Chapter 5 Appendix 8

ESTIMATION OF ^{32}P INDUCED IN SULFUR IN UTILITY-POLE INSULATORS

AT THE TIME OF THE HIROSHIMA ATOMIC BOMB

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For the estimation of ^{32}P induced in sulfur in utility-pole insulators three samples designated 407, 411, and 510 by Arakatsu[1] and Shimizu[2] were used. Ground range to each sample location (Figure 1) was reevaluated using the hyocenter determined by Hubble[3] as longitude 132°23′29″ by latitude 34°23′29″.

A Duraluminum G-M counter with a tube of 12 cm diameter, 0.1 mm wall thickness, 40 mm effective length, and filled with air of 9.0 cm Hg plus ethyl-alcohol vapor 1.5 cm Hg was used. The natural background of this counter tube was about 18 cpm. Sulfur powder was spread uniformly in a paper boat of 3 cm by 2 cm and placed 4 mm beneath the counter tube.

Total detection efficiencies were estimated by Monte Carlo calculations (30000 histories), which included corrections for self-absorption of ^{32}P beta particles in samples and for absorption in the counter wall. The geometrical efficiency as follows:

1. For transmission of beta particles in material, a mass-absorption coefficient expressed by $\mu_m = 0.693/H$, where H is a half-thickness in mg/cm^2, was used. For ^{32}P beta particles (maximum energy is 1.71 MeV) H = 79 mg/cm^2 was used.[4]
2. For self-absorption of beta particles in the sample a formula

$$\frac{(1-^{-\mu_m d})}{\mu_m d} \qquad (1)$$

where d is the source thickness in mg/cm^2 was used.

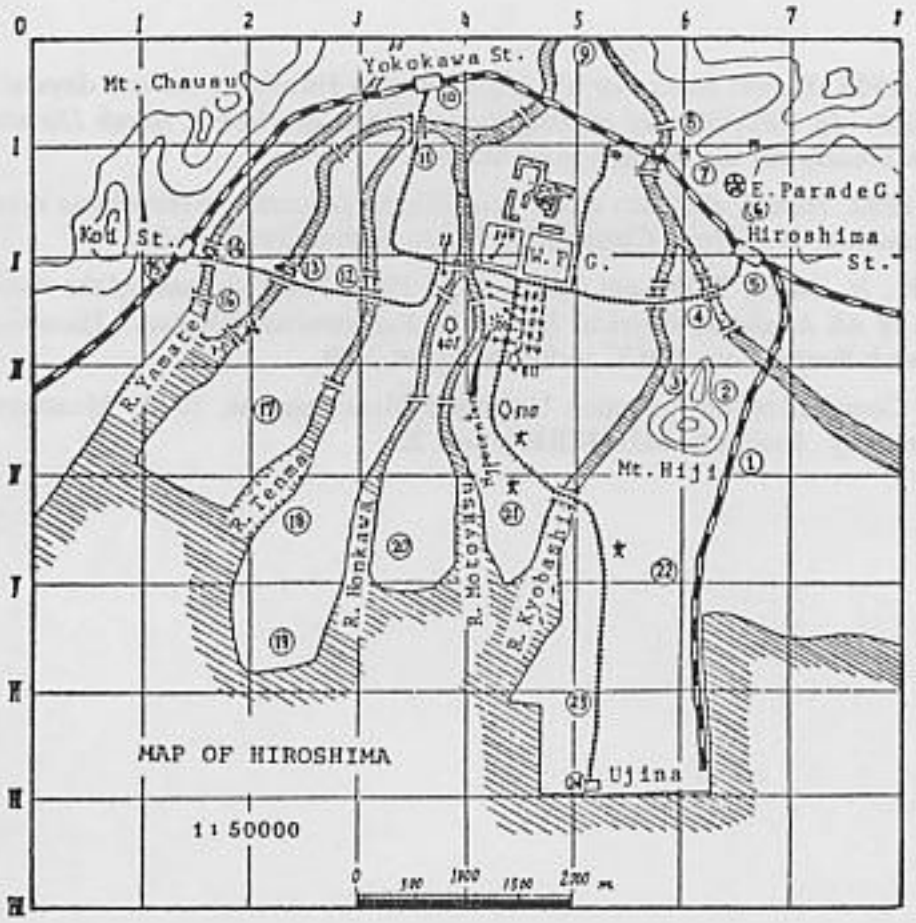

Figure 1. Map showing places where samples were collected on August 10th, 13th, and 14th, 1945

Table 1. Activity of ^{32}P in sulfur in utility-pole insulators in Hiroshima at 815 hours, 6 August 1945

Sample No.	Ground range[a] (m)	Sample weight (g)	Sample thickness (mg/cm^2)	Observed count (cpm)	Total detection efficiency	Standard deviation	Decay correction	dpm of ^{32}P per g of S_b
407	550	1.5	250.0	35	0.0454	0.00078	0.619	840
411	780	2.2	366.7	33	0.0327	0.00067	0.619	741
518	980	2.6	433.3	23	0.0280	0.00062	0.619	518

a. Error in distance was about ± 100 m.
b. Error is estimated to be within ± 15 %.

3. Density of sulfur in the sample was assumed to be $\rho = 2.07$. As a correction factor for decay of ^{32}P ($T_{1/2}$ = 14.3 d) an average value of those at 1800 hours 15 August and 1800 hours 16 August was used; 0.619 = (0.634 + 0.604)/2.

Using these conditions and assumptions the necessary factors and the final value of dpm of ^{32}P per gram of sulfur have been obtained (Table 1).

References

1. Arakatsu, B., 1953. Report on survey of radioactivity in Hiroshima several days after the atomic bomb explosion. In *Collection of Investigation Reports on Atomic Bomb Disaster*, pp. 5-10. Tokyo: Japan Society for the Promotion of Science.
2. Shimizu, S., 1982. Historical sketch of the scientific field survey in Hiroshima several days after the atomic bombing. Bull. Inst. Chem. Res. Kyoto University 60:34-54.
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4. International Commission on Radiation Units and Measurements, 1972. Measurement of Low-Level Radioactivity. Bethesda, MD: ICRU report 22.