tain assumptions are made. Assume (i) that the boulder is spherical with radius $r = 6.5$ m, (ii) that it has an average density $\rho = 3.0$ g/cm^3, and (iii) that the average width w of the track (6 m) approximates the diameter of a semicircle equal to the projected area supporting the boulder. The use of an average width of the track gives a reasonable estimate, since the moving boulder probably left a larger imprint than would be the case if it were set down gently on the surface. Measurements of boulder size and width of track to the nearest meter were made from a 3× enlargement of Fig. 1.

The ratio of the mass of the boulder to the area of its semicircular base of support is

$$(4/3)\pi r^3 \rho / \frac{\pi}{2} \cdot \left(\frac{w}{2}\right)^2 = 2.4 \times 10^4 \text{ g/cm}^2$$

Under lunar gravity (162 cm/sec^2) the corresponding effective bearing strength is 4×10^6 dyne/cm^2.

Jaffe (*2*), in an analysis based on Earth, Ranger, and Surveyor I observations, finds that the static-bearing capacity of the lunar maria with no sinkage is 4×10^5 dyne/cm^2 and that it increases at a rate of 2×10^4 dyne/cm^3 for some undetermined depth.

A calculation of the weight necessary to make the observed semicircular indentation in a material with this bearing strength yields 1.6×10^{11} dyne, in good agreement with the calculated boulder weight of 1.8×10^{11} dyne. The results suggest, at least roughly, that Jaffe's expression for the bearing strength in this area is valid up to 75 cm. The measurement of Sabine D is valuable because it can be used as a lower limit of bearing strength over a length of 650 m as opposed to the small-footpad type of measurement from a landed spacecraft. Also, a measurement in western Mare Tranquillitatis is important because this area is a potential landing site for both Surveyor and Apollo missions to the Moon.

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Strontium-90 Deposition in New York City

Abstract. *Measurements of strontium-90 deposited in New York City over the past 12 years make for broader understanding of the fallout phenomenon. The data indicate a stratospheric half-residence time of 8 to 10 months. The seasonal oscillation of strontium-90 fallout is very symmetrical and consistent from year to year and completely independent of the timing and magnitude of nuclear tests. The predicted fallout of strontium-90 in 1970 is less than 1 percent of that during the peak year 1963.*

Twelve-year accumulation of ^{90}Sr data from the New York City collection site (*1*) suggests some important characteristics of fallout. The stratospheric half-residence time of about 10 months (*2*) is corroborated. Normalization of monthly data leads to clear definition of seasonal variation independent of nuclear detonations. By mid-1966 the peak of deposition of ^{90}Sr on Earth's surface passed, and radioactive decay now exceeds fallout; deposition continues to decrease and in 1970 will amount to less than 1 percent of that in 1963.

The New York City station collects fallout monthly with steep-walled stainless steel pots and plastic-funnel, ion-exchange column collectors (*3*). Special large-area collections also are made, and from time to time experimental collection devices are tested. Results of analyses of these collections are reported quarterly (*4*), and interpretive reports are published periodically (*5–7*).

In calculation of cumulative deposit, it is assumed that deposition before 1954 was negligibly small. Analyses of soil samples provide the only direct measurement of cumulative fallout; six such samples from a selected site have yielded values for comparison with the values calculated from the monthly collections (Fig. 1) (*8, 9*); all six are lower in ^{90}Sr content.

The soils were analyzed by leaching directly with HCl. Another procedure, considered to be more accurate, incorporates complete fusion with sodium carbonate before the leach. In a recent study (*10*) with soils collected in 1963, values yielded by straight leaching averaged 90.6 percent of those obtained when fusion was incorporated. The average relation between soil deposit and cumulative monthly deposit (90.7 percent) is in remarkably good agreement. It follows, therefore, that the summing of results from continuously exposed collectors satisfactorily approximates the integrated value derived from analysis of fused soil, and that, at least in New York City, standard collectors of fallout do in fact collect everything. This conclusion may be applicable only to areas of moderate or greater annual precipitation, since dry fallout may constitute a high percentage of total deposition in regions of low rainfall and may not be collected as efficiently as is rain.

The solid curve in Fig. 1 indicates that since about mid-1965 the rate of monthly fallout closely approximates the rate of monthly decay of the deposit. The situation was similar during the first nuclear-test moratorium (1959–61); the deposit never measurably decreased, although during the latter half of 1960 and the first few months of 1961 this condition was closely approached. The current deposit of about 82 mc/km^2 is decaying at about 0.16 mc/month, a rate substantially higher than that anticipated in fallout subsequent to the middle of 1966. Thus, barring any large injections of ^{90}Sr into the atmosphere, the cumulative deposit should begin visibly to decrease; by the end of 1967 a little less than 81 mc/km^2 is expected for New York City.

In contrast with the general features shown by the cumulative deposit, the monthly rate of fallout reveals more dynamic characteristics such as the stratospheric half-residence time and seasonal variations in deposition. Figure 2 shows the monthly fallout in New York City during the last 12 years.

The effects on the deposition rate of the two periods of cessation of atmospheric tests may be related to stratospheric fallout processes. After 1 year, the initial moratorium, from November 1958, very obviously affected deposition of ^{90}Sr. The test ban now in effect since the end of 1962 caused a much less rapid decrease. From 1959 to 1960, annual fallout decreased by more than a factor of 5, while during the same relative period of the current cessation (1963 to 1964) the decrease was less than a factor of 2; between 1964 and 1965 it was by a little less than a factor of 3, and probably did not differ between 1965 and 1966.

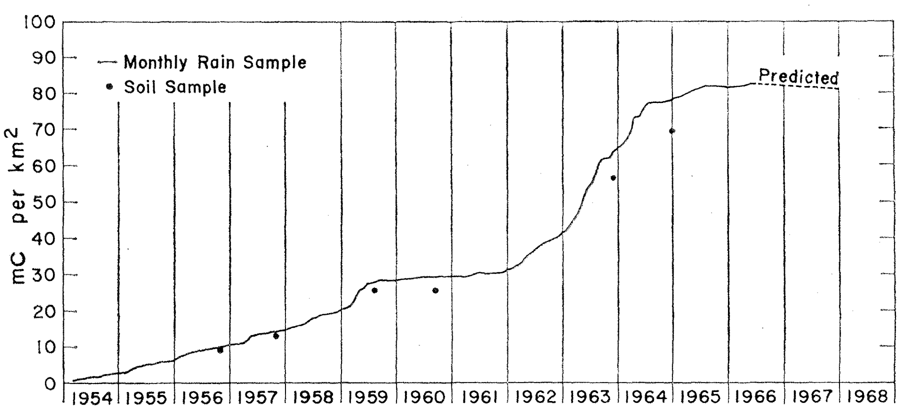
These fallout values may be used to infer the stratospheric half-residence time, if one assumes a simple exponential system, under two specific conditions: (i) sufficient time must have elapsed, since the last atmospheric detonation, for the troposphere to have been cleared of debris injected directly into that region; and (ii) deposition in New York City must be proportional to the total amount of ^{90}Sr that left the stratosphere at any given time. The first condition is satisfied if one assumes a tropospheric half-residence time of 1 month (*11*) and neglects the first 5 or 6 months after the last atmospheric injection; the observed values (*4, 5*) show that the second condition is satisfied. The New York City : world annual ratios for ^{90}Sr fallout (Table 1, last column) are constantly almost within a factor of 2 for the most extreme cases; in 9 of the 12 years they are within 20 percent of the average value of 0.15 Mc (global deposition) : 1 mc/km^2 (New York City fallout).

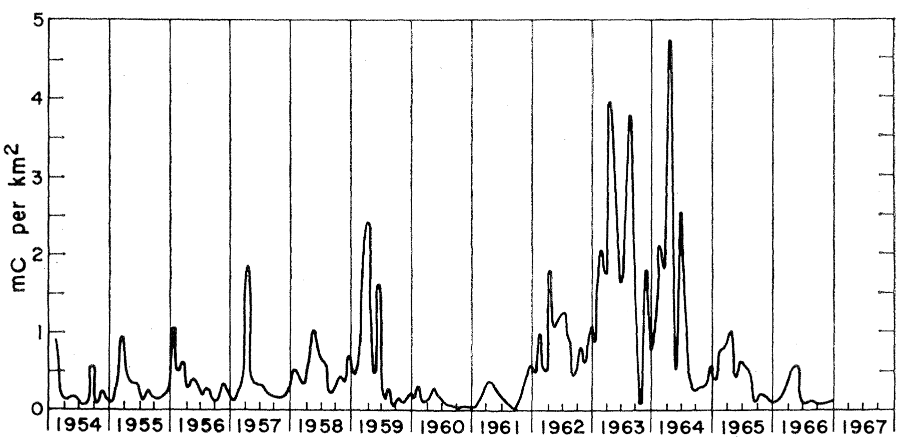
The short period of the first moratorium (December 1958 to August 1961) permitted only one calculation of stratospheric half-residence time by use of a 1-year interval (Table 2); one can see that inclusion in the computation of the early months after cessation results in a half-residence time of about 5 months. Presumably a substantial fraction of the ^{90}Sr fallout at this time was of tropospheric origin. When the first 5 months are omitted from the calculation, a stratospheric half-residence time of 9 months is derived (Table 2), in good agreement with the 10-month value indicated by direct measurements of stratospheric concentrations (*2*).

Table 2 also lists calculations of stratospheric half-residence time since the beginning of the current ban—January 1963. When no months are neglected, an apparent half-residence time of 20 months results from the 1st year's data; the two subsequent years give 8 and 10 months, respectively—about as expected. However, omission of the first 5 months of the ban yields the same value (9 months) for all 3 years of the current moratorium as for the 1st. The results of this computation for the current ban indicate that the spring of 1963 brought probably unusually little fallout, perhaps because of the type and altitude of the atmospheric injections during the final few months of testing; and that, unlike that in 1959, the relative amount of nonstratospheric debris was small.

The monthly deposition data also serve in investigation of seasonal patterns of fallout. Annual oscillation of fallout (one speaks of the spring peak; Fig. 2) is now generally accepted as a meteorological phenomenon related to yearly downward transfers of air from the stratosphere. However the relative amplitudes of the peaks, due mainly to the intensity and timing of the testing schedule, partially mask the systematic variation. In order to facilitate observation and analysis of the seasonal peaking, the monthly fallout values have been normalized; each month's deposition value is expressed relative to the average monthly value of its immediate 12-month period (5 months before and 6 months after). For the purpose of damping short-term fluctuations, these relative values are then averaged by 3-month intervals and plotted every month (Fig. 3).

It is apparent (Fig. 3) that the annual ^{90}Sr oscillations are not at all related to either the testing schedule or the intensity of specific test series. It is interesting that maximum amplitude of the variation occurred during a moratorium year, 1961, with the peak at 2.3 and the valley at 0.2; average intensities are 1.8 and 0.4, respectively. The symmetry of the annual variation is indicated by the areas (in arbitrary units) of the "plus" and "minus" portions of the curve for each year ("plus" refers to the area enclosed by the curve, above the value unity; "minus" is the enclosed area below the unit line). Peak values occur in only 4 months, February through May, with April hav-





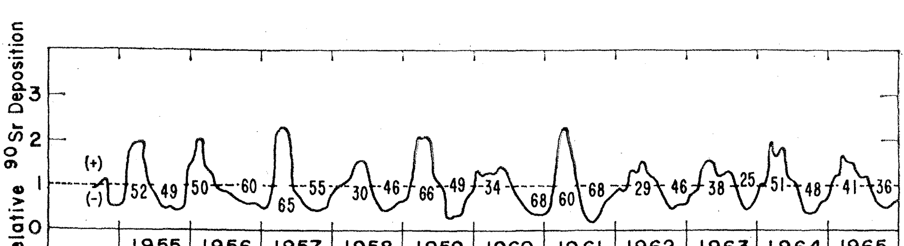


Fig. 1 (top). Cumulative deposit of ^{90}Sr in New York City from 1954 through 1967 as determined from monthly collections of fallout and from soil samples. Fig. 2 (middle). Deposition of ^{90}Sr in New York City from 1954 through 1966, determined from monthly collections of fallout. Fig. 3 (bottom). Normalized monthly deposition of ^{90}Sr from 1955 through 1965. Relative values of enclosed areas above and below the unity line indicate the symmetry of seasonal variations.

Table 1. Worldwide (Ww) and New York City (NYC) depositions of ^{90}Sr. The average ratio was 0.15. The 1966 figures are estimates.

Year	Ww (Mc)	NYC (mc/km^2)	Ratio (Ww : NYC)
1954	0.35	2.76	0.13
1955	.60	3.57	.17
1956	.55	4.43	.12
1957	.50	4.44	.11
1958	.90	6.16	.15
1959	1.13	8.68	.13
1960	0.38	1.58	.24
1961	.46	2.43	.19
1962	1.53	11.07	.14
1963	2.59	23.87	.11
1964	1.84	15.85	.12
1965	1.00	5.53	.18
1966	0.4	2.3	.17

ing the highest frequency. Plus values occur at least once during all months but September, October, and November; in every year, March, April, and May were all plus. These observations indicate that in New York City the peak is indeed a spring phenomenon generally centered on and most intense in the month of April. Conversely, the fallout is lowest in the autumn, with September having the highest frequency of minimum values.

Predictions of ^{90}Sr deposition in New York City are important, particularly in estimation of future human-body burdens (*12*). The method of predicting ^{90}Sr fallout there is based on predictions of worldwide deposition and the observed relation between worldwide and New York City fallout (*5*). Since the beginning of the current ban, the stratospheric inventory of ^{90}Sr has been decreasing, with an apparent half-residence time of about 10 months (*2*). Extrapolation of the measured stratospheric burdens yields the inventory decrease for any year, which equals the expected global fallout for that year, less the change in tropospheric inventory. Then, on the assumption that the ratio of worldwide to New York fallout is constant (Table 1), the deposition value for New York City can be calculated. This constant for ^{90}Sr is 6.6 mc/km^2 in New York for every megacurie of worldwide fallout. By this method yearly predictions of ^{90}Sr fallout from 1966 through 1970 are respectively 2.3, 1.1, 0.48, 0.21, and 0.09 mc/km^2.

Table 2. Stratospheric half-residence time (HRT) derived from fallout data for New York City. Figures for 1966 are partially estimated.

Period	Fallout (mc/km^2)	HRT (months)
First moratorium		
Dec. 58–Nov. 59	9.16	5
Dec. 59–Nov. 60	1.74	
May 59–Apr. 60	3.93	9
May 60–Apr. 61	1.56	
Current test ban		
Jan. 63–Dec. 63	23.87	20
Jan. 64–Dec. 64	15.85	8
Jan. 65–Dec. 65	5.53	10
Jan. 66–Dec. 66	2.3	
June 63–May 64	22.22	9
June 64–May 65	9.02	9
June 65–May 66	3.71	

During the course of the year (*7*) alternate predictions of yearly and monthly fallouts are computed; the historical record of ^{90}Sr fallout in New York City is employed, by use of the monthly values relative to the yearly deposition. For example, the cumulative deposition to the end of June 1966 was 1.71 mc/km^2. On the average, 67.6 percent of the annual deposition occurs by July 1; thus 2.5 mc/km^2 is predicted for the year. This is in good agreement with the original prediction based upon stratospheric depletion.

In summary: By the middle of 1966 the peak of accumulated ^{90}Sr on Earth's surface near New York passed; the deposit is now decaying faster than new material is falling. The stratospheric half-residence time of 8 to 10 months, based on the rate of ^{90}Sr deposition in New York, is in very good agreement with estimates from direct measurements.

The overpowering variations in the absolute deposition levels were virtually eliminated by a method of normalizing the monthly data on fallout on a continuing basis; thus seasonal oscillation in fallout is easily observable. This spring peak is extremely symmetrical and constant relative to the rest of the year; it is independent of the timing and magnitude of atmospheric tests.

Predictions of fallout in New York, based on empirical observations and on the assumption of no substantial additions of ^{90}Sr to the atmosphere, indicate that less than 0.1 mc/km^2 will be deposited during 1970—less than 1 percent of deposition during the peak year, 1963.

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Jupiter's Atmosphere: Its Structure and Composition

Abstract. *Recent laboratory and observational data support the hypothesis that the composition of Jupiter's atmosphere is consistent with the relative abundances of the elements found in the sun. A model based on this assumption provides a reasonable interpretation of abundances of hydrogen and other gases obtained from studies of various regions of the planet's spectrum. Two presently unidentified absorptions may be caused by organic molecules in the Jovian atmosphere.*

The composition of Jupiter's atmosphere remains an enigma, despite the fact that direct measurement of the hydrogen abundance has been possible for several years (*1*), while two minor constituents, methane and ammonia, were identified long ago (*2*). Determinations of the amount of hydrogen, made by various workers from observations of the quadrupole absorptions in the infrared, differ widely among themselves. The best new values also appear to conflict with independent H_2 abundance determinations from analysis of the ultraviolet reflectivity of the planet. Deductions concerning other possible constituents are strongly dependent on the resolution of these dilemmas; as yet no additional gases have been discovered (*3*). This report discusses some preliminary results of our efforts at reevaluating these problems. Our study is based on a structural model for the Jovian atmosphere that appears to be consistent