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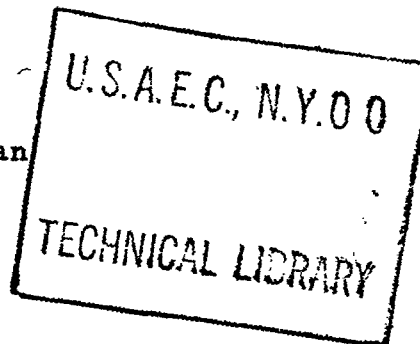
ACTIVITY-SIZE RELATIONSHIP OF FALLOUT PARTICLES
FROM TWO SHOTS, OPERATION REDWING

Research and Development Technical Report USNRDL-TR-314

19 February 1959

by

H.K. Chan



U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY

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U N C L A S S I F I E D

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Research and Development Technical Report USNRDL-TR-314
NS 081-001

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Effects of Atomic Weapons

Technical Objective
AW-7

Radiological Effects Branch
T. Triffet, Head

Chemical Technology Division
E.R. Tompkins, Head

Scientific Director
P.C. Tompkins

Commanding Officer and Director
Captain J.H. McQuilkin, USN

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
San Francisco 24, California

U N C L A S S I F I E D

ABSTRACT

The activity of coral fallout particles was studied as a function of individual size. Single particles from two shots at Operation REDWING were sized and identified as being of a spheroidal, irregular or dendrite-like type and then measured for gamma activity. Two particle size parameters were employed, equivalent projected area diameter (D_a) and maximum diameter (D_m). The study shows that an extensive range of activities is associated with each size and size-type group. Field data taken at one station indicate that the activities of a size-type group follow a normal distribution. According to the same data the activity varies as $D_a^{2.2}$ and $D_m^{1.7}$ for irregular particles, $D_a^{3.7}$ for spheroidal particles, and $D_m^{2.1}$ for dendrite-like particles.

NONTECHNICAL SUMMARY

The Problem

In order to predict the radiation hazards arising from fallout and devise protective countermeasures against them it is necessary to determine the characteristics of the fallout particles. Among the important characteristics needed is the relationship between two important individual aspects of fallout particles, size and radioactivity.

Previous studies have considered the total radioactivity associated with particles grouped according to size ranges. However, this approach does not consider the variation of radioactivity with particles of different shape, shape being an indication of the differences in the manner radioactivity is incorporated in the particle. Also, the methods used in past studies for separating the particles into size ranges did not prevent the break-up of some particles, of which the fragments were regarded as being smaller particles. These two conditions caused misleading results in the final data in attempts to quantitatively describe a relationship between the size and radioactivity of fallout particles.

The Findings

In this investigation, the shape, size, and level of radioactivity were determined for individual fallout particles. A wide range of radioactivity intensities was associated with each of the size groups and size-shape groups of particles. In the case of particles collected at one station in the field, a possibility was indicated that the radioactivity is normally distributed over a size-shape group. This set of data also indicate that regarding a relationship to particle shape, radioactivity varies approximately as the square of the diameter for irregular particles and as the 3.7 exponential power of the diameter for spheroidal particles. In the case of dendrite-like particles, the activity varies with a function exponentially greater than the irregular particle function.

ADMINISTRATIVE INFORMATION

The work reported is a direct outgrowth of Project 2.6.3, Operation REDWING. This project is described, as Problem 1, Program 2, in this laboratory's Preliminary Presentation of USNRDL Technical Program For FY 1957, dated February 1956. The work reported was done under Bureau of Ships Project No. NS-081-001, as part of Problem 1, Program 1, which is described in USNRDL Technical Program For Fiscal Year 1958. Progress of the general project of which the work is a part was most recently reported in Quarterly Progress Report, 1 October to 31 December 1958, Progress Report USNRDL-P-15, January 1958, wherein it is identified as Problem 7, Program A-1.

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INTRODUCTION

Relationships between the size and radioactivity of fallout particles play an important role in fallout phenomenology and model research. These relationships aid in the assessment of radiological situations and, more important, may reveal the manner in which activity is associated with the particles. Furthermore, the modes of association may provide some insight into the history of fallout material and suggest the mechanism of particle formation and contamination.

It has been generally hypothesized that activity is a function of either particle surface area or volume. Experimental data to confirm this hypothesis is needed. In the case of coral fallout particles, radiographic studies by Adams¹⁻⁴ have shown the existence of three general types of particles with intrinsic differences in activity association. Irregularly shaped particles generally have the activity concentrated on the exterior, indicating that it was deposited after the particle was formed. Spheroidal particles usually have the activity dispersed throughout, suggesting that it was incorporated during some molten state. Regarding the third type, particles with a dendrite-like structure, little is known of activity association. The existence of such differences necessitates the consideration of particle shape in the activity-size relationships of coral particles.

Other studies^{5,6} have been limited to the composite activity associated with size fraction. However, certain deficiencies are inherent in this method of study. The approach does not take into account the variability of particle activity due to particle type. Moreover, particle size separation was generally accomplished by sedimentation, sieving and other agitating methods; since a substantial portion of coral particles are dendrite-like and fragile, these methods very likely cause particle break-up and subsequent errors. Regarded as smaller particles, the fragments cause inaccuracies in the data, particularly fragments from particles with activity concentrated on the exterior. It is essential, therefore, to employ a method of study that will consider particle type and will not break up fragile particles.

Such requirements are met by the study of individual discrete particles.* This approach not only provides reliable data but also gives needed

* It is to be noted that Kikuchi, et al.,⁷ examined a number of individual CASTLE particles, but neglected particle type; no correlation between size and activity was found.

information regarding the distribution of activity among particles of the same size. Such an approach was employed by Project 2.63⁸ in experimental studies at Operation REDWING. During these investigations the activity-size relationships of individual coral fallout particles from two shots, designated as A and B, were studied.*

EXPERIMENTAL PROCEDURE

Experimental design was based on the collection and analysis of single discrete particles; consequently, preservation of individual characteristics was a fundamental collection requirement. Fallout particles were collected on a special sampling surface and the determinations of individual size, shape and gamma activity were undertaken. Procedures were also included to obtain some particle size distribution information, although another project⁹ featured this as its primary objective.

Sampling Technique

Fallout particles were sampled by incremental collectors (IC), which are fully described in Reference 8. The collectors sequentially exposed 4 x 4-in. plastic sampling trays, each containing a cellulose acetate disc coated with a heavy layer of special grease; the actual sampling area was 8.2 cm in diameter. For each IC, the exposure period of its trays were identical and preset at either 3, 15 or 36 min, depending on the number of IC's at a station and the expected rates of fallout.

The particles studied were collected at major project sampling stations located on several vessels. For Shot A, only the collection from the YAG-40 was studied. For Shot B, the samples investigated were from YAG-40, YAG-39, IST-611, YFNB-13, and YFNB-29 (two stations). At all stations, project collectors - of which the IC was one type - were located on an elevated wind-shielded platform, designated as a standard platform. Detailed descriptions of the vessels, platforms and their instrumentation may be found in Reference 8. Except for the YAG-40 collections from both shots, the particles investigated were sampled by platform-mounted IC's and shipped back to NRDL for analysis.

In addition to its platform collectors, the YAG-40 had special collecting equipment and a shielded laboratory with facilities to take early-time measurements. Particles for the present study were collected by two adjacent, independently operated, modified IC's designated as special incremental collectors (SIC). These instruments were in a 6 x 3-1/2 x 6-ft housing

* Shot A is the first of the shots in which USNRDL participated during Project 2.63; Shot B is the fourth.

installed on the "flight" deck, which was situated on the ship's bow approximately 8 ft above the main deck. The SIC's were so mounted that their sampling ports were located together and exposed flush with the roof of the structure. To reduce wind bias effects, a horizontal steel plate was placed on top of the SIC housing to give an 18-in. overhang on the forward and lateral sides. The opening in the plate for the sampling ports was located forward of the plate center and the plate was greased to prevent those particles falling on the plate from blowing or rolling into the sampling port. Investigators located in the shielded laboratory below controlled the SIC sampling intervals and, immediately after exposure, the trays were lowered by an elevator into this laboratory where analytical procedures were begun.

Particle Selection

Analytical procedures generally were the same at the field laboratory and at NRDL, with minor differences as noted.

Some of the sampling trays exposed during the heavier fallout were examined with a low-power binocular stereomicroscope to determine the size and shape of the particles. Each particle was typed according to shape and sized in situ. Only Shot B particle collections were studied for size distribution. Circular areas were randomly marked on each tray and in these areas, particles larger than 10 μ in diameter were studied. On the YAG-40 trays, a circle 1.2 cm in diameter was used, while a circle 0.6 cm in diameter was used on all other Shot B trays (analyzed at NRDL). No attempt was made to obtain size distribution information from the YAG-40-Shot A particles; these were selected to obtain a sufficient number of particles from all size groups present to provide reliable data.

Immediately after being sized, each particle was carefully scooped up with a hypodermic needle and suspended in a small glass vial for subsequent gamma counting.

Particle Shape and Size Determination

Particles were classified in three general categories on the basis of physical appearance:* spheroidal if spherical in character, irregular if irregular or angular, and dendrite-like when distinguished by an interlacing branching network structure of extreme delicacy (Fig. 1).

* The color of YAG-40 particles (both shots) was also determined; however, this parameter was not utilized in the present study.

Particle size was described by either of two size parameters, equivalent projected area diameter (D_a) or maximum diameter (D_m). The projected area method is conventional, and the area can be related to particle falling velocity - an important quantity in any fallout model. No significant physical relation can be attached to maximum diameter; however, it does offer ease of measurement and reproducibility. Diameters were measured with ocular micrometers having either a linear scale or a Fairs graticule (sizing circles). The linear scale was employed exclusively to size YAG-40-Shot B particles in terms of D_m . All other Shot B particles and the YAG-40-Shot A particles* were sized by the graticule system in terms of D_a , whereby particle area was compared with graticule area. Measurements were generally taken under a total magnification of 45X, although 19.5X and 9.9X were used occasionally by changing microscope objectives. In general, interpolation between scale units for either micrometer was not attempted, except in the case of YAG-40-Shot A particles.

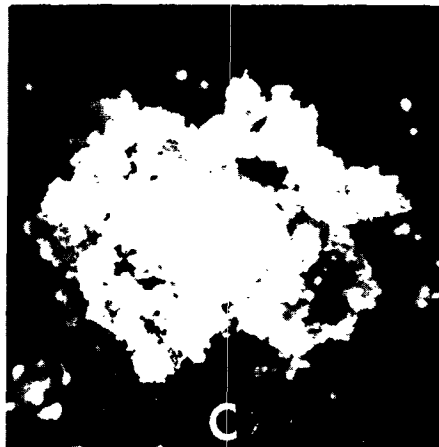
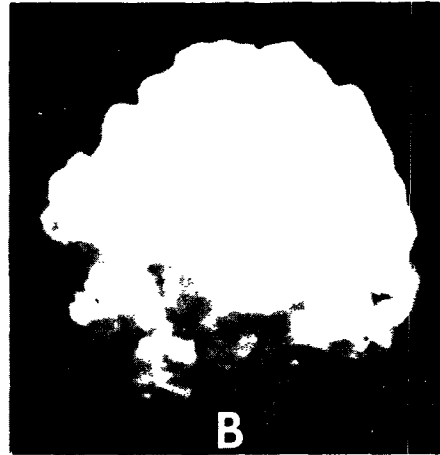
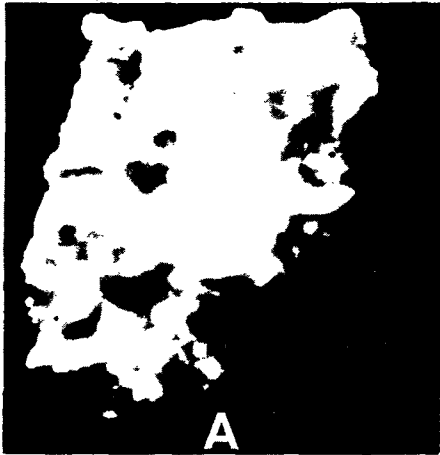
Particle Activity Measurements

Particles were individually counted for relative gamma activity in a well scintillation counter** employing a 1-3/4-in. dia. x 2-in. thick Tl-activated NaI crystal detector. In the case of measurements made at the site (YAG-40 collections), three 1-min counts were taken and, for convenience, the median was selected as the representative value. Where gross counting rates were less than twice background, single 1-min counting was done. Particles analyzed at NRDL were all counted for single 1-min periods. Backgrounds were on the order of 300 c/m. Experimentally determined coincidence loss corrections were applied when activities exceeded 10^6 c/m. Response characteristics of the several well counters employed were normalized, where necessary, through laboratory gamma standards.

Field measurements were taken from about H + 5 to 40 hr and NRDL measurements from about H + 300 to 650 hr. Activities were corrected to an appropriate reference time for analysis, and experimental decay curves were determined by following the decay characteristics of selected particles and aliquots of particle solutions.

* A small group of YAG-40-Shot A particles was sized in terms of circumscribed diameter (D_c) by utilizing graticule circumference. Because of its small number, this group was not included in this study but is listed in Appendix A.

** An end-on 1-1/2-in. dia. x 1/2-in. thick NaI scintillator was occasionally used to count exceptionally active particles. A conversion factor of 10 from shelf 1 to well was obtained from lower-activity particles counted in both counters, and has been applied to all results.



**Fig. 1 Examples of Types of Particles Studied.
A. Irregular. B. Spheroidal. C. Dendrite-like.**



RESULTS AND DISCUSSION

Individual particle data are listed in Appendix A. The results of particle measurements are summarized in Table 1, where the distribution and activity characteristics of the size and size-type group of each sample collection are listed. The small number in some of the groups emphasizes the difficulties in obtaining sufficient single particle data and indicates that the reliability of such data is low. Particles smaller than 31 μ were not studied in the YAG-40-Shot A group - probably because of investigator bias toward larger sizes and the difficulties of sizing small particles imbedded in grease.

Particle Size Distribution

For the size distribution studies, it was not possible to mark a tray area completely at random because of practical considerations. Areas selected were limited to those having 10 to 20 particles sufficiently well spaced to permit pick-up. A study¹⁰ has shown that the quantities of fall-out deposited at the different collector positions in the standard platform were affected by varying degrees of wind bias; for this reason the particle size distribution data as given may not be representative of the geographical location. Since the effects of wind bias were lower in the case of the YAG-40-Shot B sample, this collection is considered to be reasonably representative of location.

Activity Characteristics

The most notable aspect of the activity data is the wide range of activities associated with each size group and size-type subgroup. Though activity ranges were extensive, variation through each range was nearly continuous; however, in a number of cases, extreme low or high values occurred. The activity characteristics of each size group of each collection are given in Table 1 in terms of minimum activity, maximum activity, median activity, and group activity (except YAG-40-Shot A) - which is obtained by summing individual particle activities. Due to the lower frequencies of the size-type subgroups, only their median activities and subgroup activities are listed.

As discussed in the following section, there are indications that the activities of a size-type subgroup may follow a normal distribution, in



TABLE 1

Distribution and Activity Characteristics of Particle Size and Type Groups
(YAG-40-Shot A (non-random sample); Activities at H + 12)

| Size Group (μ) | Number of Particles | Composite | | | Irregular | | Spheroidal | | Dendrite-like | |
|-------------------------|------------------------|---------------------|-----------|-----------|-----------|----------------------------------|------------|----------------------------------|---------------|----------------------------------|
| | | Activity (well c/m) | | | Frequency | Median Activity (well c/m) | Frequency | Median Activity (well c/m) | Frequency | Median Activity (well c/m) |
| | | Minimum | Maximum | Median | | | | | | |
| 31-42 | 8 | 78 | 11,354 | 835 | 6 | 1,255 | 2 | 387 | 0 | --- |
| 43-60 | 20 | 33 | 833,600 | 6,985 | 13 | 6,797 | 5 | 6,631 | 2 | 423,448 |
| 61-84 | 37 | 58 | 459,321 | 12,213 | 27 | 11,871 | 10 | 17,450 | 0 | --- |
| 85-102 | 6 | 4,460 | 50,608 | 32,434 | 6 | 32,434 | 0 | --- | 0 | --- |
| 103-120 | 42 | 69 | 525,449 | 41,412 | 24 | 25,083 | 12 | 87,795 | 6 | 56,728 |
| 121-145 | 13 | 19,063 | 683,362 | 77,622 | 4 | 24,771 | 8 | 304,282 | 1 | 58,585 |
| 146-170 | 34 | 3,686 | 771,326 | 113,209 | 12 | 65,067 | 15 | 259,931 | 7 | 114,803 |
| 171-200 | 24 | 3,816 | 1,675,122 | 166,982 | 13 | 92,070 | 11 | 457,315 | 0 | --- |
| 201-240 | 27 | 25,565 | 1,310,318 | 168,795 | 22 | 152,710 | 2 | 420,669 | 3 | 221,828 |
| 241-260 | 25 | 32,178 | 726,969 | 145,494 | 22 | 131,935 | 0 | --- | 3 | 217,674 |
| 261-315 | 9 | 53,105 | 493,500 | 223,424 | 6 | 181,658 | 0 | --- | 3 | 365,685 |
| 316-382 | 1 | --- | --- | 1,774,146 | 1 | 1,774,146 | 0 | --- | 0 | --- |

Continued

TABLE 1 (Contd)
 Distribution and Activity Characteristics of Particle Size and Type Groups
 (VAC-40-Shot B, Activities at H + 300)

| Size Group (μ) | Number of Particles | Composite | | | Group | Frequency | Irregular | | | Group | Frequency | Spheroidal | | | Group | Frequency | Dendrite-like | | |
|------------------|---------------------|-----------|---------|---------|-----------|-----------|---------------------|-----------|---------|--------|-----------|------------|---------------------|---------|-------|-----------|---------------|--------|---------------------|
| | | Minimum | Maximum | Median | | | Activity (well c/m) | Minimum | Maximum | | | Median | Activity (well c/m) | Minimum | | | Maximum | Median | Activity (well c/m) |
| 11-33 | 5 | 0 | 3,222 | 372 | 4,209 | 4 | 218 | 987 | 1 | 3,222 | 3,222 | 0 | --- | --- | --- | --- | --- | --- | |
| 34-66 | 28 | 0 | 80,483 | 1,596 | 191,972 | 17 | 1,860 | 169,221 | 3 | 3,424 | 3,222 | 8 | 1,125 | --- | --- | --- | --- | --- | |
| 67-99 | 49 | 0 | 47,181 | 7,103 | 519,360 | 24 | 8,293 | 241,291 | 11 | 14,776 | 194,762 | 14 | 4,111 | --- | --- | --- | --- | --- | |
| 100-132 | 61 | 0 | 48,757 | 15,129 | 998,547 | 38 | 16,889 | 685,795 | 8 | 8,932 | 66,648 | 15 | 13,504 | --- | --- | --- | --- | --- | |
| 133-165 | 78 | 4 | 53,806 | 17,243 | 1,564,034 | 40 | 15,247 | 678,500 | 8 | 10,827 | 88,475 | 30 | 26,224 | --- | --- | --- | --- | --- | |
| 166-198 | 46 | 8 | 387,697 | 25,877 | 1,628,637 | 30 | 24,503 | 803,776 | 4 | 3,757 | 30,261 | 12 | 37,363 | --- | --- | --- | --- | --- | |
| 199-231 | 19 | 19 | 99,094 | 34,435 | 693,709 | 12 | 34,078 | 402,758 | 0 | --- | --- | 7 | 34,591 | --- | --- | --- | --- | --- | |
| 232-264 | 16 | 94 | 136,203 | 49,444 | 849,701 | 4 | 34,571 | 125,221 | 0 | --- | --- | 12 | 53,599 | --- | --- | --- | --- | --- | |
| 265-297 | 10 | 8 | 122,553 | 55,708 | 599,034 | 2 | 43,855 | 87,709 | 1 | 8 | 8 | 7 | 72,695 | --- | --- | --- | --- | --- | |
| 298-330 | 14 | 19 | 155,625 | 55,282 | 936,556 | 2 | 63,499 | 126,985 | 0 | --- | --- | 12 | 55,282 | --- | --- | --- | --- | --- | |
| 331-363 | 1 | --- | --- | 64,086 | 64,086 | 0 | --- | --- | 0 | --- | --- | 1 | 64,086 | --- | --- | --- | --- | --- | |
| 364-396 | 2 | 3,176 | 138,856 | 71,016 | 142,032 | 0 | --- | --- | 1 | 3,176 | 3,176 | 1 | 138,856 | --- | --- | --- | --- | --- | |
| 397-429 | 0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |
| 430-462 | 3 | 1,267 | 39,308 | 10,997 | 51,572 | 2 | 6,132 | 12,264 | 1 | 39,308 | 39,308 | 0 | --- | --- | --- | --- | --- | --- | |
| 463-495 | 0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |
| 496-528 | 2 | 92,688 | 197,740 | 145,214 | 290,428 | 0 | --- | --- | 0 | --- | --- | 2 | 145,214 | --- | --- | --- | --- | --- | |
| Total | 334 | | | | 8,523,877 | 175 | | 3,334,507 | 38 | | 435,392 | 121 | | | | 4,753,978 | | | |
| Contribution (%) | | | | | 52.4 | | | 39.1 | 11.4 | | 5.1 | 36.2 | | | | 55.8 | | | |

Continued



TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Type Group
(YAG-39-Shot B, Activities in Well c/m at H + 300)

| Size Group (μ) | Number of Particles | Frequency With Zero Activity | Composite | | | Irregular | | | Spheroidal | | | Dendrite-like | | | |
|-------------------------|---------------------|------------------------------|---------------------|---------|--------|---------------------|-----------|--------|---------------------|-----------|--------|---------------------|-----------|--------|--------|
| | | | Activity (well c/m) | | | Activity (well c/m) | | | Activity (well c/m) | | | Activity (well c/m) | | | |
| | | | Minimum | Maximum | Median | Group | Frequency | Median | Group | Frequency | Median | Group | Frequency | Median | Group |
| 10-21 | 20 | 7 | 0 | 232 | 18 | 1,161 | 5 | 0 | 57 | 15 | 61 | 1,104 | 0 | --- | --- |
| 22-30 | 51 | 19 | 0 | 477 | 14 | 3,115 | 34 | 11 | 1,532 | 16 | 68 | 1,583 | 1 | 0 | 0 |
| 31-42 | 59 | 27 | 0 | 872 | 16 | 5,263 | 45 | 9 | 3,554 | 3 | 0 | 307 | 11 | 22 | 1,402 |
| 43-60 | 63 | 17 | 0 | 5,451 | 54 | 12,481 | 31 | 64 | 1,335 | 3 | 469 | 9,913 | 29 | 27 | 1,233 |
| 61-84 | 49 | 8 | 0 | 2,180 | 64 | 11,992 | 29 | 61 | 5,666 | 0 | --- | --- | 20 | 64 | 6,326 |
| 85-120 | 41 | 4 | 0 | 8,994 | 317 | 80,647 | 25 | 543 | 48,395 | 1 | 739 | 739 | 15 | 98 | 31,513 |
| 121-170 | 9 | 1 | 0 | 15,755 | 494 | 32,430 | 6 | 676 | 16,170 | 1 | 494 | 494 | 2 | 7,883 | 15,766 |
| 171-240 | 5 | 0 | 1,958 | 27,120 | 16,402 | 80,525 | 2 | 10,757 | 21,514 | 1 | 27,120 | 27,120 | 2 | 15,946 | 31,891 |
| 241-340 | 3 | 0 | 5,658 | 76,906 | 34,344 | 166,908 | 3 | 34,344 | 116,908 | 0 | --- | --- | 0 | --- | --- |
| 341-480 | 0 | - | --- | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| 481-680 | 0 | - | --- | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| Total | 300 | | | | | 344,522 | 180 | | 215,131 | 40 | | 41,260 | 80 | | 88,131 |
| Contribution (%) | | | | | | | 60.0 | | 62.4 | 13.4 | | 12.0 | 26.7 | | 25.6 |

Continued



TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Type Groups
(LST-611-Shot B, Activities at H + 300)

| Size Group (μ) | Number of Particles | Frequency With Zero Activity | Composite | | | | Irregular | | | Spheroidal | | | Dendrite-like | | |
|----------------------|---------------------|------------------------------|---------------------|---------|--------|---------|---------------------|--------|---------|---------------------|--------|-------|---------------------|--------|--------|
| | | | Activity (well c/m) | | | | Activity (well c/m) | | | Activity (well c/m) | | | Activity (well c/m) | | |
| | | | Minimum | Maximum | Median | Group | Frequency | Median | Group | Frequency | Median | Group | Frequency | Median | Group |
| 10-21 | 39 | 18 | 0 | 161 | 19 | 1,897 | 22 | 13 | 1,017 | 17 | 19 | 880 | 0 | --- | --- |
| 22-30 | 23 | 10 | 0 | 212 | 11 | 939 | 22 | 24 | 929 | 1 | 10 | 10 | 0 | --- | --- |
| 31-42 | 32 | 12 | 0 | 343 | 41 | 2,269 | 27 | 44 | 1,820 | 3 | 29 | 106 | 2 | 172 | 343 |
| 43-60 | 26 | 13 | 0 | 1,112 | 10 | 2,436 | 20 | 19 | 2,261 | 4 | 0 | 118 | 2 | 29 | 57 |
| 61-84 | 12 | 2 | 0 | 7,909 | 108 | 14,161 | 7 | 198 | 9,598 | 1 | 128 | 128 | 4 | 53 | 4,435 |
| 85-120 | 14 | 3 | 0 | 11,941 | 1,994 | 47,417 | 8 | 4,201 | 35,755 | 1 | 3,282 | 3,282 | 5 | 0 | 8,380 |
| 121-170 | 20 | 3 | 0 | 17,640 | 8,699 | 176,014 | 14 | 11,323 | 150,672 | 0 | --- | --- | 6 | 883 | 25,342 |
| 171-240 | 6 | 1 | 0 | 39,681 | 11,438 | 82,752 | 5 | 8,798 | 68,472 | 0 | --- | --- | 1 | 14,280 | 14,280 |
| 241-340 | 0 | - | - | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| 341-480 | 0 | - | - | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| 481-680 | 0 | - | - | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| Total | 172 | | | | | 327,885 | 125 | | 270,524 | 27 | | 4,524 | 20 | | 52,837 |
| Contribution (%) | | | | | | | 72.7 | | 82.5 | 15.7 | | 1.4 | 11.6 | | 16.1 |

Continued



TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Type Groups
(YFNB 29-Shot B, Activities at H + 300)

| Size Group (μ) | Number of Particles | Frequency With Zero Activity | Composite | | | | Irregular | | | Spheroidal | | | Dendrite-like | | |
|----------------------|---------------------|------------------------------|---------------------|-----------|---------|-----------|---------------------|---------|-----------|---------------------|--------|---------|---------------------|---------|-----------|
| | | | Activity (well c/m) | | | | Activity (well c/m) | | | Activity (well c/m) | | | Activity (well c/m) | | |
| | | | Minimum | Maximum | Median | Group | Frequency | Median | Group | Frequency | Median | Group | Frequency | Median | Group |
| 10-21 | 33 | 6 | 0 | 506 | 48 | 2,524 | 20 | 44 | 1,683 | 13 | 70 | 841 | 0 | --- | --- |
| 22-30 | 18 | 9 | 0 | 610 | 13 | 1,299 | 15 | 0 | 1,107 | 3 | 60 | 192 | 0 | --- | --- |
| 31-42 | 19 | 5 | 0 | 534 | 62 | 1,853 | 16 | 53 | 1,487 | 0 | --- | --- | 3 | 84 | 366 |
| 43-60 | 22 | 4 | 0 | 395,842 | 490 | 408,345 | 15 | 167 | 404,211 | 1 | 9 | 9 | 6 | 848 | 4,125 |
| 61-84 | 12 | 2 | 0 | 5,554 | 272 | 11,149 | 8 | 272 | 8,493 | 1 | 927 | 927 | 3 | 88 | 1,729 |
| 85-120 | 16 | 0 | 90 | 7,801 | 926 | 37,525 | 7 | 785 | 20,133 | 4 | 554 | 4,472 | 5 | 1,625 | 12,920 |
| 121-170 | 12 | 1 | 0 | 83,316 | 2,029 | 118,296 | 6 | 1,433 | 93,965 | 0 | --- | --- | 6 | 2,421 | 24,331 |
| 171-240 | 8 | 1 | 0 | 21,240 | 6,186 | 55,882 | 3 | 6,590 | 19,723 | 1 | 21,240 | 21,240 | 4 | 2,728 | 14,919 |
| 241-340 | 9 | 0 | 3,614 | 619,448 | 61,653 | 1,445,691 | 6 | 112,640 | 720,292 | 1 | 61,653 | 61,653 | 2 | 331,873 | 663,746 |
| 341-480 | 13 | 0 | 6,204 | 1,698,631 | 71,445 | 3,265,945 | 9 | 142,176 | 2,918,445 | 3 | 71,446 | 341,296 | 1 | 6,204 | 6,204 |
| 481-680 | 7 | 0 | 50,641 | 489,310 | 184,800 | 1,610,536 | 5 | 184,800 | 1,086,799 | 0 | --- | --- | 2 | 261,869 | 523,737 |
| Total | 169 | | | | | 6,959,045 | 110 | | 5,276,338 | 27 | | 430,630 | 32 | | 1,252,077 |
| Contribution (%) | | | | | | | 65.1 | | 75.8 | 16.0 | | 6.0 | 18.9 | | 18.0 |

Continued



TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Type Groups
(YFNB 13-Shot B, Activities at H + 300)

| Size Group (μ) | Number of Particles | Frequency With Zero Activity | Composite | | | | Irregular | | | Spheroidal | | | Dendrite-like | | |
|-------------------------|---------------------|------------------------------|---------------------|---------|---------|-----------|---------------------|---------|-----------|---------------------|--------|-------|---------------------|--------|--------|
| | | | Activity (well c/m) | | | | Activity (well c/m) | | | Activity (well c/m) | | | Activity (well c/m) | | |
| | | | Minimum | Maximum | Median | Group | Frequency | Median | Group | Frequency | Median | Group | Frequency | Median | Group |
| 10-21 | 27 | 8 | 0 | 250 | 33 | 1,488 | 19 | 35 | 868 | 8 | 29 | 620 | 0 | --- | --- |
| 22-30 | 54 | 22 | 0 | 399 | 25 | 3,014 | 38 | 24 | 1,933 | 16 | 38 | 1,081 | 0 | --- | --- |
| 31-42 | 28 | 7 | 0 | 356 | 87 | 2,820 | 25 | 91 | 2,775 | 2 | 23 | 45 | 1 | 0 | 0 |
| 43-60 | 19 | 3 | 0 | 1,225 | 74 | 2,707 | 15 | 74 | 2,345 | 0 | --- | --- | 4 | 87 | 362 |
| 61-84 | 8 | 2 | 0 | 1,166 | 83 | 1,612 | 6 | 83 | 446 | 0 | --- | --- | 2 | 583 | 1,166 |
| 85-120 | 11 | 4 | 0 | 2,424 | 125 | 5,618 | 6 | 135 | 963 | 1 | 0 | 0 | 4 | 1,116 | 4,655 |
| 121-170 | 2 | 0 | 78 | 7,126 | 3,602 | 7,204 | 1 | 78 | 78 | 0 | --- | --- | 1 | 7,126 | 7,126 |
| 171-240 | 1 | 1 | --- | --- | 0 | 0 | 0 | --- | --- | 0 | --- | --- | 1 | 0 | 0 |
| 241-340 | 0 | - | --- | --- | --- | --- | - | --- | --- | - | --- | --- | - | --- | --- |
| 341-480 | 2 | 0 | 792,378 | 984,805 | 888,592 | 1,777,183 | 2 | 888,592 | 1,777,183 | 0 | --- | --- | 0 | --- | --- |
| 481-680 | 1 | 1 | --- | --- | 0 | 0 | 0 | --- | --- | 1 | 0 | 0 | 0 | --- | --- |
| Total | 153 | | | | | 1,801,646 | 114 | | 1,786,591 | 27 | | 1,746 | 12 | | 13,309 |
| Contribution (%) | | | | | | | 74.5 | | 99.2 | 17.6 | | 0.1 | 7.8 | | 0.7 |



which case the mean and median are equal. The median therefore is used in this study as an estimate of the mean, since it depends (at least in the doubtful activity region) only on the number of particles. In addition the median value is less distorted by the extreme values that occur in some cases.

Only the field data (YAG-40-Shot A and YAG-40-Shot B) are considered reliable for activity-size and activity distribution information. This set of data shows that the activity range and median activity both increase with particle size. The measurements made at NRDL are less useful, showing a high percentage of particles with very low or zero activities. These particles were counted at late times, and their activities had decayed to or past the limits of detection. In the case of zero activities the question of which of these decayed past detection and which were originally inactive cannot be resolved. It is noteworthy that all the YAG-40-Shot A particles studied were active and 98% of the YAG-40-Shot B particles were active.

Activity Distribution Studies

A preliminary study of the activity distribution within a size group and a size-type subgroup was conducted with the field data. The study was limited to considering whether or not the distribution of activities followed normal or log-normal distribution functions. A normal distribution tendency was exhibited only by the size-type subgroups containing 30 or more particles, as is shown by their data plotted on normal-probability paper in Figs. 2 through 5. A distribution function could not be assigned to the other groups.

The YAG-40-Shot B particles provide information on the distribution of activity among size groups as well as the distribution of activity by particle type within a size group. The activities, listed in Table 1, are detailed in Table 2.

Activity and Size Relationship

With the field data, median activities of size and size-type groups were plotted against mean diameters to study the activity-size relationships and the influence of particle type in such relations. Figure 6 depicts the log-log plots of the YAG-40-Shot A particles and Fig. 7, the YAG-40-Shot B group. Shot A dendrite-like and Shot B spheroidal particles were not studied typewise because their data were too sparse; however they are included in the composite group studies. In each plot the locus of points suggested a linear relationship; consequently regression lines were fitted by means of a modified least squares method. In this method the median activity of the group was weighted by the number of particles in the group. For calculation, activities greater than 10^4 c/m were

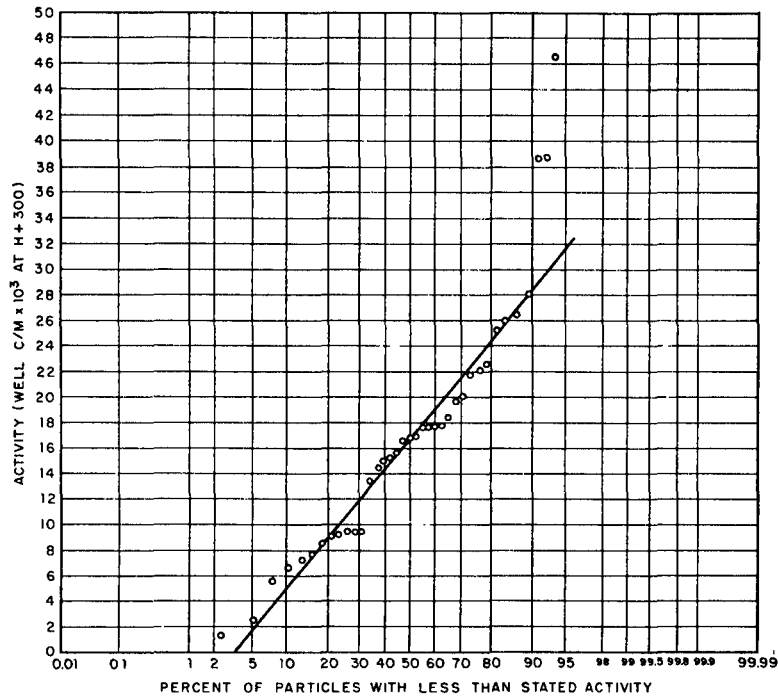


Fig. 2 Particle Activity Probability Plot.
YAG-40-Shot B collection; 100-132 μ size range;
irregular type; number of particles, 38.

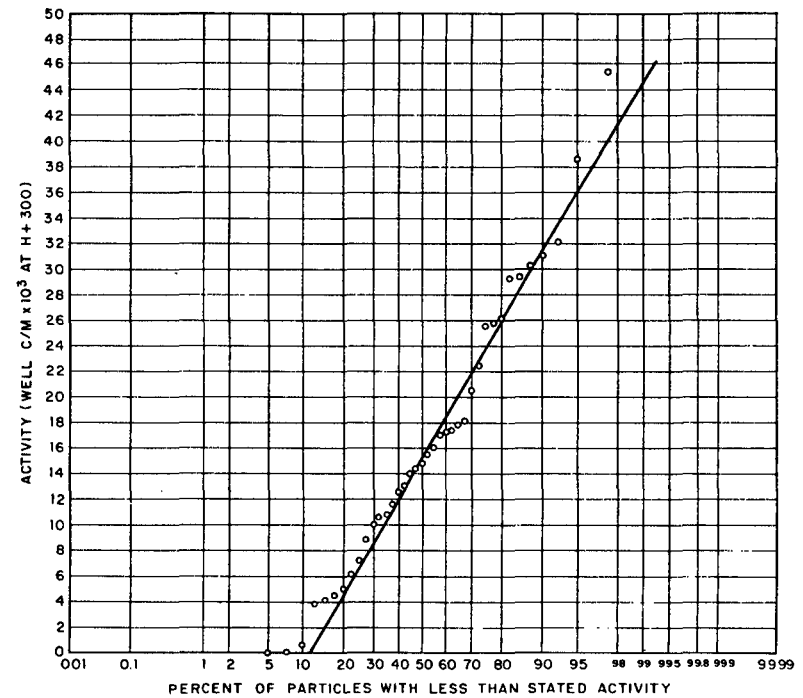


Fig. 3 Particle Activity Probability Plot.
YAG-40-Shot B collection; 133-165 μ size range;
irregular type; number of particles, 40.

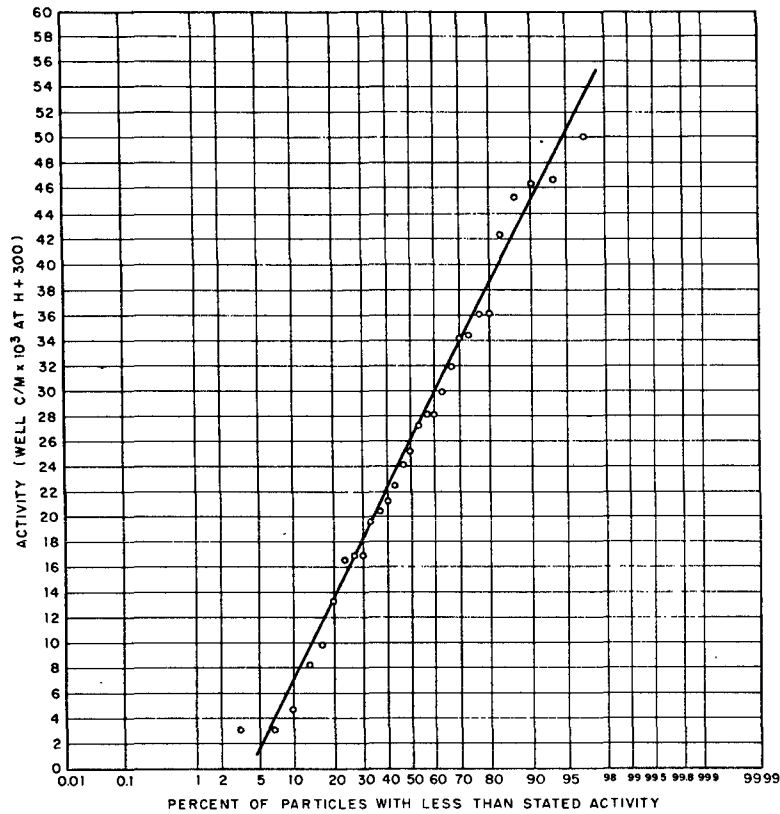


Fig. 4 Particle Activity Probability Plot.
YAG-40-Shot B collection; 133-165 μ size range;
dendrite-like type; number of particles, 30.

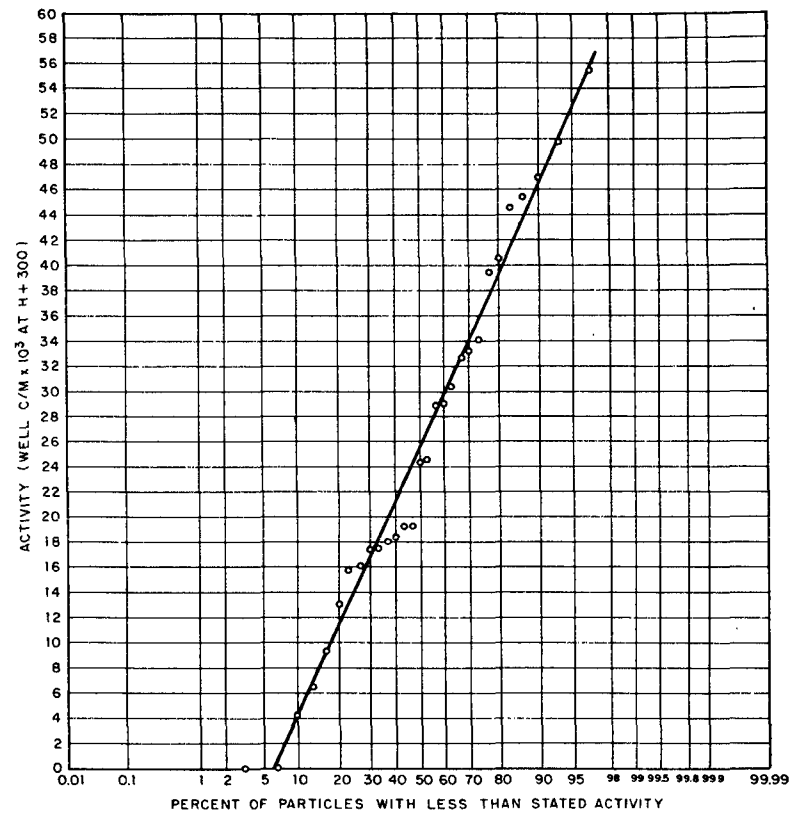


Fig. 5 Particle Activity Probability Plot.
YAG-40-Shot B collection; 166-198 μ size range;
irregular type; number of particles, 30.

TABLE 2

Distribution of Activity with Size Group and Type,
YAG-40-Shot B Particles

| Size Group (μ) | Percent of Total Sample Activity | | | |
|----------------------|----------------------------------|-----------|------------|---------------|
| | Composite | Irregular | Spheroidal | Dendrite-like |
| 11-33 | 0.05 | 0.01 | 0.04 | ---- |
| 34-66 | 2.25 | 1.99 | 0.11 | 0.16 |
| 67-99 | 6.09 | 2.83 | 2.28 | 0.98 |
| 100-132 | 11.71 | 8.05 | 0.78 | 2.89 |
| 133-165 | 18.35 | 7.96 | 1.04 | 9.35 |
| 166-198 | 19.10 | 9.42 | 0.35 | 9.32 |
| 199-231 | 8.14 | 4.72 | --- | 3.41 |
| 232-264 | 9.97 | 1.47 | --- | 8.50 |
| 265-297 | 7.03 | 1.03 | <0.01 | 6.00 |
| 298-330 | 10.87 | 1.49 | --- | 9.38 |
| 331-363 | 0.75 | --- | --- | 0.75 |
| 364-396 | 1.67 | --- | 0.04 | 1.63 |
| 397-429 | --- | --- | --- | --- |
| 430-462 | 0.61 | 0.14 | 0.46 | --- |
| 463-495 | --- | --- | --- | --- |
| 496-528 | 3.41 | --- | --- | 3.41 |
| Total | 100.00 | 39.11 | 5.10 | 55.78 |

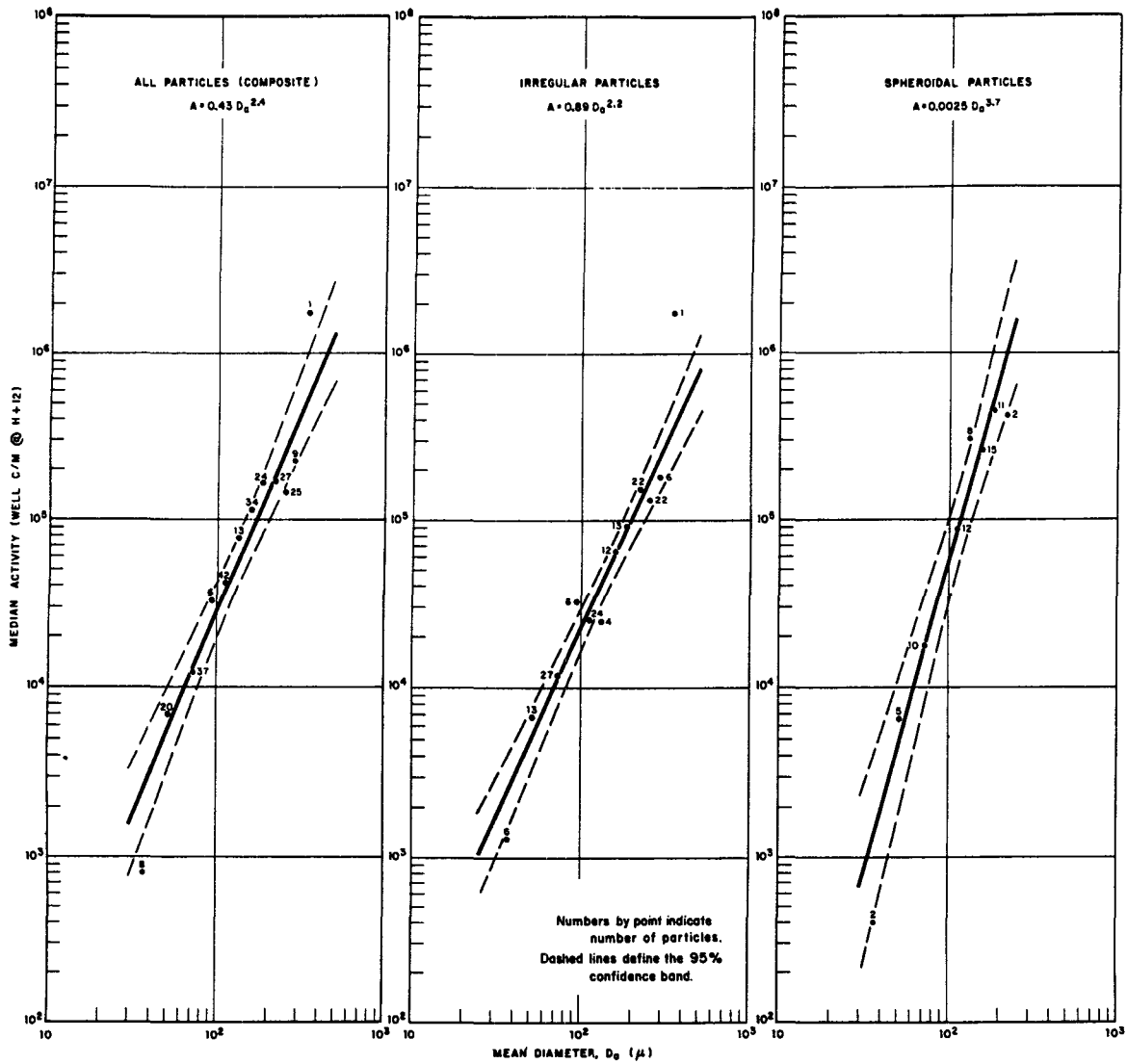


Fig. 6 Median Activity Versus Mean Size, YAG-40-Shot A Particles

rounded to three significant figures and lower activities to the nearest hundred c/m. Dashed lines representing the 95% confidence bands of the regression lines are also included. The equations of the regression lines are given in the figures, where:

A = median activity in well c/m at $H + 300$ (Shot B) or $H + 12$ (Shot A)

D_a = mean projected area diameter in microns

D_m = mean maximum diameter in microns

CONCLUSIONS

In view of the limited data no generalizations can be made; however, the results do warrant the following observations:

1. An extensive range of activities is associated with each size and size-type group. The field data indicate that the activities of a size-type group containing 30 or more particles follow a normal distribution.
2. The field data also show that the activity of irregular particles varies approximately as the square of the diameter, a surface area function. For spheroidal particles the activity varies with a function exponentially greater than a volume function. In the case of dendrite-like particles the activity varies with a function exponentially greater than the irregular particle function.

Approved by:

E. R. Tompkins

E. R. TOMPKINS
Head, Chemical Technology Division

For the Scientific Director

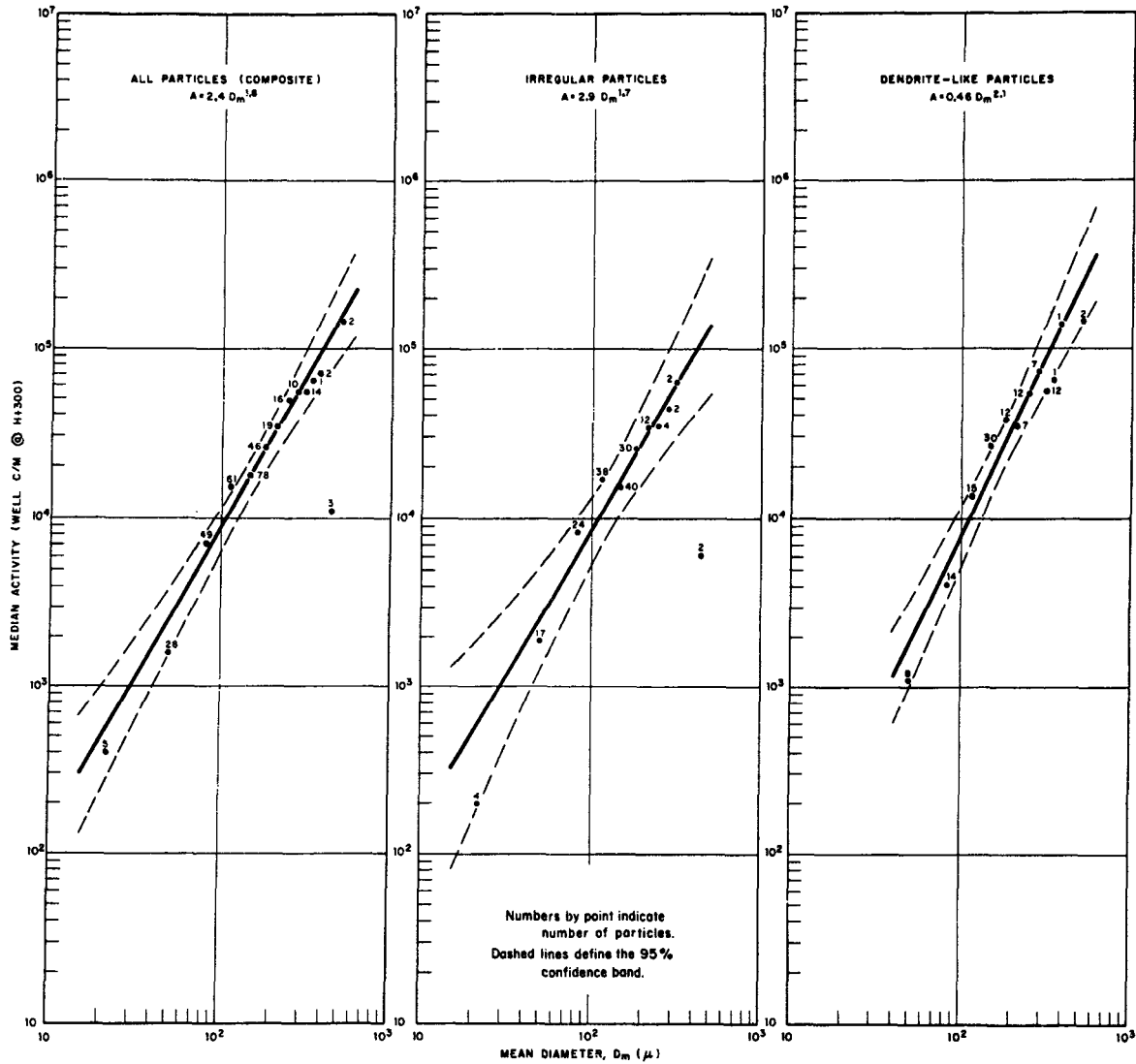


Fig. 7 Median Activity Versus Mean Size, YAG-40-Shot B Particles

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APPENDIX

MEASUREMENTS OF INDIVIDUAL PARTICLES

The size, shape, color (when determined) and corrected gamma activity of the particles investigated are listed in the following tables. In regard to particle shape, symbols S, I and D represent spheroidal, irregular, and dendrite-like respectively. Particle designation refers to the collecting tray and the sequential order in which the particle was studied. Discontinuities in sequential order indicate either labeling errors or analytical errors compelling the elimination of certain particles.

TABLE A.1

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|---|-------|-------------------|
| | D _a | D _c | | | |
| 311-1 | | 380 | 649,329 | D | white |
| 2 | | 250 | 97,790 | D | white |
| 3 | | 380 | 349,670 | D | white |
| 4 | | 360 | 756,096 | D | white |
| 5 | | 360 | 276,729 | D | white |
| 6 | | 180 | 123,092 | I | white |
| 7 | | 360 | 323,721 | D | white |
| 8 | | 260 | 125,882 | S | white |
| 9 | | 260 | 261,715 | D | yellow white |
| 10 | | 360 | 538,739 | D | translucent white |
| 11 | | 180 | 124,580 | I | yellow white |
| 12 | | 180 | 131,216 | I | yellow white |
| 13 | | 260 | 120,333 | I | white |
| 322-1 | | 360 | 542,297 | D | white |
| 2 | | 360 | 199,538 | S | white |
| 3 | | 315 | 177,259 | D | white |
| 4 | | 315 | 452,764 | I | white |
| 5 | | 285 | 67,343 | I | white |
| 6 | | 310 | 57,076 | I | white |
| 7 | | 285 | 18,485 | I | white |
| 8 | | 260 | 251,425 | I | white |
| 9 | | 260 | 144,226 | I | white |
| 10 | | 260 | 59,662 | I | yellow white |
| 11 | | 260 | 111,957 | I | white |
| 12 | | 220 | 62,603 | I | white |
| 13 | | 180 | 856,510 | S | white |
| 14 | | 180 | 44,941 | I | white |
| 15 | | 180 | 57,404 | I | yellow white |
| 16 | | 130 | 34,862 | I | white |
| 17 | 240 | | 603,872 | S | white |
| 18 | 240 | | 378,999 | I | white |
| 19 | 78 | | 1,295 | I | white |
| 20 | 145 | | 26,094 | I | white |
| 21 | 120 | | 834 | I | white |
| 22 | 110 | | 69 | I | bright yellow |
| 23 | 170 | | 20,637 | I | white |
| 24 | 120 | | 89,922 | S | white |
| 25 | 240 | | 168,795 | I | white |

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|--------------------|
| | D _a | D _c | | | |
| 322-26 | 170 | | 3,686 | I | white |
| 27 | 105 | | 9,555 | I | white |
| 28 | 155 | | 21,000 | I | white |
| 29 | 120 | | 318,325 | S | yellow |
| 30 | 120 | | 23,413 | I | white |
| 324- 1 | 260 | | 373,126 | I | |
| 2 | 170 | | 56,895 | D | translucent white |
| 3 | 84 | | 3,842 | I | translucent white |
| 4 | 120 | | 30,894 | D | translucent white |
| 5 | 105 | | 34,872 | I | translucent white |
| 6 | 220 | | 114,401 | I | white |
| 7 | 70 | | 29,331 | I | translucent white |
| 8 | 60 | | 13,295 | D | translucent white |
| 9 | 60 | | 8,376 | I | translucent white |
| 10 | 290 | | 53,105 | I | white |
| 11 | 220 | | 132,656 | I | white |
| 12 | 220 | | 236,946 | I | white |
| 13 | 260 | | 112,922 | I | white |
| 14 | 60 | | 833,600 | D | translucent white |
| 15 | 42 | | 974 | I | translucent white |
| 16 | 220 | | 724,800 | I | yellow |
| 17 | 260 | | 340,488 | I | white |
| 18 | 42 | | 1,535 | I | translucent white |
| 19 | 42 | | 8,853 | I | translucent white |
| 20 | 35 | | 233 | I | translucent white |
| 21 | 60 | | 1,228 | I | translucent white |
| 22 | 180 | | 457,315 | S | translucent white |
| 23 | 180 | | 359,105 | S | white |
| 24 | 180 | | 101,772 | I | white |
| 25 | 105 | | 209,971 | S | translucent yellow |
| 26 | 50 | | 12,303 | I | white |
| 27 | 84 | | 85,446 | S | white |
| 28 | 155 | | 259,931 | S | white |
| 29 | 84 | | 16,928 | I | white |
| 30 | 170 | | 60,499 | D | white |
| 31 | 180 | | 120,470 | I | white |
| 32 | 65 | | 12,213 | S | translucent white |
| 33.1 | 50 | | 6,797 | I | translucent white |

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|---|-------|--------------------|
| | D _a | D _c | | | |
| 324-33.2 | 60 | | 9,835 | I | translucent white |
| 34 | 120 | | 31,464 | D | translucent white |
| 35 | 170 | | 736,560 | S | translucent white |
| 36 | 110 | | 498,102 | D | translucent white |
| 37 | 60 | | 9,065 | S | translucent white |
| 38 | 120 | | 19,958 | I | white |
| 39 | 60 | | 6,631 | S | translucent white |
| 40 | 50 | | 7,212 | I | translucent white |
| 41 | 120 | | 68,758 | S | translucent white |
| 42 | 130 | | 686,362 | S | translucent yellow |
| 43 | 120 | | 85,669 | S | translucent white |
| 44 | 78 | | 16,375 | I | translucent white |
| 45 | 60 | | 4,319 | I | translucent white |
| 46 | 150 | | 87,228 | I | white |
| 47 | 70 | | 35,446 | I | translucent white |
| 48 | 240 | | 28,292 | I | white |
| 49 | 240 | | 479,678 | I | white |
| 50 | 260 | | 726,969 | I | white |
| 51 | 170 | | 247,700 | S | translucent white |
| 52 | 120 | | 55,851 | S | translucent white |
| 53 | 150 | | 424,430 | S | translucent white |
| 54 | 175 | | 559,917 | S | translucent white |
| 55 | 42 | | 78 | S | black |
| 56 | 130 | | 535,070 | S | translucent yellow |
| 57 | 260 | | 68,611 | I | white |
| 58 | 260 | | 101,647 | I | white |
| 59 | 35 | | 186 | I | translucent white |
| 325- 1 | 42 | | 696 | S | black |
| 2 | 35 | | 11,354 | I | translucent white |
| 3 | 200 | | 26,932 | I | white |
| 4 | 50 | | 1,029 | I | translucent white |
| 5 | 65 | | 1,681 | I | translucent white |
| 6 | 78 | | 58,528 | S | translucent white |
| 7 | 170 | | 106,450 | S | translucent white |
| 8 | 170 | | 89,071 | I | translucent white |
| 9 | 170 | | 114,803 | D | translucent white |
| 10 | 285 | | 224,952 | I | white |
| 11 | 105 | | 38,135 | I | white |
| 12 | 70 | | 10,783 | I | translucent white |

Continued

TABLE A.1 (Contd)
YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|-------------------|
| | D _a | D _c | | | |
| 325-13 | 70 | | 16,623 | I | translucent white |
| 14 | 170 | | 42,814 | S | white |
| 15.1 | 60 | | 7,172 | S | white |
| 15.2 | 155 | | 72,400 | I | translucent white |
| 16 | 120 | | 73,073 | I | white |
| 17 | 70 | | 11,871 | I | translucent white |
| 18 | 120 | | 44,689 | I | translucent white |
| 19 | 260 | | 223,669 | I | white |
| 20 | 120 | | 51,691 | D | translucent white |
| 21 | 70 | | 18,696 | I | translucent white |
| 22 | 90 | | 50,608 | I | translucent white |
| 23 | 105 | | 21,985 | I | translucent white |
| 24 | 84 | | 13,973 | I | translucent white |
| 25 | 145 | | 69,450 | I | translucent white |
| 26 | 65 | | 322 | S | black |
| 27 | 120 | | 23,300 | I | translucent white |
| 28 | 120 | | 525,449 | S | yellow |
| 29 | 145 | | 149,175 | S | translucent white |
| 30 | 155 | | 540,656 | S | translucent white |
| 31 | 285 | | 216,400 | I | white |
| 32 | 240 | | 89,680 | I | white |
| 33 | 240 | | 281,971 | I | white |
| 34 | 285 | | 94,314 | I | white |
| 35 | 240 | | 383,041 | I | white |
| 36 | 55 | | 1,238 | S | translucent white |
| 37 | 78 | | 8,008 | I | translucent white |
| 38 | 65 | | 4,939 | I | translucent white |
| 39 | 84 | | 17,971 | I | translucent white |
| 40 | 155 | | 229,152 | S | yellow |
| 41 | 120 | | 114,370 | S | white |
| 42 | 145 | | 23,448 | I | translucent white |
| 43 | 220 | | 221,828 | D | white |
| 44 | 180 | | 124,527 | S | translucent white |
| 45 | 175 | | 322,527 | S | white |
| 46 | 120 | | 22,606 | I | white |
| 47 | 90 | | 4,460 | I | translucent white |
| 48 | 90 | | 26,369 | I | translucent white |
| 49 | 260 | | 80,829 | I | white |
| 50 | 70 | | 459,321 | I | translucent white |
| 51 | 105 | | 19,900 | S | translucent white |

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|--------------------|
| | D _a | D _c | | | |
| 325-52 | 155 | | 194,019 | S | translucent white |
| 53 | 180 | | 231,914 | S | translucent white |
| 54 | 110 | | 66,106 | I | white |
| 55 | 105 | | 26,752 | I | translucent white |
| 56 | 84 | | 112,286 | S | white |
| 57 | 50 | | 724 | I | translucent yellow |
| 58 | 78 | | 5,027 | I | translucent white |
| 59 | 155 | | 57,733 | I | translucent white |
| 60 | 130 | | 459,389 | S | white |
| 61 | 60 | | 3,406 | I | translucent white |
| 62 | 315 | | 223,424 | D | white |
| 63 | 220 | | 168,115 | D | white |
| 64 | 240 | | 321,725 | I | white |
| 65 | 260 | | 217,674 | D | white |
| 66 | 180 | | 43,933 | I | white |
| 67 | 175 | | 160,173 | I | white |
| 68 | 240 | | 234,446 | D | translucent white |
| 69 | 240 | | 156,190 | I | translucent white |
| 70 | 260 | | 74,405 | I | white |
| 71 | 170 | | 124,458 | D | white |
| 72 | 90 | | 38,498 | I | translucent white |
| 73 | 70 | | 58 | S | black |
| 74 | 155 | | 37,990 | I | translucent white |
| 75 | 65 | | 9,533 | S | translucent white |
| 76 | | 130 | 17,417 | D | white |
| 77 | | 260 | 373,290 | S | white |
| 78 | | 380 | 189,326 | I | white |
| 79 | | 84 | 17,506 | I | white |
| 80 | | 60 | 2,717 | S | white |
| 81 | | 200 | 134,741 | I | translucent white |
| 82 | | 360 | 275,374 | D | white |
| 83 | | 380 | 165,894 | I | white |
| 84 | | 380 | 321,774 | I | white |
| 85 | | 380 | 257,242 | I | white |
| 86 | | 420 | 136,916 | I | white |
| 87 | | 10 | 2,682 | I | white |
| 88 | | 170 | 5,097 | I | black |
| 89 | | 42 | 3,994 | S | white |
| 90 | | 70 | 8,875 | D | white |
| 91 | | 145 | 21,746 | I | white |
| 92 | | 32 | 11,847 | I | black |

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|--------------|
| | D _a | D _c | | | |
| 325-93 | | 102 | 1,885 | I | black |
| 94 | | 200 | 3,100 | S | black |
| 95 | | 15 | 3,580 | I | white |
| 96 | | 70 | 2,093 | I | yellow white |
| 97 | | 84 | 9,013 | S | white |
| 98 | | 60 | 4,185 | I | black |
| 99 | | 170 | 27,494 | I | white |
| 100 | | 260 | 72,958 | I | white |
| 327- 1 | 170 | | 53,964 | I | white |
| 2 | 90 | | 38,919 | I | white |
| 3 | 180 | | 6,515 | I | white |
| 4 | 260 | | 110,612 | I | white |
| 5 | 180 | | 173,790 | I | white |
| 6 | 260 | | 130,925 | I | white |
| 7 | 150 | | 246,763 | S | white |
| 8 | 120 | | 129,485 | S | white |
| 9 | 84 | | 22,028 | I | white |
| 10 | 170 | | 80,174 | S | white |
| 11 | 120 | | 60,113 | I | white |
| 12 | 155 | | 88,631 | I | white |
| 13 | 245 | | 280,597 | I | white |
| 14 | 180 | | 92,070 | I | white |
| 15 | 200 | | 421,090 | I | white |
| 16 | 145 | | 104,847 | S | white |
| 17 | 130 | | 49,757 | S | white |
| 18 | 65 | | 5,705 | I | white |
| 19 | 110 | | 48,954 | I | white |
| 20 | 240 | | 62,294 | I | white |
| 21 | 315 | | 493,500 | D | white |
| 22 | 220 | | 34,665 | I | white |
| 23 | 260 | | 150,600 | I | white |
| 25 | | 380 | 76,138 | I | white |
| 26 | | 380 | 137,075 | I | white |
| 27 | | 380 | 387,759 | I | white |
| 28 | | 380 | 132,317 | D | white |
| 29 | | 170 | 11,480 | D | white |
| 30 | | 145 | 10,068 | I | white |
| 31 | | 170 | 123,165 | D | white |
| 32 | | 102 | 26,191 | I | white |
| 33 | | 60 | 22,016 | D | white |

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|------------------|
| | D _a | D _c | | | |
| 327-34 | | 84 | 20 | I | black |
| 35 | | 60 | 726 | I | translucent grey |
| 36 | | 84 | 48 | I | black |
| 37 | 200 | | 3,816 | I | white |
| 38 | 260 | | 145,494 | I | white |
| 39 | 260 | | 132,944 | I | white |
| 40 | 260 | | 226,986 | D | white |
| 41 | 170 | | 298,676 | D | white |
| 42 | 170 | | 137,470 | D | white |
| 43 | 170 | | 111,614 | D | white |
| 44 | 150 | | 263,419 | S | white |
| 45 | 90 | | 12,730 | I | white |
| 46 | 120 | | 92,353 | I | yellow white |
| 47 | 220 | | 77,991 | I | white |
| 48 | 180 | | 20,265 | I | white |
| 49 | 260 | | 93,124 | I | white |
| 50 | 180 | | 54,217 | I | white |
| 51 | 120 | | 20,533 | S | white |
| 52 | 120 | | 12,480 | I | white |
| 53 | 120 | | 71,571 | I | white |
| 54 | 170 | | 535,943 | S | white |
| 55 | 84 | | 49,695 | S | white |
| 56 | 220 | | 25,565 | I | white |
| 57 | 84 | | 6,071 | I | white |
| 58 | 84 | | 7,975 | I | white |
| 59 | 145 | | 489,892 | S | yellow |
| 60 | 260 | | 162,461 | D | white |
| 61 | 130 | | 58,585 | D | white |
| 62 | 315 | | 259,521 | I | white |
| 63 | 200 | | 121,838 | S | white |
| 64 | 260 | | 333,518 | I | white |
| 65 | 180 | | 258,810 | I | white |
| 66 | 315 | | 365,685 | D | white |
| 67 | 120 | | 15,629 | I | white |
| 68 | 84 | | 25,125 | I | white |
| 69 | 170 | | 79,119 | I | white |
| 70 | 145 | | 77,622 | S | white |

Continued

TABLE A.1 (Contd)
YAG-40-Shot A Particles

| Particle Designation | Size (μ) | | Activity at H + 12 (net well c/m) | Shape | Color |
|----------------------|----------------|----------------|-----------------------------------|-------|--------------------|
| | D _a | D _c | | | |
| 331- 1 | 380 | | 1,774,146 | I | white |
| 2 | 220 | | 237,465 | S | white |
| 3 | 220 | | 50,440 | I | translucent white |
| 4 | 180 | | 481,206 | S | translucent white |
| 5 | 180 | | 874,396 | S | yellow |
| 6 | 200 | | 1,675,122 | S | yellow |
| 7 | 200 | | 1,228,093 | S | yellow |
| 8 | 240 | | 1,007,132 | I | yellow white |
| 9 | 50 | | 22,797 | I | translucent white |
| 335- 1 | 260 | | 477,066 | I | white |
| 2 | 260 | | 71,768 | I | white |
| 3 | 150 | | 425,517 | S | translucent yellow |
| 4 | 220 | | 1,310,318 | I | white |
| 5 | 65 | | 28,116 | I | translucent white |
| 6 | 70 | | 135 | S | translucent white |
| 7 | 55 | | 33 | S | yellow |
| 8 | 260 | | 357,380 | I | white |
| 9 | 120 | | 32,672 | I | white |
| 10 | 120 | | 77,306 | D | yellow |
| 11 | 260 | | 32,178 | I | white |
| 12 | 84 | | 9,765 | I | translucent white |
| 13 | 315 | | 146,916 | I | white |
| 14 | 110 | | 11,543 | S | white |
| 15 | 105 | | 21,640 | I | translucent white |
| 16 | 60 | | 1,838 | I | translucent white |
| 17 | 70 | | 244 | I | translucent white |
| 18 | 170 | | 771,326 | I | translucent white |
| 19 | 65 | | 4,932 | I | translucent white |
| 20 | 60 | | 20,147 | I | translucent white |
| 21 | 260 | | 121,046 | I | white |
| 22 | 220 | | 149,231 | I | translucent white |
| 23 | 105 | | 46,522 | I | translucent white |
| 24 | 120 | | 10,634 | I | translucent white |
| 25 | 220 | | 132,781 | I | translucent white |
| 26 | 84 | | 22,686 | S | translucent white |
| 27 | 170 | | 438,630 | S | yellow |
| 28 | 63 | | 13,232 | I | translucent white |
| 29 | 145 | | 19,063 | I | translucent white |
| 30 | 120 | | 61,764 | D | translucent white |

TABLE A.2

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 1832- 1 | 99 | 5,004 | I | white |
| 2 | 99 | 4,811 | I | white |
| 3 | 132 | 38,774 | I | translucent white |
| 4 | 165 | 6,259 | I | white |
| 5 | 198 | 24,635 | I | white |
| 6 | 115 | 21,834 | I | white |
| 8 | 132 | 19,887 | I | grey |
| 9.1 | 165 | 16,912 | D | translucent white |
| 9.2 | 330 | 52,625 | D | translucent white |
| 10 | 132 | 17,633 | I | translucent white |
| 11 | 115 | 41,668 | D | white |
| 12 | 297 | 34,065 | D | white |
| 13.1 | 198 | 72,028 | D | translucent white |
| 13.2 | 132 | 48,757 | I | white |
| 14 | 198 | 17,450 | I | white |
| 15 | 165 | 34,231 | D | white |
| 17 | 165 | 8,297 | D | translucent white |
| 18 | 297 | 54,011 | I | translucent white |
| 20 | 99 | 10,207 | I | white |
| 21 | 330 | 33,667 | D | white |
| 22 | 231 | 35,442 | I | white |
| 1834- 1 | 198 | 13,081 | I | white |
| 2 | 231 | 89,500 | D | white |
| 3 | 165 | 29,930 | D | white |
| 4 | 198 | 18,137 | I | white |
| 5 | 165 | 21,254 | D | white |
| 6 | 132 | 1,352 | I | white |
| 7 | 264 | 100,540 | D | white |
| 8 | 66 | 1,910 | I | white |
| 9 | 198 | 17,505 | I | white |
| 10 | 99 | 4,310 | I | white |
| 11 | 231 | 14,761 | I | white |
| 1836- 1 | 165 | 31,928 | D | white |
| 2 | 132 | 16,814 | I | white |
| 3 | 165 | 16,673 | D | white |
| 4 | 198 | 15,803 | I | white |
| 5 | 165 | 3,914 | I | white |
| 6 | 198 | 19,241 | I | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|--------------------|
| 1836- 7 | 165 | 42,303 | D | white |
| 8 | 165 | 25,200 | D | white |
| 9 | 165 | 46,350 | D | white |
| 10 | 99 | 11,838 | D | white |
| 1837- 1 | 198 | 45,351 | I | translucent grey |
| 2 | 66 | 45,657 | I | white |
| 3 | 66 | 4,024 | I | white |
| 4 | 132 | 7,743 | I | white |
| 5 | 132 | 12,562 | D | white |
| 6 | 66 | 5,254 | S | white |
| 7 | 132 | 16,964 | I | white |
| 8 | 132 | 5,634 | I | white |
| 9 | 132 | 12,833 | S | white |
| 10 | 198 | 22,748 | S | white |
| 11 | 330 | 61,357 | D | translucent white |
| 12 | 132 | 25,277 | I | grey |
| 1838- 1 | 396 | 138,856 | D | white |
| 2 | 165 | 26,257 | I | white |
| 3 | 165 | 8,928 | I | white |
| 4 | 165 | 32,104 | I | white |
| 5 | 264 | 50,273 | D | white |
| 6 | 165 | 9,886 | D | white |
| 7 | 198 | 18,441 | I | white |
| 8 | 181 | 19,505 | I | white |
| 9 | 330 | 91,362 | D | white |
| 10 | 165 | 17,516 | I | white |
| 11 | 33 | 3,222 | S | translucent grey |
| 12 | 33 | 372 | I | white |
| 1839- 1 | 198 | 8 | I | translucent yellow |
| 2 | 165 | 12,688 | I | white |
| 3 | 165 | 5,148 | I | white |
| 4 | 198 | 7,501 | S | white |
| 5 | 297 | 33,698 | I | white |
| 6 | 132 | 10,679 | S | white |
| 7 | 231 | 19 | I | grey |
| 8 | 264 | 94 | I | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 1840- 1 | 165 | 53,806 | D | translucent white |
| 2 | 462 | 39,308 | S | translucent white |
| 3 | 132 | 333 | S | translucent white |
| 4 | 396 | 3,176 | S | translucent white |
| 5 | 165 | 716 | I | grey |
| 6 | 99 | 11,444 | I | white |
| 1841- 1 | 165 | 27,248 | D | white |
| 2 | 132 | 4,566 | S | white |
| 3 | 165 | 17,109 | I | white |
| 1842- 1 | 198 | 29,118 | I | white |
| 2 | 297 | 122,553 | D | white |
| 3 | 231 | 39,353 | I | white |
| 4 | 264 | 136,203 | D | white |
| 5 | 231 | 18,081 | I | white |
| 6 | 231 | 33,721 | I | white |
| 7 | 115 | 7,184 | S | white |
| 8 | 99 | 42,043 | S | translucent white |
| 9 | 132 | 9,534 | I | white |
| 10 | 66 | 3,424 | S | white |
| 11 | 165 | 10,762 | I | white |
| 12 | 33 | 64 | I | grey |
| 1843- 1 | 242 | 48,615 | D | white |
| 2 | 66 | 5,805 | D | white |
| 3 | 66 | 2,420 | D | white |
| 4 | 132 | 13,327 | S | white |
| 5 | 132 | 22,787 | D | white |
| 6 | 132 | 14,729 | D | white |
| 7 | 132 | 17,694 | S | white |
| 8 | 99 | 9,051 | S | white |
| 9 | 99 | 2,294 | D | white |
| 10 | 99 | 2,035 | D | white |
| 11 | 165 | 50,055 | D | white |
| 12 | 99 | 7,354 | I | white |
| 13 | 132 | 7,220 | I | white |
| 14 | 297 | 57,404 | D | white |
| 15 | 49 | 642 | I | white |
| 16 | 165 | 16,953 | D | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 1843-17 | 99 | 1,444 | I | white |
| 18 | 99 | 1,816 | I | white |
| 19 | 66 | 1,589 | I | white |
| 20 | 99 | 3,564 | D | white |
| 21 | 132 | 6,696 | I | white |
| 22 | 132 | 7,390 | D | white |
| 1844- 1 | 456 | 1,267 | I | grey |
| 2 | 456 | 10,997 | I | white |
| 3 | 99 | 14,776 | S | white |
| 4 | 264 | 59,341 | D | white |
| 5 | 99 | 6,848 | I | white |
| 6 | 198 | 32,713 | I | white |
| 7 | 231 | 34,435 | I | white |
| 8 | 330 | 52,152 | D | translucent white |
| 9 | 198 | 34,091 | I | white |
| 10 | 165 | 4,262 | S | white |
| 11 | 198 | 68,470 | I | translucent grey |
| 12 | 165 | 17,377 | I | white |
| 13 | 165 | 28,168 | D | translucent grey |
| 14 | 264 | 27,835 | I | white |
| 15 | 99 | 21,574 | S | translucent grey |
| 1848- 1 | 49 | 22 | I | white |
| 1849- 1 | 165 | 10,023 | I | white |
| 2 | 66 | 0 | I | white |
| 3 | 165 | 63 | I | grey |
| 1852- 1 | 82 | 0 | I | grey |
| 2 | 198 | 4,341 | I | white |
| 4 | 99 | 9,840 | I | white |
| 5 | 132 | 6,021 | D | white |
| 6 | 264 | 35,049 | D | white |
| 7.1 | 264 | 37,706 | D | white |
| 7.2 | 66 | 1,126 | D | white |
| 8 | 231 | 37,324 | D | white |
| 9 | 132 | 8,691 | I | white |
| 10 | 231 | 37,727 | I | white |
| 11 | 132 | 15,129 | I | white |
| 12 | 66 | 49 | F | white |
| 13 | 132 | 28,060 | I | white |
| 14 | 33 | 551 | I | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 1855- 2 | 99 | 6,819 | D | white |
| 4 | 132 | 18,490 | I | white |
| 5 | 66 | 1,476 | I | white |
| 6 | 132 | 2,578 | I | white |
| 7 | 264 | 62,776 | D | white |
| 8 | 198 | 28,934 | I | white |
| 9 | 82 | 968 | I | white |
| 10 | 297 | 72,695 | D | white |
| 11 | 99 | 7,089 | D | white |
| 12 | 132 | 15,694 | D | white |
| 13 | 99 | 4,465 | S | white |
| 16 | 99 | 3,908 | D | white |
| 17 | 132 | 3,355 | D | white |
| 18 | 198 | 12 | S | translucent grey |
| 19 | 165 | 4,779 | D | white |
| 20 | 66 | 1,123 | D | white |
| 21 | 49 | 0 | I | yellow |
| 24 | 33 | 0 | I | yellow |
| 27 | 66 | 0 | I | yellow white |
| 29 | 297 | 8 | S | translucent white |
| 1856- 1 | 144 | 14,290 | S | white |
| 2 | 144 | 11,005 | S | white |
| 3 | 144 | 8,519 | S | white |
| 4 | 216 | 52,934 | D | white |
| 5 | 72 | 6,204 | S | white |
| 6 | 72 | 27,478 | S | white |
| 7 | 144 | 4 | I | translucent white |
| 8 | 66 | 2,733 | I | grey |
| 9 | 99 | 18,484 | I | white |
| 2125- 1 | 99 | 29,328 | S | white |
| 2 | 66 | 80,483 | I | white |
| 3 | 132 | 16,619 | I | white |
| 4 | 198 | 16,120 | I | white |
| 5 | 198 | 49,732 | I | white |
| 6 | 165 | 14,531 | I | white |
| 7 | 231 | 29,285 | D | white |
| 8 | 330 | 155,625 | D | white |
| 9.1 | 165 | 15,532 | I | white |

Continued

TABLE A.2 (Contd)
YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 2125- 9.2 | 330 | 34,430 | D | white |
| 10 | 99 | 4,276 | I | white |
| 11 | 99 | 2,774 | I | white |
| 12 | 82 | 7,103 | S | white |
| 13 | 99 | 3,373 | I | white |
| 14 | 165 | 29,535 | I | white |
| 15 | 132 | 13,504 | D | white |
| 16 | 66 | 1,860 | I | white |
| 17 | 99 | 1,214 | D | white |
| 18 | 99 | 643 | D | white |
| 2129- 1 | 330 | 19 | I | yellow |
| 2 | 132 | 46,505 | I | white |
| 3 | 165 | 10,965 | I | white |
| 4 | 165 | 4,155 | I | white |
| 6 | 99 | 3,579 | D | translucent white |
| 7 | 165 | 3,107 | D | translucent white |
| 8 | 99 | 23,572 | S | white |
| 9 | 99 | 9,168 | S | white |
| 11 | 198 | 27,119 | D | white |
| 12 | 66 | 2,320 | I | white |
| 13 | 264 | 46,180 | D | white |
| 14 | 198 | 20,240 | D | white |
| 16 | 99 | 9,232 | I | white |
| 17 | 66 | 1,018 | D | white |
| 18 | 99 | 19,214 | I | white |
| 2131- 1 | 264 | 56,924 | D | white |
| 2 | 99 | 17,466 | D | white |
| 3 | 132 | 17,773 | I | white |
| 4 | 330 | 50,881 | D | white |
| 5 | 264 | 14,730 | D | white |
| 6 | 132 | 22,624 | I | white |
| 7 | 330 | 100,153 | D | white |
| 8 | 99 | 12,407 | I | white |
| 9 | 198 | 28,450 | D | white |
| 10 | 132 | 9,259 | I | white |
| 11 | 132 | 13,291 | D | white |
| 12 | 330 | 53,816 | D | white |
| 13 | 66 | 13 | I | grey |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------------------|
| 2132- 1 | 198 | 171 | I | white |
| 2 | 132 | 32 | S | grey |
| 3 | 181 | 47,067 | D | translucent white |
| 4 | 49 | 854 | S | grey |
| 5 | 330 | 56,756 | D | white |
| 6 | 165 | 4 | I | red |
| 7.1 | 504 | 92,688 | D | white |
| 7.2 | 165 | 46,612 | D | white |
| 8 | 198 | 6,562 | I | white |
| 2133- 1 | 132 | 9,508 | I | white |
| 2 | 99 | 6,601 | D | white |
| 3 | 198 | 32,125 | D | white |
| 4 | 165 | 20,588 | D | white |
| 5 | 231 | 50,840 | I | white |
| 6 | 132 | 15,682 | I | white |
| 7 | 231 | 34,591 | D | white |
| 8 | 297 | 52,721 | D | white |
| 9 | 132 | 13,476 | D | white |
| 10 | 132 | 9,572 | I | white |
| 11 | 165 | 14,041 | I | white |
| 12 | 165 | 24,173 | D | white |
| 13 | 66 | 76 | D | grey |
| 2136- 1 | 165 | 29,452 | I | white |
| 2 | 165 | 36,061 | D | white |
| 3 | 99 | 4,313 | D | white |
| 4 | 66 | 1,602 | D | white |
| 5 | 132 | 31,996 | D | white |
| 6 | 165 | 45,461 | I | white |
| 7 | 165 | 30,386 | I | white |
| 8 | 132 | 26,080 | I | white |
| 9 | 165 | 34,484 | D | white |
| 10 | 132 | 20,142 | I | white |
| 11 | 66 | 4,117 | I | grey |
| 12.1 | 198 | 24,372 | I | white |
| 12.2 | 165 | 18,244 | I | white |
| 13 | 132 | 24,035 | D | white |
| 14 | 132 | 13,549 | I | white |
| 16 | 165 | 19,601 | D | white |
| 17 | 132 | 17,619 | I | white |
| 19 | 198 | 33,286 | I | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------|
| 2137- 1 | 198 | 42,601 | D | white |
| 2 | 132 | 38,636 | I | white |
| 3 | 148 | 10,649 | S | white |
| 4 | 165 | 45,263 | D | grey |
| 5 | 231 | 25,589 | D | white |
| 6 | 363 | 64,086 | D | white |
| 8 | 132 | 26,442 | I | white |
| 10 | 198 | 44,571 | I | white |
| 2138- 1 | 165 | 13,173 | I | white |
| 2 | 198 | 0 | S | grey |
| 3 | 99 | 10,503 | I | white |
| 2139- 1 | 99 | 14,407 | I | white |
| 2 | 165 | 17,874 | I | white |
| 3 | 165 | 11,718 | I | white |
| 4 | 132 | 17,601 | I | white |
| 5 | 132 | 14,521 | I | white |
| 6 | 165 | 13,273 | D | white |
| 2142- 1 | 198 | 39,469 | I | white |
| 2 | 198 | 19,008 | D | white |
| 3 | 198 | 60,256 | D | white |
| 4 | 165 | 7,319 | I | white |
| 6 | 165 | 22,536 | D | white |
| 7 | 165 | 3,121 | D | white |
| 8 | 297 | 90,809 | D | white |
| 9 | 165 | 31,123 | I | white |
| 10 | 99 | 14,443 | I | white |
| 11 | 132 | 22,138 | I | white |
| 12 | 231 | 15,388 | I | white |
| 13 | 165 | 36,143 | D | white |
| 14 | 198 | 55,457 | I | white |
| 15 | 165 | 16,142 | I | white |
| 16 | 132 | 25,596 | D | white |
| 2144- 2.1 | 165 | 22,485 | I | white |
| 2.2 | 66 | 22,375 | I | white |
| 3 | 99 | 11,944 | D | white |
| 4 | 198 | 40,442 | I | white |

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

| Particle Designation | Size, D_m (μ) | Activity at H + 300 (net well c/m) | Shape | Color |
|----------------------|-----------------------|------------------------------------|-------|-------|
| 2144- 5 | 198 | 48,203 | D | white |
| 6 | 198 | 30,402 | I | white |
| 7 | 231 | 23,897 | I | white |
| 8 | 165 | 1,166 | S | white |
| 9 | 198 | 387,697 | D | white |
| 10 | 132 | 9,126 | I | white |
| 2145- 1 | 132 | 0 | D | grey |
| 2 | 264 | 76,143 | D | white |
| 3 | 330 | 56,747 | D | white |
| 4 | 297 | 81,070 | D | white |
| 5 | 198 | 46,974 | I | white |
| 6 | 165 | 25,819 | I | white |
| 7 | 165 | 47,123 | I | white |
| 8 | 165 | 4,767 | I | white |
| 9 | 165 | 20,618 | I | white |
| 10 | 165 | 38,736 | I | white |
| 11 | 165 | 23,154 | S | white |
| 12 | 132 | 15,332 | I | white |
| 13 | 99 | 20,951 | I | white |
| 14 | 99 | 47,181 | I | white |
| 15 | 528 | 197,740 | D | white |
| 2993- 4 | 264 | 41,307 | I | white |
| 5 | 330 | 126,966 | I | white |
| 7 | 198 | 9,394 | I | white |
| 8 | 264 | 55,985 | I | white |
| 9 | 198 | 9,806 | D | white |
| 10 | 231 | 21,728 | D | white |
| 11 | 165 | 28,124 | D | white |
| 2999- 1 | 152 | 14,962 | I | grey |
| 2 | 231 | 99,094 | I | white |
| 3 | 165 | 15,430 | S | white |
| 4 | 165 | 25,467 | I | white |

TABLE A.3

YAG-39-Shot B Particles

| Particle Designation | Size, D_g (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2583- 1 | 240 | 27,120 | S |
| 2 | 145 | 494 | S |
| 3 | 120 | 6,973 | I |
| 4 | 42 | 307 | S |
| 5 | 120 | 3,324 | I |
| 6 | 60 | 116 | I |
| 7 | 120 | 3,823 | D |
| 8 | 103 | 165 | I |
| 9 | 103 | 281 | I |
| 10 | 103 | 120 | I |
| 11 | 340 | 5,658 | I |
| 12 | 103 | 5,292 | I |
| 13 | 42 | 460 | I |
| 14 | 60 | 1,249 | I |
| 15 | 30 | 477 | I |
| 16 | 60 | 83 | I |
| 17 | 84 | 1,128 | D |
| 18 | 60 | 5,451 | I |
| 19 | 30 | 61 | S |
| 20 | 42 | 201 | I |
| 21 | 30 | 75 | S |
| 22 | 30 | 75 | I |
| 23 | 223 | 16,402 | D |
| 24 | 84 | 2,180 | D |
| 25 | 42 | 425 | I |
| 26 | 30 | 134 | S |
| 27 | 30 | 53 | I |
| 28 | 42 | 872 | D |
| 29 | 120 | 4,436 | D |
| 30 | 42 | 33 | I |
| 31 | 60 | 850 | S |
| 32 | 30 | 0 | I |
| 33 | 84 | 51 | I |
| 34 | 290 | 34,344 | I |
| 35 | 30 | 165 | I |
| 36 | 60 | 64 | I |
| 37 | 42 | 576 | I |
| 39 | 84 | 878 | I |
| 40 | 103 | 8,322 | D |
| 41 | 120 | 8,721 | D |
| 42 | 60 | 469 | S |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2583-43 | 84 | 112 | I |
| 44 | 60 | 449 | I |
| 45 | 84 | 100 | I |
| 46 | 60 | 89 | I |
| 47 | 170 | 78 | I |
| 48 | 84 | 760 | D |
| 49 | 103 | 34 | D |
| 50 | 30 | 36 | I |
| 51 | 21 | 110 | S |
| 52 | 60 | 13 | I |
| 53 | 84 | 36 | D |
| 54 | 30 | 0 | S |
| 55 | 30 | 72 | I |
| 56 | 84 | 223 | I |
| 57 | 21 | 98 | S |
| 58 | 30 | 313 | S |
| 2791- 1 | 84 | 162 | D |
| 2 | 42 | 162 | I |
| 3 | 60 | 90 | I |
| 4 | 120 | 98 | D |
| 5 | 170 | 11 | D |
| 6 | 120 | 47 | D |
| 7 | 84 | 64 | D |
| 8 | 42 | 74 | I |
| 9 | 120 | 24 | D |
| 10 | 60 | 27 | D |
| 11 | 60 | 0 | I |
| 12 | 30 | 46 | I |
| 13 | 30 | 4 | I |
| 14 | 84 | 50 | I |
| 15 | 42 | 0 | I |
| 16 | 84 | 125 | I |
| 17 | 120 | 0 | D |
| 18 | 60 | 79 | D |
| 19 | 60 | 0 | D |
| 20 | 60 | 0 | D |
| 21 | 15 | 139 | S |
| 22 | 30 | 0 | I |
| 23 | 42 | 129 | D |
| 24 | 15 | 46 | I |

Continued

TABLE.A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2791-25 | 42 | 215 | I |
| 26 | 30 | 50 | I |
| 27 | 42 | 97 | D |
| 28 | 42 | 0 | I |
| 29 | 21 | 11 | I |
| 30 | 51 | 0 | I |
| 31 | 30 | 0 | I |
| 32 | 60 | 69 | I |
| 33 | 15 | 24 | S |
| 34 | 15 | 0 | S |
| 35 | 21 | 0 | S |
| 36 | 30 | 106 | S |
| 37 | 42 | 0 | S |
| 38 | 30 | 0 | D |
| 39 | 60 | 168 | D |
| 40 | 84 | 244 | D |
| 41 | 30 | 65 | I |
| 42 | 30 | 90 | S |
| 43 | 42 | 179 | I |
| 44 | 60 | 69 | D |
| 45 | 30 | 179 | I |
| 46 | 120 | 309 | D |
| 47 | 60 | 65 | I |
| 48 | 30 | 8 | I |
| 2796- 1 | 84 | 24 | I |
| 2 | 30 | 0 | I |
| 3 | 42 | 0 | I |
| 4 | 42 | 0 | S |
| 5 | 42 | 49 | D |
| 6 | 42 | 0 | I |
| 7 | 60 | 4 | I |
| 8 | 42 | 115 | I |
| 9 | 42 | 0 | I |
| 10 | 42 | 0 | I |
| 11 | 42 | 0 | I |
| 12 | 84 | 0 | D |
| 13 | 60 | 115 | D |
| 14 | 42 | 205 | D |
| 15 | 42 | 286 | I |
| 16 | 42 | 16 | I |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|--------------------------|--|-------|
| 2796-17 | 42 | 123 | I |
| 18 | 21 | 119 | S |
| 19 | 60 | 16 | S |
| 20 | 84 | 156 | I |
| 21 | 84 | 0 | D |
| 22 | 84 | 0 | I |
| 23 | 103 | 0 | D |
| 24 | 60 | 0 | D |
| 25 | 30 | 0 | S |
| 26 | 120 | 33 | D |
| 27 | 60 | 0 | D |
| 28 | 42 | 0 | I |
| 29 | 30 | 0 | I |
| 30 | 60 | 0 | I |
| 31 | 60 | 123 | D |
| 32 | 84 | 206 | I |
| 33 | 42 | 0 | I |
| 34 | 60 | 54 | I |
| 35 | 60 | 0 | D |
| 36 | 60 | 12 | D |
| 37 | 42 | 0 | I |
| 38 | 60 | 0 | I |
| 39 | 42 | 12 | D |
| 40 | 30 | 12 | S |
| 41 | 21 | 228 | S |
| 42 | 21 | 0 | I |
| 43 | 120 | 137 | I |
| 44 | 60 | 0 | D |
| 45 | 60 | 0 | D |
| 46 | 84 | 157 | D |
| 47 | 84 | 21 | D |
| 48 | 30 | 12 | I |
| 49 | 84 | 0 | I |
| 50 | 42 | 62 | I |
| 51 | 84 | 62 | D |
| 52 | 84 | 137 | I |
| 53 | 30 | 311 | S |
| 54 | 60 | 33 | I |
| 55 | 120 | 42 | I |
| 56 | 84 | 95 | I |
| 57 | 42 | 0 | I |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2796-58 | 30 | 220 | S |
| 59 | 30 | 0 | I |
| 60 | 84 | 12 | I |
| 61 | 84 | 0 | I |
| 62 | 42 | 125 | I |
| 63 | 84 | 0 | I |
| 64 | 60 | 70 | I |
| 65 | 42 | 42 | I |
| 66 | 60 | 48 | I |
| 67 | 60 | 78 | D |
| 68 | 21 | 10 | S |
| 69 | 84 | 64 | D |
| 70 | 60 | 54 | D |
| 71 | 84 | 6 | I |
| 72 | 30 | 39 | I |
| 73 | 30 | 89 | I |
| 74 | 84 | 42 | I |
| 75 | 60 | 103 | D |
| 76 | 42 | 103 | I |
| 77 | 84 | 61 | I |
| 78 | 60 | 110 | D |
| 79 | 60 | 64 | I |
| 80 | 30 | 0 | S |
| 81 | 60 | 18 | I |
| 82 | 30 | 42 | I |
| 83 | 103 | 36 | I |
| 84 | 42 | 0 | I |
| 85 | 60 | 36 | D |
| 86 | 30 | 236 | S |
| 87 | 60 | 0 | I |
| 88 | 84 | 65 | D |
| 89 | 60 | 43 | D |
| 90 | 30 | 0 | I |
| 91 | 51 | 0 | I |
| 92 | 103 | 73 | I |
| 93 | 42 | 28 | I |
| 94 | 21 | 6 | S |
| 95 | 42 | 0 | I |
| 96 | 42 | 0 | D |
| 97 | 42 | 25 | I |
| 98 | 60 | 0 | D |
| 99 | 30 | 62 | I |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2796-100 | 60 | 10 | D |
| 101 | 42 | 0 | D |
| 102 | 60 | 6 | D |
| 2801- 1 | 84 | 75 | I |
| 2 | 84 | 1,188 | D |
| 3 | 340 | 76,906 | I |
| 4 | 60 | 37 | I |
| 5 | 84 | 0 | D |
| 6 | 42 | 22 | D |
| 7 | 30 | 16 | S |
| 8 | 30 | 35 | I |
| 9 | 42 | 0 | I |
| 10 | 60 | 56 | I |
| 11 | 84 | 604 | I |
| 12 | 120 | 0 | D |
| 13 | 84 | 0 | D |
| 14 | 30 | 0 | I |
| 15 | 30 | 0 | I |
| 16 | 42 | 0 | I |
| 17 | 30 | 0 | I |
| 18 | 42 | 0 | I |
| 19 | 120 | 3,913 | I |
| 20 | 30 | 0 | S |
| 21 | 21 | 77 | S |
| 22 | 120 | 8,994 | I |
| 23 | 30 | 0 | I |
| 24 | 170 | 34 | I |
| 25 | 84 | 26 | D |
| 26 | 42 | 0 | I |
| 27 | 42 | 0 | I |
| 28 | 60 | 129 | I |
| 29 | 42 | 9 | I |
| 30 | 42 | 0 | I |
| 31 | 30 | 14 | I |
| 32 | 60 | 0 | D |
| 33 | 42 | 0 | D |
| 34 | 84 | 43 | I |
| 35 | 60 | 0 | D |
| 36 | 60 | 43 | D |
| 37 | 42 | 0 | I |
| 38 | 30 | 9 | I |
| 39 | 15 | 232 | S |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2806- 1 | 170 | 15,755 | D |
| 2 | 120 | 3,201 | D |
| 3 | 84 | 35 | D |
| 4 | 42 | 182 | I |
| 5 | 84 | 17 | I |
| 6 | 30 | 9 | S |
| 7 | 120 | 299 | I |
| 8 | 120 | 317 | I |
| 9 | 120 | 0 | I |
| 10 | 42 | 0 | I |
| 11 | 21 | 0 | I |
| 12 | 30 | 0 | I |
| 13 | 21 | 0 | S |
| 14 | 15 | 0 | S |
| 15 | 21 | 0 | I |
| 16 | 15 | 61 | S |
| 2811- 1 | 120 | 1,946 | I |
| 2 | 120 | 2,898 | I |
| 3 | 60 | 126 | I |
| 4 | 60 | 73 | D |
| 5 | 205 | 15,489 | D |
| 6 | 120 | 87 | I |
| 7 | 60 | 70 | I |
| 8 | 145 | 8,300 | I |
| 9 | 240 | 19,556 | I |
| 10 | 30 | 0 | I |
| 11 | 42 | 32 | I |
| 12 | 170 | 1,274 | I |
| 13 | 84 | 40 | I |
| 14 | 42 | 53 | I |
| 15 | 103 | 1,038 | I |
| 16 | 30 | 0 | I |
| 17 | 120 | 4,370 | I |
| 18 | 60 | 84 | D |
| 19 | 84 | 5 | I |
| 20 | 170 | 0 | I |
| 21 | 120 | 739 | S |
| 22 | 84 | 982 | I |

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2811-23 | 120 | 67 | I |
| 24 | 120 | 1,368 | I |
| 25 | 120 | 2,345 | I |
| 26 | 60 | 0 | D |
| 27 | 42 | 0 | I |
| 28 | 42 | 44 | I |
| 29 | 60 | 908 | I |
| 30 | 84 | 1,430 | I |
| 31 | 120 | 2,465 | D |
| 32 | 170 | 6,484 | I |
| 33 | 120 | 3,767 | I |
| 34 | 60 | 563 | I |
| 35 | 240 | 1,958 | I |
| 36 | 84 | 134 | D |
| 37 | 120 | 543 | I |
| 38 | 84 | 192 | I |

TABLE A.4

LST-611-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2553- 1 | 120 | 590 | I |
| 2 | 170 | 6,370 | D |
| 3 | 170 | 6,240 | I |
| 4 | 120 | 11,941 | I |
| 5 | 120 | 6,617 | I |
| 6 | 84 | 4,329 | D |
| 7 | 42 | 153 | I |
| 8 | 30 | 10 | S |
| 9 | 42 | 0 | I |
| 10 | 84 | 47 | I |
| 11 | 42 | 77 | S |
| 12 | 30 | 0 | I |
| 13 | 60 | 0 | S |
| 14 | 21 | 0 | I |
| 15 | 42 | 0 | I |
| 16 | 84 | 7,909 | I |
| 17 | 21 | 101 | S |
| 18 | 42 | 118 | I |
| 19 | 84 | 87 | D |
| 20 | 120 | 6,199 | I |
| 21 | 120 | 5,867 | I |
| 22 | 60 | 118 | S |
| 23 | 170 | 11,663 | I |
| 24 | 205 | 14,078 | I |
| 25 | 30 | 0 | I |
| 26 | 60 | 0 | S |
| 27 | 73 | 128 | S |
| 28 | 120 | 1,452 | I |
| 29 | 170 | 6,539 | I |
| 30 | 42 | 44 | I |
| 31 | 51 | 0 | I |
| 32 | 30 | 81 | I |
| 33 | 15 | 0 | I |
| 34 | 42 | 0 | I |
| 35 | 30 | 212 | I |
| 36 | 21 | 134 | I |
| 37 | 21 | 0 | I |
| 38 | 60 | 302 | I |
| 39 | 42 | 81 | I |
| 40 | 60 | 0 | I |

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2553-41 | 120 | 554 | I |
| 42 | 170 | 16,674 | I |
| 43 | 170 | 14,480 | I |
| 44 | 240 | 8,798 | I |
| 45 | 120 | 8,369 | D |
| 46 | 240 | 5,915 | I |
| 47 | 145 | 9,549 | I |
| 48 | 103 | 3,282 | S |
| 49 | 170 | 12,256 | I |
| 50 | 84 | 1,136 | I |
| 51 | 60 | 1,112 | I |
| 52 | 42 | 0 | I |
| 53 | 42 | 0 | I |
| 54 | 21 | 7 | I |
| 55 | 15 | 0 | I |
| 56 | 21 | 0 | I |
| 2576- 1 | 60 | 201 | I |
| 2 | 60 | 153 | I |
| 3 | 170 | 10,982 | I |
| 4 | 21 | 143 | I |
| 5 | 42 | 75 | I |
| 6 | 84 | 41 | I |
| 7 | 21 | 105 | S |
| 8 | 30 | 75 | I |
| 9 | 60 | 0 | I |
| 10 | 145 | 0 | D |
| 11 | 42 | 156 | I |
| 12 | 21 | 0 | S |
| 13 | 15 | 34 | I |
| 14 | 60 | 0 | S |
| 15 | 60 | 85 | I |
| 16 | 21 | 0 | S |
| 17 | 42 | 0 | I |
| 18 | 30 | 75 | I |
| 19 | 42 | 0 | S |
| 20 | 60 | 117 | I |
| 21 | 30 | 77 | I |
| 22 | 15 | 0 | S |
| 23 | 21 | 127 | S |
| 24 | 15 | 0 | S |

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2576-25 | 42 | 33 | I |
| 26.1 | 42 | 10 | I |
| 26.2 | 42 | 0 | I |
| 28 | 21 | 0 | I |
| 29 | 15 | 0 | I |
| 30 | 30 | 0 | I |
| 31 | 30 | 0 | I |
| 32 | 30 | 0 | I |
| 33 | 84 | 0 | I |
| 34 | 21 | 101 | I |
| 35 | 170 | 0 | D |
| 36 | 170 | 1,727 | D |
| 37 | 170 | 0 | I |
| 38 | 60 | 0 | D |
| 39 | 42 | 101 | I |
| 40 | 42 | 207 | I |
| 41 | 21 | 54 | I |
| 42 | 21 | 89 | S |
| 43 | 15 | 125 | I |
| 44 | 21 | 161 | S |
| 45 | 42 | 143 | I |
| 46 | 30 | 107 | I |
| 47 | 60 | 0 | I |
| 48 | 21 | 0 | S |
| 49 | 30 | 11 | I |
| 50 | 30 | 71 | I |
| 51 | 30 | 46 | I |
| 52 | 21 | 64 | I |
| 2578- 1 | 170 | 17,207 | D |
| 2 | 60 | 0 | I |
| 3 | 170 | 4,712 | I |
| 4 | 42 | 29 | S |
| 5 | 15 | 125 | S |
| 6 | 30 | 36 | I |
| 7 | 240 | 39,681 | I |
| 8 | 120 | 2,535 | I |
| 9 | 170 | 17,640 | I |
| 10 | 15 | 19 | S |
| 11 | 15 | 38 | S |
| 12 | 170 | 15,267 | I |

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

| Particle Designation | Size, D_p (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2578-13 | 240 | 14,280 | D |
| 14 | 170 | 38 | D |
| 15 | 30 | 50 | I |
| 16 | 30 | 0 | I |
| 17 | 170 | 7,849 | I |
| 18 | 42 | 88 | I |
| 19 | 42 | 210 | I |
| 20 | 170 | 16,821 | I |
| 21 | 30 | 88 | I |
| 22 | 21 | 76 | I |
| 23 | 21 | 145 | I |
| 24 | 15 | 19 | I |
| 25 | 60 | 57 | D |
| 26 | 30 | 0 | I |
| 27 | 21 | 0 | S |
| 28 | 42 | 38 | I |
| 29 | 15 | 115 | S |
| 30 | 21 | 0 | S |
| 31 | 21 | 115 | I |
| 32 | 15 | 0 | I |
| 2581- 1 | 205 | 0 | I |
| 2 | 120 | 11 | D |
| 3 | 60 | 19 | I |
| 4 | 42 | 134 | I |
| 5 | 42 | 0 | I |
| 6 | 84 | 267 | I |
| 7 | 60 | 69 | I |
| 8 | 60 | 0 | I |
| 9 | 60 | 19 | I |
| 10 | 42 | 57 | I |
| 11 | 42 | 172 | I |
| 12 | 84 | 19 | D |
| 13 | 60 | 0 | I |
| 14 | 30 | 0 | I |
| 15 | 60 | 0 | I |
| 16 | 120 | 0 | D |
| 17 | 60 | 88 | I |
| 18 | 42 | 0 | I |
| 19 | 60 | 96 | I |
| 20 | 120 | 0 | D |

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

| Particle Designation | Size, D_p (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2581-21 | 120 | 0 | D |
| 22 | 84 | 0 | D |
| 23 | 42 | 0 | D |
| 24 | 60 | 0 | I |
| 25 | 15 | 0 | S |
| 26 | 42 | 0 | I |
| 27 | 21 | 0 | I |
| 28 | 30 | 0 | I |
| 29 | 30 | 0 | I |
| 30 | 73 | 198 | I |
| 31 | 21 | 0 | I |
| 32 | 42 | 343 | D |

TABLE A.5

YFNB-13-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1974- 1 | 120 | 459 | I |
| 2 | 120 | 0 | S |
| 3 | 30 | 83 | I |
| 4 | 42 | 112 | I |
| 5 | 60 | 77 | I |
| 6 | 30 | 122 | I |
| 7 | 60 | 15 | I |
| 8 | 60 | 73 | I |
| 9 | 21 | 25 | S |
| 10 | 21 | 35 | I |
| 11 | 30 | 0 | I |
| 12 | 21 | 19 | I |
| 13 | 30 | 162 | I |
| 14 | 21 | 97 | I |
| 15 | 42 | 58 | I |
| 16 | 60 | 251 | I |
| 17 | 84 | 125 | I |
| 18 | 21 | 0 | I |
| 19 | 680 | 0 | S |
| 20 | 15 | 0 | S |
| 21 | 30 | 146 | S |
| 22 | 240 | 0 | D |
| 23 | 21 | 0 | I |
| 24 | 21 | 0 | I |
| 25 | 21 | 35 | I |
| 26 | 30 | 0 | I |
| 27 | 15 | 87 | I |
| 28 | 42 | 200 | I |
| 29 | 30 | 87 | I |
| 30 | 60 | 58 | I |
| 31 | 30 | 78 | S |
| 32 | 84 | 97 | I |
| 33 | 84 | 58 | I |
| 34 | 42 | 132 | I |
| 35 | 120 | 144 | I |
| 36 | 120 | 78 | I |
| 37 | 60 | 74 | I |
| 38 | 42 | 45 | S |
| 39 | 30 | 78 | S |
| 40 | 60 | 0 | I |
| 41 | 42 | 143 | I |

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1974-42 | 30 | 157 | I |
| 43 | 60 | 152 | I |
| 44 | 42 | 7 | I |
| 45 | 30 | 121 | I |
| 46 | 30 | 230 | I |
| 47 | 30 | 0 | I |
| 48 | 30 | 0 | I |
| 49 | 60 | 0 | I |
| 50 | 30 | 0 | I |
| 51 | 30 | 24 | S |
| 52 | 30 | 7 | S |
| 53 | 30 | 0 | S |
| 54 | 21 | 24 | S |
| 55 | 30 | 0 | S |
| 56 | 30 | 48 | I |
| 57 | 42 | 0 | I |
| 58 | 30 | 168 | I |
| 59 | 42 | 0 | I |
| 60 | 30 | 0 | S |
| 61 | 60 | 167 | D |
| 62 | 21 | 52 | I |
| 63 | 42 | 35 | I |
| 64 | 30 | 91 | I |
| 65 | 30 | 52 | S |
| 66 | 30 | 73 | S |
| 67 | 42 | 47 | I |
| 68 | 30 | 91 | S |
| 69 | 42 | 13 | I |
| 70 | 30 | 99 | S |
| 71 | 30 | 73 | I |
| 72 | 30 | 21 | I |
| 73 | 21 | 183 | S |
| 74 | 30 | 399 | S |
| 75 | 21 | 0 | I |
| 76 | 30 | 0 | I |
| 77 | 42 | 0 | D |
| 78 | 15 | 0 | S |
| 79 | 21 | 105 | I |
| 80 | 30 | 66 | I |
| 81 | 30 | 86 | I |

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1974-82 | 21 | 0 | I |
| 83 | 30 | 34 | I |
| 84 | 30 | 0 | I |
| 85 | 21 | 0 | I |
| 86 | 30 | 0 | I |
| 87 | 30 | 144 | I |
| 88 | 30 | 0 | I |
| 89 | 30 | 0 | I |
| 90 | 30 | 26 | I |
| 91 | 30 | 0 | I |
| 92 | 21 | 144 | I |
| 93 | 21 | 13 | I |
| 94 | 30 | 13 | S |
| 95 | 30 | 0 | I |
| 96 | 60 | 132 | D |
| 97 | 15 | 105 | S |
| 1977- 1 | 480 | 984,805 | I |
| 2 | 480 | 792,378 | I |
| 3 | 145 | 78 | I |
| 4 | 120 | 125 | I |
| 5 | 120 | 157 | I |
| 6 | 60 | 117 | I |
| 7 | 30 | 21 | S |
| 8 | 42 | 0 | S |
| 9 | 42 | 21 | I |
| 10 | 120 | 0 | D |
| 11 | 30 | 0 | I |
| 12 | 21 | 117 | I |
| 13 | 30 | 0 | I |
| 14 | 84 | 0 | D |
| 15 | 30 | 117 | I |
| 16 | 84 | 83 | I |
| 17 | 42 | 167 | I |
| 18 | 103 | 0 | I |
| 19 | 73 | 83 | I |
| 20 | 60 | 1,225 | I |
| 21 | 42 | 233 | I |
| 22 | 42 | 200 | I |
| 23 | 30 | 0 | I |

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

| Particle Designation | Size, D_p (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1977-24 | 120 | 2,424 | D |
| 25 | 120 | 2,231 | D |
| 26 | 170 | 7,126 | D |
| 27 | 42 | 193 | I |
| 28 | 42 | 310 | I |
| 29 | 60 | 27 | I |
| 30 | 60 | 176 | I |
| 31 | 42 | 356 | I |
| 32 | 84 | 1,166 | D |
| 33 | 30 | 0 | I |
| 34 | 60 | 0 | I |
| 35 | 84 | 0 | I |
| 36 | 42 | 0 | I |
| 37 | 30 | 0 | S |
| 38 | 120 | 0 | D |
| 39 | 60 | 43 | D |
| 40 | 15 | 250 | S |
| 41 | 21 | 77 | I |
| 42 | 21 | 33 | S |
| 43 | 42 | 0 | I |
| 44 | 42 | 226 | I |
| 45 | 42 | 93 | I |
| 46 | 42 | 0 | I |
| 47 | 60 | 20 | D |
| 48 | 42 | 83 | I |
| 49 | 42 | 90 | I |
| 50 | 30 | 57 | I |
| 51 | 60 | 100 | I |
| 52 | 30 | 0 | I |
| 53 | 30 | 0 | I |
| 54 | 21 | 30 | I |
| 55 | 21 | 57 | I |
| 56 | 30 | 40 | I |

TABLE A.6

YFNB-29-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1373- 2 | 480 | 47,958 | S |
| 3 | 480 | 71,445 | S |
| 4 | 580 | 72,781 | I |
| 5 | 240 | 21,240 | S |
| 6 | 480 | 31,486 | I |
| 7 | 240 | 6,590 | I |
| 8 | 120 | 3,111 | S |
| 9 | 205 | 7,352 | I |
| 10 | 240 | 9,463 | D |
| 11 | 290 | 3,614 | I |
| 12 | 120 | 1,040 | D |
| 13 | 120 | 4,135 | I |
| 14 | 240 | 388 | D |
| 15 | 240 | 5,781 | I |
| 16 | 170 | 2,620 | I |
| 17 | 120 | 811 | S |
| 18 | 120 | 785 | I |
| 19 | 120 | 254 | S |
| 20 | 170 | 1,437 | D |
| 21 | 170 | 3,405 | D |
| 1377- 1 | 340 | 43,991 | I |
| 2 | 170 | 245 | I |
| 3 | 410 | 221,893 | S |
| 4 | 410 | 383,104 | I |
| 5 | 480 | 27,364 | I |
| 6 | 84 | 927 | S |
| 7 | 120 | 149 | I |
| 8 | 120 | 6,716 | D |
| 9 | 84 | 448 | I |
| 10 | 170 | 66 | I |
| 11 | 170 | 106 | I |
| 1381- 1 | 480 | 388,486 | I |
| 2 | 290 | 234,906 | I |
| 3 | 480 | 174,877 | I |
| 4 | 340 | 61,653 | S |
| 5 | 580 | 184,800 | I |
| 6 | 120 | 3,191 | D |
| 7 | 680 | 489,310 | I |
| 8 | 680 | 289,267 | I |

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1381- 9 | 340 | 619,448 | D |
| 10 | 580 | 169,124 | D |
| 1385- 1 | 290 | 44,298 | D |
| 2 | 84 | 95 | I |
| 3 | 340 | 166,440 | I |
| 4 | 290 | 212,502 | I |
| 5 | 580 | 354,613 | D |
| 6 | 170 | 15,622 | D |
| 7 | 60 | 1,407 | I |
| 8 | 103 | 293 | I |
| 9 | 120 | 6,880 | I |
| 10 | 60 | 756 | I |
| 11 | 120 | 348 | D |
| 12 | 410 | 8,467 | I |
| 13 | 60 | 395,842 | I |
| 14 | 120 | 7,801 | I |
| 15 | 30 | 0 | I |
| 16 | 60 | 966 | D |
| 17 | 60 | 1,811 | I |
| 18 | 60 | 729 | D |
| 19 | 60 | 1,082 | D |
| 20 | 84 | 813 | I |
| 21 | 170 | 3,698 | D |
| 22 | 205 | 0 | D |
| 23 | 410 | 6,204 | D |
| 24 | 60 | 0 | I |
| 25 | 84 | 0 | I |
| 26 | 30 | 0 | I |
| 27 | 30 | 0 | I |
| 28 | 21 | 0 | S |
| 29 | 15 | 40 | S |
| 30 | 60 | 979 | D |
| 31 | 42 | 84 | D |
| 32 | 15 | 73 | S |
| 33 | 21 | 29 | S |
| 34 | 42 | 0 | I |
| 35 | 120 | 1,625 | D |
| 36 | 60 | 1,780 | I |
| 37 | 60 | 250 | D |
| 38 | 42 | 184 | I |

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1385-39 | 145 | 7,612 | I |
| 40 | 42 | 239 | I |
| 41 | 84 | 5,554 | I |
| 42 | 30 | 251 | I |
| 43 | 30 | 0 | I |
| 44 | 60 | 1,269 | I |
| 45 | 84 | 1,556 | D |
| 46 | 21 | 36 | I |
| 1389- 1 | 340 | 58,839 | I |
| 2 | 580 | 50,641 | I |
| 3 | 410 | 63,854 | I |
| 4 | 410 | 1,698,631 | I |
| 5 | 30 | 0 | I |
| 6 | 15 | 119 | I |
| 7 | 21 | 152 | I |
| 8 | 84 | 1,560 | I |
| 9 | 60 | 1,003 | I |
| 10 | 170 | 169 | D |
| 11 | 30 | 54 | I |
| 12 | 60 | 65 | I |
| 13 | 30 | 87 | I |
| 14 | 60 | 119 | D |
| 15 | 21 | 39 | S |
| 16 | 42 | 282 | D |
| 17 | 205 | 5,068 | D |
| 18 | 21 | 152 | I |
| 19 | 42 | 43 | I |
| 20 | 42 | 0 | I |
| 21 | 15 | 121 | S |
| 22 | 42 | 0 | D |
| 1392- 1 | 410 | 142,176 | I |
| 2 | 145 | 83,316 | I |
| 3 | 42 | 0 | I |
| 4 | 15 | 506 | I |
| 5 | 30 | 60 | S |
| 6 | 30 | 610 | I |
| 7 | 15 | 0 | I |
| 8 | 15 | 0 | I |

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 1392- 9 | 103 | 90 | I |
| 10 | 60 | 0 | I |
| 11 | 15 | 0 | I |
| 12 | 15 | 218 | I |
| 13 | 15 | 57 | I |
| 14 | 30 | 0 | I |
| 15 | 21 | 28 | I |
| 16 | 30 | 44 | I |
| 17 | 15 | 126 | S |
| 18 | 21 | 0 | I |
| 19 | 42 | 0 | I |
| 20 | 21 | 39 | I |
| 21 | 15 | 39 | I |
| 22 | 42 | 534 | I |
| 23 | 21 | 0 | I |
| 24 | 42 | 28 | I |
| 25 | 30 | 0 | S |
| 26 | 84 | 0 | I |
| 27 | 15 | 7 | S |
| 28 | 42 | 65 | I |
| 29 | 60 | 0 | I |
| 30 | 30 | 0 | I |
| 31 | 21 | 76 | S |
| 32 | 84 | 23 | I |
| 33 | 15 | 148 | S |
| 2293- 1 | 120 | 296 | S |
| 2 | 60 | 167 | I |
| 3 | 42 | 9 | I |
| 4 | 170 | 0 | D |
| 5 | 21 | 70 | S |
| 6 | 21 | 79 | I |
| 7 | 42 | 62 | I |
| 8 | 60 | 67 | I |
| 9 | 84 | 85 | D |
| 10 | 30 | 35 | I |
| 11 | 30 | 132 | S |
| 12 | 42 | 93 | I |
| 13 | 21 | 19 | S |
| 14 | 21 | 146 | I |
| 15 | 21 | 58 | I |

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

| Particle Designation | Size, D_a (μ) | Activity at H + 300 (net well c/m) | Shape |
|----------------------|-----------------------|------------------------------------|-------|
| 2293-16 | 30 | 0 | I |
| 17 | 60 | 9 | S |
| 18 | 60 | 44 | I |
| 19 | 60 | 0 | I |
| 20 | 42 | 9 | I |
| 21 | 42 | 115 | I |
| 22 | 84 | 88 | D |
| 23 | 42 | 106 | I |
| 24 | 30 | 26 | I |
| 25 | 21 | 48 | I |
| 26 | 21 | 6 | I |
| 27 | 21 | 93 | S |

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