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PROJECT SUNSHINE
(Contract AT(30-1)-1656)

ANNUAL REPORT
Period March 31, 1955-April 1, 1956

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April 15, 1956

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I: General Summary

A. Human Sr^{90} Program

1. The highest Sr^{90} activity yet recorded is 6.7 S.U. in an individual from Vancouver B.C..

2. The regional differences can not yet be defined on the basis of the limited data so far available.

3. The average person has less than 0.1 S.U. in his skeleton.

4. The general curve of Sr^{90} vs. age shows a ten fold increase in the younger age group (5-10) but the individuals may depart radically from this. Some children have less than 0.1 S.U. whereas some people over 30, even one 70, show Sr^{90} concentration considerably above 0.1 S.U..

5. It is essential to determine the reason for the high values and to plan a sampling program which will include more of these. It appears that the average Sr^{90} concentration in a population will remain lower than some individuals by factors of ten or more.

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B. Common Strontium in Human Bone

1. A new emission spectrographic technique for the direct analysis of Sr in bone ash has been developed which yields good precision.

2. A Total of 227 human bones from all over the world have been analyzed and show no correlation with age, bone type or sex.

3. There are regional variations doubtless dependent on crustal abundance for that area.

4. The human body selectively discriminates against Sr by a factor of 10 over its natuaral environment. This is consistent with biochemical tracer experiments with animals and the present strontium metabolic study.

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I: General Summary (Cont'd)

5. Because apatite generally accepts strontium, it is suggested that in the process of fossilization the strontium content might increase with time giving a new method for the relative chronology of fossil bone.

6. The data accumulated to date show no correlation between Sr^{90} and total Strontium present in human bone.

C. Radium in Human Bone

1. Although widely distributed geographically, results obtained on several dozen specimens show the average radium content of human bone to be a factor of 5 lower than previously reported. If this is generally true the dose from Sr^{90} in young people is already considerably larger than for natural radium.

2. The radium concentrations are characteristic of the geographical locality.

3. There is no obvious correlation between radium and the Sr^{90} content of human bone. This is expected on geochemical grounds.

4. There might be a correlation between radium and stable strontium since granite rocks have higher Sr/Ca and Ra/Ca ratios and basaltic rocks lower. Therefore if the diet directly reflected the relative concentration this correlation would be found. This correlation is not apparent from these results.

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D. Sr Metabolism in Humans

1. The techniques used gave a precision of better than 5% for the Ca^{45} and Sr^{85} assay.

2. Ca^{45} and Sr^{85} are rapidly distributed through the body following intravenous administration.

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I: General Summary (Cont'd)

3. The biological half life of Sr^{85} in tissue is about 7-12 days over a two month interval, whereas the biological half life in bones is at least 50 days at the outset but probably increases rapidly after the initial period of adjustment.

4. The biological half life for Ca^{45} is consistently higher than that for Sr^{85}.

5. A measurable quantity of Ca^{45} is found in both bone and soft tissue 32 months after administration (i.e. one half that after two months).

6. The enrichment factor in favor of calcium is somewhat greater for bone than soft tissue. In fact soft tissues typically show an enrichment in favor of strontium in the early phase after administration but ultimately, after 39 and 65 days show a calcium enrichment. The fractionation against strontium in bone after a month or so appears to be about 2.5.

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7. The specific activity of calcium(i.e. uc Ca^{45}/gm. calcium) as well as the concentration of Sr^{85}/gm. calcium is greater for tissue than for bone and is also greater for outer layers of bone than for the inner layers. The specific activity is also greater for the metabolically active bones like vertebra and sternum than for the long bones such as femur and humerus. Rib is intermediate and hence is a reasonable sample of the Sr^{90} activity of a particular human.

10. Separate portions of the same organ may vary by as much as a factor of two. Local inhomogeneity appears to be the rule although the average value for an individual changes regularly with time.

I: General Summary (Cont'd)

E. Soil Program (New York Area)

1. Sr^{90} analyses in soil have a precision of better than 5%.

2. Samples taken a few feet away from each other may vary by a factor of two.

3. Total base exchangeable Sr^{90} can be obtained from successive ammonium acetate leaches or a single 6N HCl leach.

4. 30% of the Sr^{90} is not in base-exchangeable form.

5. In most cases 80% of the Sr^{90} is in 0-2".

6. The New York area has an average total integrated Sr^{90} fallout of 320 dpm/ft^2.

7. The New York area soil shows an average of 70 Sunshine Units and a range from 1.7 to 234 in the depth of 0-2". Thus the average for tilled fields should be about 12 Sunshine Units yielding plants with about 6 Sunshine Units internally.

8. By carefully selecting and mixing 10-20 soil samples from an area it is possible to make a single measurement and determine the total integrated fallout in the area to within 50%.

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F. Leaf Retention Program

1. The relative dosage of Sr^{89}: Ba^{140}: I^{131}: Sr^{90} from the surface of clover at Norfolk or Charleston under the conditions of maximum fallout are 160:100:240:5000.

2. The Sr^{90} is largely inside the plants having come from the soil. These plants contain 3-54 Sunshine Units.

3. There was no significant geographic effect for the series on a whole, however, for a given cloud there may have been a difference of a factor of two.

I: General Summary (Con't)

4. Clover picks up twice as much fallout debris as oats due to the large surface area.

5. The fallout is localized in hot particles.

6. The surface contamination will become increasingly unimportant. Thus already during a test series in Nevada the greatest hazard to eating unwashed vegetation in the eastern United States has resulted from internal Sr^{90}.

7. Milk from cows grazing in the eastern United States during a Nevada test series will get a negligible quantity of I^{131}.

G. Specific Activity of Vegetation in a Field of Known Sr^{90}/Ca

In a field where the soil had a consistent value of 145 ± 5 Sunshine Units, a grass called Broomsedge was analyzed for its Sr^{90}/Ca ratio. A Value of 152 ± 4 S.U. (Internal Sr^{90}) indicates that the plant lives in an average environment of 300 S.U. since most vegetation is known to discriminate against strontium by a factor of approximately two. The high number of Sunshine Units suggests that such vegetation may be a means whereby material of a high Sr^{90}/Ca ratio can be introduced into the body. Since the New York area has a total fallout similar to the world-wide average, people who are primarily vegetarians could in principle be getting a consistent diet of over 100 S. U. at the present time.

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H. Miscellaneous

1. Atlantic Ocean water contains negligible S.U. of Sr^{90} and the surface life will probably never constitute a hazard. Except for close-in fallout carried by surface currents neither ocean water or fish appear fruitful samples for Sr^{90} analysis for the purpose of Project Sunshine.

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I: General Summary (Cont'd)

2. Rain water is higher in Sr^{90} than surface or tap Water.

3. There is a general increase in both Sr^{90} and H^3 in the rain of March 1954 but in detail there is no correlation suggesting that these isotopes do not come from the same source.

4. The soil sample taken by Beltsville in connection with the Spring 1955 Leaf Retention Program do not show obvious correlation with exposure.

5. Animal bones show a progressive increase in Sr^{90} content with time; sheep are higher than calves; United States is higher than Europe.

6. Dairy products also show an increase with time. Where they are the only important calcium source in the diet the human population will show about one-tenth the Sunshine Units of Sr^{90} as the dairy foods.

7. Human thyroids from autopsies taken during the Spring 1955 series showed occassional slight traces of I^{131} from fallout uptake. Except for a few samples from Vancouver, B.C., the levels of dosage per gram organ were much less than the Sr^{90} equivalent of 0.1 S.U..

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II: Human Sr^{90} Program
(J. Laurence Kulp)

During this past contract year the excellent cooperation of the medical doctors at the various sampling stations has resulted in a collection of over 1300 human bone samples from twenty-six locations. Table II-1 shows the present distribution of sampling stations. Table II-2 lists the samples that have already been sent out to the two commercial laboratories: Isotopes Incorporated, Westwood, N. J. and the Nuclear Science and Engineering Corp., Pittsburgh, Pa. Table II-3 gives the preliminary data on human bone samples submitted by the commercial assay laboratories and II-7 the earlier data obtained at Lamont. Table II-4 shows the collection stations, Table II-5 and 6 describe the soil and food samples submitted from these stations.

Since only a small fraction of the 600 samples to be analyzed have been reported and since there is evidence of contamination in some of the NSEC measurements, no detailed discussion is warranted at this time. It would also be desirable to complete the soil and food analyses on the samples which are just now coming in from the worldwide network before such a discussion. With these limitations, however, some preliminary conclusions may be drawn.

1. The average person has less than 0.1 Sunshine Units in his bones in 1955.

2. There is a ten fold increase in the Sr^{90} concentration in young (5-10 yrs.) people over that in people older than 30. This statement reflects the general trend only.

3. Some young people also have less than 0.I.S.U.. Some older people

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have much more than 0.I.S.U.. Although the consistently high values for the Venezuelan samples reported by NSEC are suspect, there are enough others to support this conclusion. It is clear therefore that individual diet and age are both primary factors.

4. The highest Sr^{90} activity so far recorded was 6.6 S. U. in an individual from Vancouver.

5. There may be regional differences but the data are not definitive at this point yet.

6. This preliminary data emphasizes the need for analyses on large samples to get useable results. It also shows the value of individual rather than integrated samples only.

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TABLE II-1

1. Human Bone Samples

Brazil

Sample No.	Sex	Date of Death	Age
B-1022	Female	11/29/55	14 days
B-1270	Male	8/16/55	20 days
B-1085	Male	10/10/55	1 month
B-1074	Male	9/10/55	2 months
B-1268	Female	8/11/55	1 year
B-1018	Male	11/16/55	2 years
B-1080	Male	9/29/55	13 years
B-1266	Male	7/31/55	15 years
B-1289	Male	12/7/55	16 years
B-1082	Male	10/6/55	16 years
B-1294	Male	12/22/55	16 years
B-1269	Female	8/11/55	18 years
B-1286	Male	12/4/55	19 years
B-1302	Male	1/23/56	20 years
B-1288	Male	12/6/55	20 years
B-1275	Male	8/26/55	20 years
B-1299	Male	1/14/56	21 years
B-1301	Male	1/18/56	22 years
B-1295	Female	1/3/56	22 years
B-1277	Female	8/29/55	22 years

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TABLE II-1 (Con't.)

1. Human Bone Samples

Brazil

Sample No.	Sex	Date of Death	Age
B-1014	Female	11/6/55	23 years
B-1290	Female	12/9/55	24 years
B-1073	Female	9/6/55	24 years
B-1016	Female	11/8/55	24 years
B-1272	Female	8/18/55	25 years
B-1017	Female	11/14/55	25 years
B-1298	Female	1/11/56	25 years
B-1297	Female	1/10/56	26 years
B-1296	Female	1/4/56	26 years
B-1274	Female	8/22/55	26 years
B-1267	Female	8/8/55	28 years
B-1265	Female	7/28/55	28 years
B-1264	Male	7/28/55	28 years
B-1263	Male	7/22/55	29 years
B-1287	Male	12/6/55	29 years
B-1023	Male	11/11/55	29 years
B-1285	Female	11/30/55	30 years
B-1284	Female	11/30/55	30 years
B-1283	Male	11/29/55	30 years
B-1271	Female	8/17/55	30 years
B-1087	Female	10/24/55	30 years

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TABLE II-1 (Con't.)

1. Human Bone Samples

Brazil

Sample No.	Sex	Date of Death	Age
B-1083	Female	10/7/55	30 years
B-1078	Female	9/23/55	30 years
B-1300	Male	1/17/56	31 years
B-1021	Male	11/24/55	31 years
B-1262	Male	7/17/55	34 years
B-1084	Male	10/8/55	35 years
B-1292	Female	12/14/55	36 years
B-1020	Female	11/23/55	36 years
B-1086	Female	10/24/55	37 years
B-1015	Male	11/8/55	37 years
B-1291	Male	12/13/55	39 years
B-1076	Male	9/17/55	40 years
B-1273	Male	8/19/55	41 years
B-1261	Male	7/26/55	42 years
B-1013	Male	11/2/55	42 years
B-1303	Male	1/27/56	45 years
B-1079	Male	9/25/55	45 years
B-1276	Male	8/26/55	46 years
B-1077	Male	9/23/55	47 years
B-1019	Male	11/23/55	48 years

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