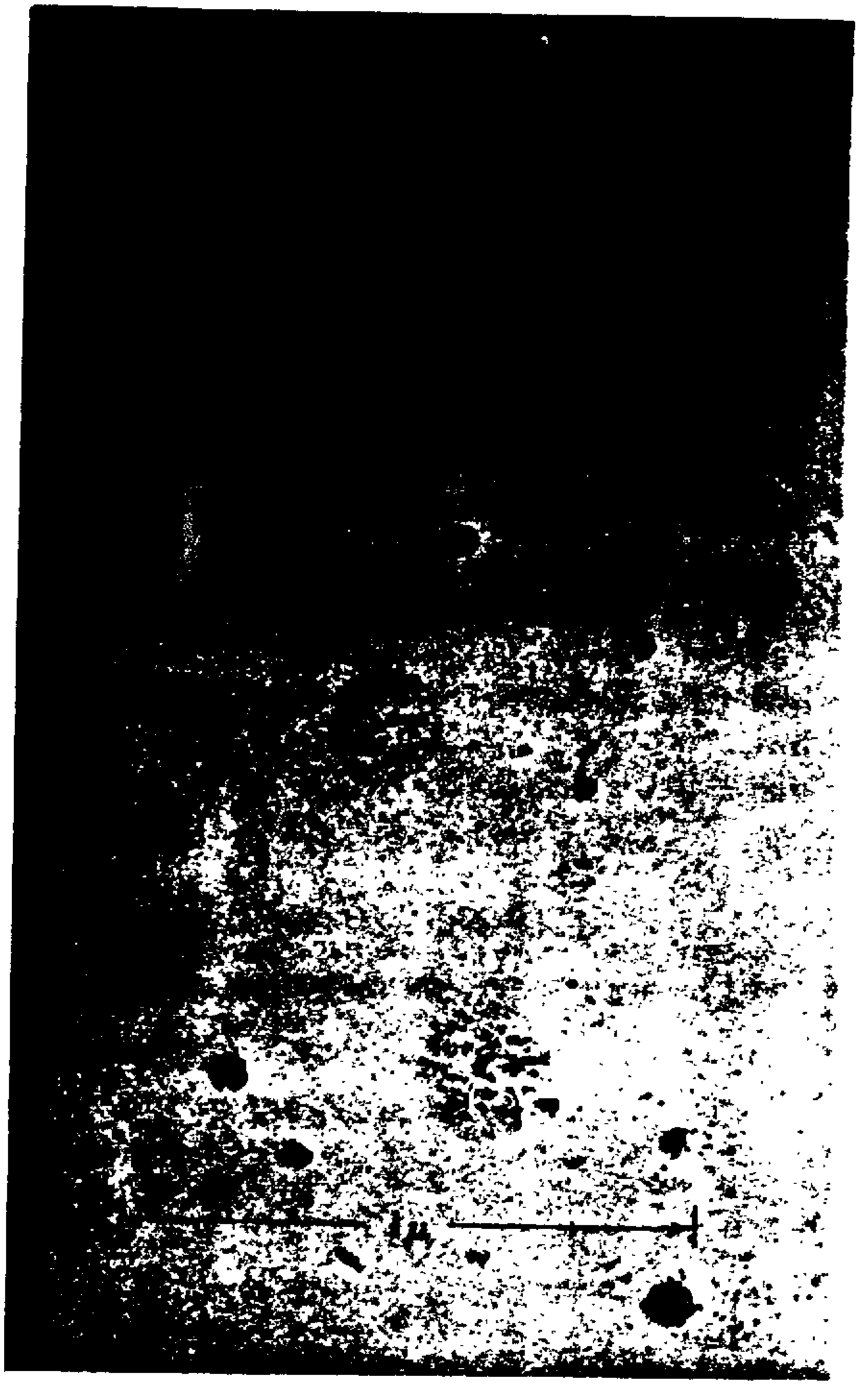

Figure 3.13 Electron micrograph of debris particles.

Figure 3.14 Electron micrograph of debris particles.

re 3.15 Electron micrograph of debris particles.

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